CSC138-01 HW1

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1. a. nodal processing delay, queuing delay, transmittion delay, propagation delay

   b. transmittion delay is the time taken to push all the bits of a paket into the link, whereas propagation delay is the time taken for a bit to travel over the link.

   c. The propagation delay will increase if the length of the paket is increased.

2. a. circuit switched type would be more proper because the data is continuously given and the amount is fixed, so there is no waste if a resource is reserved.

   b. $150 \div 10 = 15$ people is the maximum
   because in circuit-switched network each person should reserve 10Mbps all the time, even they are only active 10 percent of the time.

3. Let X is the number of users transimmitting at a given time.

   a. $P(X=1) = \binom{29}{1}(0.1)^1(0.9)^{28} = 29 \times 0.1 \times 0.9^{28} \approx 0.151771$

   b.

```
import math

def binomial_pmf(n, x, p):
    # Calculate binomial coefficient
    binomial_coeff = math.comb(n, x)
    # Calculate PMF using binomial distribution formula
    pmf = binomial_coeff * (p ** x) * ((1 - p) ** (n - x))
    return pmf

# Total users
n = 29
# Probability of a single user transmitting
p = 0.1  # 10% active time

# Calculate P(x <= 15) by summing P(x) for x = 0 to 15
accuracy = 6
probability_x_leq_15 = sum(math.floor(binomial_pmf(n, x, p)*10**accuracy)/10**accuracy for x in range(16))
print(f'Probability P(x <= 15): {probability_x_leq_15:.{accuracy}f}')
```

```
Python 3.10.11 (tags/v3.10.11:7d4cc5a, Apr  5
C v.1929 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "licens
mation.
>>>
========== RESTART: C:WUsersWs_uu0078W
==========
Probability P(x <= 15): 0.999991
>>>
```

$$P(X \le 15) = \sum_{k=0}^{15} \binom{29}{k}(0.1)^k(0.9)^{29-k} \approx 0.999991$$

   c. $P(X>15) = 1 - P(X \le 15) \approx 0.000009$
   Since the probability of having more than 15 people at the same time is really low, packet switching is very efficient in this scenario as it allows a large number of users (in this case 29)

4. a. transmission delay: $8000 \text{ bits} / 100 \text{ Mbps} = \frac{8000 \text{ bits}}{100 \times 10^6 \text{ bits/sec}} = 8 \times 10^{-5} \text{ sec} = 80 \mu s$

propagation delay: $3 \text{ km} / (3 \times 10^8 \text{ m/sec}) = \frac{3000 \text{ m}}{3 \times 10^8 \text{ m/sec}} = 10^{-5} \text{ sec} = 10 \mu s$

b. transmission delay: $8000 \text{ bits} / 10 \text{ Mbps} = \frac{8000 \text{ bits}}{10 \times 10^6 \text{ bits/sec}} = 8 \times 10^{-4} \text{ sec} = 800 \mu s$

propagation delay: $5000 \text{ km} / (3 \times 10^8 \text{ m/sec}) = \frac{5000\,000 \text{ m}}{3 \times 10^8 \text{ m/sec}} = \frac{1}{60} \text{ sec} = \frac{10^5}{6} \mu s$

c. transmission delay: $8000 \text{ bits} / 1000 \text{ Mbps} = \frac{8000 \text{ bits}}{1000 \times 10^6 \text{ bits/sec}} = 8 \times 10^{-6} \text{ sec} = 8 \mu s$

propagation delay: $2 \text{ km} / (3 \times 10^8 \text{ m/sec}) = \frac{2000 \text{ m}}{3 \times 10^8 \text{ m/sec}} = \frac{2}{3} \times 10^{-5} \text{ sec} = \frac{2}{3} \times 10 \mu s$

d. $80 \mu s + 10 \mu s + 800 \mu s + \frac{10^5}{6} \mu s + 8 \mu s + \frac{2}{3} \times 10 \mu s$

$= 898 \mu s + \frac{5}{3} 10^4 \mu s + \frac{2}{3} 10 \mu s = 17571.\dot{3} \mu s$

e. Let's let link1 should be x km to meet the condition.

$80 \mu s = x \text{ km} / 3 \times 10^8 \text{ m/sec}$

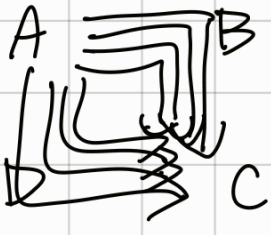
$= \frac{1000 \cdot x \text{ m}}{3\,0000\,0000 \text{ m}} \text{ sec} \quad (1 \mu s = 10^{-6} \text{ sec})$

$x = 80 \mu s \times 3000000 \frac{1}{\text{sec}}$

$= 80 \frac{300000 \text{ sec}}{1000000 \text{ sec}} = 24 \quad \therefore 24 \text{ km}$

5. a. $4 \times 4 = 16$

b. 4 (through A, B, C) + 4 (through A, D, C) = 8



c. possible like this

6. $\frac{200 \text{ terabytes}}{10 \text{ Gb/s}} = \frac{200 \times 8 \times 10^{12} \text{ bits}}{10 \times 10^9 \text{ bits/s}} = 16 \times 10^4 \text{ s} = \frac{16 \times 10^4 \text{ s}}{3600 \text{ s/h}} = 44.44 \text{ h}$

so dedicated link will take 44.44h which is longer than 24h.

Therefore I should use FedEx.

7. a. First, protocal layers allow for the modular design of network systems. It enables easier development, maintenance, and upgrades of individual layers without impacting the entire system.
Secondly, protocol layers promote interoperability as different layers can be developed and updated independently. This ensures compatibility and smooth communication between diverse HW, SW components.

b. First, protocol layers leads additional processing and communication overhead due to the need for encapsulation, parsing, and routing at each layer, potentially increase latency in data transmission.
Secondly, managing and troubleshooting a system with multiple protocol layers can be challenging, as issues at one layer can affect others, requiring expertise and time for resolution.

8.

A	A	A	A	A	B	B	C	C	C	D	D	E

13 slots are needed. (each slot recieves 4Kbps)