ECE361 Homework 1

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R1. What is the difference between a host and an end system? List several different types of end systems. Is a Web server an end system?

*The word, **host**, and **end system** are used interchangeably, so there is no significant difference. Quoted from section 1.2 (p11), "host = end system".*

List different types of end systems: TVs, gaming consoles, home security systems, cars, etc.

Web server is an end system, as it connects to the Internet.

R4. List 4 access technologies. Classify each one as home access, enterprise access, or wide-area wireless access.

Access technologies:

- *Home access*
  - *Digital subscriber line (DSL)*
  - *Cable*
  - *Fiber to the home (FTTH)*
  - *5G fixed wireless*
- *Enterprise access*
  - *Ethernet*
  - *Wifi*
- *Wide-area wireless access*
  - *3G*
  - *LTE 4G*
  - *5G*

R14. Why will two ISPs at the same level of the hierarchy often peer with each other? How does an IXP earn money?

*To obtain global Internet interconnectivity, customer ISPs pay their provider ISPs, and **peering** with each other reduce this cost. This is because peered ISPs can directly connect their networks such that all traffic are kept within their direct connection rather than through the costly upstream intermediaries.*

As an IXP is a stand-alone building with its own switches and thus it enables ISPs to meet at one location and exchange traffic. Therefore, it earns money by charging its connected ISPs according to their received amount of traffic.

P2.

$$\because d_{end-to-end} = N\frac{L}{R} \Rightarrow \text{having P number of packages, we need to have } (\mathrm{P}-1)$$

extra source package emissions （ not counting the first package emission ）

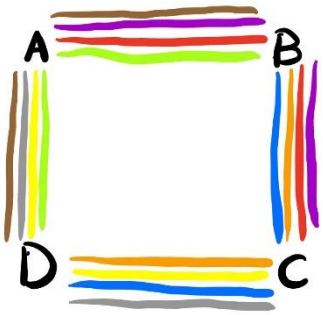
$$\therefore d_{\mathrm{end-to-end}} = \mathrm{N}\frac{\mathrm{L}}{\mathrm{R}} + (\mathrm{P}-1)\frac{\mathrm{L}}{\mathrm{R}}$$

P4.

a. $4 \times 4 = 16$

b. 4

c. Yep.



P7.

$$\frac{56 \text{ byte}}{64 \text{ kb/sec}} = \frac{56*8 \text{ bit}}{64*1000 \text{ bits/sec}} = 0.007 \text{ s} = 7 \text{ ms}$$

$$\frac{56 \text{ byte}}{10 \text{ Mb/sec}} = \frac{56*8 \text{ bit}}{10*10^{6}\text{bits/sec}} = 4.48 \times 10^{-5} \text{ s} = 0.0448 \text{ ms}$$

$$\mathrm{t_{total}} = 7 + 0.0448 + 10 = 17.0448 \text{ ms}$$

P8.

a. $\frac{10*10^{6}}{200*10^{3}} = 50 \text{ users}$

b. $\frac{1}{50} * 0.1 = 0.002$

c. $P[\text{n users active}] = \binom{120}{n} (0.1)^n (1-0.1)^{120-n}$

d. $P = \sum_{k=51}^{120} \binom{120}{k} (0.1)^k (1-0.1)^{120-k} = 2.06e-20 \approx 0$

Python codes for calculating summation:

```
import math

def nCr(n,r):
    f = math.factorial
    return f(n) // f(r) // f(n-r)

p=0
for i in range(51,121):
    p += nCr(120,i)*(0.1**i)*(0.9**(120-i))

print("the total prob is: ", p)
```

P12.

a. $\frac{1500*8*4.5}{2.5*10^6} = 0.0216s = 21.6ms$

b. $t_{half-way} = \frac{L-x}{R}, \; t_{wait} = \frac{L}{R} \cdot n$

$t_{queue} = t_{half-way} + t_{wait} = \frac{L-x+L \cdot n}{R}$

P16.

$$d = 20ms + \frac{1}{100}s = 0.03s$$

$$N = a*d \Rightarrow d = \frac{N}{a} = \frac{100 \text{ packets}}{0.03ms} = 3333.3 \text{ packets/ms}$$

P24.

$$\frac{50*8*10^{12}}{100*10^6} * \frac{1}{60*60*24} = 46.2963 \text{ days} > 1 \text{ day}$$

Therefore, FedEx overnight delivery is a much better choice.