DATA LINK LAYER

➤DESIGN ISSUSES:

- Error detection and correction
- Stop and wait protocol
- Sliding window protocols

Eg : data link protocols

➤THE MAC SUB LAYER:

- The channel allocation problem
- Multiple access protocols
- Wireless LANS-bridges-FDDI

DESIGN ISSUES

- Second layer of OSI model

- Most complicated layer and has complex functionalites

DLL IS DIVIDED INTO 2 SUBLAYERS

- Logical link control: It deal with protocols, flows, error controls
- Media access control: It deal with actual control of media

FUNCTIONALITY OF DATA LINK LAYER

- Farming
- Addressing
- Synchronization
- Error control
- Flow control
- Multi access

➤FRAMING:

- It takes packets from internet layer and encapsulates them into frames
- It sends each frame bit by bit to receiver.

➤ADDRESSING:

- DLL provides addressing destination hardware address will be included in header

➤SYNCHRONIZATION:

- To avoid data loose sending some check point and if any data is lost will not go with the first frame and continue with the same frame where error is occur

➤ERROR CONTROL:

- It can occur during transmission that can be detect in data link layer. Receiver sends acknowledgement to transmit the corrupted data

➤FLOW CONTROL:

- When a data frame is send from one host to other over a single medium, it is required that a sender and receiver should at a same speed
- It sender is sending to fast the receiver may be over loaded

➤MULTIACCESS:

- Multiple user can access a shared media among multiple system

ERROR DETECTION AND CORRECTION

There are many mesons such as noise, cross-talk etc. which may help data to get corrupted during transmission. DLL uses some error control mechanism. To understand how errors is controlled, it is essential to known what types of errors may occur.

TYPES OF ERROR

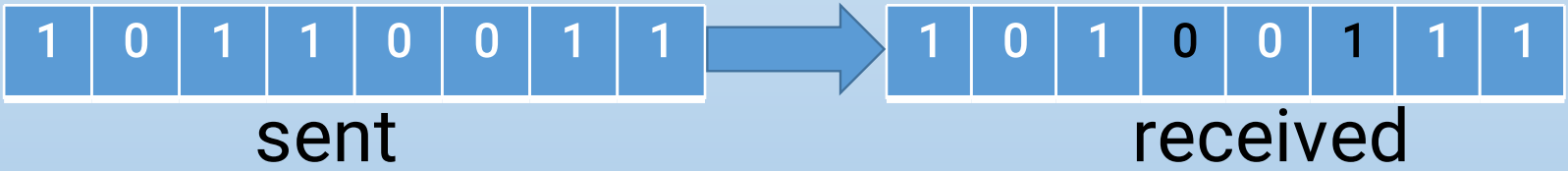
THREE TYPES OF ERRORS

- Single bit error
- Multiple bit error
- Burst error

➤SINGLE BIT ERROR:

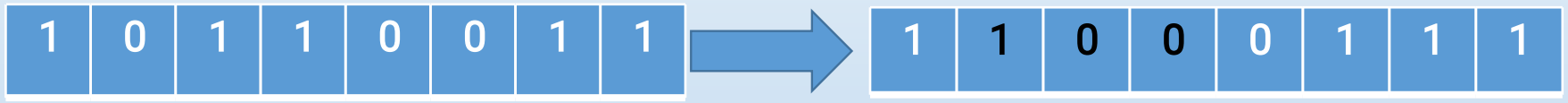
In a frame, there is only one bit, anywhere through, which is corrupt.

➤MULTIPLE BIT ERROR:



Frame is received with more than one bits in corrupted state

➤BURST ERROR:



sent received

Frame contains more than or consecutive bits corrupted

Error control mechanism may involve two possible ways

- Error detection
- Error correction

ERROR DETECTION

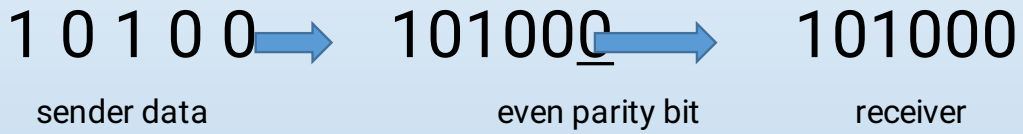
Errors in the received frames are detected by means of

- Parity check
- Cyclic redundancy check
- Check sum

PARITY CHECK:

One extra bit is sent along with the original bits to make number of is either even in case of even parity or odd in case of odd parity.

- Count of is should be even



This is even parity. The no. ‘1’ is in odd

- Odd parity:

10101 → 101001<u>1</u> ⟶ 101011

Sender data odd parity

The no. of ‘1’ is in even.

- Multiple error bits are not rectified by parity check

CYCLIC REDUNDANCY CHECK

- Data – 1 0 1 1 0 1
- CRC generator – 1 1 0 1
- CRC bits = n-1 =3

CHECK SUM:

In check sum error detection scheme, the data is divided into ‘k’ segments each of ‘m’ bits

- In the gender’s end the segments are added using 1’s complement arithmetic to get the sum. The sum is complemented to get check sum
- The check sum segment is sent along with the data segments
- At the receivers end, all received segments are added using is complement arithmetic to get the sum. The sum is complemented

- If the result is zero the received data is accepted, other wise discarded original data

ERROR CORRECTION TECHNIQUES:

Error correction techniques find out the exact number of bits that have been corrupted and as well as their locations.

Two principle ways

- Backward error correction (retransmission)
- Forward error correction

BACKWARD ERROR:

- Receiver detects an error in the incoming frame, it requests the sender to retransmit the frame
- Retransmitting is not expensive as in fiber optics.

FORWARD ERROR CORRECTION:

- Receiver detects some error in the incoming frame, it executes error correction code that generates the actual frame
- It there are too many errors, the frames need to be retransmitted.

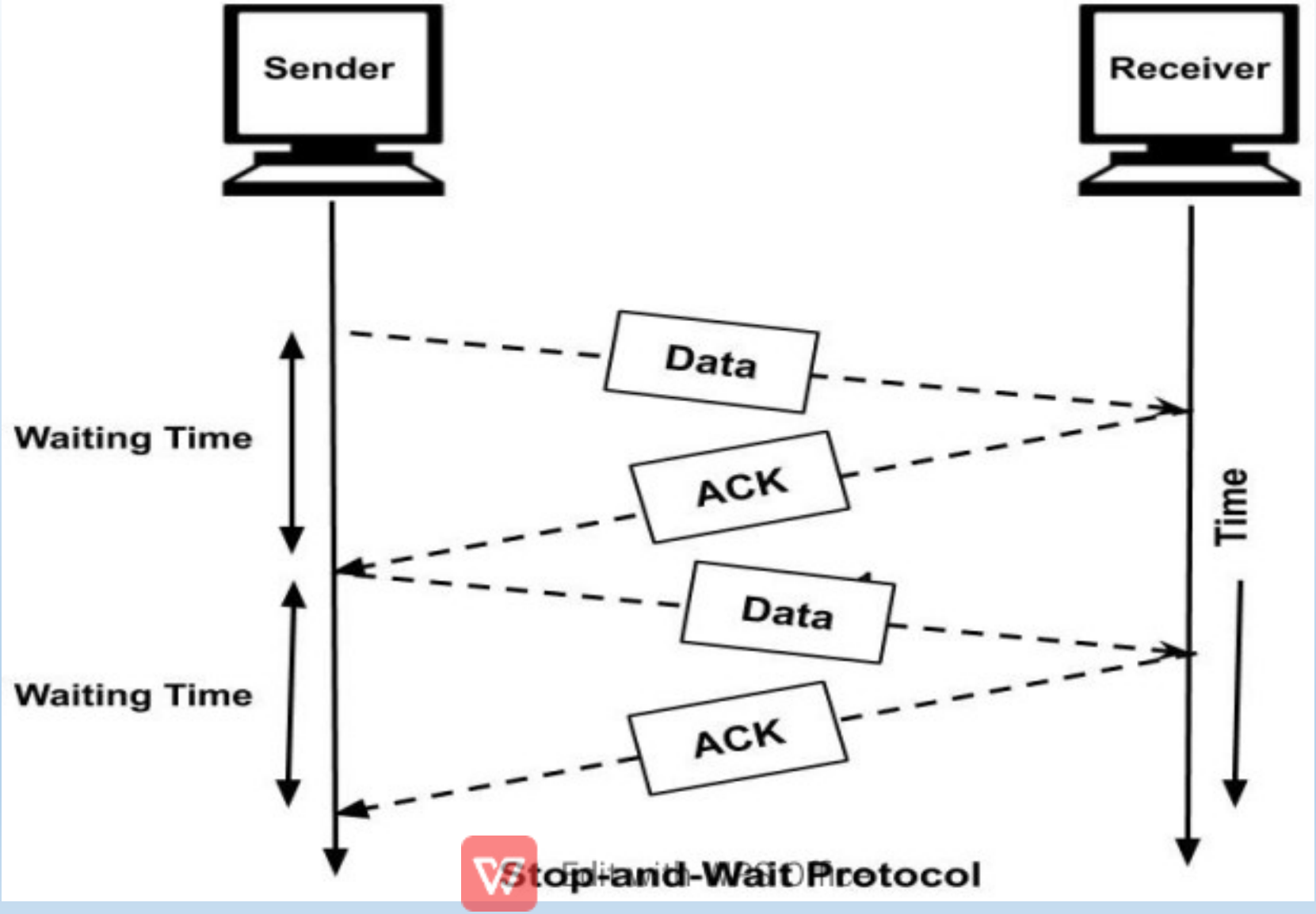
The two main error correction codes are

1.Hamming codes 2. binary convolution code

STOP AND WAIT

Two types of mechanism can be implemented to the control the flow

This flow control mechanism forces the sender after transmitting a data frame to stop and wait until the acknowledgement of the data frame send is received.


Sender
Receiver
Data
ACK
Data
ACK
Waiting Time
Waiting Time
Time
Stop-and-Wait Protocol

REQUIREMENTS FOR ERROR CONTROL MECHANISM

Error detection

Positive ack

Negative ack

Retransmission

- ERROR DETECTION:

The sender and receiver, either both or any, must know that there is some error in transit.

- POSTIVE ACK:

When the receiver receives the correct frame, it should acknowledgement it

- NEGATIVE ACK:

When the receiver receives a damage frame or duplicate frame,

It send a NACK. Back to the sender and the sender must retransmit the correct frame.

- RETRANSMISSION:

The sender maintains a clock and sets a time out period

It may acknowledgement of a data frame previously transmitted does not arrive before the time out the sender retransmit the frame, thinking the frame or it’s acknowledgement is lost in transit

There are three types of techniques available in DLL

- Stop – and – wait (ARQ- Automatic repeat request)-
- go-back-N ARQ
- Selective repeat ARQ

SLIDING WINDOW:

In this flow control mechanism both sender and receiver agree on the number of data frames after which the acknowledgement should be sent stop and wait flow control mechanism. Wastes resource this protocol tries to make use of underlying resource as much as possible.

1. go-back-N
2. Selective repeat

Send multiple frames at a time

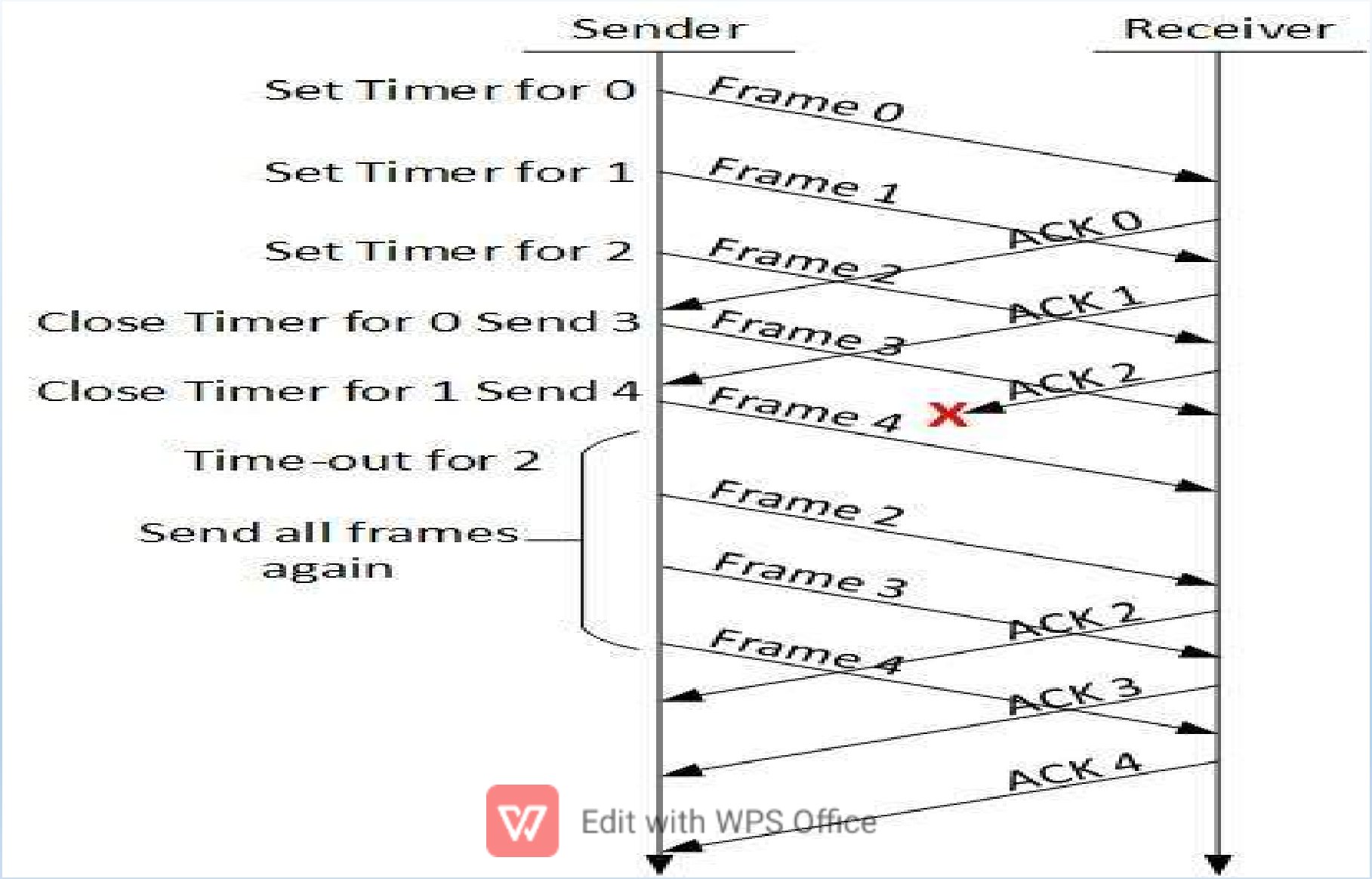
No of frames to be send is based on window sizes

Each frame is number sequences number.

- Go-back-N ARQ:

Stop and wait ARQ mechanism does not utilize the resources at there best.

When the acknowledgement is received the sender sits ideal and does nothing, in go-back-N ARQ method, both sender and receiver maintain the window



- The sending window size enables the sender to send multiple frames without receiving the acknowledgement of the previous one. The receiving window enable the receiver to receive multiple frames and acknowledge them. The receiver keeps track of incoming frames in sequences number.
- When the sender sends all the frames in window, it checks up to what's sequences number it has receive positive acknowledgement. If all frames are positively acknowledged, the sender sends next set of frames. If sender finds that it has received "NACK" or has not receive any ack for a particular frame, it retransmits all the frames after to which does not receive any positive ack.

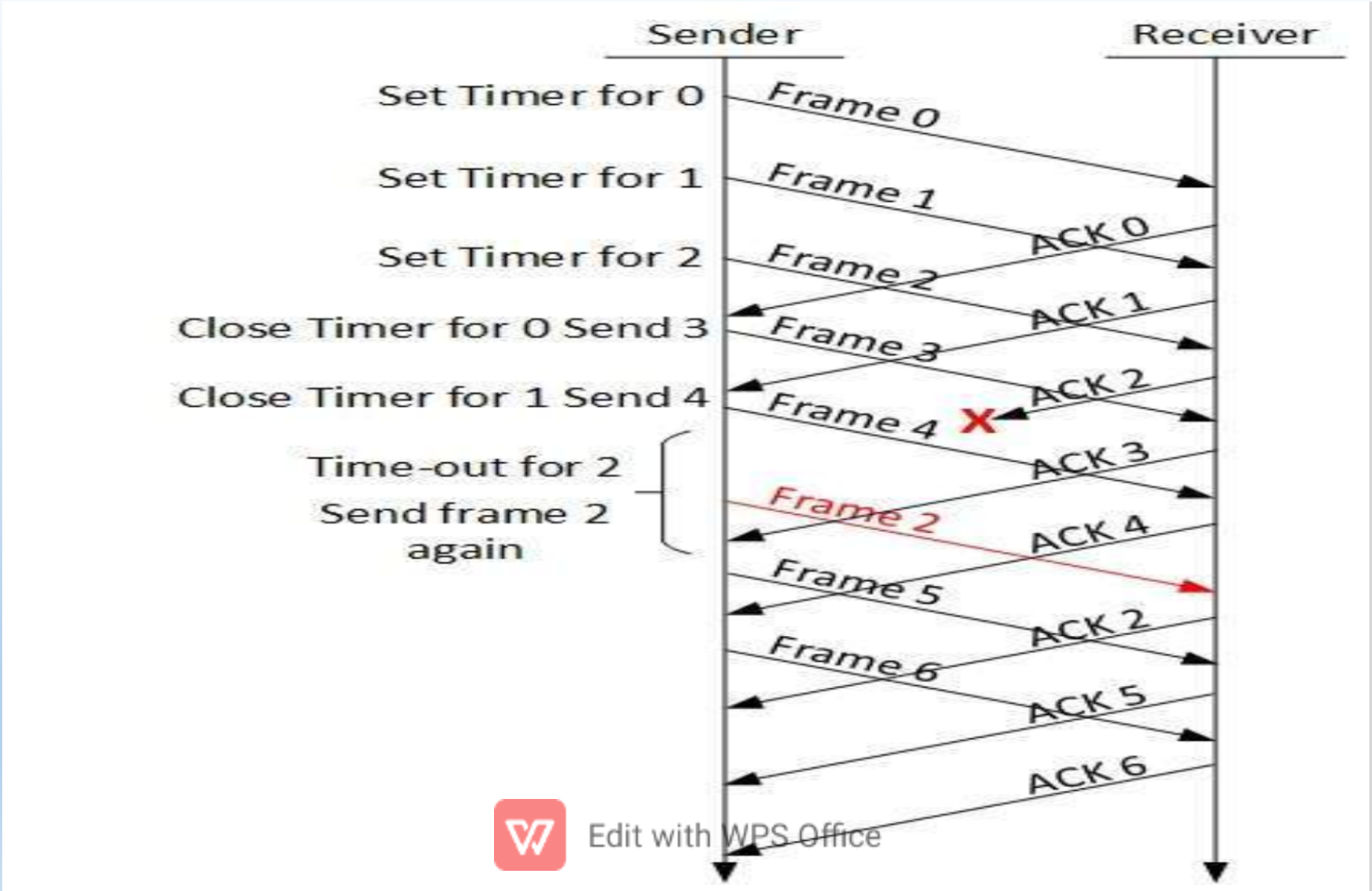
- SELECTIVE REPEAT ARQ:

In Go-back-N ARQ, it is assumed that the receiver does not have any buffer space for it's window. Size and has to process each frame as it comes. This enforces the sender to retransmit

All the frames which are not acknowledged

In selective repeat ARQ, there is receiver by keeping track of sequences number, buffer. The frame in memory and send NACK for only framed which is missing or damaged

- The sender in this case sends only packet for which NACK is received.



• Example data link protocols:

1. HDLC [High level data link control]
2. The data link layer in the internet

HDLC :

Derived from SDLC used in IBM Main framing

[Synchronous Data link protocols]

Bit oriented protocol used bit stuffing

Reliable protocol / selective repeat or go-back-N

Full duplex communication

There are three different classes or Frames used in HDLC

❖Information frames: which carry actual information such frames can piggy back Ack.

- Supervisory frames:

Which are used for error and flow control purpose and hence contain send and sequence numbers

- Unnumbered frames:

Used in link set up and disconnection

HDLC Frames types:

1. Information frames
2. Supervisory frames
3. Unnumbered frames

FLAG	ADDRESS	CONTROL	USER INFROMATION	FCS	FLAG

INFORMATION FRAME

FLAG	ADDRESS	CONTROL	FCS	FLAG

SUPERVISORY FRAME

FLAG	ADDRESS	CONTROL	MANAGEMENT INFORMATION	FCS	FLAG

UNNUMBERED FRAME

- FLAG FIELD:

Is 8bits of a fixed pattern (01111110)

There is one flag at the beginning and one at the end frame

The ending flag of one frame can be used as the beginning flag of the next frame

To guarantee that the flag does not appear any where else in the frame

HDLC uses a process called bit suffing

BITS

01111110	ADDRESS	CONTROL	DATA	CHECKSUM	01111110

- HDLC Control field:

Data link layer is highly responsible for hop to hop delivery

I- FRAME

I-FRAME

N(S) N(R)

S-FRAME

CODE N(R)

U-FRAME

CODE CODE

- POLL/FINAL:

P/F=1 poll or final

Poll if frame is send by the primary

Final if frame is sent by the secondary

INFORMATION:

User data in an I-frame

Missing in an S-frame

Management information in a U-frame

- S-FRAMES

CODE N(R)

Code	command
00	RR-receiver ready
01	REJ-reject
10	RNR-receiver not ready
11	SRE-selective reject

- RECEIVER READY (RR):

Positive ack of received I-frame

- RECEIVER NON-READY (RNR):

Is RR frame with additional duties

It ack the receipt of a frame that the receiver is busy

- REJECT (REJ):

This is a NAK frame that can be used in go-back-N

- SELECTIVE REJECT (SREJ):

This is a NAK frame used in selective repeat ARQ

- U-FRAMES:

FLAG	ADDRESS	CONTROL	MANAGEMENT INFORMATION	FCS	FLAG

1	1			PF			

EG: 11 010 – disconnect connection

MAC sublayer:

- Is sublayer in which channel is allocation to multiple user
- MAC sublayer is important in LANS

CHANNEL ALLOCATION PROBLEM:

In which a single channel is divided allotted to multiple user is order to carry a user specific tasks

STATIC CHANNEL ALLOCATION:

It is a traditional approach of allocating a single channel among multiple users by FDM

- If these are 'N' users, the bandwidth PS divided into N equal sized portions each user being assigned one portion.
- Difference between no interface and user

$$T = \frac{1}{\mu C + \lambda}$$

T=Time delay

C=capacity of channel

$\lambda = arrival\ rate\ of\ frames$

$\mu = bits\ per\ frames$

DYNAMIC CHANNEL ALLOCATION

It is based up on possible

- Station model
- Single channel assumption
- Collision assumption
- Time
    - Continuous
    - Slotted
- Carrier sense
- No carrier sense

✔STATION MODEL:

- Model consists of N independent stations (Eg: computer, telephone or personal communication) each with a program
- Stations are sometime called terminates
- A frame being generated in an interval of length Δt is

$\lambda \Delta t$

- Where lamda is a constant create of new frame
- One frame is generated, station is blocked and does nothing until

the frame has be successfully transmitted

✔SINSLE CHANNEL ASSUMPTION

- Single channel is available for all communication
- All stations can transmit on it and all can receive from it

✔COLLISION ASSUMPTION

- If two frames are transmitted simultaneously, they develop in time, tjis event is called a collision
- Collision frame must be transmitted again

✔TIME:

It can be divided into two types

1. Continuous time
2. Slotted time

• CONTINUOUS TIME:

frame transmission can begin at any instant. There is no matter clock dividing time into discrete intervals

• SLOTTED TIME:

Time is divided into discrete intervals (slots). Frame transmissions always begin at the start of a slot.

✔CARRIER SENSE

If the channel is in use before trying to use it, if the channel is busy no station will be use

✔NO CARRIER SENSE

Stations cannot sense the channel before trying to use it. Time of used to sense loss data.