a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

COSC 328

NOTE: You are not alllowed to share this document with other students (not your current classmates, and not the next year or future stuents of this course), and you should not post it online.

NOTE: The main focus is on subnetworks, IP addressing, and the lecture slides after the midterm exam. However, you should know the concepts of the course before midterm, including delays, and the main concepts about TCP and UDP. The main focus is on Topics 4, 5, and 6. But again, you should know the concepts of TCP and UDP and the delays, as these are interrelated to later chapters.

The followings are not included in the exam:

- Chapter 4: IP v6, Match and Action and Open flow.
- Chapter 5: slides 78-end except ICMP are not in the exam. SDN are not included. But, you should know what SDN is and the differences of SDN with traditional routing. ICMP (slides 97-98) are part of the exam.
- Chapter 6: MPLS and data center networking are not in the exam.

Final exam format:

- There are three sections.
- Section I: There is T/F, multiple choice, and very short answer questions.
- Section II: short answers. There is no multiple choice available and you should write the responses clearly.
- Section III: long answers. There is no multiple choice available and you should show the solution clearly to receive the mark.

Final exam sample questions:

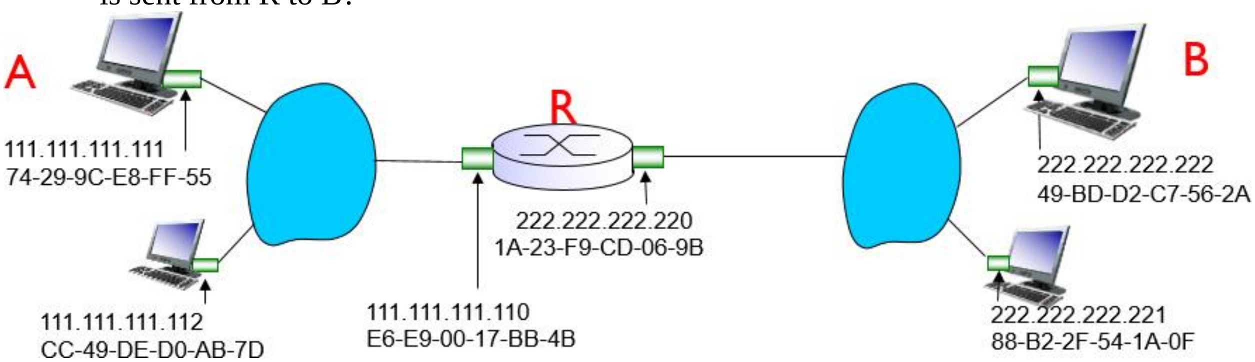
- MAC, ethernet frames
- Data plane and control plane
- Routing algorithms: OSPF, BGP
- OSPF vs BGP
- "BGP, OSPF, Forwarding Table Entries" (Look at the slides with the same title)
- Hot potato routing
- Dijkstra's Algorithm and forwarding tables (See examples in lecture slides)
- Distance Vector algorithm and forwarding tables (See examples in lecture slides)
- ICMP
- **IP addressing, broadcasts, subnet masking and sub-networking**
- Information about routers
- IP fragmentation and assembly

- TCP and IP
- NAT, VLAN
- General info about link layer
- Parity checking
- CRC
- CSMA/CD, CSMA/CA
- Ethernet's MAC protocol: unslotted **CSMA/CD with binary backoff**
- ARP and routing to another LAN
- What is the difference between hub, switch, and router?
- What is the difference between per-router control and SDN?
- DHCP and its applications?
- MTU and **IP fragmentation**
- **Subnet masking**

1. Consider the following diagram in which A wants to send data to B. Answer the following question.

a) What are the IP and MAC addresses of source and destination in the link-layer frame that is sent from node A?

b) What are the IP and MAC addresses of source and destination in the link-layer frame that is sent from R to B?



Answer:

At A=> IP src: A's address, IP dest: B's address

MAC src: A's MAC address, MAC dest: R's MAC which is in A's network (E6-E9-00-17-BB-4B)

At R=> IP src: A's address, IP dest: B's address

MAC src: R's MAC address which is in B's network (1A-23-F9-CD-06-9B), MAC dest: B's MAC address

2. Suppose nodes A and B are on the same 10 Mbps broadcast channel, and the propagation

delay between the two nodes is 245 bit times. Suppose A and B send Ethernet frames at the same time, the frames collide, and then A and B choose different values of K in the CSMA/CD algorithm. Assuming no other nodes are active, can the retransmissions from A and B collide? For our purposes, it suffices to work out the following example. Suppose A and B begin transmission at t = 0 bit times. They both detect collisions at t = 245 bit times. Suppose KA = 0 and KB = 1. At what time does B schedule its retransmission? At what time does A begin transmission? (Note: The nodes must wait for an idle channel after returning to Step 2—see protocol.) At what time does A's signal reach B? Does B refrain from transmitting at its scheduled time?

Answer:

Jam signal is 48

idle time is 2 * 48 = 96

Time, t	Event
0	A and B begin transmission
245	A and B detect collision
293	A and B finish transmitting jam signal
293+245 = 538	B's last bit arrives at A; A detects an idle channel
538+96=634	A starts transmitting
293+512 = 805	B returns to Step2
	B must sense idle channel for 96 bit times before it transmits
634+245=879	A's transmission reaches B

Because A's retransmission reaches B before B's scheduled retransmission time (805+96), B refrains from transmitting while A retransmits. Thus A and B do not collide. Thus the factor 512 appearing in the exponential backoff algorithm is sufficiently large.

3. A) Assume the MTU is 500 bytes and the IP datagram is 2000 bytes. How many IP fragments are generated? Provide the offset field for each fragment.

(b) Assume a file of size 10,000 bytes is being transmitted using TCP. The MTU is 1500 bytes. How many IP datagrams are transmitted to send the whole file (assume both TCP and IP headers are 20 bytes each)? How many bytes of header are transmitted in total?

Answer:

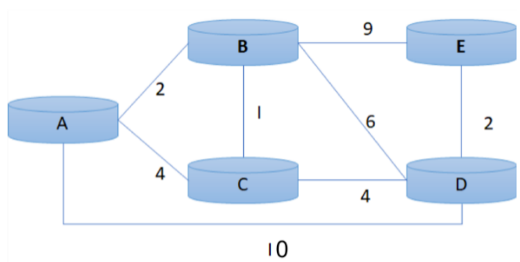
a)

Ceiling (2000 / (500 - 20)) = 5 fragments
Fragment 1 has byte range 0-479 and offset = 0.
Fragment 2 has byte range 480-959 and offset = 480/8= 60.
Fragment 3 has byte range 960-1439 and offset = 120.
Fragment 4 has byte range 1440-1919 and offset = 180.
Fragment 5 has byte range 1920-1999 and offset = 240.

b)

Ceiling (10,000 / (1500 - 40)) = 7 datagrams
Total byte overhead = 7*40 = 280 bytes

4. Given the network below, find the routing table for node A, using Distance Vector algorithm. Show <u>the initial table for all nodes</u> and the routing table <u>after one step (exchanging the initial routing tables once) for node A only</u>. (3 Marks)



At node A:

To A	To B	To C	To D	To E
0	2	4	10	infinity

At node B:

To A	To B	To C	To D	To E

At node C:

To A	To B	To C	To D	To E

At node D:

To A	To B	To C	To D	To E
10				

New routing table at node A after one step:

	To A	To B	To C	To D	To E
Cost to node	0	2	3		
Through	-	B	B		

5. Explain two main differences between OSPF and BGP.
6. Name three uses of DHCP?
7. Your ISP has provided your company with a subnet of 192.168. 254/23, but your supervisor wants you to divide this further into six subnets. The first subnet needs to support 250 interfaces (hosts), the second subnet needs to support 120 interfaces and the third subnet needs to support 128 interfaces. The other three subnets should each be able to support two interfaces. How you would divide up the original subnet and provide the new network addresses for each of the new subnets? Choose as many correct answers as possible. The new network addresses for each of the new subnets can be in the form of a.b.c.d/x or a.b.c.d/x – e.f.g.h/y. The latter shows a range of addresses. Hint1: Assign the address for the first subnet first (250 interfaces), then assign the address for the subnet that supports 128 interfaces. Hint2: Think about the number of addresses supported in each remaining subnet. Hint3: If you convert the numbers to binary, it helps a lot!

Note: This is another example and solution provided by the textbook. I did not check the answer, the IP address ranges might not be correct. But the approach to solve the problem is worth noting. When you convert the addresses, no address should appear in two subnets.

P12. Consider the topology shown in Figure 4.20 . Denote the three subnets with hosts (starting clockwise at 12:00) as Networks A, B, and C. Denote the subnets without hosts as Networks D, E, and F. a. Assign network addresses to each of these six subnets, with the following constraints: All addresses must be allocated from 214.97.254/23; Subnet A should have enough addresses to support 250 interfaces; Subnet B should have enough addresses to support 120 interfaces; and Subnet C should have enough addresses to support 120 interfaces. Of course, subnets D, E and F should each be able to support two interfaces. For each subnet, the assignment should take the form a.b.c.d/x or a.b.c.d/x – e.f.g.h/y. b. Using your answer to part (a), provide the forwarding tables (using longest prefix matching) for each of the three routers.

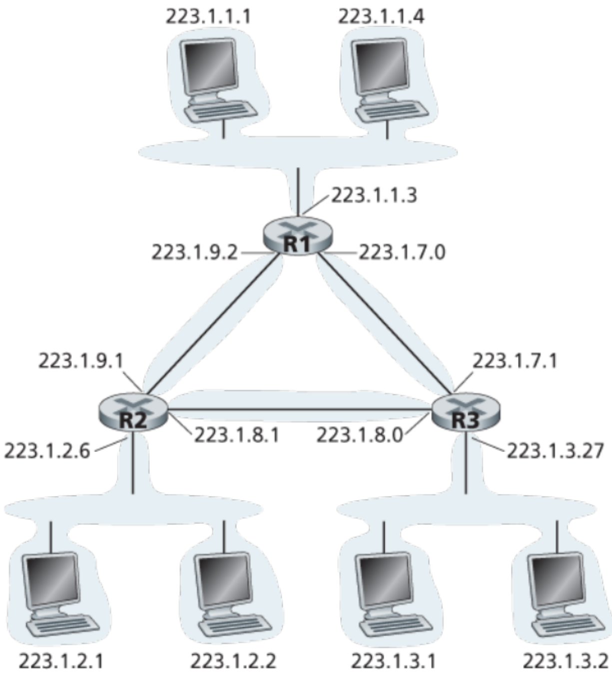


Figure 4.20 Three routers interconnecting six subnets

Answer:

From 214.97.254/23, possible assignments are a) Subnet A: 214.97.255/24 (256 addresses) Subnet B: 214.97.254.0/25 - 214.97.254.0/29 (128-8 = 120 addresses) Subnet C: 214.97.254.128/25 (128 addresses) Subnet D: 214.97.254.0/31 (2 addresses) Subnet E: 214.97.254.2/31 (2 addresses) Subnet F: 214.97.254.4/30 (4 addresses)

To simplify the solution, assume that no datagrams have router interfaces as ultimate destinations. Also, label D, E, F for the upper-right, bottom, and upper left interior subnets, respectively.

Router 1

Longest Prefix Match	**Outgoing Interface**
11010110 01100001 11111111	Subnet A
11010110 01100001 11111110 0000000	Subnet D
11010110 01100001 11111110 000001	Subnet F

Router 2

Longest Prefix Match	**Outgoing Interface**
11010110 01100001 11111111 0000000	Subnet D
11010110 01100001 11111110 0	Subnet B
11010110 01100001 11111110 0000001	Subnet E

Router 3

11010110 01100001 11111111 000001	Subnet F
11010110 01100001 11111110 0000001	Subnet E
11010110 01100001 11111110 1	Subnet C

8. The forwarding table of a router is shown below. When the router receives 11001000 00010111 00011000 10101010 address, which of the output ports is used to forward the packet?

Destination Address Range	Link interface
11001000 00010111 00010 *** ********	0
11001000 00010111 00011000 ********	1
11001000 00010111 00011 *** ********	2
otherwise	3

a) Interface 0
b) Interface 1

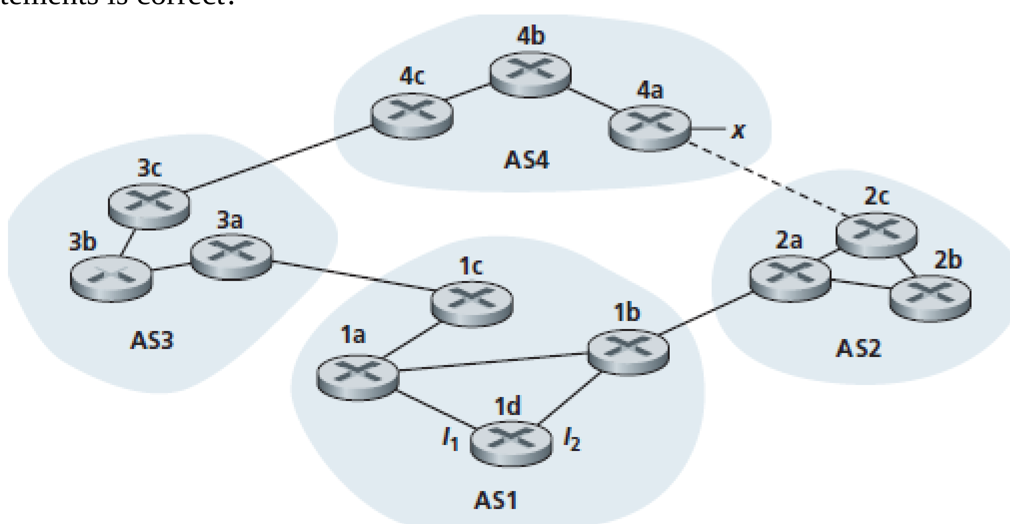
c) Interface 2
d) Interface 3

9. Consider IP address of 192.168.24.170/24. What is the subnet mask of this address? Note that subnet address (address of the subnet part, also known as network address) and the subnet mask are different.

   A: 255.255.255.0/24

10. Consider IP address of 192.168.24/24. How many host addresses can be supported in this subnet?
    A: 254

11. Consider the network shown below. Suppose AS3 and AS2 are running OSPF for their intra-AS routing protocol. Suppose AS1 and AS4 are running RIP for their intra-AS routing protocol. Suppose eBGP and iBGP are used for the inter-AS routing protocol. Initially suppose there is no physical link between AS2 and AS4. Which of the following statements is correct?



A) Router 3c learns about prefix x from OSPF routing protocol.
B) Router 3a learns about x from iBGP routing protocol.
C) Router 1c learns about x from RIP routing protocol.
D) Router 1d learns about x from eBGP routing protocol.

12. Consider IP address of 172.27.104.202/20. What is the subnet mask of this address? Note that subnet address (address of the subnet part, also known as network address) and the subnet mask are different.

A: 11111111. 11111111. 11110000. 00000000

13. Consider IP address of 172.27.104.202/20. What is the subnet address of this address? Note that subnet address (address of the subnet part, also known as the network address) and the subnet mask are different.
    A: 172.27.96.0/20
14. An ISP has assigned 192.168.1.0/24 to a company named NETWORK328. NETWROK328 requires to create two subnetworks in its network, each supporting 126 hosts. What are the addresses of the new subnetworks?
    A: 192.168.1.0/25 and 192.168.1.128/25
15. IP Packets and Fragmentation: Assume an MTU of 1500 bytes, 20 bytes IP header, and 20 bytes TCP header. How many IP datagrams are sent to transfer a file of [x=19,100] bytes?

Answer: Ceiling ([x=19,100] / (1500 – 20 -20)) = 14 fragments

16. IP Packets and Fragmentation: Assume an MTU of 1500 bytes, 20 bytes IP header, and 20 bytes TCP header. Hint: Totally, use 40 bytes as header size.)

How many bytes of IP and TCP header are sent to transfer a file of [x] bytes?

Answer: if x =19,100

Ceil(x / 1460) * 40 = 560 bytes

17. 2D parity check
18. CRC: Consider the 5-bit generator, G = 10011, and suppose that D has the value 1010101010. What is the value of R when CRC is applied and what is sent by the sender?
19. Suppose nodes A and B are on the same 10 Mbps broadcast channel, and the propagation delay between the two nodes is 245 bit times. Suppose A and B send Ethernet frames at the same time, the frames collide, and then A and B choose different values of K in the CSMA/CD algorithm. Assume no other nodes are active. Suppose A and B begin transmission at t = 0 bit times. At what time do nodes A and B detect a collision? After collision detection, each of the nodes send a jam signal. Consider that the jam signal is set to 48 bit times. When does the jam signal that is sent by B is received at node A?

    A: Collision is detected at t = 245 bit times; The jam signal is received completely at t=538 bit times.