Module 2 – Part 2

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Dealing with transmission errors

- Transmission errors occur due to the **NOISE** (Interference) in the transmission media or other issues during transmission.
- The data that is transmitted can contain errors.
- In the worst case the entire data can get lost.
- The error detection mechnaisms in the previous section can identify the errors.
- **SOLUTION**
- **Ask the sender to resend the data if it has errors or has been lost.**

The plot

- Every frame has to be given a sequence number.
- The recipient has to acknowledge(ACK) the acceptance of a frame.
- **The acknowldegment includes the next frame number that is expected by the recepient.**
- Upon sending one frame a timer will be started and the sender will wait a fixed time for the acknowlegement.
- Once the timer gets expired the sender will resend the data.
- The timer is based on an estimate of the time required for a round trip.

Case of duplicate transmission

- **What if the acknowledgement (ack) is lost or delayed?**
- 1.The sender timer will expire
- 2.The same frame will be resent.
- Since the frame has already been received ,the frame will be discarded by the recepient.
- The same happens to an ack when it is delayed.

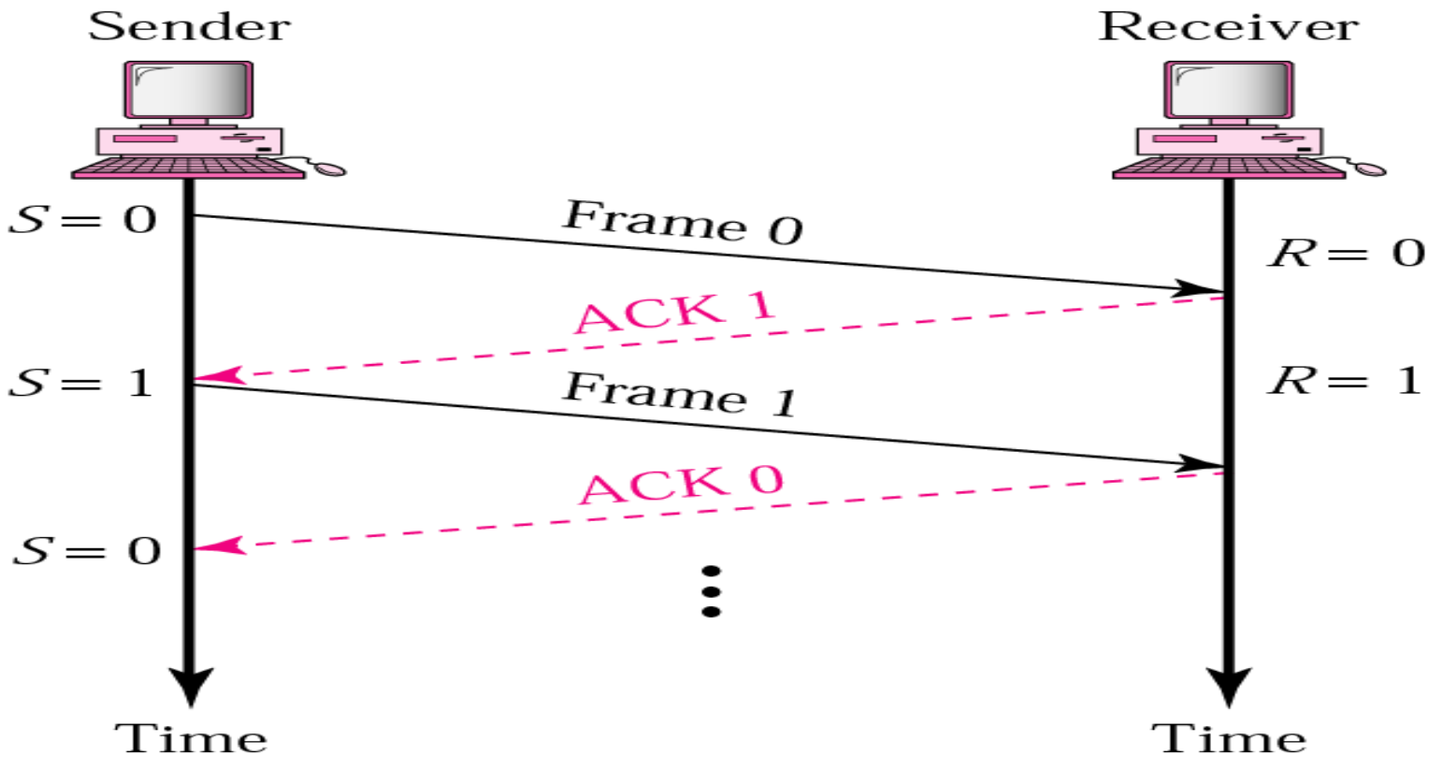
THERE ARE WELL DEFINED PROTOCOLS TO MANAGE ALL THESE

1.Stop and Wait ARQ

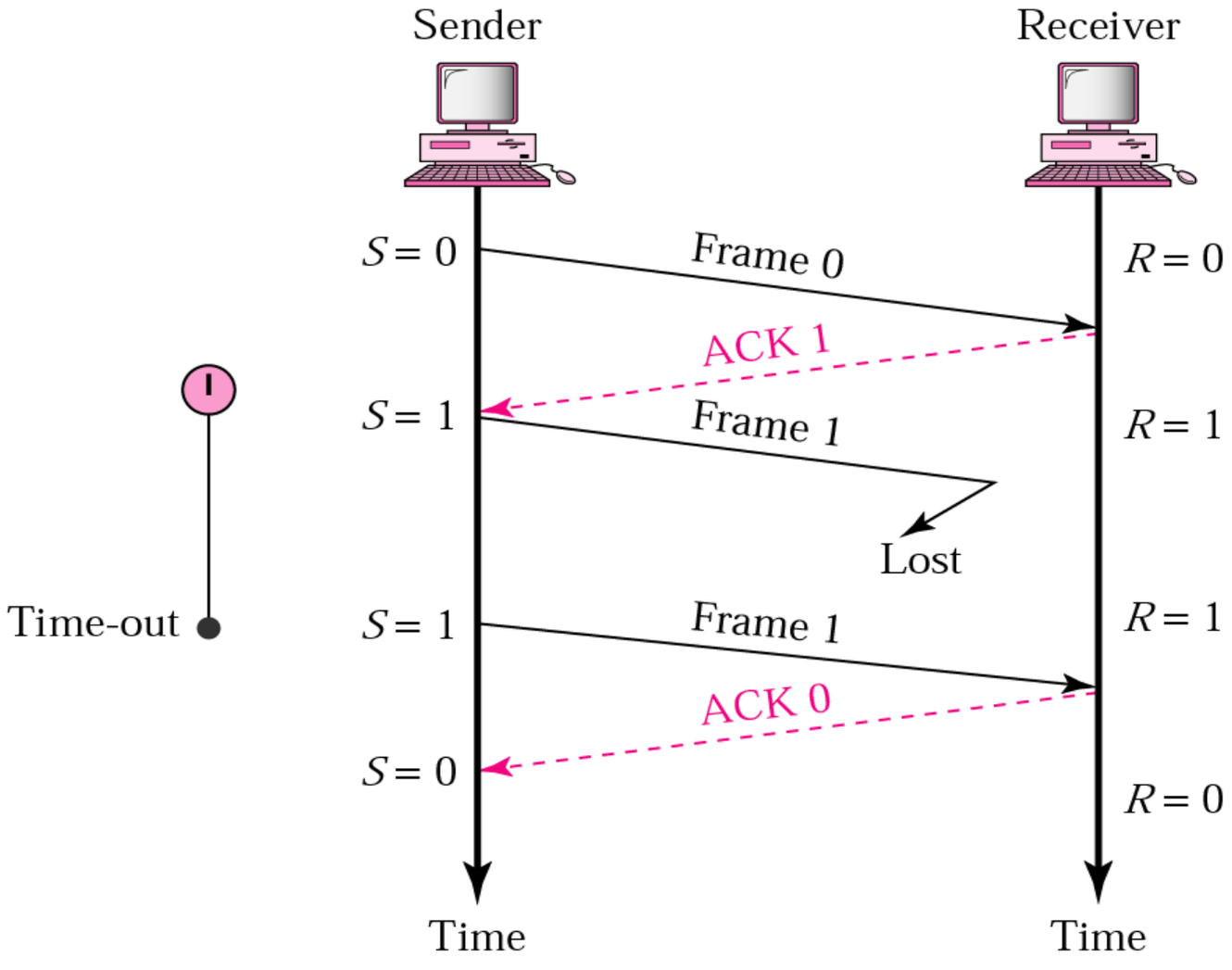
ARQ->Automatic Repeat Request.

- In Stop and Wait ARQ sequence numbers are always in modulo 2 [Remainder after division by two].
- So the sequence numbers always swings in between 0 and 1.
- On successfully receiving frame 0,the ack 1 will be sent.
- The sender will buffer frame 0 until the ack is received.
- If the ack not received / timer expired ,this frame will be resend.
- The receiver will remember the ack to keep track of order of frames.

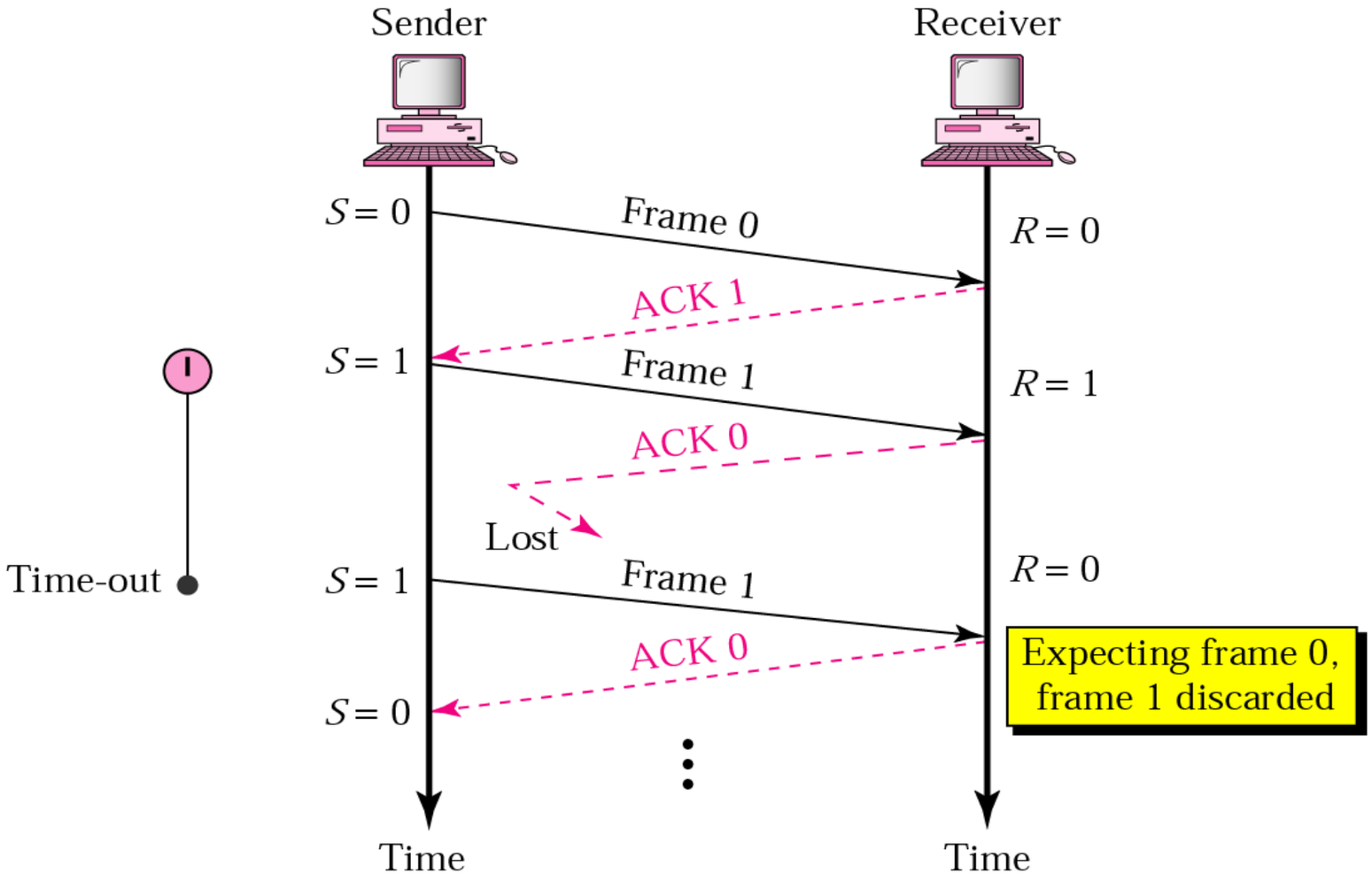
Normal operation



Stop and wait ,lost frame



Stop and wait ,Lost ACK



Issues with Stop and Wait

- Although the algorithm is simple ,the waiting for acknowldegement for each frame delays the overall transmission.
- The sender is idle until the ack is received or a timer out event.
- The effective bandwidth will also be wasted by sending ack for each frame.

Before we move on !!!....The concept of sliding window.

- The frame number contain numbers from 0 to (2^m)-1 .
- A subset of these sequence numbers are considered at a time the sender .
- An imaginary box can be considered over these frames under consideration and is known as the window.
- The window size can max upto (2^m)-1.
- The sliding of the window means considering next set of frames.
- At anytime the window divides the total sequence numbers into 4 regions.

2.Go Back N ARQ.

- In Go Back N ARQ ,the sending window has a size of (2^m)-1.
- The receiver window size is one.
- The sending window will be moved forward based on the ACK received.
- The ACK are cumulative .
- Ex :- Send frame 0,1,2..Receive ACK 3 ,indicating frame 0,1,2 are received correctly.
- The sender can transmit full window frames or part.
- sf-> First outstanding frame to be acknowleged.
- sn->Next frame to be sent.

Contd..

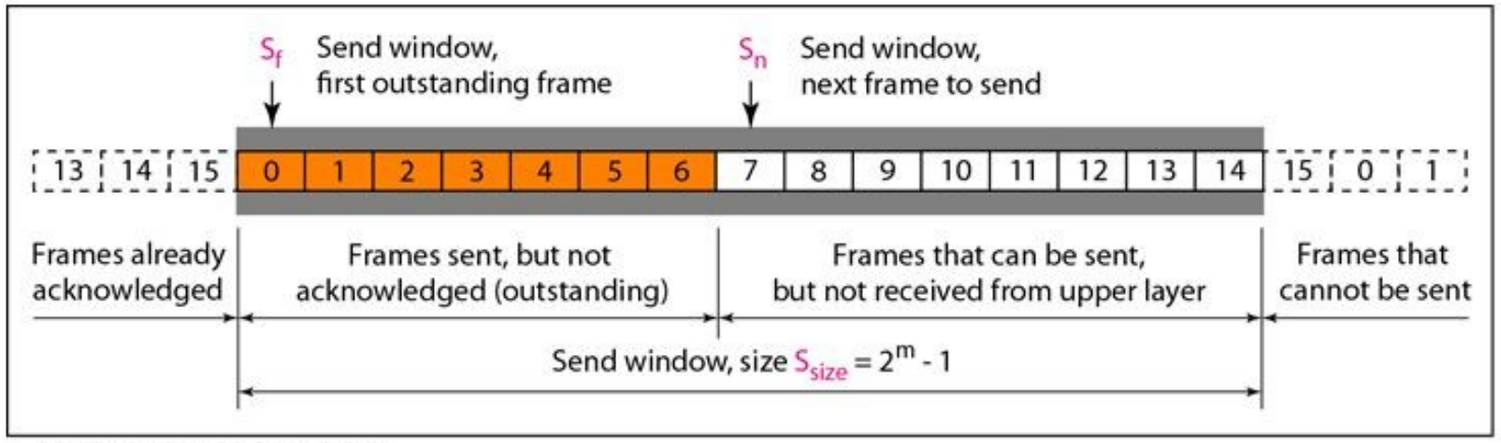
On timer expiry

All the frames which are not acknowledged are resent.

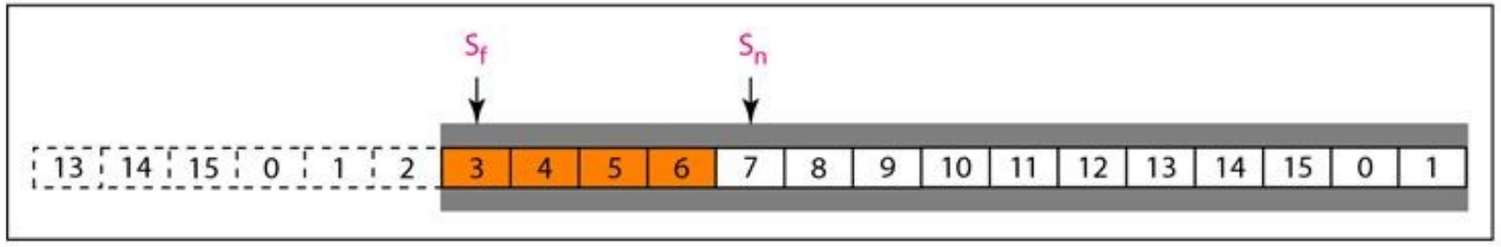
On ACK Lost/Delayed

The frames whose ACK are not received will be resent after timer expiry,but duplicate frames will be discarded at the receiver.

Window Structure in Go Back N ARQ



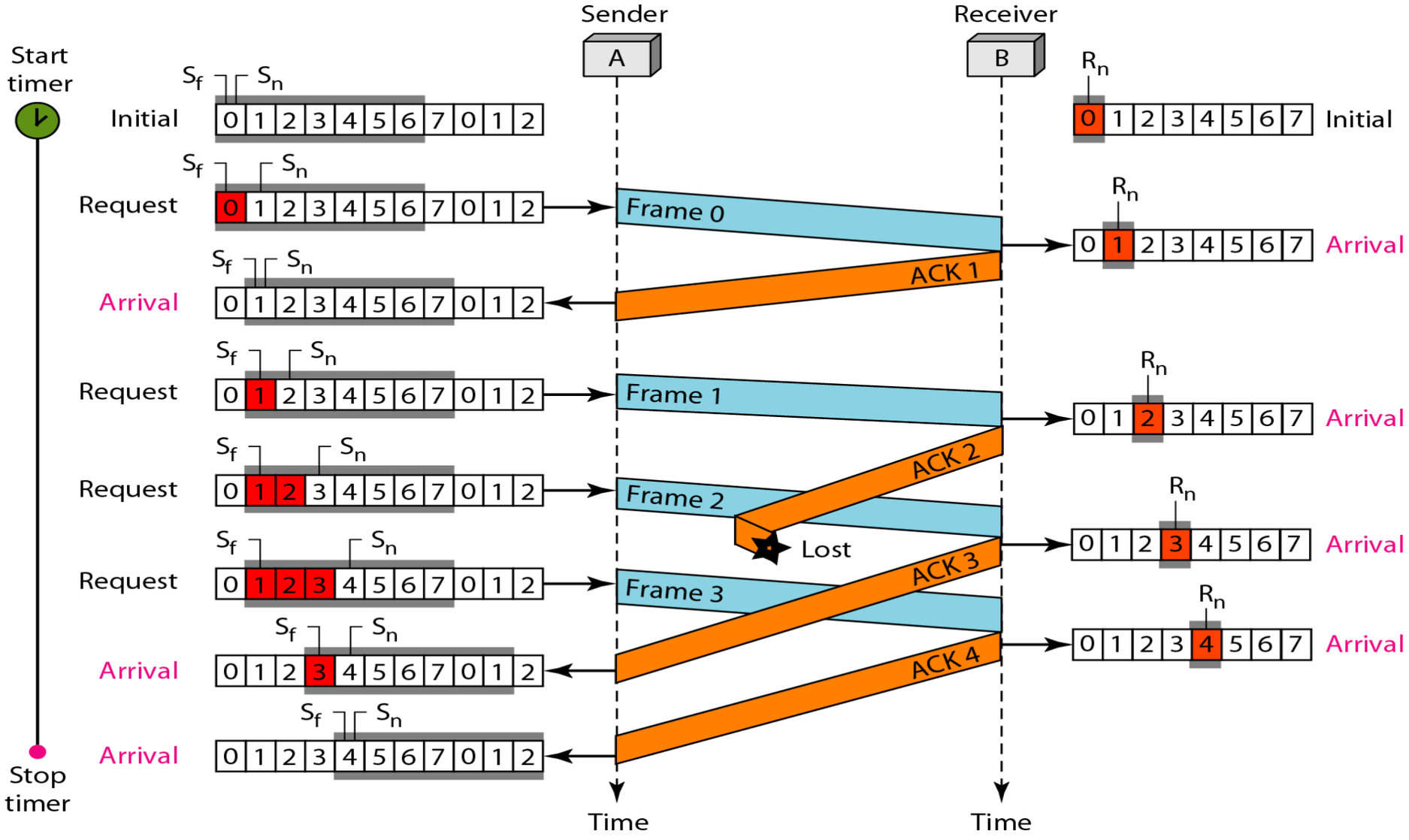
a. Send window before sliding



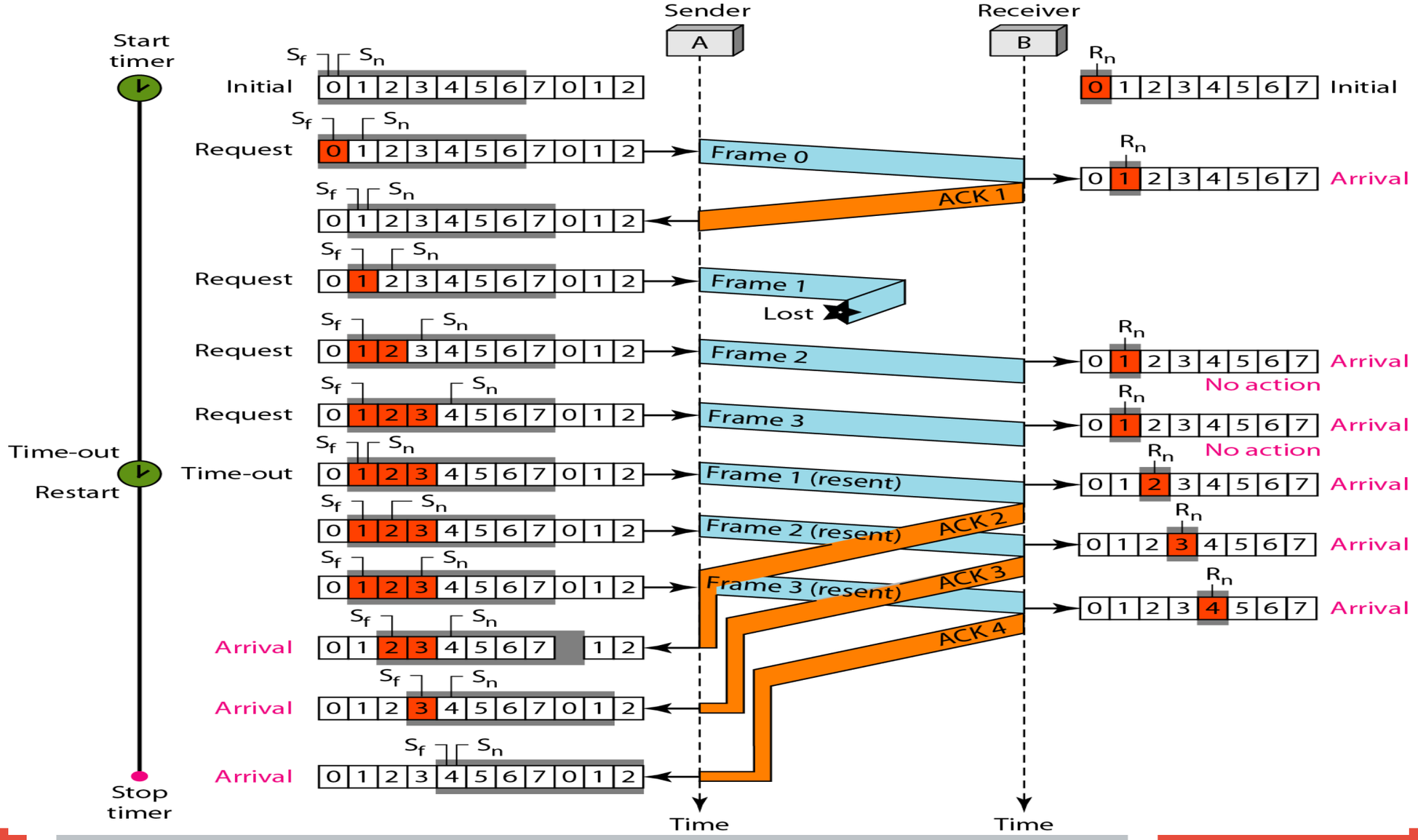
b. Send window after sliding

Assuming frames are numbered from 0 to 15 (m=4).The sequence numbers are repeated.

Contd..


Sender
Receiver
A
B
Start timer
Stop timer
Initial
Request
Arrival
Frame 0
Frame 1
Frame 2
Frame 3
ACK 1
ACK 2
ACK 3
ACK 4
Lost
Time
Time

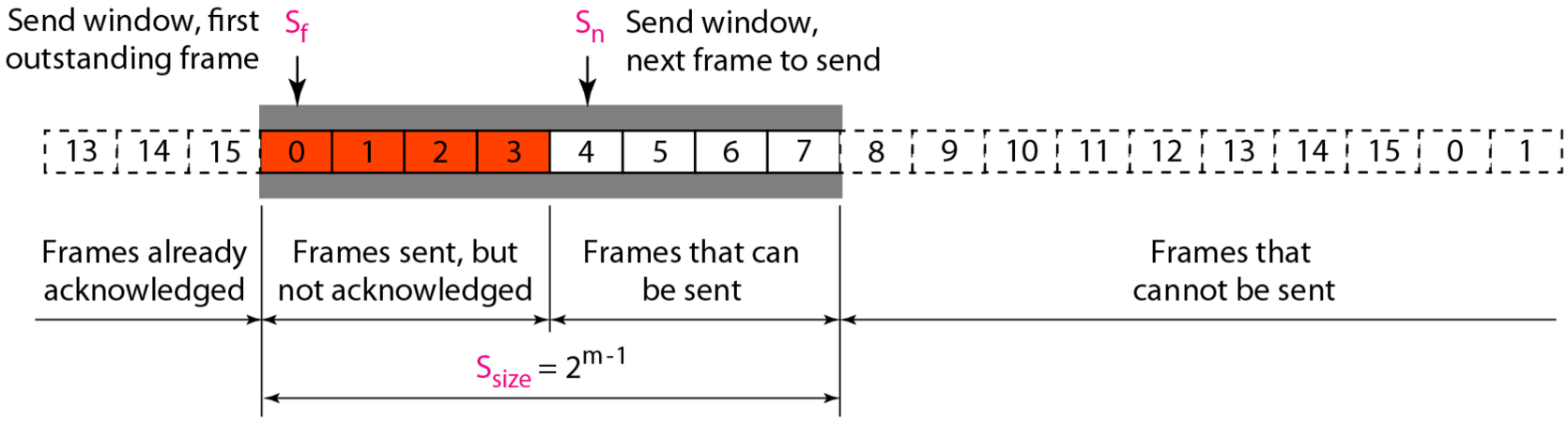
Frame Lost


Sender
A
Receiver
B
Start timer
Initial
Request
Frame 0
ACK 1
Frame 1
Lost
Request
Request
Frame 2
Request
Frame 3
Time-out
Restart
Time-out
Frame 1 (resent)
Frame 2 (resent)
ACK 2
Frame 3 (resent)
ACK 3
ACK 4
Arrival
Arrival
Arrival
Stop timer
Time
Time
Initial
Arrival
Arrival
No action
Arrival
No action
Arrival
Arrival
Arrival

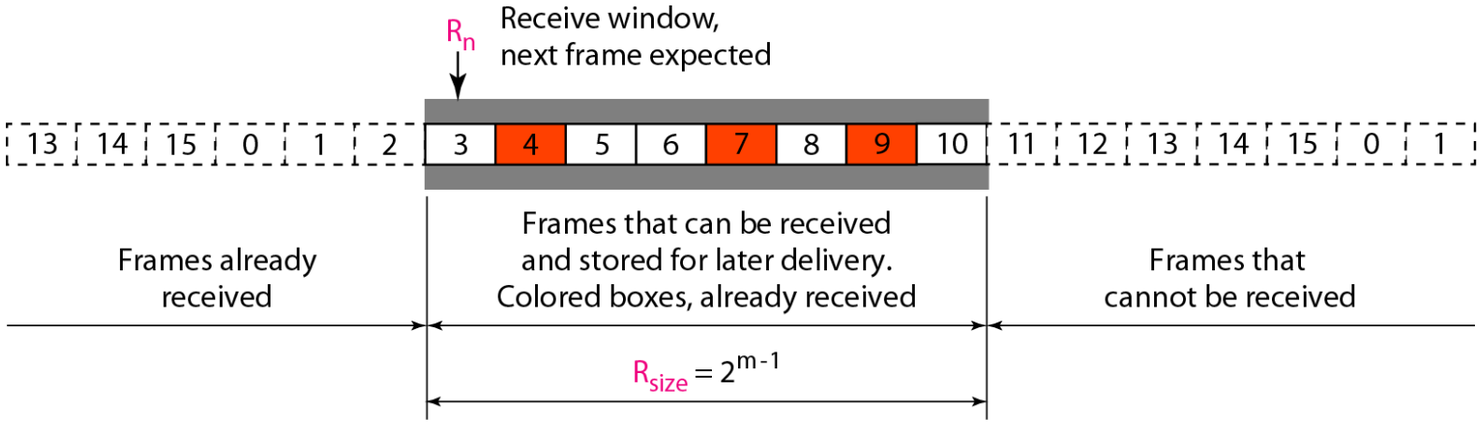
3. Selective Repeat ARQ

- In selective repeat ARQ , the sender and receiver window are of same size.
- For m bits the maximum window size is 2^(m-1).
- The receiver will accept frames which are not in order,but within the window.
- The receiver will send cumulative ACK .
- If one frame is lost during transmission ,**N**egative ACK with the **lost frame numer is sent.**
- The sender will retransmit that frame itself.Hence the name for the method.
- Each frame will start its own timer .

Window in Selective repeat

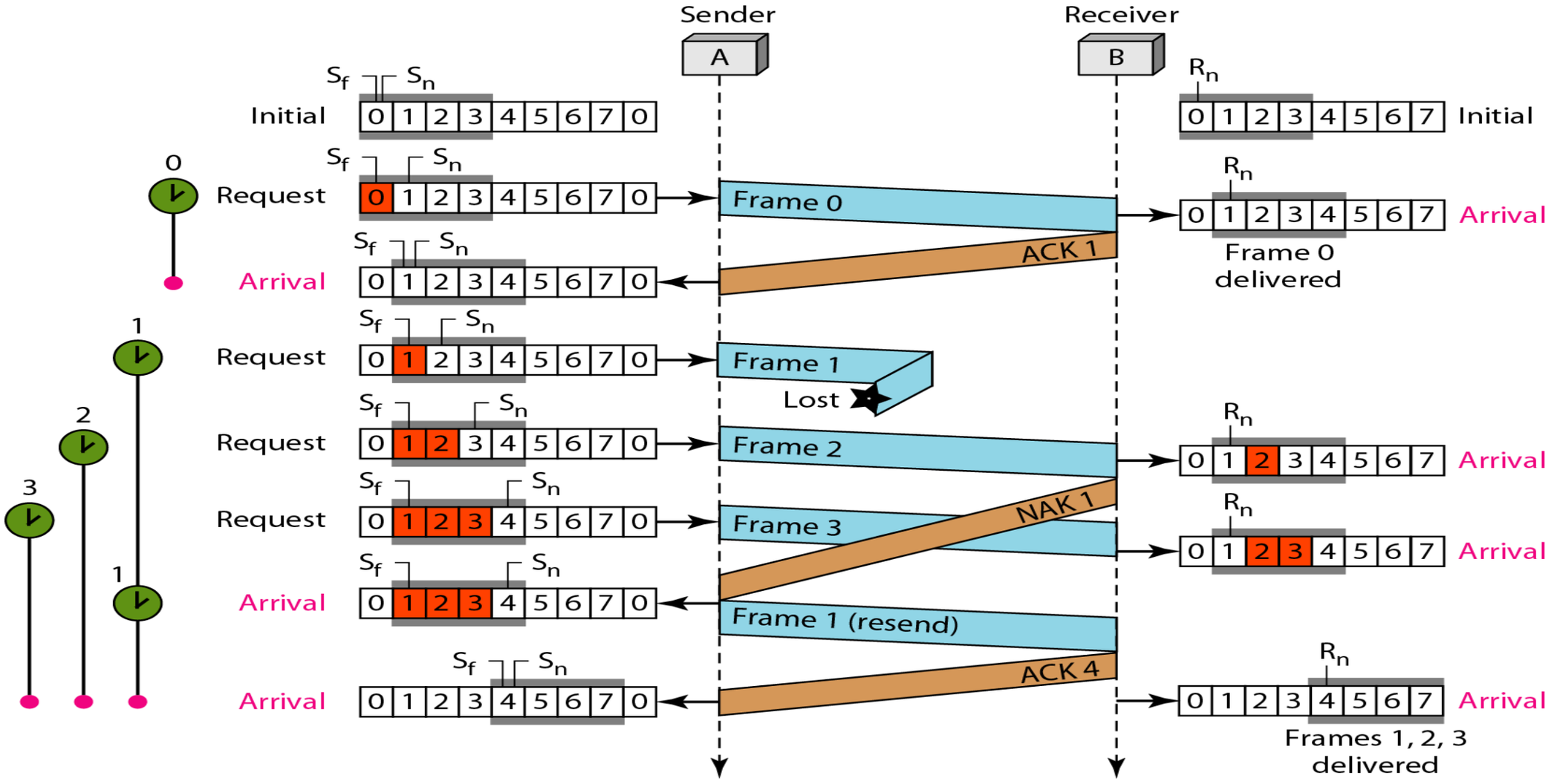


Sender



Receiver

Contd..


Sender
A
Receiver
B
Initial
Request
Arrival
Frame 0
ACK 1
Frame 0 delivered
Frame 1
Lost
Frame 2
Frame 3
NAK 1
Frame 1 (resend)
ACK 4
Frames 1, 2, 3 delivered

Piggybacking

- In all the algorithms that we discussed,data flows in one direction.
- In the opposite direction ACK/NACK travels.
- **Piggybacking** is the concept of carrying ACK/NACK along with the dataframe.
- This needs modification of the frame structure.
- Since data is included in all the transmission , a timer is started at both the places.

Assignment 1

1.Identify the various networking topology used in RB Labs.Describe your observations and construct the topology.

Submit to linways portal on or before 22/12/2021.

Include your name and MGP number in the submission document.

HDLC – High level Data Link Control.

HDLC protocol is used for communication in Point to Point and Multipoint communication systems.

Point to Point – Typically transmission in between two systems.

One system can behave as a master node.

In Multipoint ,one master many attached clients.

HDLC protocol frames are structured to enforce ARQ mechanisms.

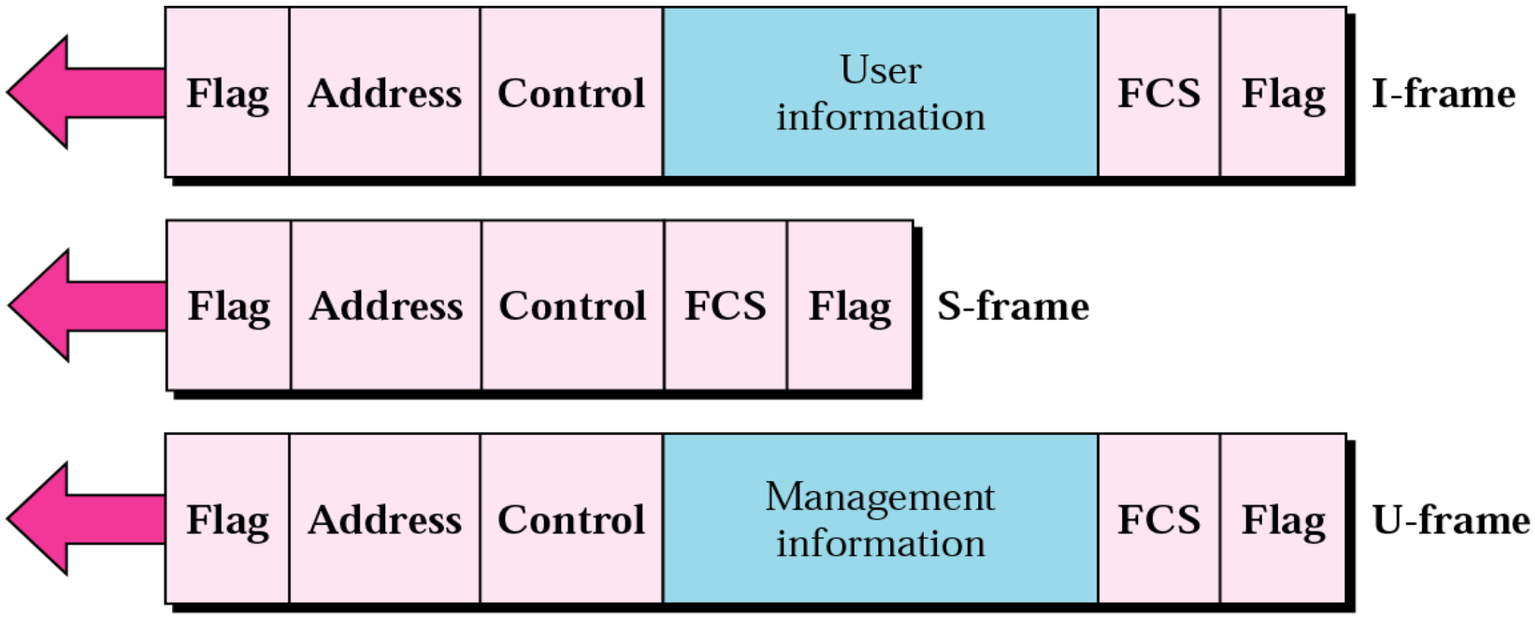
Each piece of data is encapsulated in an HDLC frame by adding a trailer and a header.

The header contains an HDLC address and an HDLC control field.

The trailer is found at the end of the frame, and contains a (CRC) which detects any errors which may occur during transmission.

The frames are separated by HDLC flag sequences which are transmitted between each frame and whenever there is no data to be transmitted.

HDLC Frames



I-Frames -->Information frame. Used to exchange data.

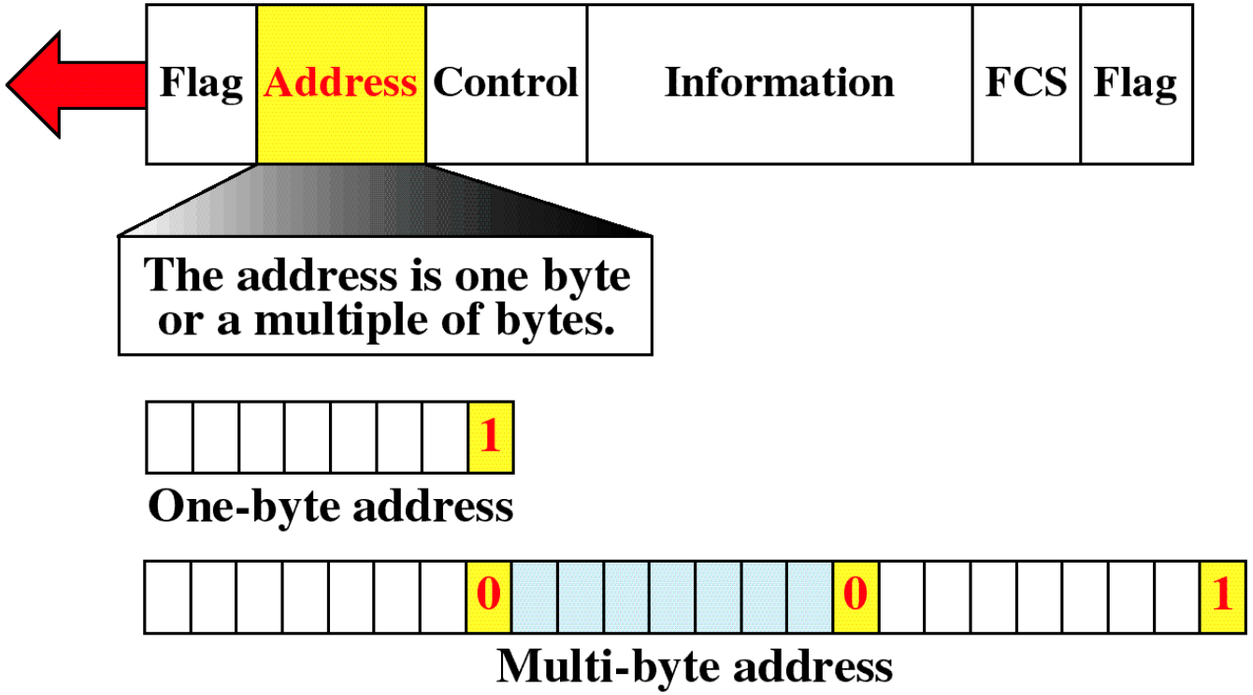
S- Frames -->Supervisory frame. Used for ARQ only

U-Frame-->Unumbered frames.Used for link management

Flag

- Uses 8 bits of a fixed pattern (0111 1110).
- 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 anywhere else in the frame
- HDLC uses bit stuffing
- Every time a sender wants to transmit a bit sequence having more than 6 consecutive 1's, it inserts 1 redundant 0 after the 5_{th} 1

Address Field



The address field length varies depends on the type of communication.

Address field is one byte or more

If the address is more than one byte, all bytes will end with 0,except the last o

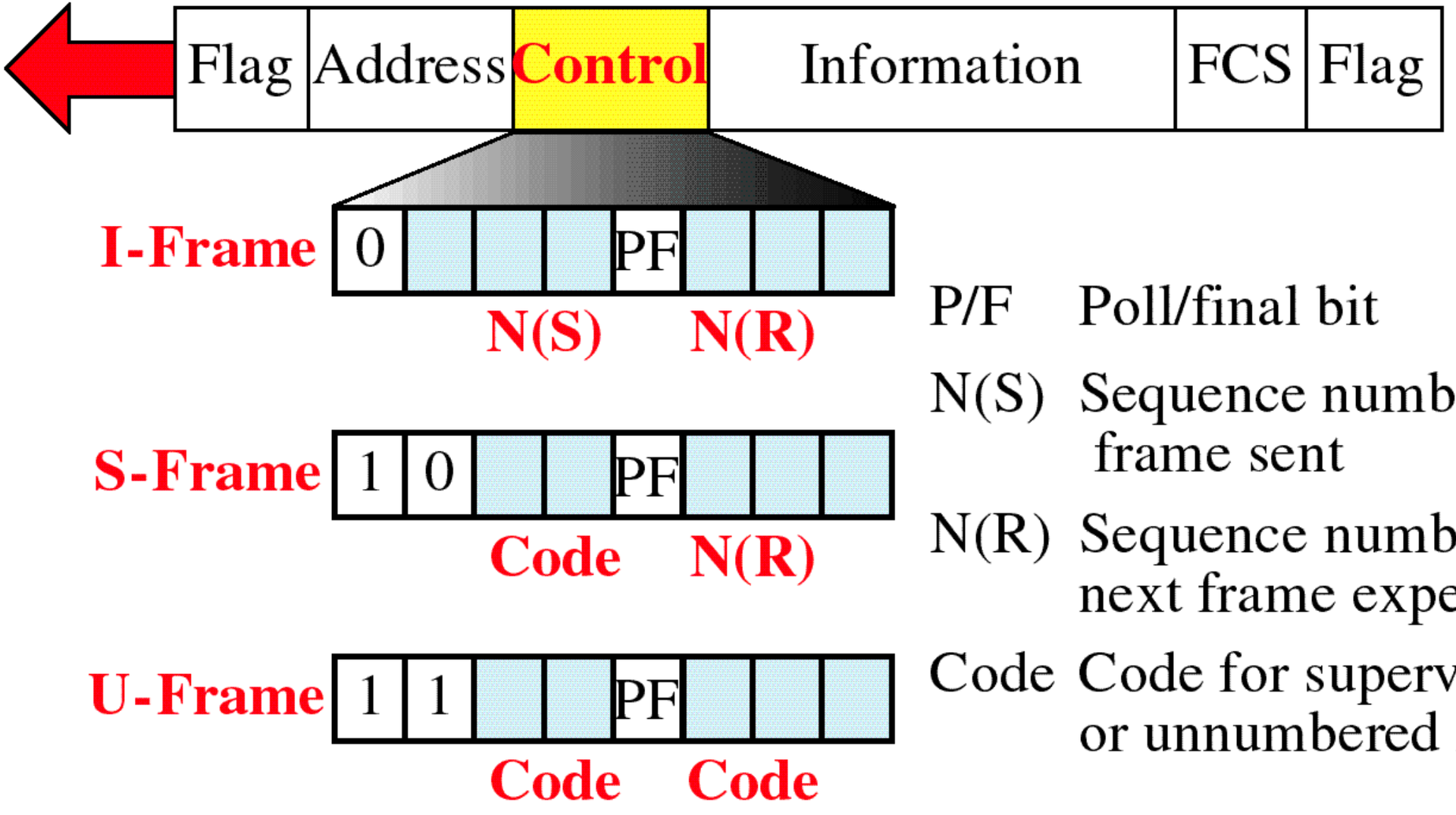
Control Field

Control field characteristics vary based on the type of the frame.

When used in I-frames,the fields are used to piggy back sequence numbers and ACK.

Contains a **P**oll/**F**inal bit.It has meaning when this bit is set.

Polling is done to check with the clients if they have anything to sent.



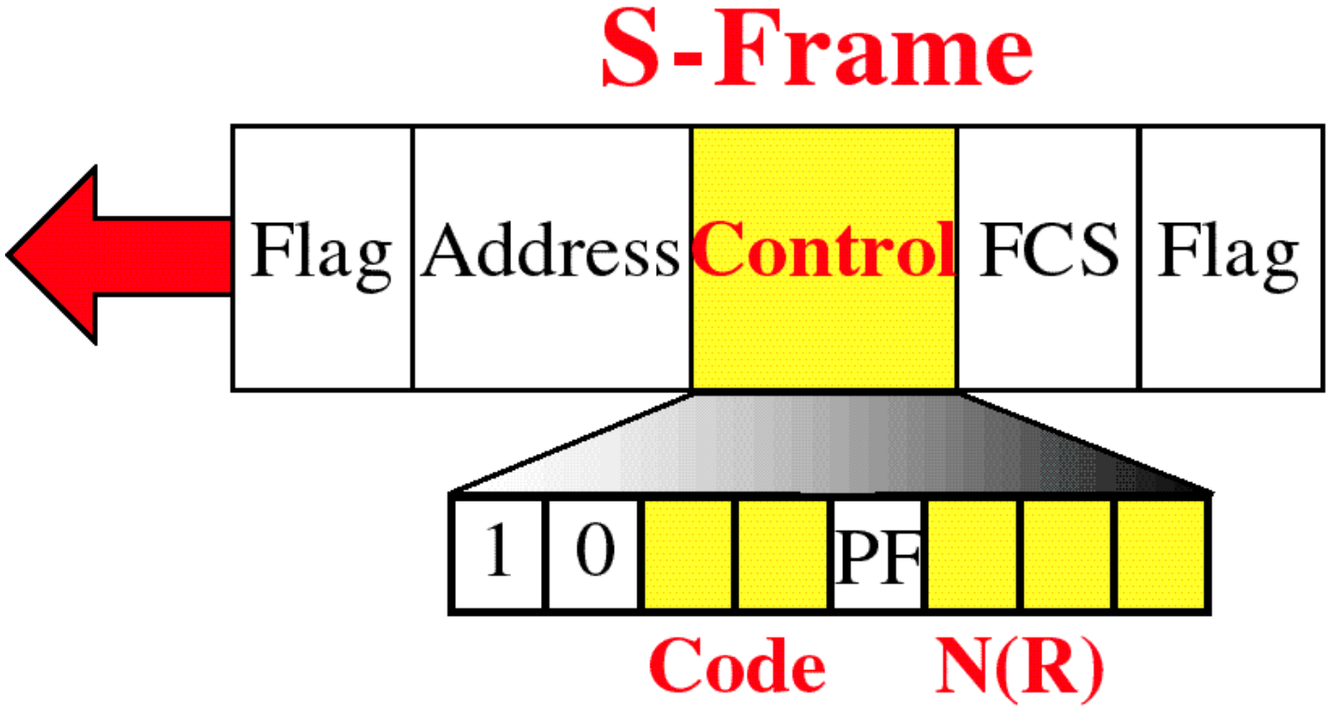
P/F Poll/final bit

N(S) Sequence number of frame sent

N(R) Sequence number of next frame expected

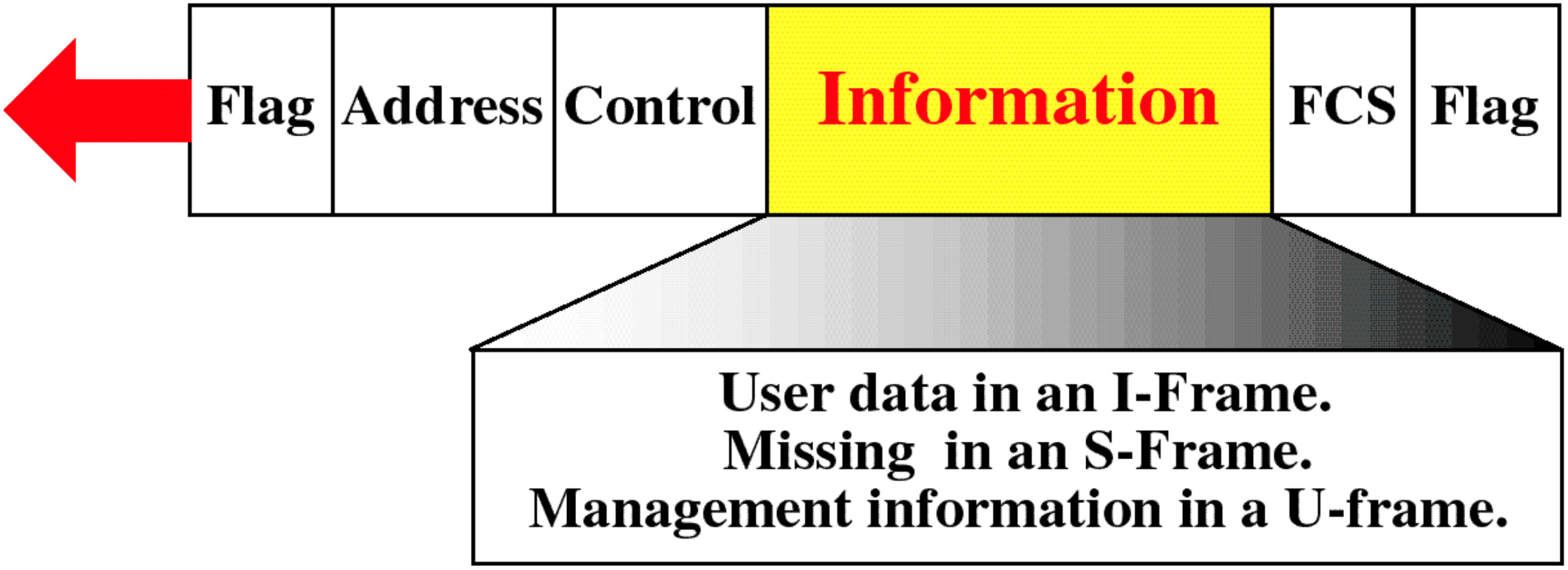
Code Code for supervisory or unnumbered frame

Code bits in S Frame

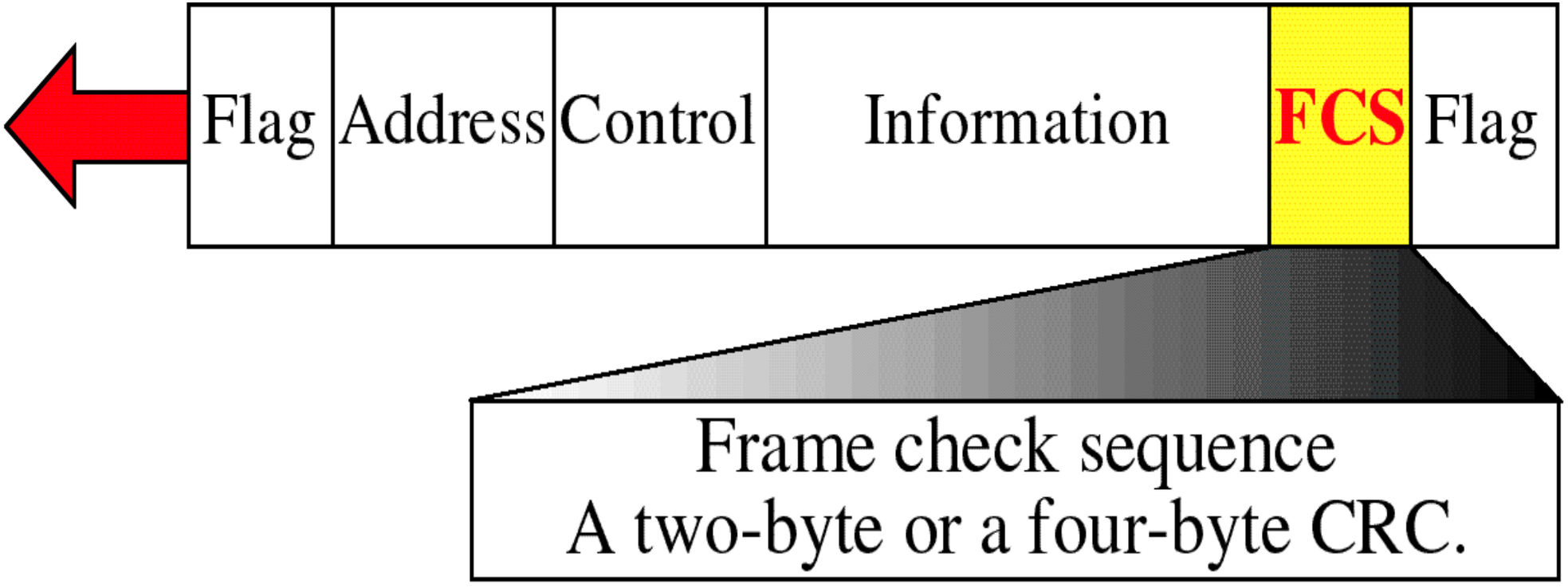


Code	Command	
00	RR	Receive ready
01	REJ	Reject
10	RNR	Receive not ready
11	SREJ	Selective-reject

Information field

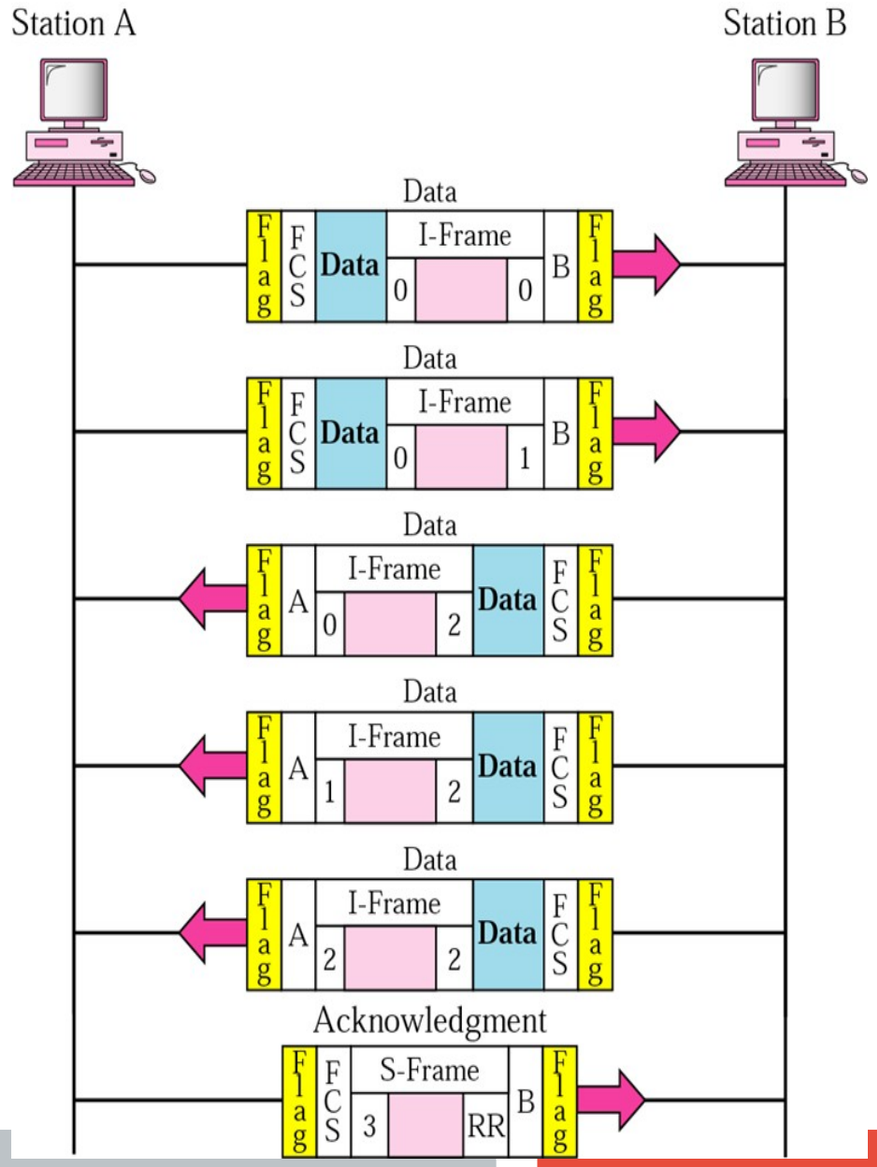


FCS -> Frame Check Sequence



Example 1

- The figure shows an exchange using piggybacking where is no error
- Station A begins the exchange of information with an I-frame numbered 0 followed by another I-frame numbered 1.
- Station B piggybacks its acknowledgment of both frames onto an I-frame of its own.
- Station B's first I-frame is also numbered 0 [N(S) field] and contains a 2 in its N(R) field, acknowledging the receipt of A's frames 1 and 0 and indicating that it expects frame 2 to arrive next.
- Station B transmits its second and third I-frames (numbered 1 and 2) before accepting further frames from station A.
- Its N(R) information, theefore, has not changed: B frames 1 and 2 indicate that station B is still expecting A frame 2 to arrive next.
-

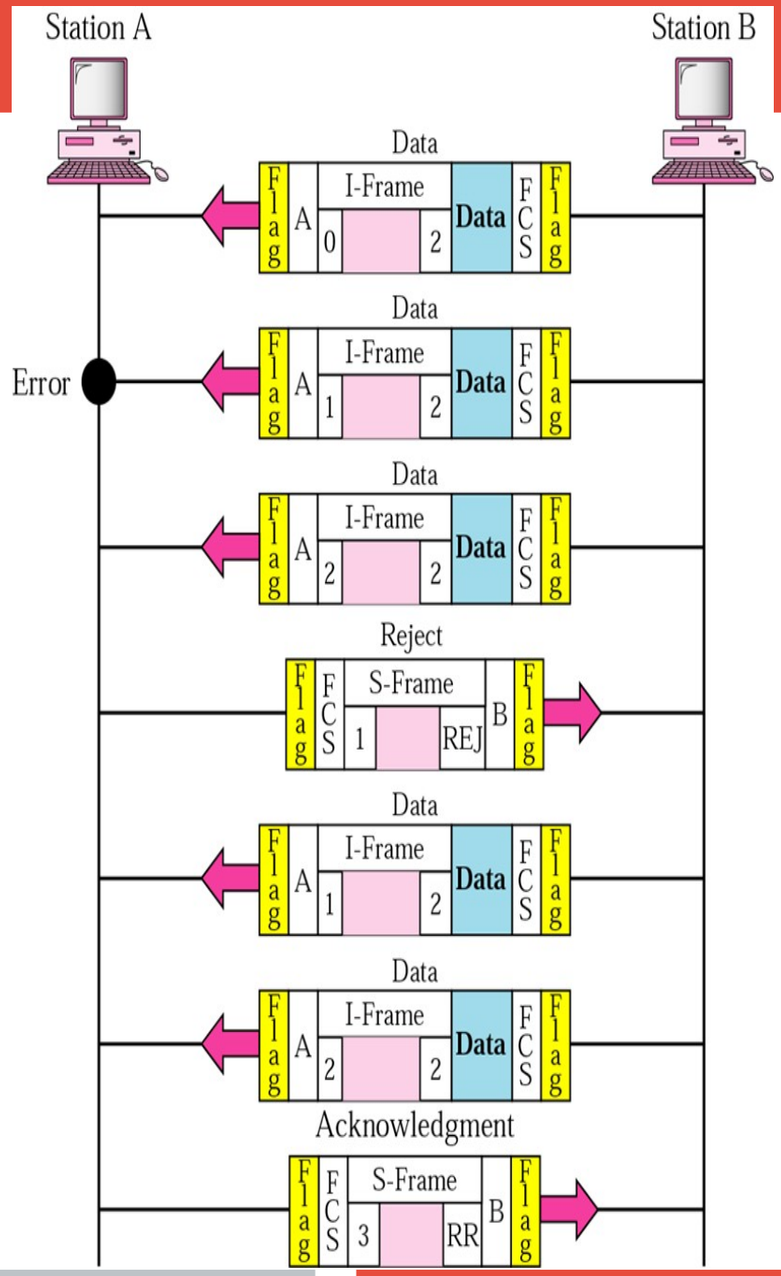


Example 2

In the previous Example, suppose frame 1 sent from station B to station A has an error.

Station A informs station B to resend frames 1 and 2 (the system is using the Go-Back-N mechanism)

Station A sends a reject supervisory frame to announce the error in frame 1



HDLC Stations

1.Primary Station

Has the responsibility of controlling the other nodes.

The other nodes respond to commands from primary nodes.

2.Secondary Nodes

When primary station is present,secondary stations needs to be added.

These station has no responsibility on its own and acts based on commands from primary station

3.Combined Station

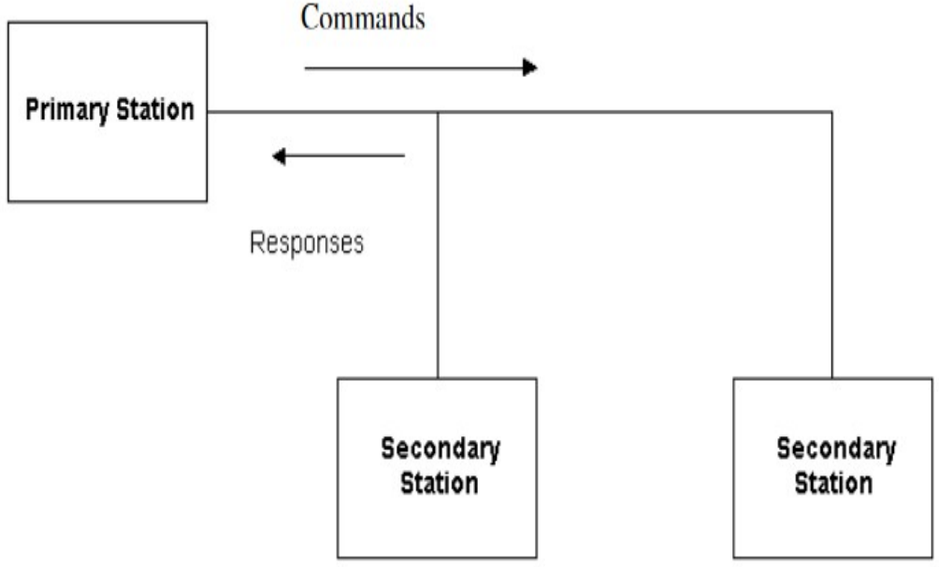
Combined stations does not depend on any other nodes.

These stations have full control .

HDLC Station Configuration

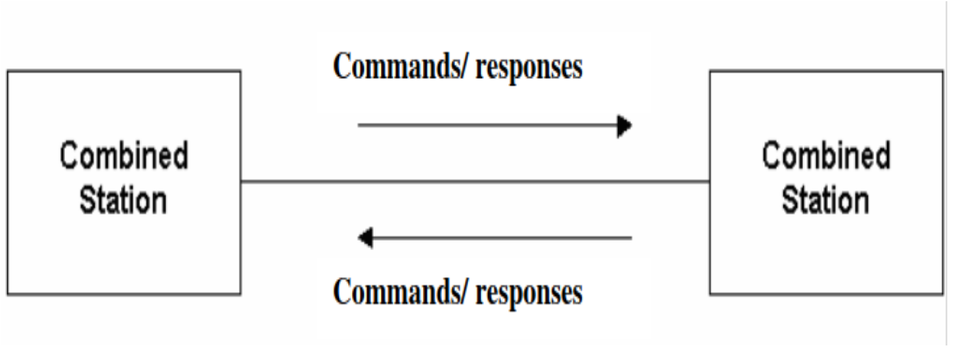
1.Unbalanced Configuration

Contains one primary station and one or more secondary stations.



2.Balanced Configuration

Contains two or more combined stations.

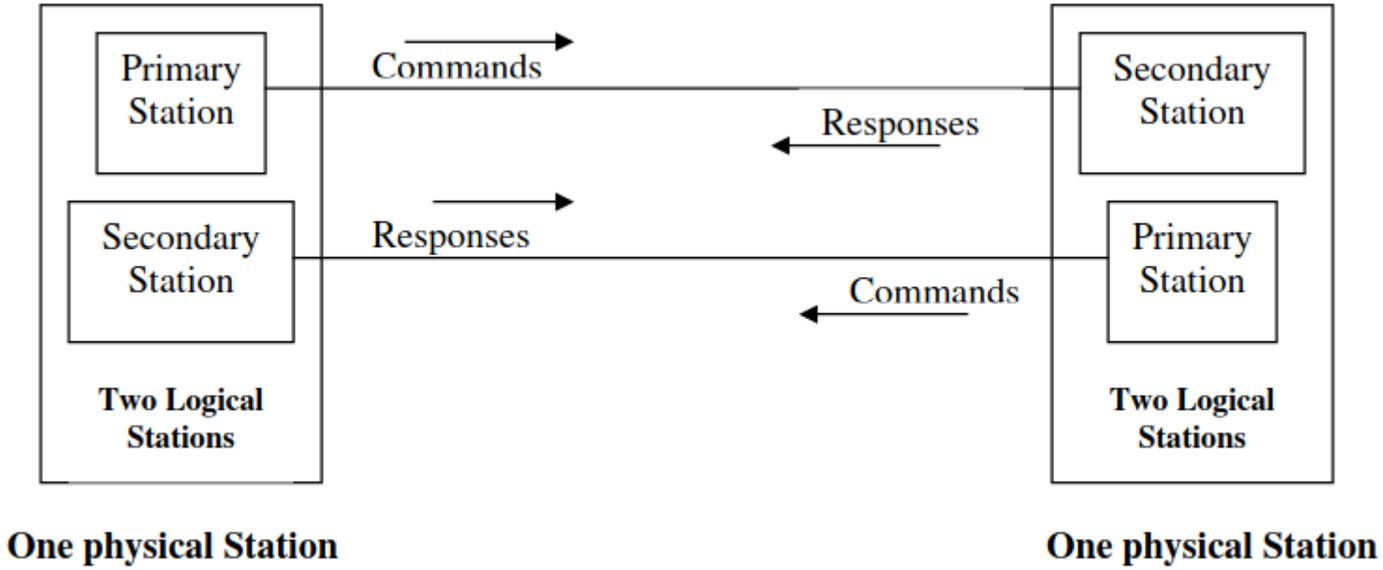


Contd..

3.Symmetrical Configuration

Each station has primary and secondary status.

Each station logically considered as two



HDLC Transfer modes

Divisions are made based on who controls the link

1.Normal response mode

The transmission is controlled by primary station.

The secondary station can start its transmission only after being instructed by the primary station.

The transmission from secondary station may contain more than one frame.

This mode is used in unbalanced configuration.

Contd.

2.Asynchronous Response Mode

No need to wait for the master to permit transmission.

The secondary node can transmit when he has data to send.

Since it is asynchronous , the sender has to ensure that transmisson channel is not used .

- In case of full duplex channel there will not be such an issue

The primary station still has the responsibility of setting up the connection and error recovery.

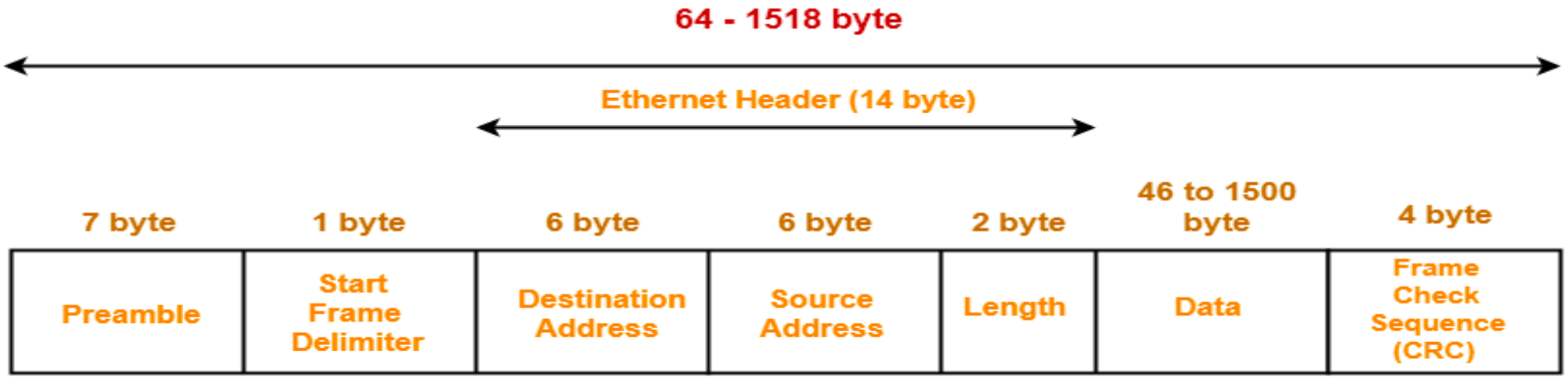
Contd..

3.Synchronous Balanced Mode

Used in the case of combined stations.

No need for any permission to transmit.

IEEE 802.3 Ethernet frame format.



IEEE 802.3 Ethernet Frame Format

The total size of the frame ranges from 64 bytes to a maximum of 1518 bytes.

The variable part is the data present in the frame.

Contd..

Preamble- An alternating sequence of 0 and 1.The preamble section is used to synchronize the sender and receiver.

Start Frame Delimiter- The only value is 10101011.This byte indicates the beginning of actual frame contents.

Destination and Source Addrerss – Represented using 6 bytes. The address that is included is the hardware address and is also known as MAC address.

Length- Indicates the length of the data field.Can max upto a value of 1500.

Contd..

Data- The place to hold the actual data.

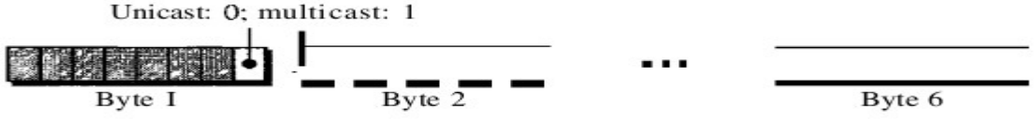
CRC- 4 byte CRC code to check for errors.

Address in Ethernet Frame

06:01 :02:01:2C:4B

6 bytes = 12 hex digits = 48 bits

If the LSB part of the first byte is a 0 it indicates a Unicast (one to one Address) else a multicast (One to Many)



If all the bits in all the bytes are 1 it indicates a brodcast in which the frame will reach all the connected nodes **FF:FF:FF:FF:FF:FF**

IEEE 802.11 Wireless LAN

Two types of service is supported.

1.BSS [Basic Service Set]

The BSS service includes a set of nodes and an optional Access Point.

The devices can connect among themselves and form a *adhoc network*.No access point is involved.

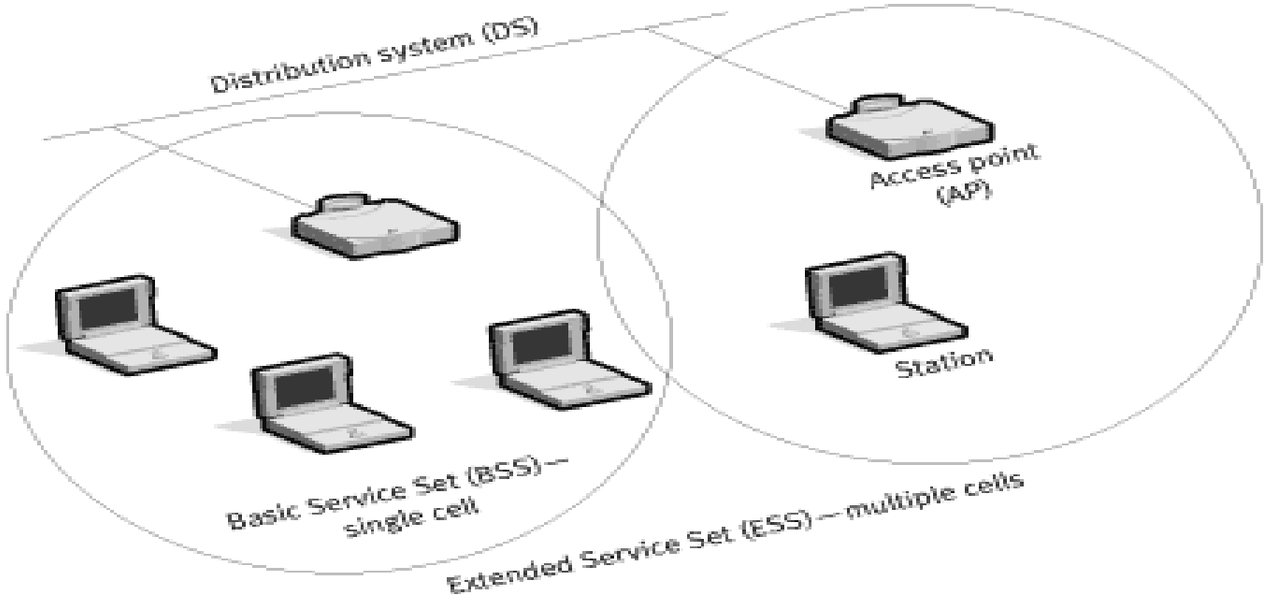
The devices can connect to an access point and the frames will be transmitted through it.This is *Infrastructure network.*

Contd..

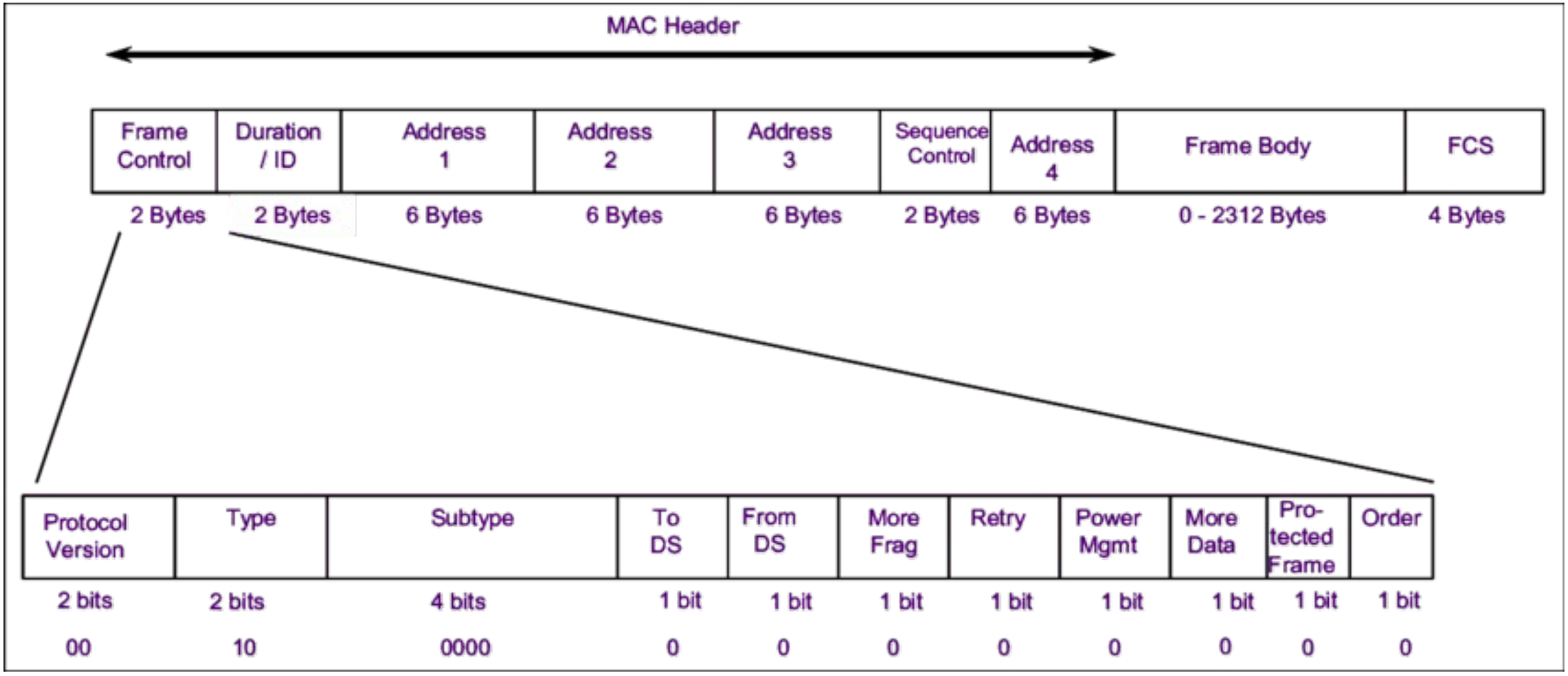
2.ESS [Extended Service Set]

Two or more BSS with access points are involved in ESS.

The BSS are connected through *distribution system* (**DS)** which can normally be a LAN.[Wired /wireless]



IEEE 802.11 Wireless LAN frame format.



Also known as IEEE 802.11 MAC [Medium Access Control] frame.

Expanding 2 Bytes of Frame Control

Version – 2 bit field to indicate version.Normaly set as the value 0.

Type – 2 Bit field indicates the type of the frame.

00 ->Management

01 -> Control

10 -> Data

11 -> Reserved.

Subtype – 4 bits indicate the specific type of frame

Example

0000 -> Association request [To pair]

1000 -> Beacon Frame [Advertise the network presence etc]

Contd..

To DS – If 1 ,indicates that the frame is intended to the distribution system [DS].

From DS -If 1, indicates that the frame is coming from a DS.

Power Mgmt-If 1,the station goes to power saving mode,else the station will always be active.

More Data – If the bit is set,the receiver may expect more frames from the recepient.

WEP – If the bit is set, the standard security measure is applied.

Retry -Retry bit is set if the current frame is a retransmission of older frame.

Protected Frame -If 1 ,encyption is done on the data [In some texts the field is named reserved]

Order -If this bit value is 1,the recepient should process the frames in order.The order is determined by the sequence numbers.

Other fields

Duration/Id -Duration in microseconds and the value indicates the duration of transmission. In control frame the fields indicate the ID.

Frame Body – The actual data

Sequence Control -The frame sequence number field.

FCS -Frame check sequence .4 byte long CRC

The Addresses in IEEE 802.11

There are 4 address fields defined as per the standard.

The fields are populated based on *To DS* and *From DS* fields.

To DS	*From* DS	*Address* 1	*Address* 2	*Address* 3	*Address* 4
0	0	Destination	Source	BSS ID	N/A
0	1	Destination	SendingAP	Source	N/A
1	0	Receiving AP	Source	Destination	N/A
1	1	Receiving AP	SendingAP	Destination	Source

Optional material
https://www.oreilly.com/library/view/80211-wireless-networks/0596100523/ch04.html

How does one node get the Physical address of destinations.??

In a LAN -wired/wireless nodes advertise their physical address.

There is a well defined protocol know as **A**ddress **R**esolution **P**rotocol.

The known physical addresses are stored locally