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Q.1 One-bit bidirectional sliding window protocol.

→ For bidirectional we have a single common function which handles both sender and reciever side.

Pseudo code:-

```
seq_nr  nxt;      // next expected frame (sender)
seq_nr  fe;       // frame expected (reciever)
event_type e;     // whenever packet arrives
packet  p;        // from network layer fetching into p.
frame   s, r;     // two frames on sender & reciever side.

nxt = fe = 0;     // Initializing.
from_network_layer(&p);
 s.info = p;
 s.seq = nxt
 s.ack = fe
 to_physical_layer(&s)
 start_timer(&s)
```

//Here we are assuming that atleast one packet will be available from network layer at starting point.

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```
while (true)
{
  wait_for_event (&e);
  if (e == frame_arrival) {  // Reciever side
  from physical_layer (&r);          code:
  ~~to physic~~  if (r.seq == fe) {
  to_network_layer (&r.info);
    inc (fe);
  }
```

// The above mentioned code take frame from the ~~reciever~~ sender and then assigns to ~~phy~~ network-layer.

```
  ~~if (e==~~

  if ( r.ack == nxt )
  {
      stop_time (&r.ack);
      enable_networ_layer();
      from_network_layer (&p);
      inc (nxt);
    }
}
```

// ~~the~~ second if loops checks whether acknowledgment recieved was ~~from~~ the same it was expecting.

// it accepts and then unless their is no available packets from network layer it waits and continues the procedure.

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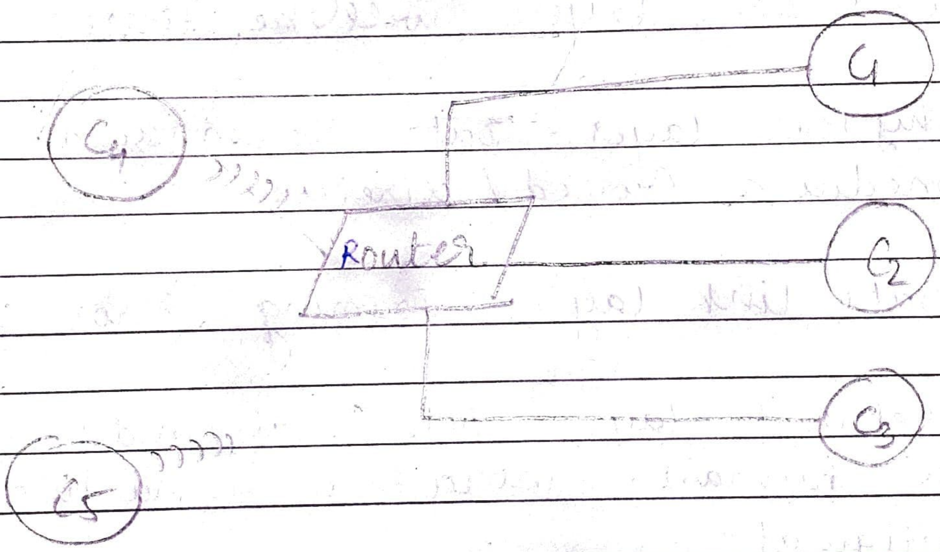
```
    s.info = p
    s.ack = 1-fe;
    s.seq = nxt
    to_physical_layer (&s);
    Start_timer (&s);
  }
}
```

// At last if their is any error such as checksum or timeout then it will just not enter if loop and will be sending package frame again.
(In these case the medium was error free so no need)

Q.2.



C1, C2, C3 → wired Ethernet connection
C4, C5 → wireless connection.

(1) Network topology:-

→ Here star topology is being used.

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→ B/c every device needs to be connected to a central router from where routing takes place.

(ii) Communication Medium:

→ Wired and Wireless as some devices may connected through ethernet or some through WIFI.

(iii) Encoding technique:
→ Differential Manchester as it is most common in digital data transmission.

(iv) Here we will be using TCP/IP protocol thus 4/5 layers will be there.

(v) i) Physical layer:- Data transmission through medium (wired / wireless)

(ii) Data Link Layer:- Framing, Error controlling

(iii) Network layer:- Acts as a middleware b/w human interaction & hardware configuration

(iv) Application layer:- Handles with the UI part i.e. software & interaction with human beings.

(vi) Functions such as transmission from one-end- to another will be handled by

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physical layer. Adding some redudancy to data would be handled at data link layer. Encryption / decryption would be handled at application layer.

Q.3. Packet size = 1000 bits
Total data to be sent = 1 million = 10^6 bits.

speed = 2×10^8 m/s
distance = 2500 Km

so first of all we need the time it takes to travel at reciever's end and again Acknowledging back.

No. of packets = $\frac{\text{Total data}}{\text{Packet size}} = \frac{10^6}{10^3} = 10^3$ packets.

Let's count for a single packet.

so t_p = propogation time = $\frac{2500 \times 10^3}{2 \times 10^8 10^5} = 1250 \times 10^{-5}$

1.25×10

$t_p = 0.0125$ s.

These is for one traversal, for Round trip time RTT = $t_p \times 2 = 0.025$ s.

For 1 packet → 0.025 s
1000 packet → (?)

$= 0.025 \times 1000 = \boxed{25 \text{ s}}$

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∴ Time taken for 1000 packets to travel is 25s.

Q.4 To calculate frames to retransmit we need to calculate the difference b/w ~~two~~ frame sended and acknowledgment recieved.

transmission time = $\frac{256 \times 500}{5 \times 10^3}$ = 25.6s.

Propogation time = $\frac{2.5 \times 10^3}{2 \times 10^8}$ = 1.25×10^{-5} s

Transmission time for 1 frame = $\frac{500}{5 \times 10^3}$ = 0.1s.

Now total ~~Round trip~~ time =
time to reach reciever = $t_p + t_t$
$\simeq 0.1$ s.

1 frame Frame transmitted in one timeout interval = $\frac{1.2 \times RTT}{0.1}$ = $\frac{1.2 \times (2 \times 1.25 \times 10^{-5})}{0.1}$

In 0.1s the frames sent are
$0.1 \times 1.2 \times RTT$
$0.1 \times 1.2 \times 1.25 \times 10^{-5}$

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Q.5. Advantages of Packet Switching over Circuit Switching :-

(1) Efficiency :-
→ As their is no predefined path, thus it basically results into more efficient use of bandwidth.

(2) Speed :-
→ As their is minimal latency as compared to circuit switching, thus more speeder.

(3) ~~Ba~~ Cost :-
→ Cost-wise efficient b/c packet switching only cost as per the usage. while circuit switching cost on duration as well as distance.

(4) Digitally More efficient as compared to circuit switching

(5) Faults can be easily handled as loss packets may arrive through some different paths.

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8.6. Bandwidth = 1Mbps
RTT = 30ms
packet size = 1000bit

For stop & wait protocol as window size is 1

we can write formula as

$\frac{1}{1+2BD}$ OR $\frac{1}{1+2\times\frac{t_p}{t_t}}$ OR $\frac{1}{1+2xa}$.

$t_t = \frac{10^3}{10^6} = 10^{-3}s = 1ms.$

$t_p = \frac{RTT}{2} = 15ms$

Now link utilization = $\frac{1}{1+\frac{2\times15}{1}} = \frac{1}{31} = 0.0322$

or 3.22%