【111-2】Introduction to Computer Network

Final Exam

1. Known that rdt3.0 is applied between sender and receiver with 100 Mbps link, 5000 bit packet, and 5 ms propagation delay (end-to-end delay between sender and receiver). Please calculate the utilization of the sender by using following operations.
   a. Stop-and-wait operation. **(5%)**
   b. Pipelined operation with 5 packets, see **Fig. 1**. **(5%)**

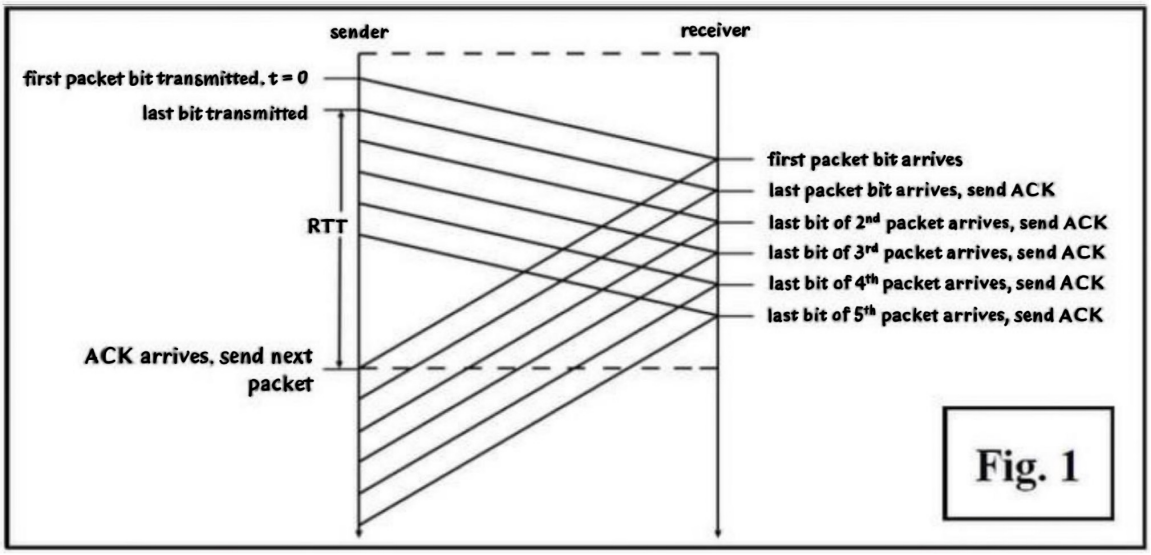


Fig. 1

link speed : 100 M bps

packet size : 5000 bits

propagation delay : 5 ms = 0.005 s ⇒ RTT = 10 ms

$$\text{Transmission Delay} = \frac{\text{packet size}}{\text{link speed}} = \frac{5000}{100\times10^{-6}} = 5\times10^{-5}$$

(a).

$$\text{Utilization} = \frac{\text{Transmission Delay}}{\text{RTT} + \text{Transmission Delay}} = \frac{5\times10^{-5}}{10\,\text{ms} + 5\times10^{-5}} = \frac{1}{201} \fallingdotseq 0.00497$$

(b).

$$\text{Utilization} = \frac{\text{Transmission Delay} \times \text{packets 數量}}{\text{RTT} + \text{Transmission Delay}} = \frac{5\times10^{-5}\times5}{10\,\text{ms} + 5\times10^{-5}} = \frac{5}{201}$$

$$\fallingdotseq 0.02485$$

2. There is one flow in one router. The router's butter is finite and its link capacity is R. Known that sender sends only when router buffers are available. The relation between original data (λ_{in}) and throughput (λ_{out}) is depicted in **Fig. 2**. If packet can be lost or dropped due to full buffers, retransmissions are required. The new original data plus retransmitted data is denoted as λ'_{in}. Please depict the relation between λ_{out} and λ'_{in} under the following scenarios.
You MUST point out the affected throughput is attributed to what operations.

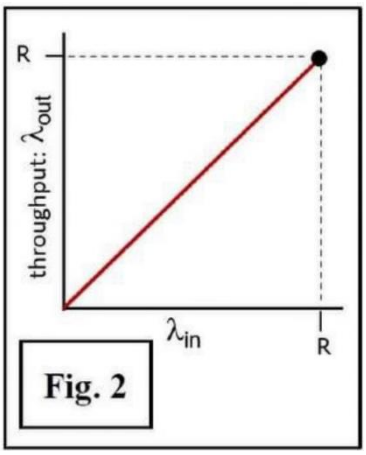
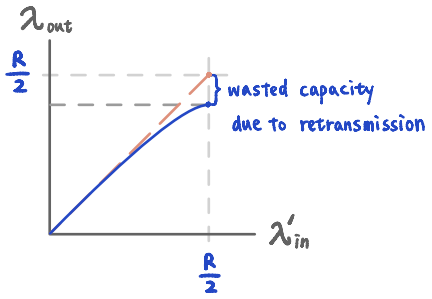


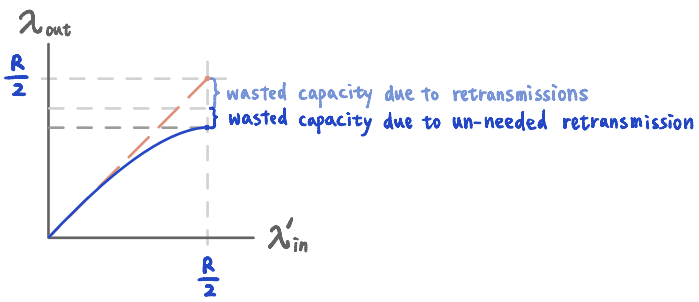
Fig. 2

   a. Loss then retransmission. **(5%)**
   b. Loss then un-needed retransmission. **(5%)**

a.



b.



3. Please compare TCP (Transmission Control Protocol) and UDP (User Datagram Protocol) at least three points of view. **(10%)**

1. TCP 是 connected oriented , UDP不是
2. TCP 是 reliable delivery , UDP 是 unreliable delivery
3. TCP 是 in-order delivery , UDP 是 unordered delivery
4. TCP 有 congestion control 和 flow control , UDP 沒有

4. Known that an IP address is 140.116.246.125/26 and its subnet mask is 255.255.255.192. Please present it as the dotted decimal notation format **(5%)**, and point out the bits belong to subnet part and host part espectively **(5%)**. Including the first IP address and the last IP address (broadcast IP address), how many IP addresses in this subnet? **(5%)**

140.116.246.125/26

10001100,01110100,11110110,01111101

subnet part　　host part

6 bits ⇒ $2^6 = 64$

64個 IP address in this subnet

255.255.255.192

11111111,11111111,11111111,11000000

5. **Fig. 3** shows that layer 2 frames with destination MAC address 22:A7:23:11:E1:02 should be forwarded to router output port 6. Please depict the flow tables of the following operations.
   a. IP datagrams destined to IP address 51.6.0.8 should be forwarded to output port 3. **(5%)**
   b. Block (do not folward) all datagrams destined to HTTP port 80. **(5%)**

	Switch Port	MAC src	MAC dst	Eth type	VLAN ID	VLAN Pri	IP Src	IP Dst	IP Prot	IP ToS	TCP s-port	TCP d-port	Action
Fig. 3	*	*	22:A7:23:11:E1:02	*	*	*	*	*	*	*	*	*	port6

a.

Swich Port	Mac src	Mac dst	Eth type	VLAN ID	VLAN Pri	IP Src	IP Dst	IP Prot	IP Tos	TCP s-port	TCP d-port	Action
*	*	*	*	*	*	51.6.0.8	*	*	*	*	*	port 3

b.

Swich Port	Mac src	Mac dst	Eth type	VLAN ID	VLAN Pri	IP Src	IP Dst	IP Prot	IP Tos	TCP s-port	TCP d-port	Action
*	*	*	*	*	*	*	*	*	*	*	*	port 80

6. When looking for forwarding table (see **Table 1**) entry for a given destination address use longest address prefix that matches the destination address. Please answer which interface should take for the following destination addresses.
   a. 11001000 00010111 00011010 10110011 **(5%)**
   b. 11001000 00010111 00101000 11011000 **(5%)**

Destination Address Range	Link interface
11001000 00010111 00010*** ********	0
11001000 00010111 00011000 ********	1
11001000 00010111 00011*** ********	2
11001000 00010111 00100000 ********	3
11001000 00010111 00100*** ********	4
11001000 00010111 00101000 ********	5
11001000 00010111 00101*** ********	6
11001000 00010111 00110*** ********	7
otherwise	8

Table 1

a. interface 2
b. interface 5

7. A datagram (D) 10110010 is to be sent, and the generator (G) 10011 is given. We already know that the Cyclic Redundancy Check (CRC) bits is $R = remainder[\frac{D \cdot 2^r}{G}]$.
   a. Please find out the CRC bits. Hint: by mod 2 operations. **(10%)**
   b. If no error occurs, what datagram (in bits) will the receiver receive? Hint: If no error, the received datagram should be divisible by the generator. **(5%)**

a. G 10010 ⇒ 5 bits = r+1 bits
⇒ r = 4 (補4個0)

CRC bits = 0111

```
            10101101
10011 ) 101100100000
        10011           XOR
         10101
         10011          XOR
           11000
           10011        XOR
            10110
            10011       XOR
              10100
              10011     XOR
               0111
```

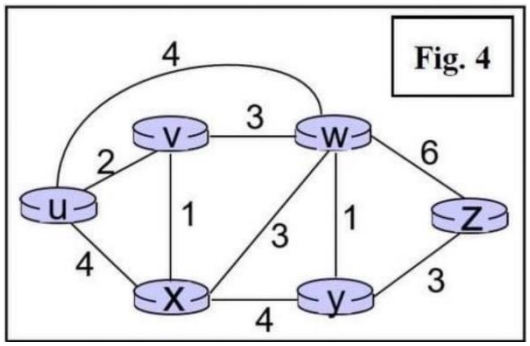
b. < D, R > = 101100100111

8. Use Dijkstra's link-state routing algorithm, known that $D(v) = min(D(v),\ D(W) + c_{w,v})$, where $D(v)$ is the current cost estimation of the least-cost-path from source to destination v, and $c_{w,v}$ is the direct link cost from node w to node v. The network topology is depicted in **Fig. 4**. Also, see **Table 2**, the notation $p(v)$ is the predecessor node along path from source to v, and N' is the set of nodes whose least-cost-path definitively known.

   a. Please complete **Table 2** on your answer sheet by using Dijkstra's link-state routing algorithm to find the least cost path from node u to all nodes. **(10%)**

   b. Please depict the resulting least-cost-path tree from node u. **(5%)**

   c. Please complete the resulting forwarding table (**Table 3**) in node u. **(5%)**



destination	outgoing link
v	(u, v)
x	(u, v)
y	(u, w)
w	(u, w)
z	(u, w)

Table 3

Step	N'	v D(v),p(v)	w D(w),p(w)	x D(x),p(x)	y D(y),p(y)	z D(z),p(z)
0						
1						
2						
3						
4						
5						

Table 2

a.

Step	N'	v D(v),p(v)	w D(w),p(w)	x D(x),p(x)	y D(y),p(y)	z D(z),p(z)
0	u	(2,u)	(4,u)	(4,u)	∞	∞
1	uv	x	(4,u)	(3,v)	∞	∞
2	uvx	x	(4,u)	x	(7,x)	∞
3	uvxw	x	x	x	(5,w)	(10,w)
4	uvxwy	x	x	x	x	(8,y)
5	uvxwyz					

c.

destination	outgoing link
v	(u, v)
x	(u, v)
y	(u, w)
w	(u, w)
z	(u, w)

b.