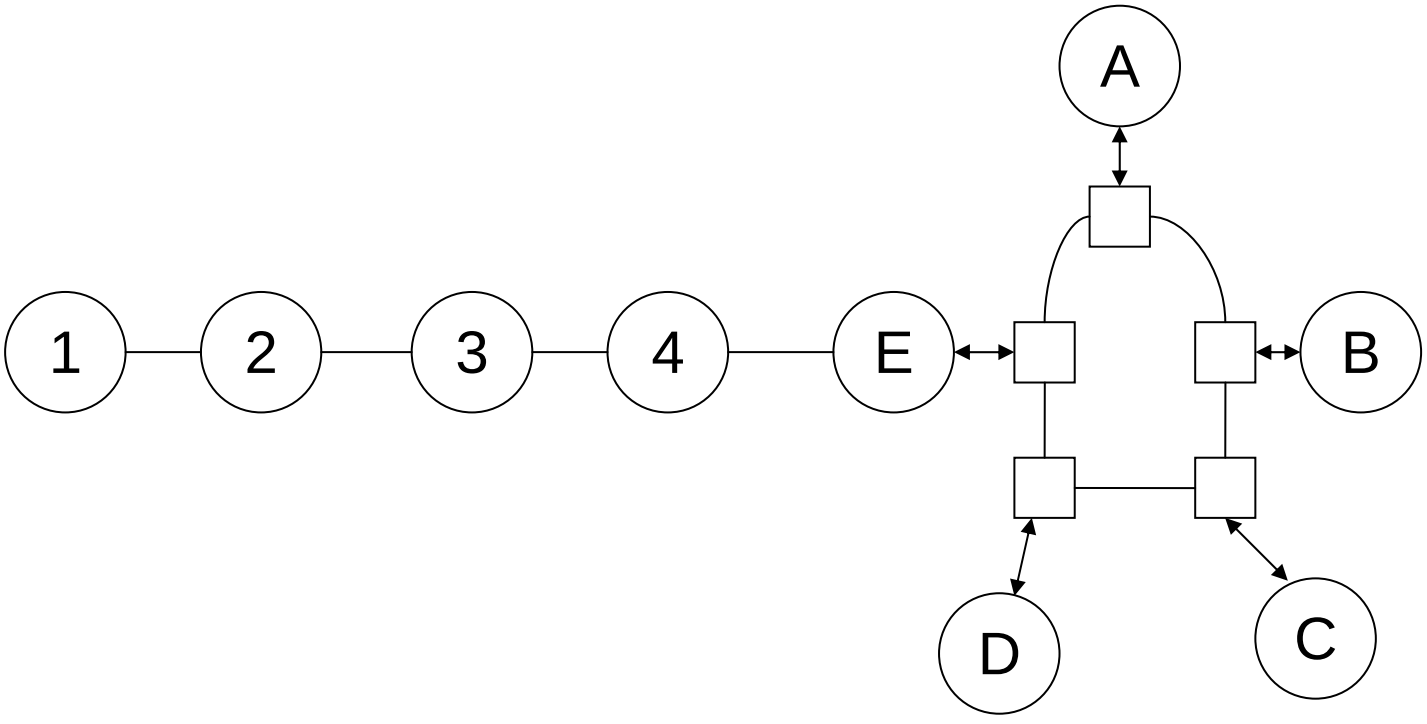
(18 pts.) 14. Given the internet pictured below with a propagation speed of 150m/microsec on the packet-switched WAN and 200 m/microsec on the ring LAN where the five nodes (A, B, C, D, E) are equidistantly spaced 300 meters apart and connected with CAT5e (20 MHZ) twisted pair using differential Manchester encoding. Assume that every frame on the ring incurs a one microsecond delay passing through each node repeater.

Nodes 1-4 and E are equidistantly spaced 5 km apart on the WAN with 2 Gbps links between nodes. Node 4 is the only WAN node with 10 millisec. processing time.

Given the following characteristics and assuming one packet = one frame:
Frame payload = 1000 bytes
Frame header = 150 bytes Frame trailer = 100 bytes

a. **How long will it take to send a packet from node A to node 1 in the situation that when the packet arrives at node 2 there are three packets waiting to go to node 1 and two packets waiting to go to node 4?**

b. **How long will it take to send a packet from node C to node 1 under the identical circumstances as in part a?**



delay = PD + QD + TT + PT
one packet = 1250 bytes x 8 = 10000 bits = 10^4 bits
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frame from A to E: {assume ring is transmitting counter-clockwise}

PD = QD = 0

$$TT = \frac{10^4 \text{ bits}}{10^7 \text{ bits/ sec.}} = 10^{-3} \text{ sec.} = 0.001 \text{ sec} = 1000 \text{ microsec.}$$

$$PT = \frac{300 \text{ m}}{200 \text{ m/microsec.}} = 0.0000015 \text{ sec} = 1.5 \text{ microsec.}$$

Repeater (two) = 2 microsec.

AE Total = 1003.5 microsec

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packet from E to 1:

$$TT = \frac{10^4 \text{ bits}}{2 \times 10^9 \text{ bits/ sec.}} = 5 \times 10^{-6} \text{ sec.} = 0.000001 \text{ sec} = 5 \text{ microsec.}$$

$$PT = \frac{5000 \text{ m}}{150 \text{ m/microsec.}} = 0.000033\tfrac{1}{3} \text{ --sec} = 33\tfrac{1}{3} \text{ -- microsec.}$$

QD = 3 x TT

PD at node 4 = 0.010 sec = 10000 microsec.

4 Hops : 4 TT + 4 PT

7 x TT = 7 x 5 = 35 microsec.

4 x PT = 4 x 33 1/3 = 133 1/3 – microsec.

E1 Total = 10168 1/3 microsec.

AE Total = 1003.5 microsec.

A1 Total = 11171 5/6 microsec.

b. C to 1 = AE + CA

CA = 2 x AE (PT + repeater) = 2 (1.5 +1) = 5 microsec.

C1 Total = 11176 5/6 microsec.