(18 pts.) 14. Given the **internet** pictured below with a propagation speed of **200m/microsec** on the packet-switched WAN and **150 m/microsec** on the **counter-clockwise 10 Mbps** ring LAN where the five nodes (A, B, C, D, E) are equidistantly spaced **300 meters** apart. Assume that every frame on the ring incurs a **one-bit delay** when it passes through each node repeater.

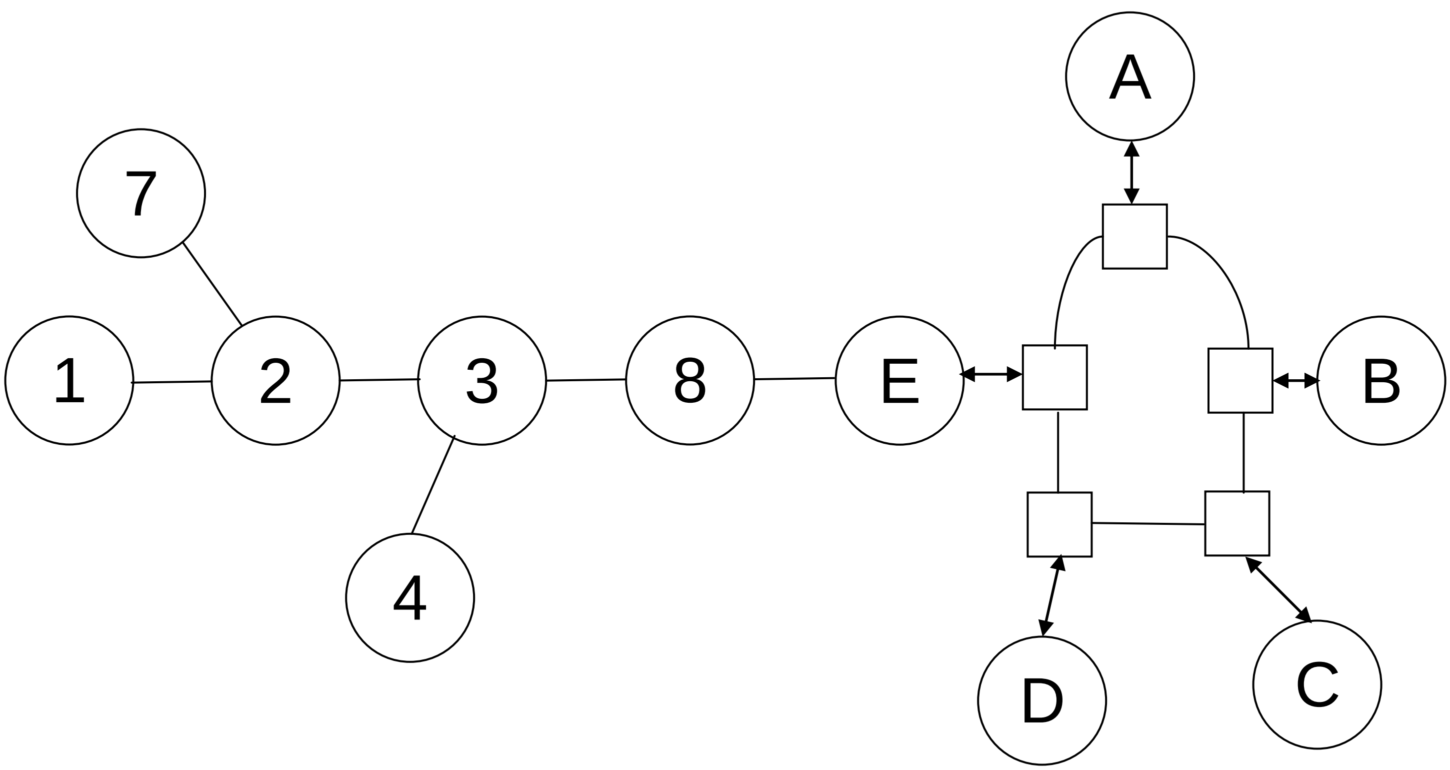
Nodes 1-4, 7, 8 and E are equidistantly spaced **6 km** apart on the WAN with **1 Gbps** links between nodes. Node E is the only WAN node with a processing time of **100 microsec**.

Assuming one packet fits exactly into one frame payload and given the following frame specifications:

Frame payload = **1170 bytes**
Frame header = **40 bytes** Frame trailer = **40 bytes**

a. How long will it take to send a packet from **node D** 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 7**? Assume no other queuing on the WAN and the transmitting node has the token.

**{List any assumptions made and show ALL work to receive full and/or partial credit.}**



**$D_{D1}$ = $D_{DE}$ + $D_{E1}$**

**delay = PD + QD + TT + PT**
**one packet = (1170+40+40) x 8 = 1250 bytes x 8 = 10000 bits = $10^4$ bits**

---

**$D_{DE}$** packet from D to E: {assume ring is transmitting counter-clockwise}

PD = QD = 0

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

$$PT = \frac{4 \times 300 \text{ m}}{150 \text{ m/microsec.}} = 0.000008 \text{ sec} = 8 \text{ microsec.}$$

R**epeater (four counting E) use 4 (3 accepted as correct )**

**One bit = 1/ R 1/$10^7$ bits/ sec. = 0.0000001 sec x 4 = 0.4 microsec.**

**$D_{DE}$ = 1008.4 microsec**

---

$D_{E1}$ packet from E to 1: = **PD + QD + TT + PT**

$$TT = \frac{10^4 \text{ bits}}{10^9 \text{ bits/ sec.}} = 10^{-5} \text{ sec.} = 0.00001 \text{ sec} = 10 \text{ microsec.}$$

$$PT = \frac{4 \times 6000 \text{ m}}{200 \text{ m/microsec.}} = 0.000120 \text{ sec} = 120 \text{ microsec.}$$

QD = 3 x TT

**PD at node E = 100 microsec = 100 microsec.**

**QD + 4 TT = 7 x TT = 7 x 10 microsec. = 70 microsec.**

**$D_{E1}$ = (100 + 70 + 120 microsec) = 290 microsec.**

**$D_{D1}$ = $D_{DE}$ + $D_{E1}$ = (1008.4 + 290 microsec.) = 1,298.4 microsec.**