

Solutions for CSE 5344 Homework 1

Problem 1 Solution:

- When circuit switching is used, at most 15 circuit-switched users that can be supported. This is because each circuit-switched user must be allocated its 10 Mbps bandwidth, and there is 150 Mbps of link capacity that can be allocated.
- No. Under circuit switching, the 29 users would each need to be allocated 10 Mbps, for an aggregate of 290 Mbps - more than the 150 Mbps of link capacity available.
- The probability that a given (*specific*) user is busy transmitting, which we'll denote p , is just the fraction of time it is transmitting, i.e., 0.100. The probability that one specific other user is not busy is $(1-p)$, and so the probability that *all* of the other $N_{ps}-1$ users are not transmitting is $(1-p)^{N_{ps}-1}$. Thus the probability that one specific user is transmitting and the remaining users are not transmitting is $p(1-p)^{N_{ps}-1}$, which has the numerical value of 0.0052334763302736. This user will be transmitting at a rate of 10 Mbps over the 150 Mbps link, using a fraction 0.0667 of the link's capacity when busy.
- The probability that exactly one (*any* one) of the N_{ps} users is busy is N_{ps} times the probability that a given specific user is transmitting and the remaining users are not transmitting (our answer to (c) above), since the one transmitting user can be any one of the N_{ps} users. The answer to (d) is thus $N_{ps}p(1-p)^{N_{ps}-1}$, which has the numerical value of 0.15177081357793.
- The probability that 15 specific users of the total 29 users are transmitting and the other 14 users are idle is $p^{15}(1-p)^{14}$. Thus the probability that *any* 15 of the 29 users are busy is $(29 \text{ choose } 15)p^{15}(1-p)^{14}$, ($29 \text{ choose } 15$) is the $(29, 15)$ coefficient of the binomial distribution. The numerical value of this probability is 1.7742956555841E-08.
- The probability that more than 15 users of the total 29 users are transmitting is $\sum_{i=16,29} (29 \text{ choose } i)p^i(1-p)^{29-i}$. The numerical value of this probability is 1.88317594851384E-09. It's important to note that 15 is the maximum number of users that can be supported using circuit switching (the answer to part (a)). With packet switching, nearly twice as many users (29) are supported with a small probability that more than 15 of these packet-switching users are busy at the same time.

Problem 2 Solution:

Link 1 transmission delay = $L/R = 8000 \text{ bits} / 100 \text{ Mbps} = 0.08000 \text{ msec}$.

Link 1 propagation delay = $d/s = 3 \text{ Km} / 3 \times 10^8 \text{ m/sec} = 0.010000 \text{ msec}$.

Link 2 transmission delay = $L/R = 8000 \text{ bits} / 10 \text{ Mbps} = 0.800000 \text{ msec}$.

Link 2 propagation delay = $d/s = 5000 \text{ Km} / 3 \times 10^8 \text{ m/sec} = 16.666667 \text{ msec}$.

Link 3 transmission delay = $L/R = 8000 \text{ bits} / 1000 \text{ Mbps} = 0.008000 \text{ msec}$.

Link 3 propagation delay = $d/s = 2 \text{ Km} / 3 \times 10^8 \text{ m/sec} = 0.006667 \text{ msec}$.

Thus, the total end-to-end delay is the sum of these six delays: 17.499333 msec.

Problem 3 (Wireshark Intro) Solution:

Answers will vary due to the details of your connection and local area network. See instructor for examples or with questions.

Discussion of Q1. Some of the common protocols that you should see are UDP, TCP, ARP, ICMP, MDNS, and STUN.

Discussion of Q2. By default, the value of the Time column in the packet listing window is the amount of time, in seconds, since Wireshark tracing began. To display the Time field in time-of-day format, select the Wireshark View pull down menu, then select Time Display Format, then select Time-of-day. In one example, the GET was sent at 11.300694 and the reply was received at 11.301658. The delay was thus 0.000964 seconds. If yours varied significantly, try to assess why you think this is so.

Discussion of Q3. The IP address of gaia.cs.umass.edu is 128.119.245.145. The address of your computer will vary.