Homework 5

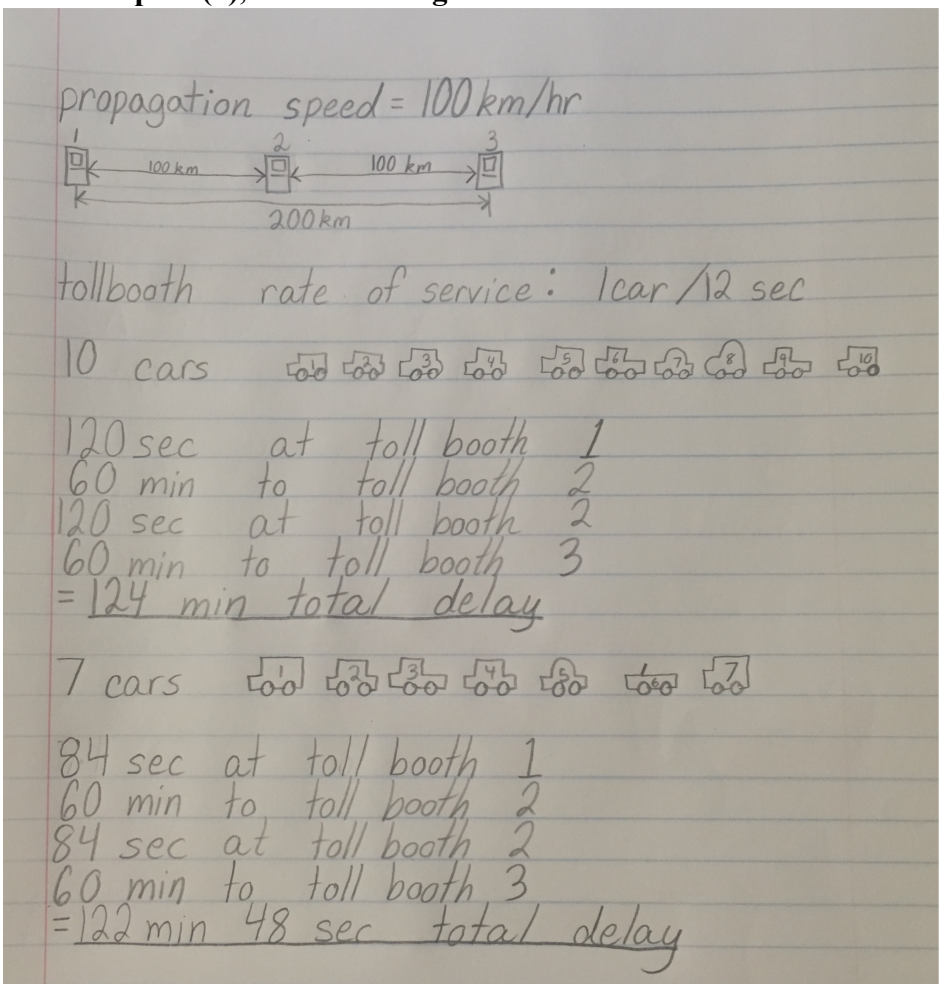
1. **Which layers in the Internet protocol stack does a router process? Which layers does a link- layer switch process? Which layers does a host process?**

   A router processes the network, link, and physical layers of the Internet protocol stack. The link-layer switch processes the link and physical layers. The host process all 5 layers of the Internet protocol stack.

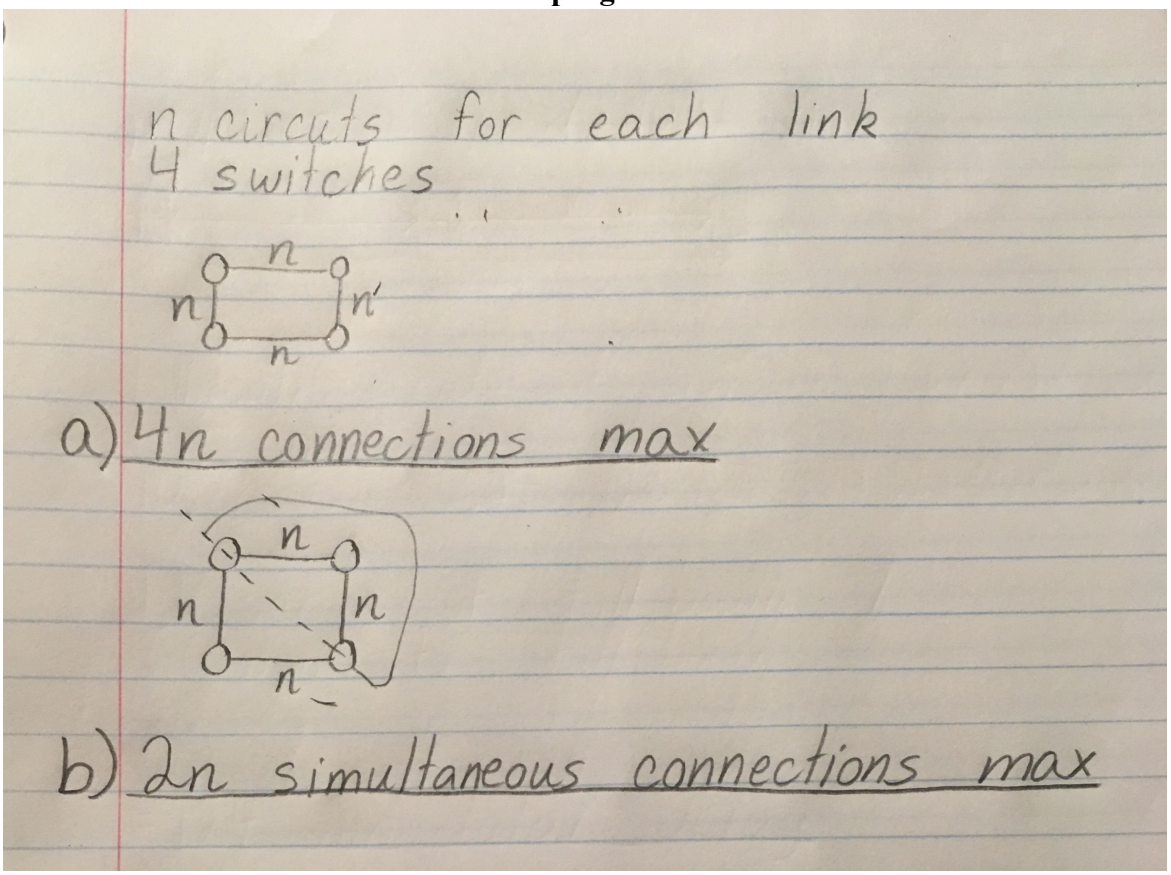
2. **What is the difference between a virus and a worm?**

   Viruses require a host file to spread the virus. A worm on the other hand, does not require any file to help it spread as it is a standalone software.

3. **Review the car-caravan analogy in Section 1.4. Again assume a propagation speed of 100km/hour.**
   a. **Suppose the caravan travels 200km, beginning in front of one tollbooth, passing through a second tollbooth, and finishing just before a third tollbooth. What is the end-to-end delay?**
   b. **Repeat (a), now assuming that there are seven cars in the caravan instead of ten.**

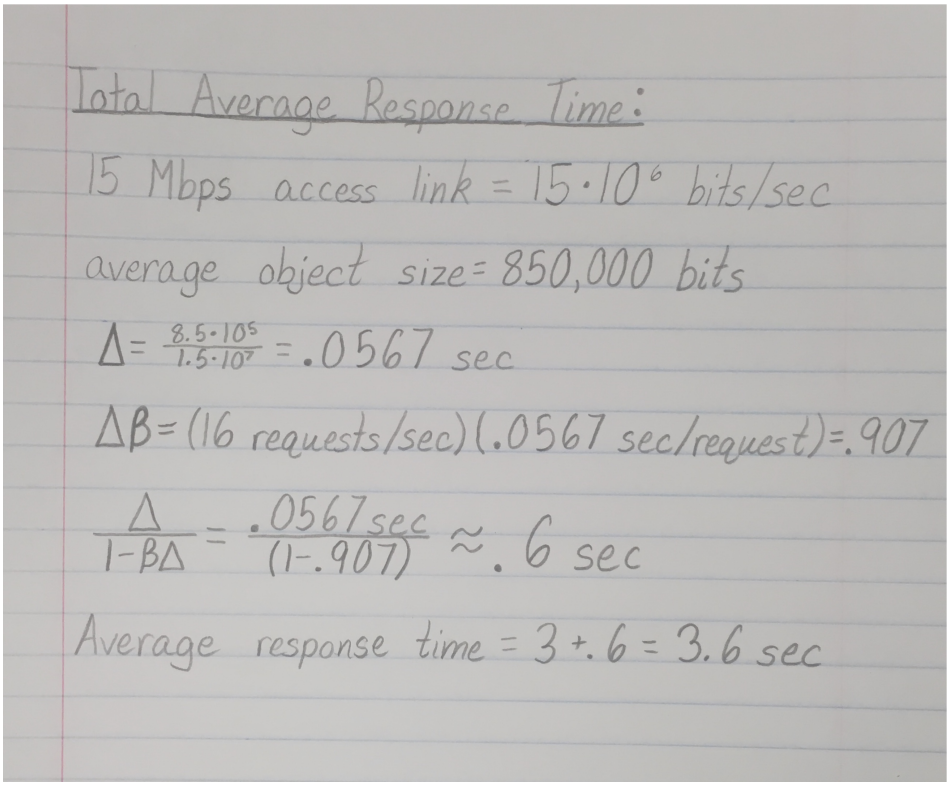


4. **Consider the circuit-switched network in the following figure. Recall that there are n circuits on each link.**
   a. What is the maximum number of simultaneous connections that can be in progress at any one time in this network?
   b. Suppose that all connections are between the switch in the upper-left-hand corner and the switch in the lower-right-hand corner. What is the maximum number of simultaneous connections that can be in progress?

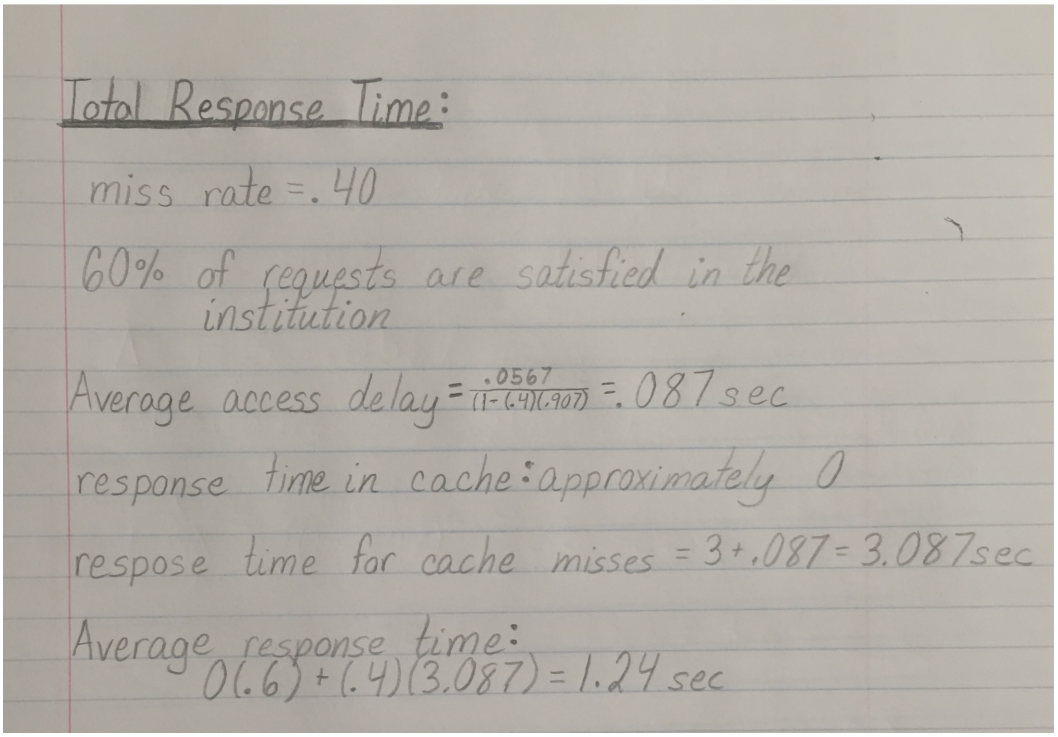


5. **Consider the following figure, for which there is an institutional network connected to the Internet. Suppose that the average object size is 850,000 bits and that the average request rate from the institutions' browsers to the original servers is 16 requests per second. Also suppose that the amount of time it takes from when the router on the Internet side of the access link forwards an HTTP request until it receives the response is three seconds on average (see Section 2.2.5). Model the total average response time as the sum of the average access delay (that is, the delay from Internet router to institution router) and the average Internet delay. For the average access delay, use $\Delta/(1-\Delta\beta)$, where Δ is the average time required to send an object over the access link and β is the arrival rate of objects to the access link.**

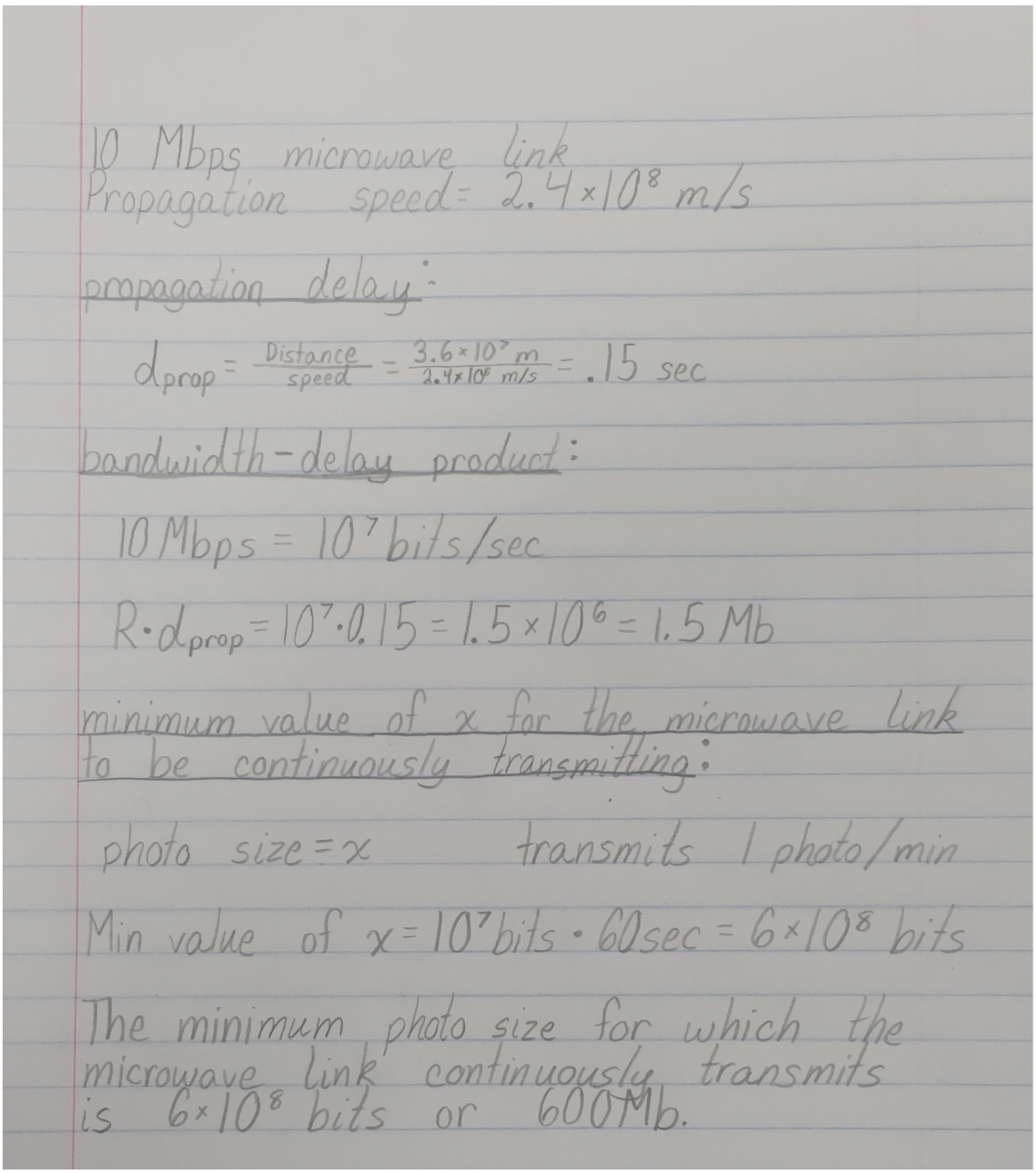
a. Find the total average response time.



b. Now suppose a cache is installed in the institutional LAN. Suppose the miss rate is 0.4. Find the total response time.



6. **Suppose there is a 10 Mbps microwave link between a geostationary satellite and its base station on Earth. Every minute the satellite takes a digital photo and sends it to the base station. Assume a propagation speed of 2.4 x 10^8 meters/sec.**
   a. What is the propagation delay of the link?
   b. What is the bandwidth-delay product, R · d_{prop}?
   c. Let *x* denote the size of the photo. What is the minimum value of *x* for the microwave link to be continuously transmitting?



10 Mbps microwave link
Propagation speed = 2.4×10^8 m/s

propagation delay:

$d_{prop} = \frac{\text{Distance}}{\text{speed}} = \frac{3.6 \times 10^7 \text{ m}}{2.4 \times 10^8 \text{ m/s}} = .15$ sec

bandwidth-delay product:

10 Mbps = 10^7 bits/sec

$R \cdot d_{prop} = 10^7 \cdot 0.15 = 1.5 \times 10^6 = 1.5$ Mb

minimum value of x for the microwave link to be continuously transmitting:

photo size = x transmits 1 photo/min

Min value of $x = 10^7$ bits · 60sec = 6×10^8 bits

The minimum photo size for which the microwave link continuously transmits is 6×10^8 bits or 600Mb.