Avery Peiffer
ECE 1150
Assignment 1

1. (a) A packet-switched network would be better for this application because the network's resources can be allocated on-demand. This network has a short duration of connection and a low probability of connection, so allocating resources to a circuit switching network would be inefficient and slow.

(b) A circuit-switched network would be more appropriate for this application because it is a more consistent application. The connections also run for a relatively long period of time, so it mitigates the setup cost for connections.

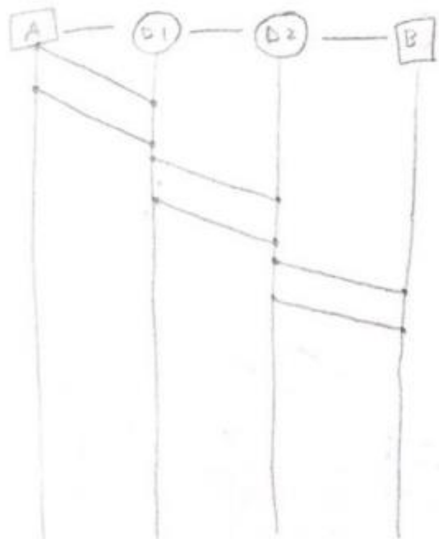
2. (a) In the star topology, all nodes are connected to a central node. These networks are susceptible to traffic problems and have a single point of failure. The tree topology establishes a parent-child relationship between routers and end devices, but also suffers from having a single point of failure. The ring topology connects all devices in a loop, which can lead to poor communication latency for long routes. Finally, mesh networks establish links directly between devices, which is flexible but can be more expensive and harder to manage.

(b) In simplex communications, communication can occur in one direction only, at all times. Half-duplex communications have bi-directional communication, but only one direction is possible at a time. Full-duplex communications have communication in both directions simultaneously.

(c) Personal Area Networks (PANs) tend to encompass an individual. Local Area Networks (LANs) connect a building. Metropolitan Area Networks (MANs) connect cities and Wide Area Networks (WANs) connect entire countries.

3. (a)

3.




$P = 5\ \mu s = 5 \times 10^{-6}\ s$

$$T_{p,total} = \frac{1 \times 10^3\ m}{3 \times 10^8\ \frac{m}{s}} \cdot (3\ \text{links})$$

$$= 1 \times 10^{-5}\ s = 10\ \mu s$$

$$T_t = \frac{M}{B} = \frac{1050 \cdot 8\ \text{bits}}{1 \times 10^6\ \frac{b}{s}} = .0084\ s$$

(a) $\text{Delay} = N_H T_p + N_m T_t + (N_H - 1)(T_T + P)$

$$= (3)\left(\frac{1 \times 10^3\ m}{3 \times 10^8\ \frac{m}{s}}\right) + (10)\left(\frac{1050 \cdot 8\ \text{bits}}{1 \times 10^6\ \text{bps}}\right)$$

$$+ (2)\left(\frac{1050 \cdot 8\ \text{bits}}{1 \times 10^6\ \text{bps}} + 5 \times 10^{-6}\ s\right)$$

$$= 1 \times 10^{-5}\ s + .084\ s + .01681\ s$$

$$= \boxed{.10082\ s}$$

(b)

(b) $$\text{Throughput} = \frac{\left(1000\ \frac{\text{bytes}}{\text{packet}}\right)(10\ \text{packets}) \cdot 8}{.10082\ s} = \boxed{.793\ \text{Mbps}}$$

$$\text{Efficiency} = \frac{1000\ \text{bytes}}{1050\ \text{bytes}} = \boxed{.952}$$

(c)

(c) Setup = teardown = 70 $\mu s$

$1000 \cdot 10 \cdot 8 = 80000$ bits

$\text{Delay} = \text{Setup} + T_p + T_t + \text{Teardown}$

$$= 7 \times 10^{-6}\ s + \frac{3 \times 10^3\ m}{3 \times 10^8\ m/s} + \frac{80000\ \text{bits}}{1 \times 10^6\ \frac{\text{bits}}{s}} + 7 \times 10^{-6}\ s$$

$$= \boxed{.080024\ s}$$

(d) The circuit switching network looks to be more efficient for this application.

(d) $\text{Throughput} = \dfrac{80000 \text{ bits}}{.080024 \text{ s}} = \boxed{.9997 \text{ Mbps}}$

$$\text{Efficiency} = \frac{.9997 \text{ Mbps}}{1 \text{ Mbps}} = \boxed{.9997}$$

$$= \frac{\text{Throughput}}{\text{Bit rate}}$$

4.

4. Total bytes $= 800 \times 600 \times 3 = 1440000$ bytes $= 11520000$ bits

$$\frac{11520000 \text{ bits}}{56 \cdot 10^3 \frac{\text{bits}}{\text{s}}} = 205.7 \text{ s} \qquad \frac{11520000 \text{ bits}}{1 \times 10^6 \frac{\text{bits}}{\text{s}}} = 11.52 \text{ s} \qquad \frac{11520000 \text{ bits}}{1 \times 10^7 \frac{\text{bits}}{\text{s}}} = 1.15 \text{ s}$$

$$\frac{11520000 \text{ bits}}{100 \times 10^6 \frac{\text{bits}}{\text{s}}} = 0.115 \text{ s} \qquad \frac{11520000 \text{ bits}}{1 \times 10^9 \frac{\text{bits}}{\text{s}}} = .0115 \text{ s}$$

5. (a)

(a) $\# \text{ Users} = \dfrac{3 \times 10^6 \text{ bits/s}}{150 \times 10^3 \text{ bits/s}} = \boxed{20 \text{ users}}$

(b) Used Python to output to console

```
r        p(r)
10       0.10749523359635779
20       0.007825579711977492
30       1.293075347099429e-06
40       2.5027750202425175e-12
60       1.7361798631142224e-28
120      1.0000000000000094e-120
mean = 12.0
variance = 10.8
```

6. (a)

(a) $$\text{Delay} = \underbrace{N_H T_P}_{2\ \mu s} + N_M T_T + (N_H - 1)(T_T + P)$$

Ignore

$$T_1 = \frac{240 \text{ bytes}}{B} \qquad T_2 = \frac{10 \text{ bytes}}{B}$$

$$\text{Delay total} = (2\times10^{-6}\,s) + \frac{(240 \text{ bytes})8}{B}(1) + (1)\left(\frac{240\cdot 8}{B}\right)$$

$10\times10^{-3}$ s

$$+ (2\times10^{-6}\,s) + \left(\frac{10 \text{ bytes}}{B}\right)\cdot 8 + \left(\frac{10\cdot 8}{B}\right)$$

$$.009996 = 8\cdot\left(\frac{500 \text{ bytes}}{B}\right) \qquad \boxed{B = 0.4 \text{ Mbps}} \qquad 401606\ \frac{b}{s}$$

(b)

(b) $$10\times10^{-3} = (4\times10^{-6}) + \frac{500\cdot 8}{B} + 5\times10^{-3} \qquad \boxed{B = 0.8 \text{ Mbps}} \qquad 800640\ \frac{b}{s}$$

(c) The premium DSL technology is the only one that would support this application because it requires too high of a bit rate for the other two options.

7. (a)

```
C:\Users\Avery Peiffer\Desktop>tracert www.pitt.edu

Tracing route to www.pitt.edu [136.142.34.104]
over a maximum of 30 hops:

  1     3 ms     1 ms     2 ms  192.168.0.1
  2    15 ms     *       14 ms  96.120.62.169
  3    11 ms    26 ms    12 ms  96.110.215.125
  4    13 ms    19 ms    17 ms  69.139.195.125
  5     *       12 ms    15 ms  96.108.91.110
  6    16 ms    11 ms    13 ms  162.151.152.154
  7    17 ms    66 ms    12 ms  50-207-186-42-static.hfc.comcastbusiness.net [50.207.186.42]
  8     *        *        *     Request timed out.
  9     *       16 ms    11 ms  vl712.cl-core-2.gw.pitt.edu [136.142.2.162]
 10    20 ms     *       11 ms  et8-1.rd-core-1.gw.pitt.edu [136.142.253.237]
 11    16 ms    15 ms    25 ms  www.pitt.edu [136.142.34.104]

Trace complete.
```

(b) There are 26 hops from my device to the destination.