Week 3 – Data Link Layer

Lecturer: Ling Luo

Semester 2, 2021

Flow Control

- Principles to control when sender can send next frame
  - **Feedback based flow control** (usually used in Da
  - Rate base

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 no e frames
- Requires **dis** rames already sent/received and those 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;

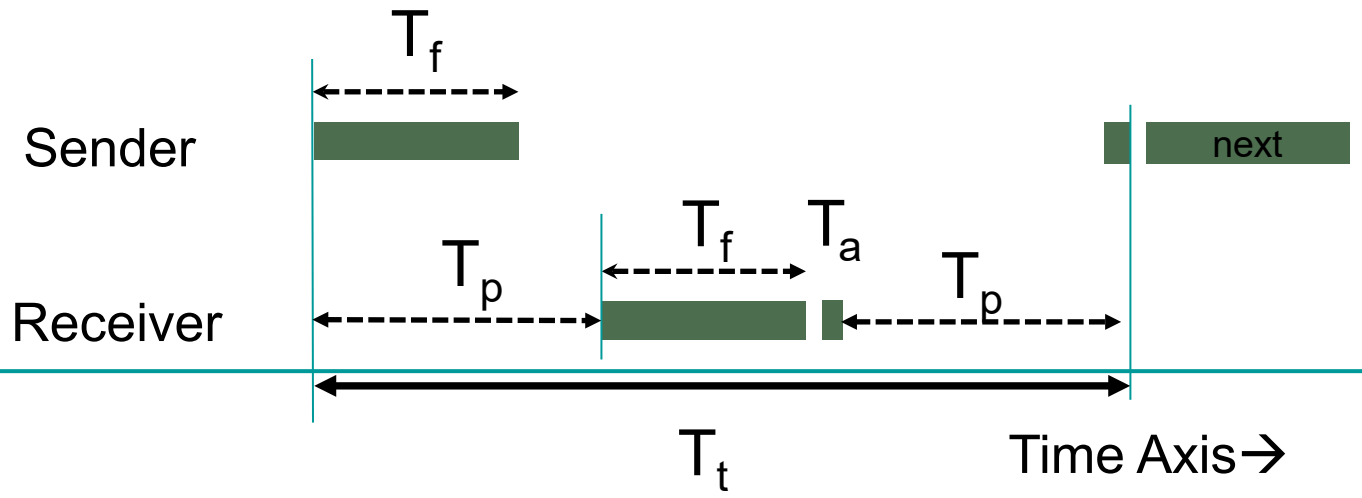
T_a = Time for transmitting an Ack, and we can assume $T_a = 0$.

$T_t = T_f + 2T_p$

U = (Time of transmitti ansfer) = **T_f / T_t**

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

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

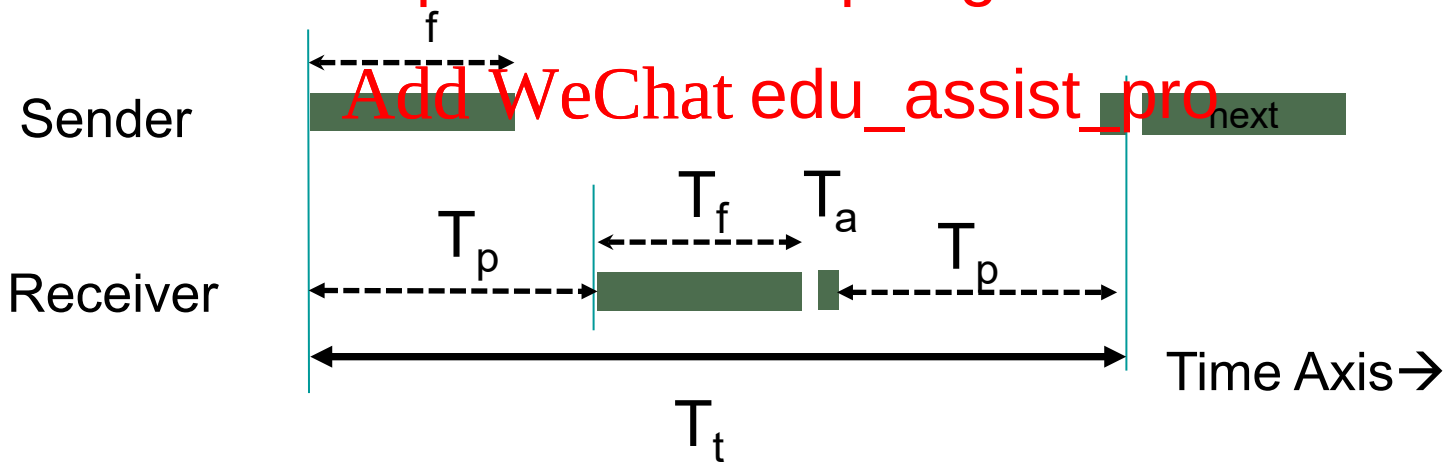


Link Utilisation in Stop and Wait Protocols

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 nu to frames allowed to ac
- What is the window size o d 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

sender

receiver

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

sender

receiver

Go-Back-N vs Selective Repeat

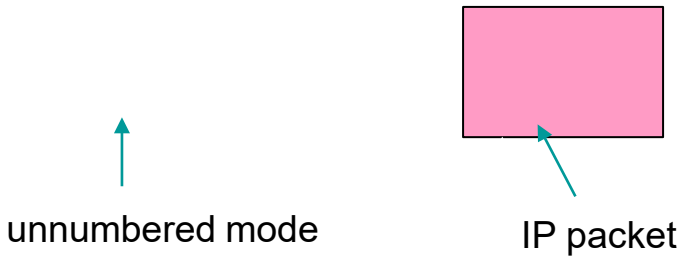
- Go-Back-N: receiver discards all subsequent frames from error point, sending no acknowledgement, until receiving the next frame in sequence
- Selective Repeat: receiver buffers good frames after an error point, and nd oldest unacknowledge
- Trade-off between efficient us dth and data link layer buffer 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 un ctionless unacknowle
  - Errors are detected with a



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 a AL5, 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 frame (PPPoA)
  2) AAL5 fram lls

Structure of AAL5 frame

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