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Q2)
1) The OSI model

7	Application
6	Presentation
5	Session
4	Transport
3	Network
2	Data link
1	Physical layer

- Computers are made by different manufacturers & equipment ranges from kind to kind.
- These computers may be located over different networks & posses different characteristics which disabled communication between them.
- To solve this gap, the International Standards Organisation developed the OSI reference model which stands for "Open System Interconnection"
- This model is a specification for device

communication that is accepted worldwide.

- It defines 7 layers:
  1) Physical layer
  2) Data link layer
  3) Network layer
  4) Transport layer
  5) Session layer
  6) Presentation layer
  7) Application layer.

1) Physical layer:
- Devices like bridges, work at this layer.
- It is the layer where communication happens in bits and its the lowest level.
- It transmits raw bits through physical mediums like wires etc.

2) Data links
- Devices like switches, hubs operate here.
- This defines the format of data on the network.
- Communication happens by means of MAC Addresses here (ie physical addresses)

3) Network layer:
- Communication happens by IP addresses here
- This decides the physical path of the data

4) Transport layer
- Transmit data using protocols like TCP & UDP.

5) Session layer
- Maintains connections & is responsible for controlling ports & sessions

6) Presentation layer
- This ensures that data remains usable in the proper format & here is where data encryption technologies ~~are~~ come into play.

7) Application layer
- This is the final layer, where actual real world communication between users (humans) ~~can~~ and the devices
- Here users access the network.

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2) OSI model vs TCP/IP

OSI model	TCP/IP model
i) Stands for Open System Interconnection model	i) Stands for Transmission control Protocol / Internet Protocol model.
ii) In this model, at the transport layer packet delivery is guaranteed.	ii) Here in the transport layer, delivery is not guaranteed.

iii) It has a total of 7 layers, where Presentation and Session are seperated	iii) It can have 4 or 5 layers based on whether physical & data link are separated. Presentation & session are not seperated.
iv) Here Transport layer is connenction oriented which means connection is established before communication	iv) Here transport layer is not ~~connion~~ connection oriented.
v) OSI model is ~~the~~ widely accepted as the reference model	v) TCP/IP model is more or less based on the OSI model as reference.
vi) It is not used in real life and is less reliable overall	vi) It is more widely used & is very reliable.

3) Connectionless	Connection oriented
i) In Connectionless, no reservation is required for resources	ii) In connection-oriented, reservation is required for resources since a connection is established.

ii) Here the utilization of resources is well managed.	ii) Utilization of resources is less and not that great.
iii) It does not create any virtual path between the sender & receiver	iii) It creates a virtual between ~~user~~ sender & receiver.
iv) UDP / IP / ICMP are connectionless protocols	iv) TCP is a connection oriented protocol.
v) These protocols are message based. (Datagram in UDP)	v) These protocols are stream-based
vi) Does not require authentication before transmission	vi) Requires authentication before transmission

Q3)

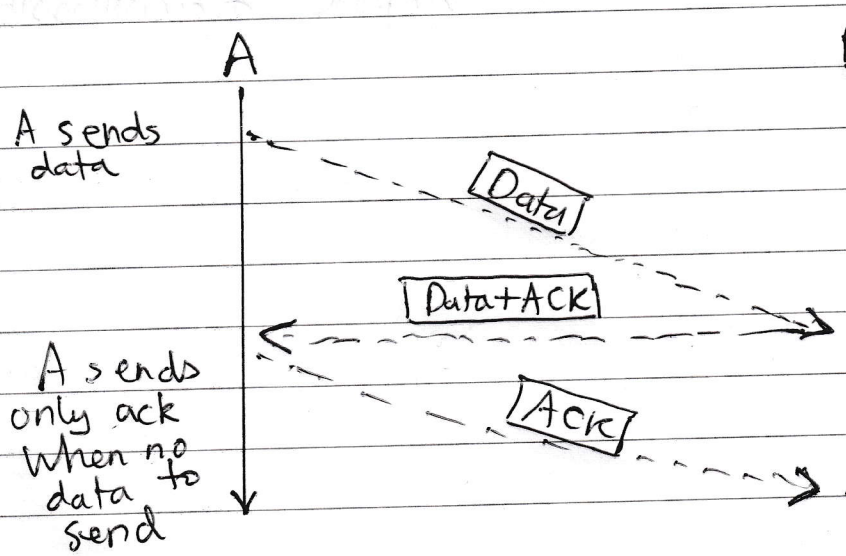
1) Piggybacking

- As in normal english language, piggybacking is described as the action of climbing on one's shoulder & travelling along with them.

- In the same way, in networking, when we have bi-directional communication (also known as full duplex communication), it is quite resource expensive to have two seperate channels for sending & acknowlegement

- Here, the bandwidth of the acknowledgement chanel is tottally wasted since it is only used for acknowlegdements.

- Henee, we come to the concept of Piggybacking.



- Hence in Piggybacking, as shown in the diagram, the receiver does not send empty acknowledgements always.
- Instead, the receiver waits for the next data packet from the network layer to arrive, and then sends this acknowledgement (Ack) on the back (along with) of the data to be sent.
- This drastically improves performance, since no bandwidth is wasted on empty Ack packets.
- This technique of ~~temporarily~~ temporarily delaying Ack packet to send it later along data is known as piggybacking.

2) Calculation of CRC

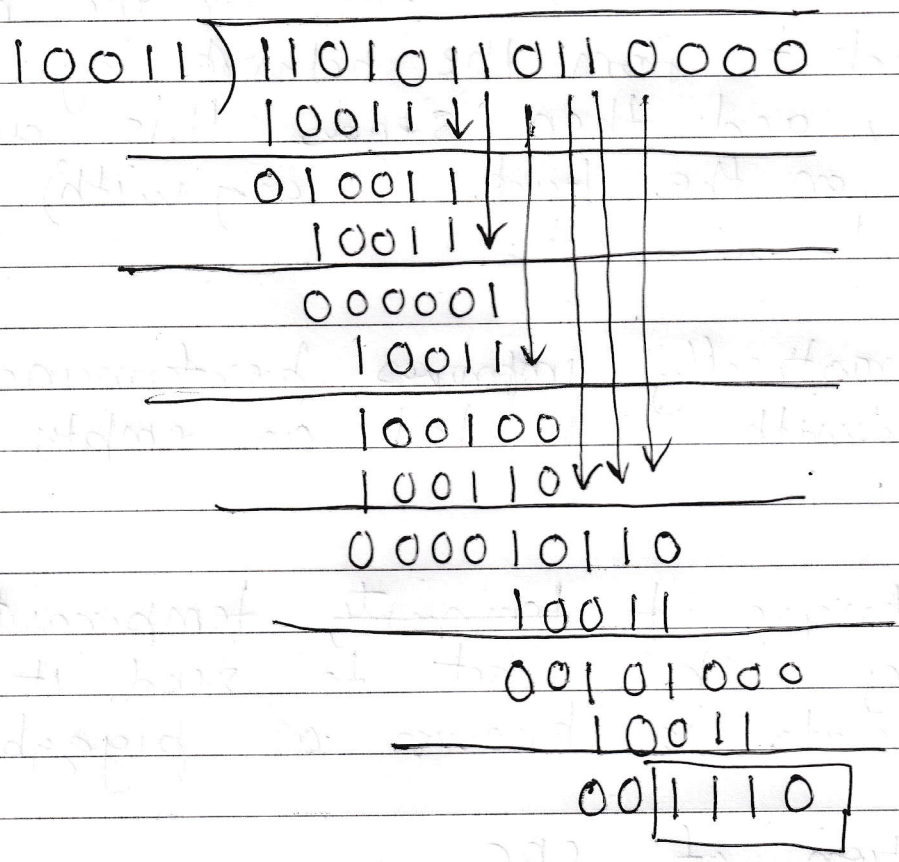
$$f(x) = 11010111011$$
$$g(x) = 10011$$

$$r = n(g(x)) - 1$$
$$= 5 - 1$$
$$= 4$$

Now we append r 0's to the data unit to be ~~transmission~~ transmitted:

$f(x) = 11010110110000$

Now performing division



Hence the CRC code is 1110

Data to be transmitted → 1