Week 3 – Data Link Layer

COMP90007 Internet Technologies

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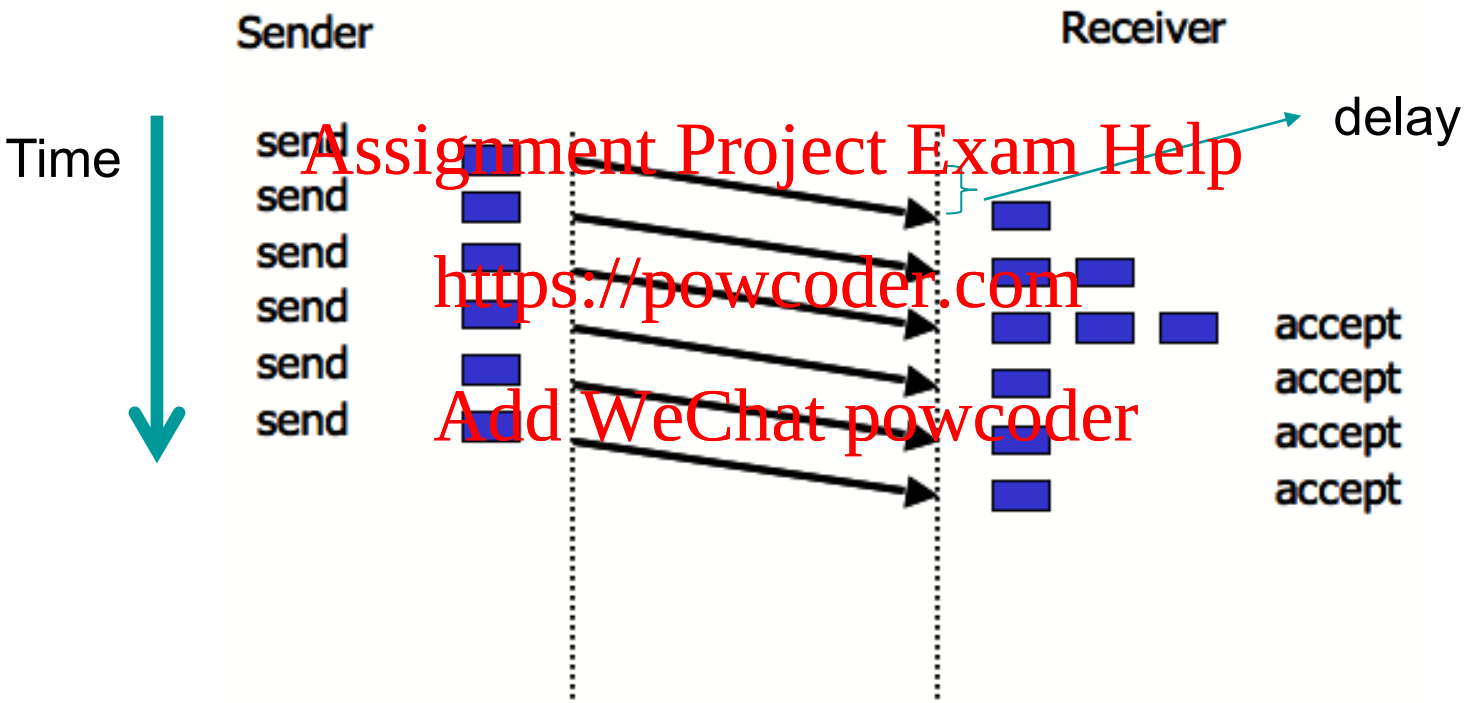
Flow Control

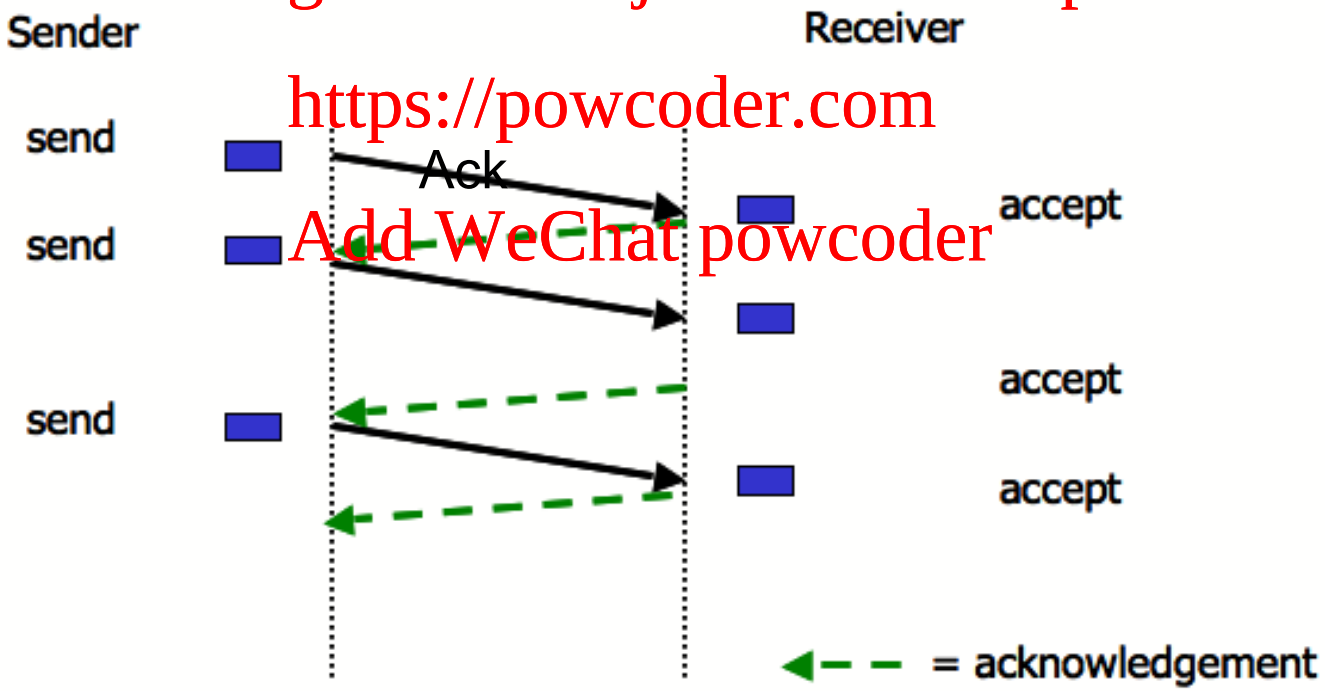
- Principles to control when sender can send next frame
  - **Feedback based flow control** (usually used in Data Link layer)
  - Rate based flow control

A Very Simple Protocol



Acknowledged Transmission

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

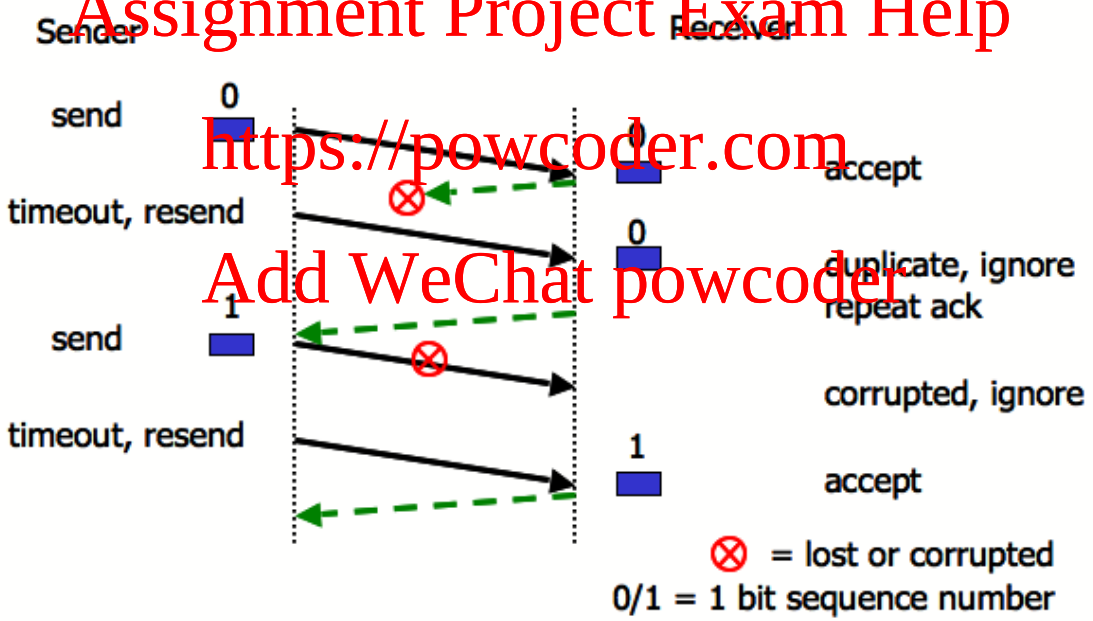


Noisy Channel Protocol

- 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 and Timeout



Link Utilisation in Stop and Wait Protocols

Link Utilisation (U) measures the efficiency of communication.

T_f = Transmission delay, time needed to transmit a frame of length L;

T_p = Propagation delay;

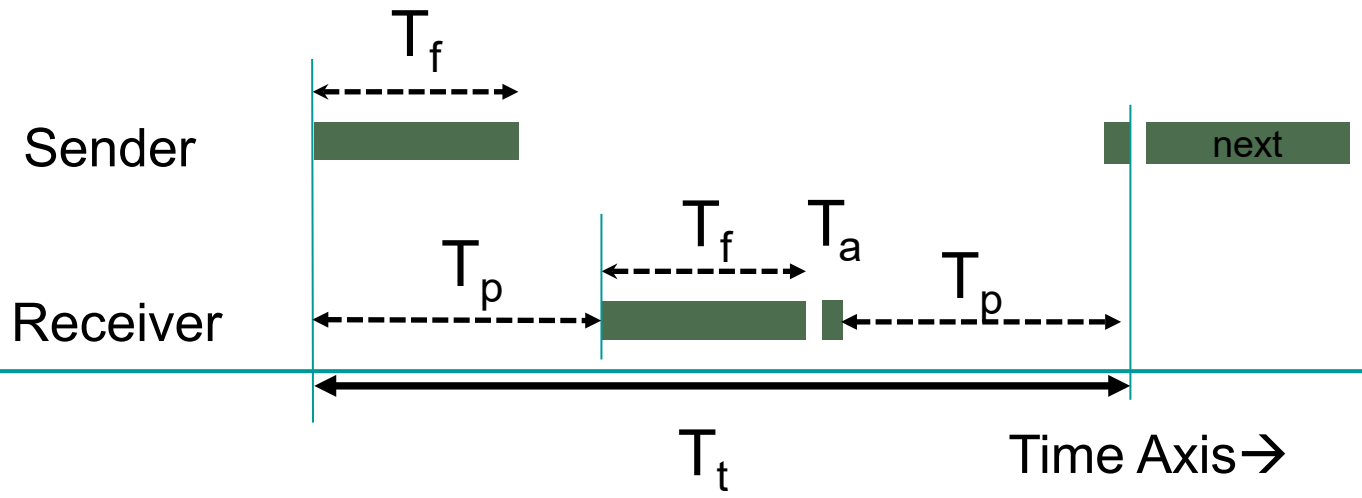
T_a = Time for transmitting an Ack, and we can assume $T_a = 0$.

$T_t = T_f + 2T_p$

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

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

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

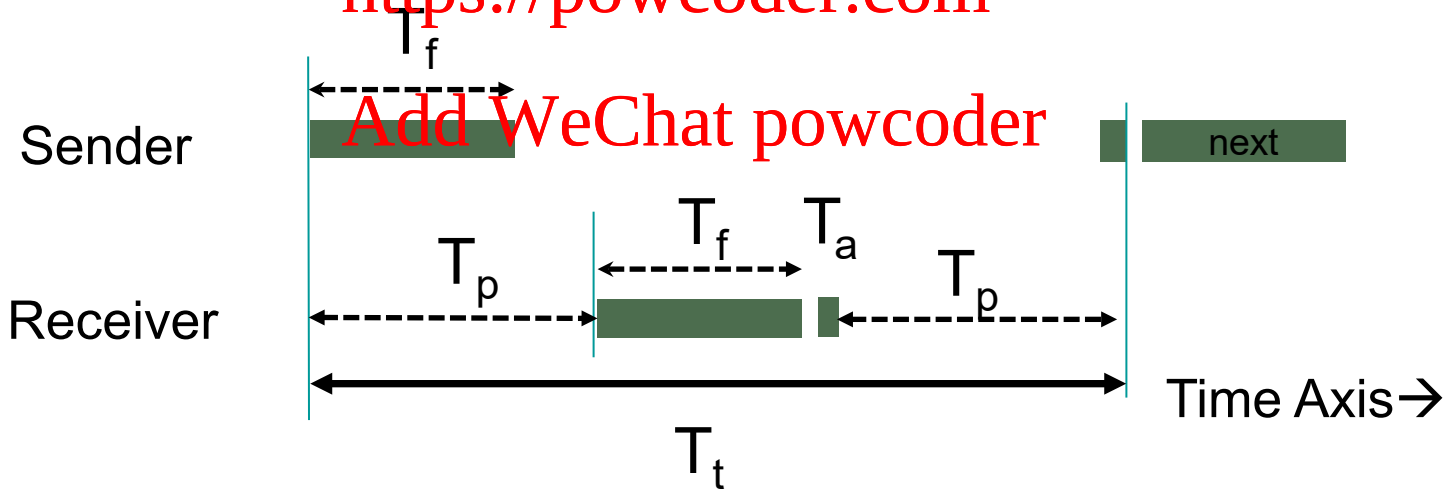


Link Utilisation in Stop and Wait Protocols

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

$$U = L/ (L+ 2T_p B)$$

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

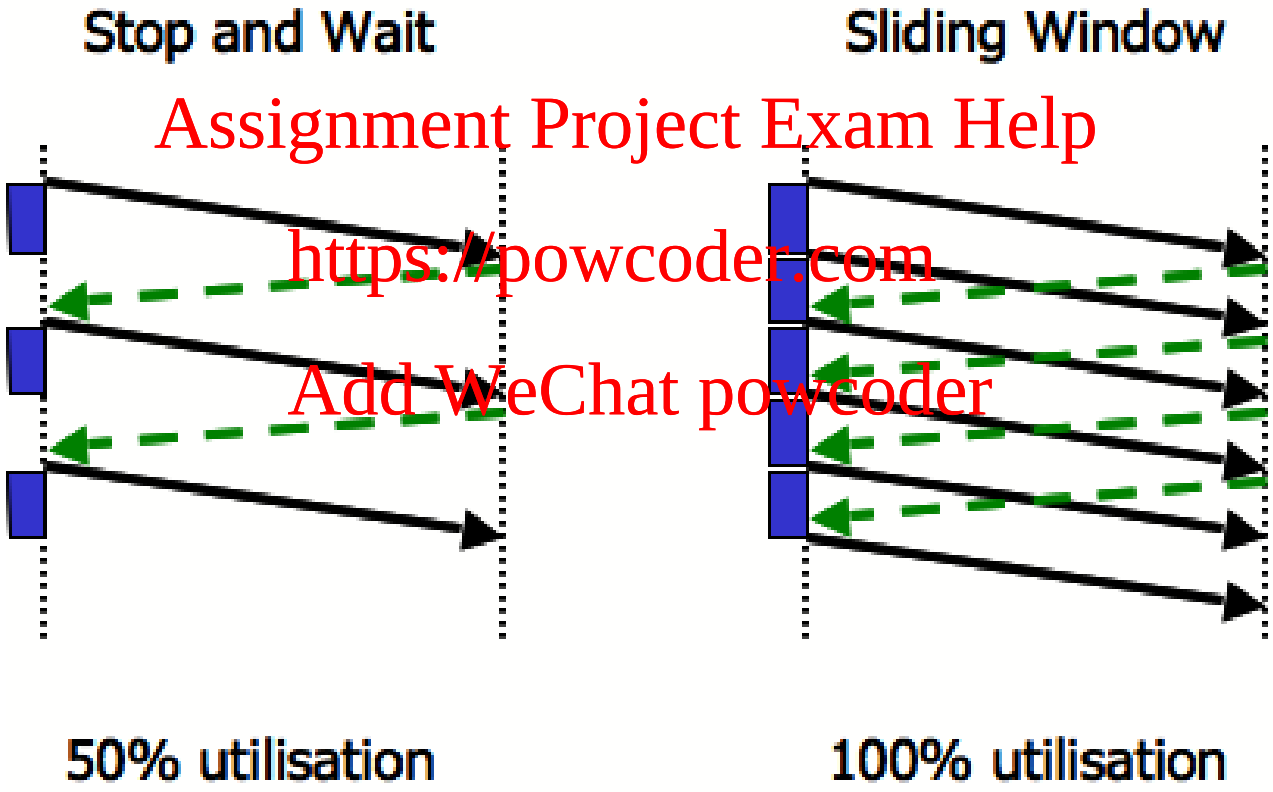


Sliding Window Protocols

- 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?

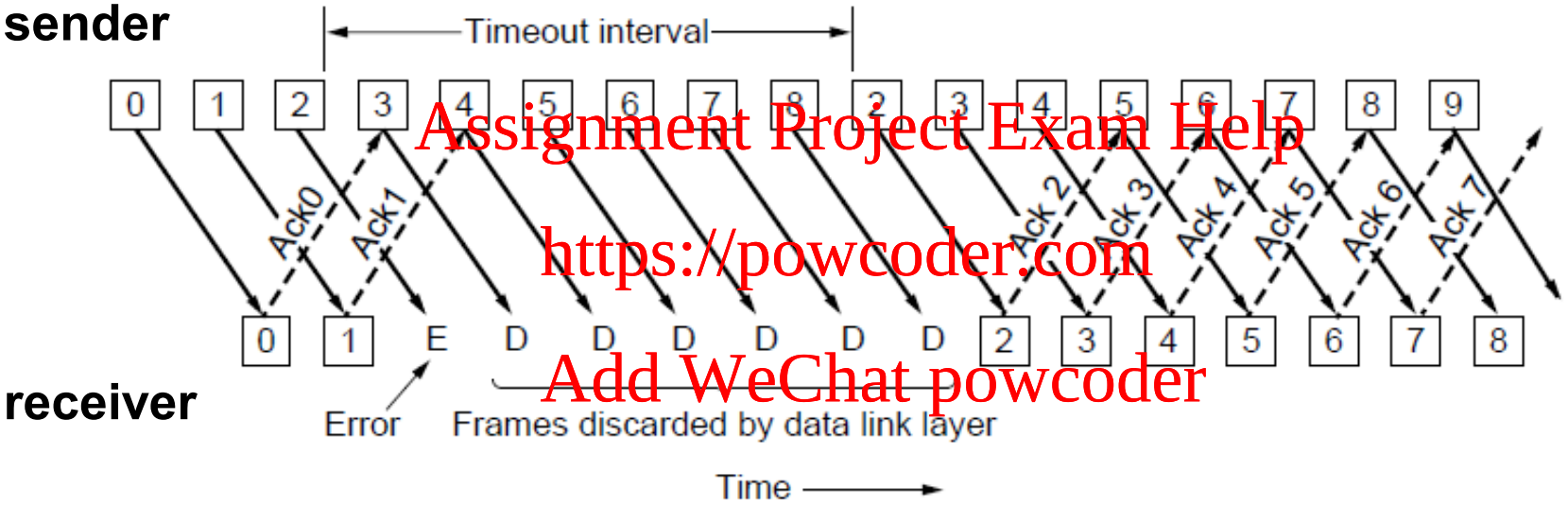
Sliding Window Protocols

- Link Utilisation:



Go-Back-N

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

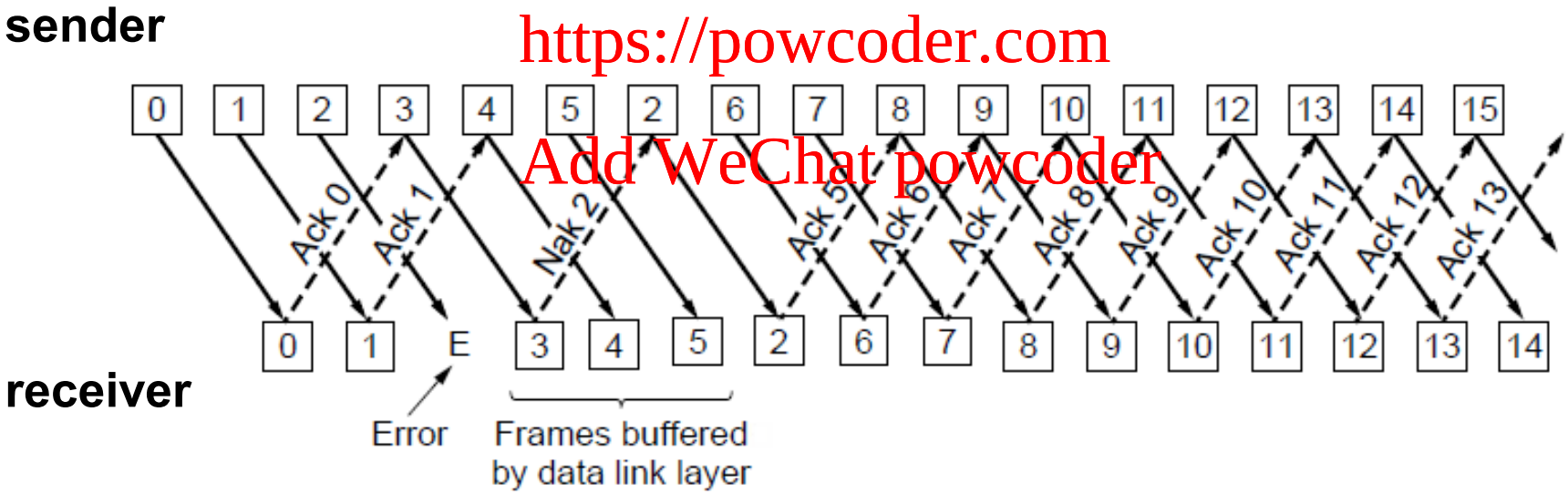


Receiver window size =1, Sender window size is N

- 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 highest in-order frame



Go-Back-N vs Selective Repeat

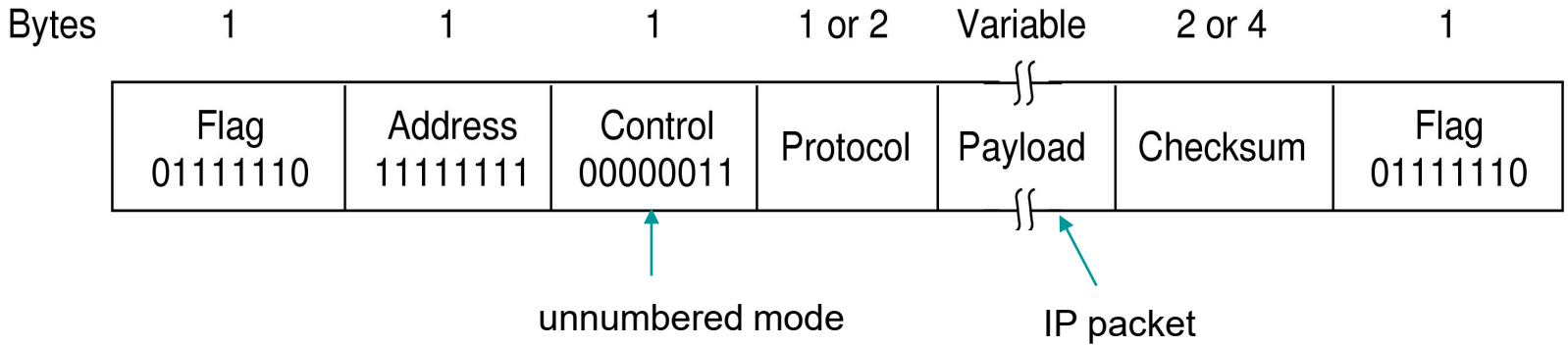
- Go-Back-N: receiver discards all subsequent frames from error point, sending no acknowledgement, until receiving the next frame in sequence
- Selective Repeat: receiver buffers good frames after an error point, and relies on sender to resend oldest unacknowledged frames
- Trade-off between efficient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

Examples of Data Link Protocols

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

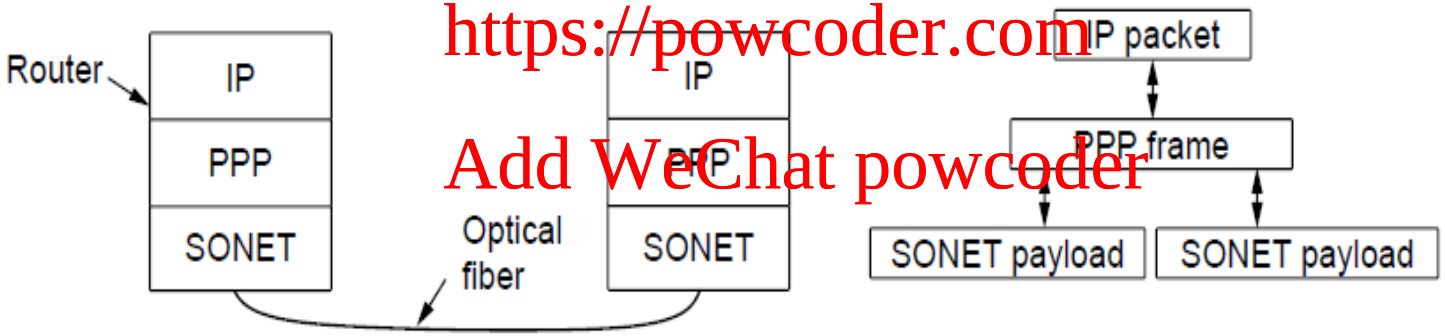
Point-to-Point Protocol

- PPP is a standard protocol 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

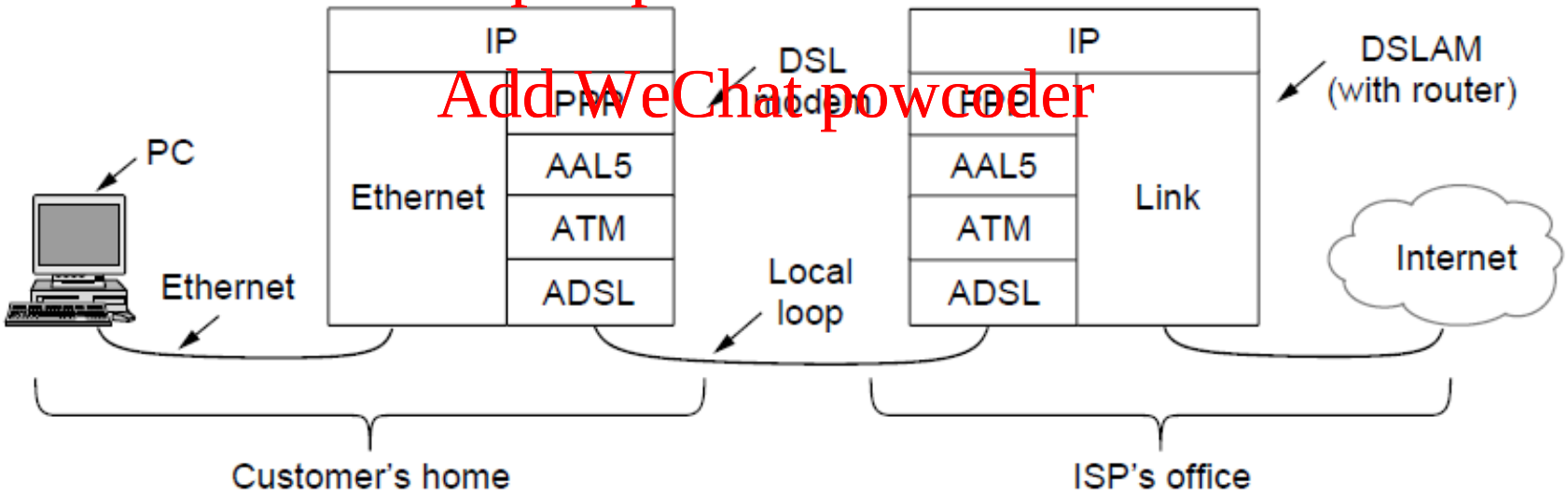


Protocol stack

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



ADSL

- PPP data is sent in ATM cells over ADSL
- ATM 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

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