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Thanks!

University of Southern California
EE450: Introduction to Computer Networks
Final Exam, Two Hours
May 8, 2003

Name: **Location:**

Student ID:

Part 1	25%	21
Part 2	15%	13
Part 3	20%	20
Part 4	20%	17
Part 5	20%	15
Extra Credit (No deduction)	5%	4
Total	105%	

90

Notes:

- All your answers should be on the exam paper. If you need additional paper, please write your name, ID and location in each extra sheet
- You can work the problems in any order you wish (the goal is to try to accumulate as many points as you can)
- Try your best to be clean, and to show all the steps of your work

Rules:

- This is a closed book, closed notes exam. One 5"x7" containing formulas only and another 5"x7" containing the TCP/IP header structures are allowed along with a calculator

- Adherence to the University's Code of Ethics will be strictly monitored and enforced. Academic Integrity violations, such as cheating, will result in a series of actions and penalties including the student failing the class.

Extra Credit (5 Points, No deduction)

A router has the following CIDR entries in its table

Address/Mask	Next Hop
135.46.56.0/22	Interface 0
135.46.60.0/22	Interface 1
192.53.40.0/23	R1
Default	R2

⇒ mask 255.255.252.0
⇒ 255.255.252.0
⇒ 255.255.254.0

For each of the following IP addresses, what does the router do if a packet with that address arrive? Show your work

a) 135.46.63.10
b) 135.46.57.14
c) 135.46.52.2
d) 192.53.40.7
e) 192.53.56.7

a 135.46.63.10 AND 255.255.252.0 ⇒ 135.46.60.0
b 135.46.57.14 AND 255.255.252.0 ⇒ 135.46.56.0
192.53.40.7 AND 255.255.254.0 ⇒ 192.53.40.0
192.53.56.7 AND 255.255.254.0 ⇒ 192.53.40.0
135.46.52.2 AND 255.255.252.0 ⇒ no

so. a → interface 1
b → interface 0
c → default
d → R1
e → R1

Part 1: True/False Question (25 Points)

1. A NAT is a proxy server allowing hosts on the internet the ability to communicate with hosts on a private network

2. The sequence number in the header of the TCP segment identifies the sequence number of the segment being transmitted

3. In TCP, an ACK number of 1000 always means that 999 bytes have been successfully received.

4. TCP uses checksum, acknowledgements and time-out mechanisms for end-to-end error detection and control

5. Route calculation is not a function of the IP protocol

6. ARP is a protocol that provides a mechanism for a host to learn the MAC address of any other host across the Internet when knowing only the IP address of that other host

7. UDP provide for error-free delivery of messages to the application layer

8. Congestion control seeks to prevent sender from overburdening the network and thus from causing the router's buffers to overflow

9. In iterative DNS services, the local DNS service will return, to the DNS client, the IP address of a DNS server that will probably have the IP address of a host whose name address was specified in the DNS query.

10. Switched hubs have multiple broadcast domains where as shared hubs have single broadcast domain

11. TCP has the property of slow start to avoid congestion in the network

12. To send a request to a web server, a browser must know the web server name address

13. The MTU is the maximum number of octets that the IP protocol can encapsulate

14. In TELNET, control characters are embedded in the data stream where as in FTP, control characters are transmitted over a separate TCP connection from the data stream.

15. The maximum window size in TCP is limited by the round trip time RTT of the connection

F 16. A Host can get its IP address dynamically from its DHCP server by using 255.255.255.255 as a source IP address and 0.0.0.0 as the destination IP address.

T 17. The purpose of the MTA (mail transfer agent) is to prepare the e-mail message and create an envelope for it.

T 18. In link state routing, every router has exactly the same link state database but the routing tables are different in each router

OSPF

相邻的路由器

F 19. In distance vector routing, each router receives routing tables from every router in the network

RIP 交换路由表

F 20. BGP is an inter-domain routing protocol based on distance vector routing

T 21. Masking is the process of extracting the network/subnet address from an IP address

F 22. In switched hubs, all ports are dedicated to the stations attached to them

T 23. HTTP is a state-less application protocol where as FTP is not

T 24. In CSMA/CD-based LANs, the stations must always listen to the media even if they have no frames to transmit

F 25. A T1 service is a dedicated digital service provided over a two-wire circuit and supporting traffic at a rate of 1.544Mbps

Part 2 (5-Points for Part1, 10-Points for Part 2)

1. A packet of length 1504 Bytes (20 Bytes of header and 1484 Bytes of payload) is to be transmitted over a link that has an MTU of 576 Bytes. How many fragments are generated? For each fragment, indicates the following fields in it's header: The total length and the fragment offset.

552

Solution: MTU = 576   payload = 1484. $\frac{1484}{576} = 2.576$

so there is 3 fragments to be generated

556 ⇒ 552?

1st fragment: length: 576 + 20 (header) bytes   offset : 0

556 ⇒ 552.   69

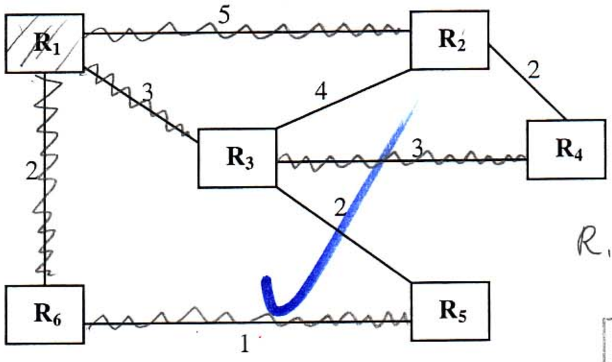
2nd fragment length 576 + 20 (header) bytes   offset : 72

⇒ 380.   139

3th fragment : length 332 + 20 (header) bytes   offset 144

-2

2. For the network shown below assume the Dijkstra algorithm is used. Find the shortest path tree from R_1 to every other router in the network. I am not interested in answers only. You need to show me the step-by-step procedure of the algorithm. Highlight the SPT and show the resulting final routing table that will be set up at router R1 (with the columns: Destination Router, Next Hop Router, Route Cost).



Solution

step	confirm	tentative
1	(R1, 0 –)	
2	(R1 0 –)	(R6, 2 R6) (R3, 3 R3) (R2, 5 R2)
3	(R1, 0 –) (R6, 2, R6)	(R5, 3, R6) (R3, 3, R3) (R2, 5, R2)
4	(R1, 0, –) (R6, 2, R6) (R5, 3, R6)	(R3, 3, R3) (R2, 5, R2)

Step	Confirm	tentative
5	(R1, 0, –) (R6, 2, R6) (R5, 3, R6) (R3, 3 R3)	(R2, 5 R2) (R4, 6, R3)
6	(R1, 0, –) (R6, 2, R6) (R5, 3 R6) (R3, 3, R3) (R2, 5, R2)	(R4, 6, R3)
7	(R1, 0, –) (R6, 2, R6) (R5, 3, R6) (R3, 3 R3)	(R2, 5, R2) R4, 6, R3)

R1 router table

desti Router	next hop	cost
R2	R2	5
R3	R3	3
R4	R3	6
R5	R6	3
R6	R6	2

Part 3 (20 Points, 10 Points for part a, 10 Points for part b)

√ a) We have a 1-km long, 10 Mbps, heavily loaded, token ring network. There are 50 stations uniformly spaced around the ring each introducing a 10-bit delay. Assume that the length of the free token is 24 bits. The overall length of the data frame is 256 bits. The propagation speed is 2×10^8 m/sec. Two different algorithms are used as described below. Calculate the effective throughput of the ring for each case

1. In the first algorithm, the station holding the token shall release it immediately after it transmits the last bit of its frame = released after completion of transmission

2. In the third algorithm, the station shall release the free token only after it receives the last bit of its data frame from the ring. =

Solution 1

$B = 10\,\text{Mbps}$, distance $= 1\,\text{Km}$

$N = 50$. $\tau = 10$ bit delay free token $= 24$ bit

frame $= 256$ bits speed $= 2 \times 10^8\,\text{m/s}$

$$T_{prop} = \frac{1\,\text{Km}}{2 \times 10^8\,\text{m/s}} = 5\,\mu s, \quad T_f = \frac{256\text{ bits}}{10 \times 10^6\,\text{bps}} = 25.6\,\mu s$$

$$T_{token\,ring} = \frac{24\text{ bit}}{10 \times 10^6\,\text{bps}} = 2.4\,\mu s \quad T_{delay} = 50 \times \tau = \frac{10\text{ bit}}{10 \times 10^6\,\text{bps}} = 1\,\mu s \times 50\,\mu s$$

$$\text{Total Time} = T_f + T_{token} + \frac{T_{prop}}{N} + \tau \qquad \text{Total Time} = T_f + T_{token} + \frac{1}{50} T_{prop} + \frac{1}{50} T_{delay}$$

$$= 25.6\,\mu s + 2.4\,\mu s + \frac{5\,\mu s}{50} + 1\,\mu s = 29.1\,\mu s$$

$$\text{Throughput} = \frac{256\text{ bits}}{29.1\,\mu s} = 8.797\,\text{Mbps}$$

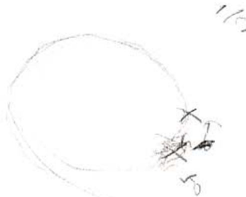
Solution 2

$$\text{Total Time} = T_f + T_{prop} + T_{token} + N \times \tau + \frac{T_{prop}}{N} + \tau$$

$$= 25.6\,\mu s + 5\,\mu s + 2.4\,\mu s + 50 \cdot 1\,\mu s + \left(\frac{5\,\mu s}{50} + 1\,\mu s\right)$$

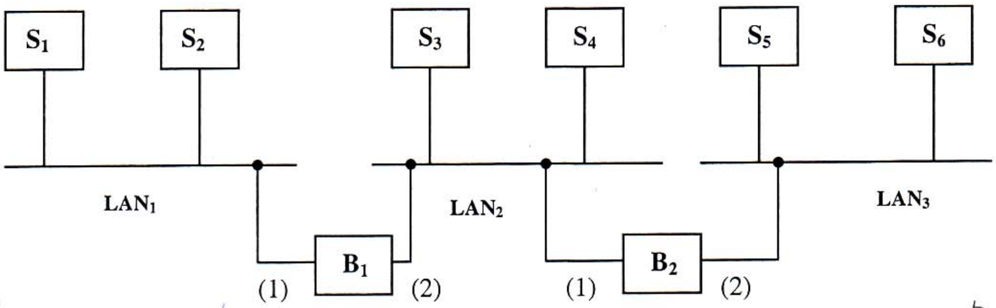
$$= 84.1\,\mu s$$

$$\text{Through put} = \frac{256\text{ bits}}{84.1\,\mu s} = 3.04\,\text{Mbps}$$



$$\text{Total Time} = T_f + \cancel{T_{prop}}\,T_{token} + \frac{51}{50} T_{prop} + \frac{51}{50} T_{delay}$$

b) Consider the following Bridged LAN comprising of three LANs. Assume the forwarding Tables are initially empty. Suppose the following stations transmit frames (in the following order): S_2 to S_1, S_2 to S_5, S_2 to S_4, S_3 to S_5, S_1 to S_2, S_6 to S_5. Clearly explain, step by step (I am not interested in final answer!) how the forwarding tables for B_1 and B_2 are filled up with appropriate entries after the frames have been completely transmitted in the above order. Indicate the mode of operation of each bridge during each step of transmissions.



(Continue)

$S_1 \to S_2$ B_1 receives it, on the table. B_1 know S_2 on port 1. So. B_1 filters it record S_1 to the table
So, B_2 cannot receive anything.

$S_6 \to S_5$: B_2 receive it, record S_6 to the table
B_2 don't know where S_5 is
B_2 flood it to LAN2
B_1. received it record S_6 to the table, B_1 flood it to LAN3

Station	Port
S_2	1
S_3	2
S_1	1
S_6	2

Station	Port
S_2	1
S_3	1
S_6	2

Solution: step 1 $S_2 \to S_1$, B_1 receive frame. B_1 will record S2, know it from port 1.
Because Table is empty. B_1 don't know where S_1 is. So flood frame to LAN2,
B_2 receive frame, record S_2 come from port 1. Because Table is empty so it ~~flood frame to every station of LAN3~~

$S_2 \to S_5$ B_1 table don't know where S_5 is. So. B_1 flood frame to LAN2
B_2. receive it. and also don't know where S_5 is. B_2 flood to LAN3

$S_2 \to S_4$. B_1 table don't know where S_4 is. So. B_1 flood to LAN2
B_2 receive it and don't know where S_4 is. B_2 flood to LAN3

$S_3 \to S_5$ B_1 receives it. record S_3 to table. Because B_1 don't know where B_5 is
B_1 flood it to LAN1. B_2 receive it, record S_3 to table
B_2 flood it to LAN3

$1\times10^3 \times 20\times10^{-3}$
$2\,K$

$100\times10^3 \times 20\times10^{-3}$
2000

Part 4 **(20 points)**

-3

a) Assume that you have a TCP source with unlimited amount of information that is transmitting over a link whose bandwidth (capacity) is 100 Mbps. The maximum segment size (MSS) is 1 Kbytes and the receiver window size is 32 Kbytes. The link RTT is 20 msec.

1. Explain, with the aid of a diagram, the behavior of the congestion window. Will there ever be congestion? If yes, when (i.e. at which RTT) and what is the threshold congestion window? If no, why not?

2. What is the effective throughput of the transfer?

b) Repeat part "a" (both questions) if the link capacity is reduced to 1 Mbps.

Solution: $B = 100\,Mbps$ $MSS = 1\,Kbps$ $W_{recv} = 32\,Kbytes$ $RTT = 20\,ms$

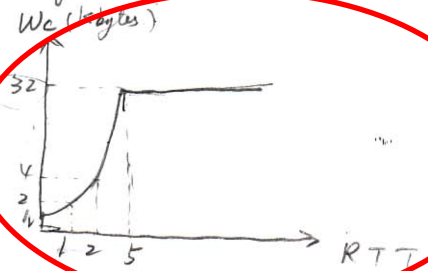
(a) 1 if we want to receive 100% utilization. the maximum send size $= 100\,Mbps \times 20\,ms$
$= 2\,M\,bit$
$= 250\,k\,bytes$

So. it will be larger than receiver window size (32 Kbytes)

The behavior of congestion window:

(1) slow-start phase

W_c will be $1 \rightarrow 32$ Kbytes



(2) because $W_r = 32\,Kbytes$ so. $W_{c(max)} = 32\,k$ bytes

There is no congestion because $W_{c(max)} < 250\,k\,bytes$

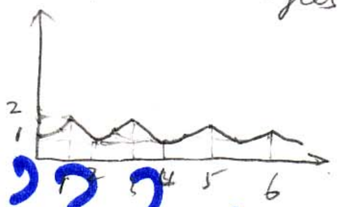
(2) Throughput $= \dfrac{\text{file size}}{\text{Time} = 1RTT} = \dfrac{32\ \text{k bytes}}{20\,ms} = \dfrac{32\times8\times10^3\ \text{bit}}{20\times10^{-3}} = 16\,M\,bps$

check your calculation

(b) The max send size. if 100% utilization $= 1\,Mbps \times 20\,ms = 20\times10^3$ bits
$= 2.5$ Kbytes

In this situation there will be congestion $W_c(kbyte) < 32$ bytes

The threshold is on 2 k bytes.



when in slow start, when reached 2 kbytes then is regard at 1 RTT

???

Throughput $= \dfrac{2.5\,K\,bytes}{1\,RTT} = \dfrac{\cancel{2\times8\times10^3}}{\cancel{20\times10^{-3}}} = 1.6\,Mbps$

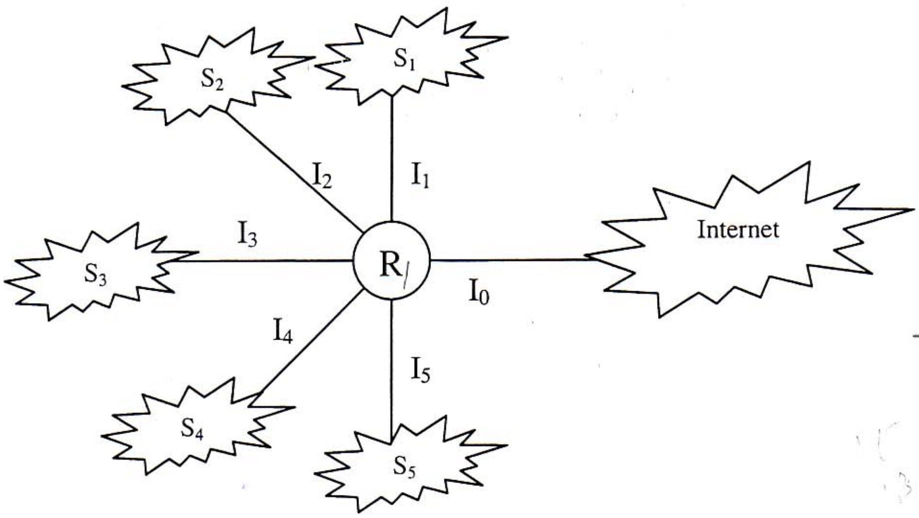
throughput > capacity

7

-5

Part 5 (20 Points)

A given organization was given one class B address network address of 132.132.0.0. The organization has 42,900 hosts, which need to be divided into 5 subnets S1, S2, S3, S4, and S5 as follows (shown in the diagram below)



- S1: 20000 hosts
- S2: 11000 hosts
- S3: 6000 hosts
- S4: 3000 hosts
- S5: 2900 hosts

a) Devise a Subnetting scheme for this network, indicating how many bits of host ID are required for each sub-network. What is the range of host addresses in each subnet?

Solution a

S_1 : 20000 host $< 2^{15}-2 \Rightarrow$ we need 15 bit, subnet 1 bit

S_2 : 11000 host $< 2^{14}-2 \Rightarrow$ 14 bit $\Rightarrow$ subnet 2 bit

S_3 : 6000 host $< 2^{13}-2 \Rightarrow$ 13 bit

S_4 : 3000 host $< 2^{11}-2 \Rightarrow$ 11 bit

S_5 : 2900 host $< 2^{11}-2 \Rightarrow$ 11 bit

$\Rightarrow S_3, S_4, S_5$ subnet for 3 bit

Subnet 1 132.132: x _ 0 _ 0

Subnet 2 132.132 x x _ 0

Subnet 3 132 132 x x x _ _ _ _ . 0

Subnet 4

Subnet 5

Subnet 1 : 132.132. 0. host address from : 132.132. 0.1 ~ 132.132.127.254

Subnet 2. 132.132. 64.0 host address from: 132.132. 64.1 ~ 132.132.63.254

Subnet 3 132.132. 160. host address from: 132.132. 160.1 ~ 8 132.132 191. 254

subnet 4. 132 132. 192 0 host address from 132.132 192 1 ~ 132 132.223. 254

Subnet 5 132.132.224.0 host address from: 132.132. 224 1 ~ 132.132.254.254

b) Fill in the following routing table for router R1 accordingly.

Subnet Address	Subnet Mask	Interface
132.132.0.0	255.255.128.0	I_1
132.132.64.0	255.255.192.0	I_2
132.132.160.0	255.255.224.0	I_3
132.132.192	255.255.~~224~~ 240.0	I_4
132.132.224.0	255.255.224.0	I_5
Default		I_0

X X

c) For the above network, assume packets arrive at R_1 for the following destination IP addresses. Which interface will each of these packets be forwarded to? Clearly explain your answers.

- 132.132.0.57
- 132.132.225.48
- 132.132.250.15
- 198.128.250.15

132.132.0.57 AND 255.255.128.0 ⇒ 132.132.0.0 ⇒ I_0
132.132.225.48 AND 255.255.224.0 ⇒ 132.132.224.0 ⇒ I_5
132.132.250.15 AND 255.255.224.0 ⇒ I_5
198.128.250.15 AND anyone MASK
⇒ Default

X

32

128 64 32 16

224