HW1

1. What devices can be considered as an end system in the network?

Answer: ABCD

2. Consider two hosts A and B transmit packets through three routers S1, S2, S3. Suppose the rates of the A – S1, S1 – S2, S2 – S3, and S3 – B links are R1, R2, R3, and R4, respectively. Let R1 < R2 < R3 < R4. What should the throughput between A and B be?

Answer: A 因为吞吐量取决于最短的 link R1

3. Consider a router transmitting a packet of 15KB to another router on the same university campus, at a data rate of 10 Mbps. Assuming delay is expressed as n・10−k (seconds), where 1/= n<10, the value k for propagation delay is (choose from a to d). In this example, the statement that “total packet delivery time is dominated by the propagation delay time”is (choose from e and f).

Answer: B E

4. 传输时延 (transmission delay) = 数据包大小 / 传输速率

数据包为 15KB = 15 × 8 Kbits = 120 Kbits = 120 × 10^3 bits。

传输速率为 10 Mbps = 10 × 10^6 bps。

传输时延 = (120 × 10^3 bits) / (10 × 10^6 bps) = 0.012 seconds = 12 × 10^(-3) seconds

当处理时延和队列时延都为 0 时，端到端的总时延是由以下组成的：

Answer: D

传输时延 (transmission delay)：这是将整个数据包的所有比特传输到链路上所需的时间。

传播时延 (propagation delay)：这是一个比特从发送端传到接收端所需的时间

总时延便是第一个 bit 传播完成+所有 bit 传输的时间

5. Choose all the following statement(s) that is(are) correct about ‘La/r’, where ‘a’ is the packet arrival rate, ‘L’ is the number of bits per packet, and ‘r’ is the router’s service rate.

Answer: CD

La/r 表示平均到达速率与服务速率的比率，也被称为流量强度。

当平均 La/r>1 时，到达速率超过了路由器的服务速率，这意味着路由器无法处理所有到达的数据包，因此一些数据包将会在队列中被丢弃。

如果平均 La/r 减少，平均等待时间会减少。当流量强度 (到达速率与服务速率的比率) 减少时，系统的负载也会减少，因此数据包的平均等待时间会减少。

当 La/r 接近 0 时，平均等待时间也会接近 0。当流量强度几乎为 0 时，几乎没有数据包等待处理，因此平均等待时间会接近 0。

当 La/r 增加并接近 1 时，平均等待时间会线性增加。这个陈述是不准确的。当流量强度接

近 1 时，系统变得越来越繁忙，队列长度和等待时间会急剧增加，但不是线性增加

6. A network administrator tells you that at most 800 users can be accommodated by statistical multiplexing, given that each user needs 1 Mbps bandwidth and has a 20% chance of being active. This means, the total bandwidth is no less than (choose from a and b). With TDM, 800 such users (choose from c and d) be accommodated.
Answer: BC

2. Probability and Throughput
Suppose that 3 users are sharing a 300 Mbps connection. Each user uses the link 20% of the time. Assume their internet access activity is independent from each other and the network use is distributed uniformly.
1. What is the probability that no user is using the link simultaneous at the given time?
Answer: $0.8 \times 0.8 \times 0.8 = 0.512$

2. What is the probability that two users are using the link simultaneous at the given time?
Answer: 3C2*0.2*0.2*0.8 = 0.096 = 9.6%

3. Suppose that you want to use the link. Assume that when two or more people use the bandwidth are divided fairly among them. What is the average bandwidth you will receive?
Answer:
1）myself alone: 0.8*0.8*0.8 = 0.512 300Mbps
2）use with other one: 3*0.8*0.8*0.2 = 0.384 150Mbps
3）use with other two: 3*0.2*0.8*0.2 = 0.096 100Mbps
4）use with other three 0.2*0.2*0.2 = 0.008 75Mbps
So the average bandwidth is 0.512*300 + 0.384*150 + 0.096*100 + 0.008*75 = 221.4 Mbps

3. Delays
1. Explain the difference between transmission delay and propagation delay.
Transmission Delay: This is the amount of time it takes for a packet (or the entire message) to be pushed out of the source node onto the link. It depends on the size of the packet and the bandwidth (rate) of the link. If L is the length of the packet in bits and R is the bandwidth of the link in bits per second, the transmission delay is given by:
dtrans = L/R
Propagation Delay: This is the time it takes for a bit to travel from the beginning of the link to the other end. It's determined by the physical length of the link and the propagation

speed of the signal in the medium (which is typically a fraction of the speed of light). If D is the distance the signal travels and s is the propagation speed, the propagation delay is given by:
dprop = D/s

2. Suppose a router processes packets at the rate R=1 packet per second. Packets are arriving into the router's queue at time ticks (in seconds) shown in the table below. Compute (A) the average packet throughput in the first 10 seconds (B) the average queuing delay. Please only type in the final result in the text box. (Round your answer to 2 decimal places)

1. first one

A: 9 packets arrive in the first 10 seconds, so the average packet is 9/10 = 0.90 packet/s

B: 1/10 = 0.10. Since the rate is 1 packet/second, and the p6 and p7 arrivea at the same time, p7 need to wait one second while the following two packages are not affected.

2. second one

A: 10 packets arrive in the first 10 seconds, so the average packet is 10/10 = 1.00packet/s

B: (0+1+2+3+0+1+2+3+4+5)/10 = 2.10

Consider two hosts, A and B, that are connected by switch S. The link A-S is 100Mbps and has a propagation delay of 10ms. The link B-S is 80Mbps and has a propagation delay of 30ms. (1B = 8 bit, Assume 1KB = 1000B, 1MB = 1000KB)

1) . Assume that no processing delay. If A sends a 1MB packet to B, what will the end-to-end delay be?

1MB*8/100Mbps = 0.08s

1MB*8/80Mbps = 0.1s

10ms+30ms+80ms+100ms = 220ms

2) . Suppose A sends 20 100KB packets to B continuously. Suppose S has a 500KB buffer for packets, will the packet be dropped?

100KB*8/100Mpbs = 8ms

20*8ms = 160ms

100KB*8/80Mbps = 10ms

Every 10ms, S send a packet to B, while every 8ms A send a packet to S.

There can be at most 5 packets in S.

10-8 = 2ms, every one packet is sent, 2ms of the data will increase in the buffer. n*2/8 = 5 -> n = 20. Therefore, there is no packets droped.

3). Assume the buffer is infinite. A sends 100KB packets continuously. How long will it take for A to send 100MB. What is the average throughput?

100MB/100kb = 1000 packets

1000*8ms = 8s

100MB/8s = 12.5MB/s

Answer: It taks 8s to send 100MB, the average throughput is 12.5MB/s

4 Bandwidth

Shannon's ground breaking equation says that: C = Blog2 (1 + SNR) where C is the data rate in bits/s achievable on the communication link (also called capacity), B is the bandwidth in Hz, and SNR is the ratio of received signal power to the receiver's noise power. Assume that the received signal power density P ∝ 1 R2 where R is the distance between sender and receiver.

1. Suppose a laptop tends to transmit to a WIFI station located 10m away. Assume signal power density measured 2 meters from the laptop is Q = 12milliW att/m2 and the noise power density at the receiver is N = 0.01milliW att/m2 . Suppose the laptop transmits at a bandwidth of 20MHz, what data rate can it achieve? (round your answer to 3 decimal places)

p10 = P2* (R2/R10)^2 -> p10 = 0.48

SNR = p10/N = 48

C = 20log(1+NSR) = 112.29Mbps

Answer: The laptop can achieve a data rate of approximately 112.294Mbps

2. List two methods to increase the data rate:

Increase the Bandwidth and improve the SNR

3.

C' = 3*C

C' = 3*112.294 = 336.882

C' = B*log(1+SNR')

log(1+SNR') = 16.8441 -> SNR' = 117645.5917

SNR' = (R/R')^2 * SNR -> R' = 0.20199

Answer: the laptop should be 0.20199m

5 Internet concept

1. abdfg

a) : T

b) : T

c) : F

d) : T

e) : F

f) : T

g) : T

2. Briefly answer the following questions.

(a) List at least one advantage and disadvantage of protocol layering.

Advantage: Modularity: Protocol layering allows each layer to focus on a specific functionality or service. This modular design means that changes or updates can be made to one layer without necessarily affecting others. It simplifies design, implementation, and troubleshooting.

Disadvantage: Overhead: Each layer can introduce its own header or encapsulation, leading to additional overhead. This can decrease the efficiency, especially when the data units being transmitted are small relative to the combined size of the headers.

(b) Why will two ISPs at the same level of the hierarchy often peer with each other? How does an IXP earn money?
Cost Savings and Improved Performance:
By peering directly, ISPs can avoid paying transit fees to upstream providers for routing traffic to one another. Direct peering also often results in shorter paths and thus lower latencies and potentially better throughput.

How does an IXP earn money?
Membership/Connection Fees: IXPs (Internet Exchange Points) often charge ISPs and other members a fee for connecting to the exchange. This fee may vary based on the connection speed or capacity.