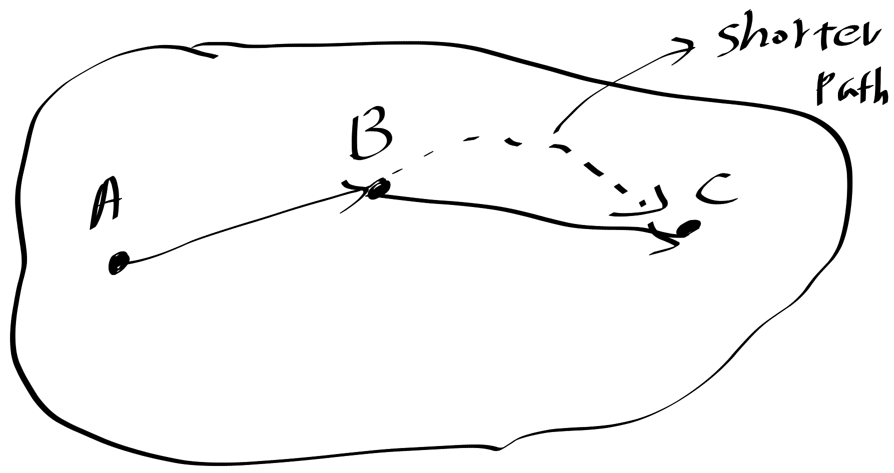
CSE 422 Homework #4 Fall 2017

Due at the beginning of class, Thursday, December 7

Name: Doyeon Kim Score: ______

Please write your answers CLEARLY on these sheets, which will assist the TA in grading. You must show all your work! A correct numerical answer without the accompanying calculations will count only one point. The final answer to a problem involving computation should be a single numerical value.

1. (5 points) State the Principle of Optimality (include in your description a supporting diagram) and briefly describe how this principle applies to Dijkstra's shortest path algorithm.



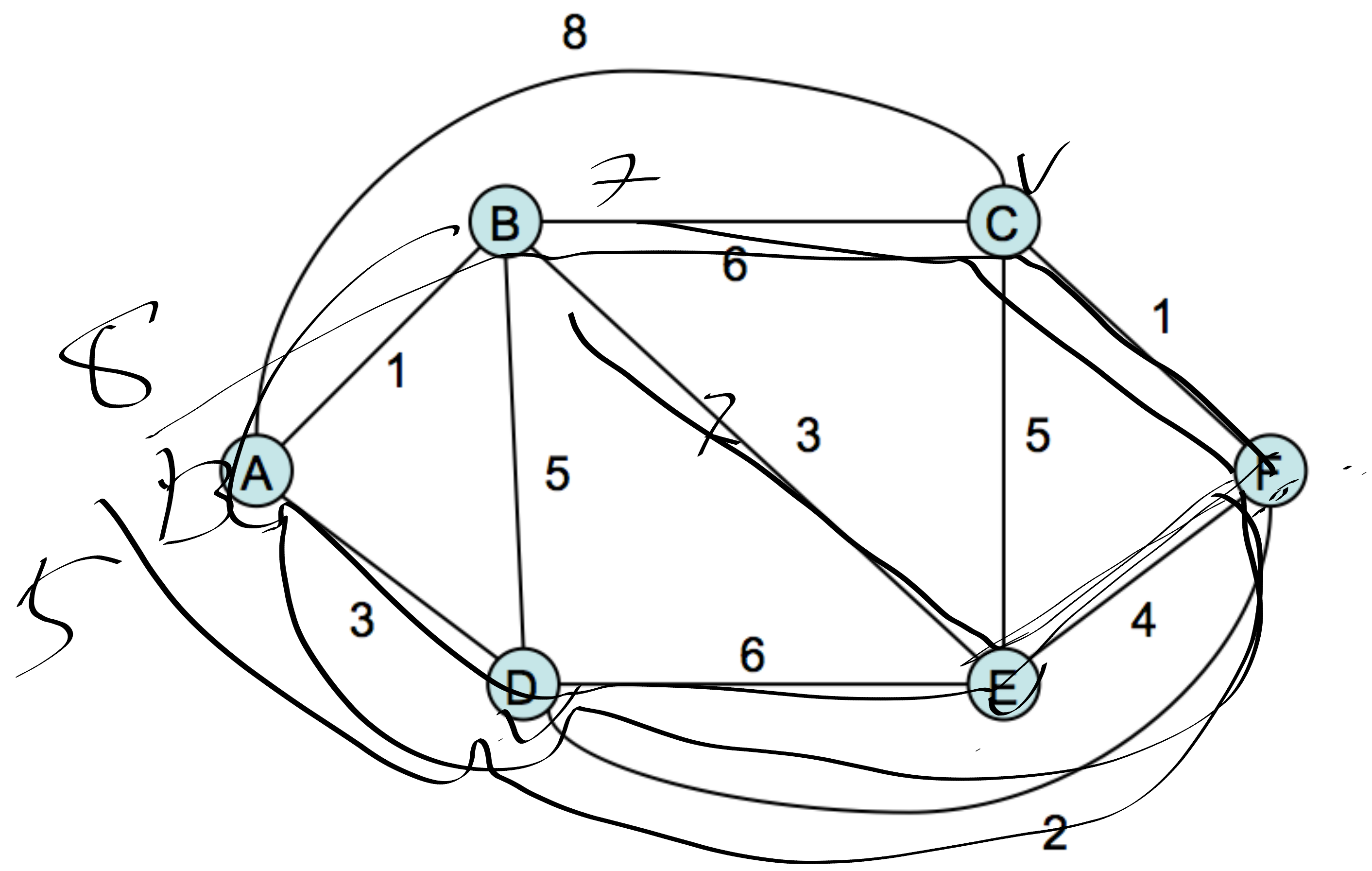
A → B → C is A to C path but between B to C, there is shorter path, then packet will be follow A → B ⋯→ C path.

2. (8 points) Briefly describe the operation of link-state routing and distance vector routing, including: (a) the type and manner in which routing information is distributed throughout a network and (b) the relationships to shortest path routing algorithms (e.g., Dijkstra's, Bellman-Ford). For each, (c) give an example of a real protocol that uses the corresponding method.

Link-state routing:
- Dijkstra's algorithms
  - In-memory graph of network
  - network topology, link costs known to all nodes,
    - accomplished by flooding "link state advertisements" (LSAs)
    - all nodes have same info
  - Computes least cost paths from one node (source) to all other nodes
    - gives forwarding table for that node
  - Iterative: after k iterations know least cost path to k destinations
- Real protocol: open shortest path First

Distance vector routing:
- Bellman-Ford
  - Each node maintains a vector describing its cost to reach every other node and the first hop in the path to each node
  - Cost of least-cost path from source x to y
  - From time-to-time, each send its own distance vector estimate to neighbors
  - Real protocol: IP, Routing Information Protocol

3. (14 pts total) Consider the following graph, which represents a network with seven nodes, A, B, C, D, E, F. The number associated with each edge is the cost of the corresponding link in the network.



Show each step of the following algorithms as executed on the above graph, assuming that **node F** (not node A) is the source node. That is, use the algorithms to find the shortest paths from node F to each of the other nodes. In the case of ties, select the path with the fewest number of hops. (You may not need all the rows of the tables.)

(a) (7 points) Dijkstra's algorithm (at each step, show D_i for each node and contents of M)

M	D_F	D_A	D_B	D_C	D_D	D_E
F	0	∞	∞	1	2	4
FC		8	6		2	5
FCD		3	5			5
FCDA			1			5
FCDAB						3
FCDABE						

(b) (7 points) Bellman-Ford. Please fill in the following table to show, at each step h, the value $D_i^{(h)}$ for each node i. (Note: the table may be larger than you will require.)

h	$D_F^{(h)}$	$D_A^{(h)}$	$D_B^{(h)}$	$D_C^{(h)}$	$D_D^{(h)}$	$D_E^{(h)}$
0	0	∞	∞	∞	∞	∞
1	0	∞	∞	1	2	4
2	0	9	7	1	2	4
3	0	5	6	1	2	4
4	0	5	6	1	2	4

no change
⇒ stop

4. (6 pts) Briefly explain how CIDR (Classless Inter-Domain Routing) address allocation works and why it is more efficient in address allocation than the original three-class (A, B, C) method.

A | 1 | 24 | $\Rightarrow 2^{24}$

B | 1 | 16 | $\Rightarrow 2^{16}$

C | 1 | 8 | $\Rightarrow 2^{8}$

This way of method led to a lot of wasting of addresses, particularly with the assignment of Class B network to organizations that needed for fewer than 2^{16} IP address.

With CIDR, the address could be allocated in chunk size of any power of 2. This allocation method is more save and efficient than original method, as the allocated number of IP address can better match the need of the organization to assigneed one

5. (12 points total) Consider a CIDR-allocated IP address: 236.14.205.33/20.

(a) (3 pts) What is the subnet mask for this address?

$32 - 20 = 12$

$\therefore$ If 20 bits of the address are 1, then remaining 12 bits are 0.

11111111 11111111 11110000 00000000 $\Rightarrow$ decimal notation is 255.255.240.0

(b) (3 pts) How many host addresses are associated with this CIDR allocation?

The host is represented by 12 bits

$\Rightarrow 2^{12} = 4096$ possible host addresses (including reserved patterns)

(c) (3 pts) What is the range of addresses in this allocation, that is, what is the lowest address and what is the highest address?

236.14.205.33

lowest address : 11101100 00001110 11001100 00000000

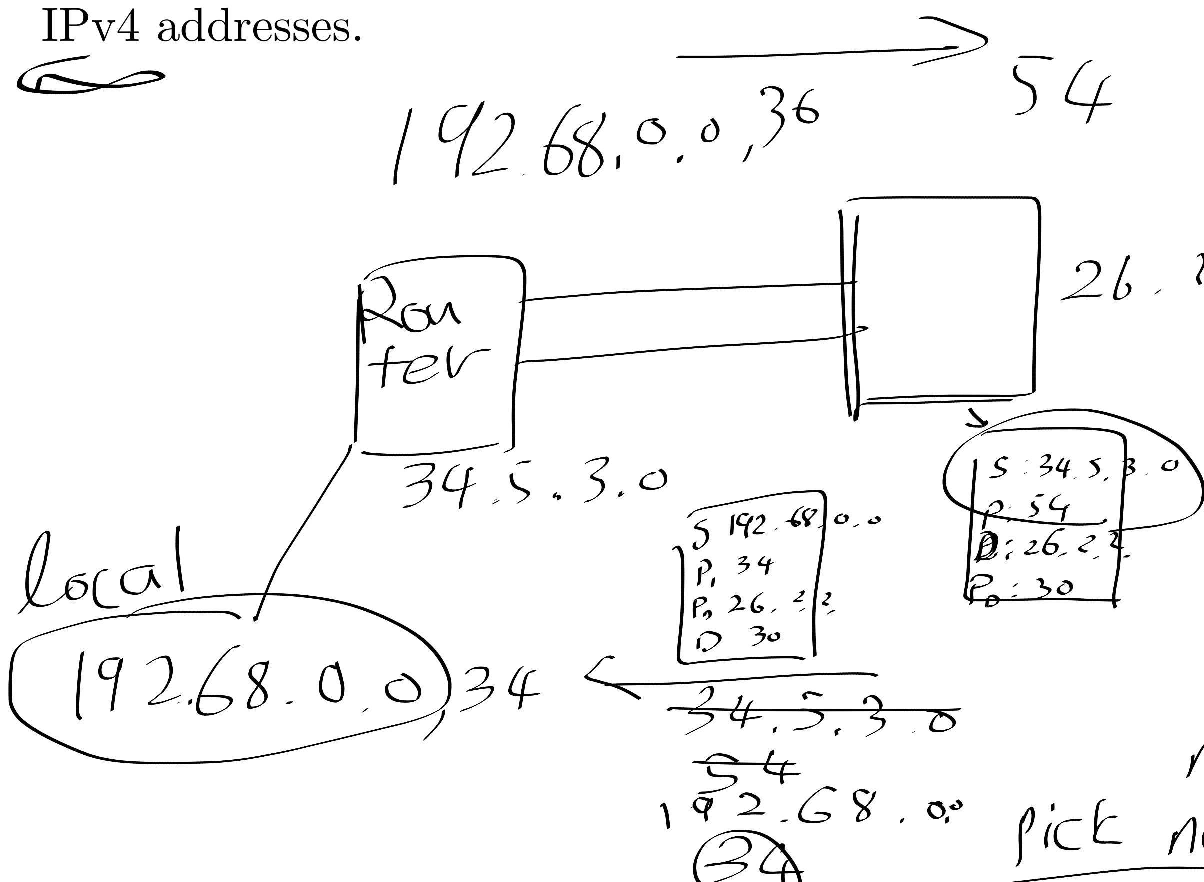
highest address : 11101100 00001110 11001111 11111111

(d) (3 pts) How many bits are in the host identifier for the address 236.14.205.33/20 and what is the value of those bits?

236.14.205.33

11101100 00001110 110011$\boxed{01\ 00100001}$

6. (6 pts) Briefly explain how Network Address Translation works and how it helps slow the allocation of IPv4 addresses.

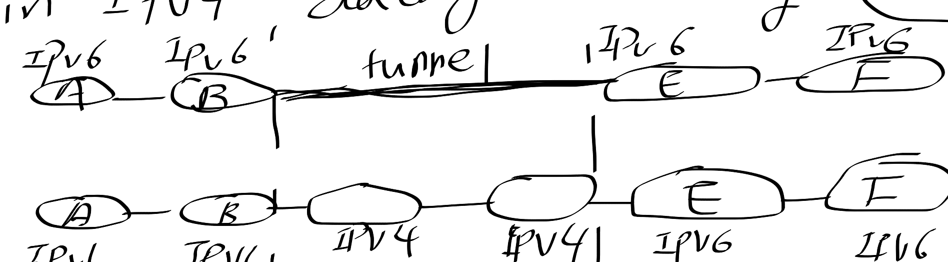


local has own Ip addhess and when it send some data it pass throw router, so router know where this data come from and where the data send to, after destination recieved and try to send back to local, but destination does not know local port number so randomly pick num and put on the table then send to router then router try to figure for compare that router know about ip address and re-order to right port number

7. (5 points) With respect to IPv6 deployment, what is tunneling and how does it work?

IPv6 can be deployed without having to switch the entire Internet at once. These IPv6 stuffs can exist in an otherwise IPv4-ranted Internet. Tunneling refers to the method to deliver an IPv6 datagram from a IPv6 stuff to another IPv6. IPv6 carried as payload in IPv4 datagram among IPv4 routers. logical view:

physical view:



8. (6 pts) Describe how the traceroute command exploits ICMP functionality in order to discover the route between two Internet hosts.

The traceroute is advantage of how the time-to-live field of the IP header is used by router.

When each router sent by the packet decrements the time-to-live field.

When it hits 0, the router sends an ICMP message to the source.

ICMP message is type, code plus IP header and first 8 bytes of payload in datagram causing error. First has TTL =1, enabling the command to identify the first router in the route when it receives the ICMP packet. Second has TTL = 2, the probe will make second router before dropped and the returned ICMP message will identify the second router in the route and this is continue until it reach at destination. So the entire route has been traced.

9. (6 pts) Dynamic Host Configuration Protocol (DHCP) enables an Internet host to obtain an IP address dynamically from a DHCP server when it joins a network. But how does the host contact the server if it does not know the IP address of the server?

Host uses IP broadcast address, so all 1 such as 255.255.255.255 to send the request to all nodes on the local network. It can renew its lease on address in use allows reuse of address (only hold address while connected and "on")

Host broadcasts "DHCP discover" msg ⇒ DHCP server responds with "DHCP offer" msg ⇒ host requests IP address: "DHCP request" msg ⇒ DHCP server send address "DHCP ack" msg

10. (6 pts) An advantage of IPv6 compared to IPv4 is larger address space. How many times larger is the IPv6 address space, compared to the IPv4 address space? In other words, how many times would the entire IPv4 address space fit into the IPv6 address space?

IPV4 is 32-bits address
and IPV6 is 128 bits address

$$\therefore \frac{2^{128}}{2^{32}} \approx 8 \times 10^{28}$$

11. (6 pts) A student who has not yet studied computer networks states, "I know about IP addresses. The network card on my computer has an IP address, and other computers send packets to my computer by putting that IP address in a packet header." Explain to the student some of the details missing in this description.

All computer interface on the Internet has at least two address which are IP address and physical address. Broadcast IP and physical address, along with multicast address can be tied to the interface. Interface usually are not knowing of IP address, but only physical address. And As student mentioned when a computer send packet to other computer. It must know IP address and also physical address of the destination ⇒ (ARP) ARP will request having the destination IP address, and the computer with what IP address responds with its physical address.

12. Error detection

(a) (4 pts) Consider a CRC code with a generator polynomial of $G(x) = x^5 + x^2 + 1$. Compute the checksum generated on the following (very short) data frame: 1100. You must show your work.

```
100101 | 1100 00000
         1001 01
         ---------
          101010
          100101
         ---------
           111100
           100101
         ---------
            11001
```

CheckSum $\boxed{11001}$

(b) (4 points) Can the above CRC code detect all burst errors in which the number of bits in error is odd? Explain why or why not.

$(x+1)$ $x^5 + x^2 + 1$

No, It will be missed because if a generator contains $(x+1)$ as a factor, then that generator can detect all odd-bit errors.

```
11 | 100101
     11
     --
      10
      11
      --
       11
       11
       --
       00
```

X

(c) (4 points) Consider the following error pattern that occurs in a frame: **X** _ **X** **X** _ _ _ **X**, where **X** represents a bit in error and _ represents a bit that is correct. Will the above CRC code detect this *particular* error? Explain why or why not.

1 0 1 1 0 0 0 1

T(x) $\quad R = T \oplus E$

R(x)

E(x)

```
100101 | 10110001
         100101
         ------
          100101
          100101
          ------
               0
```

No, it not able to detect this particular error

(d) (4 points) What is the probability that the above CRC code will **detect** a burst error of length 6? Show your work.

Checksum is 5bits $\therefore$ burst errors of length $6 \Rightarrow r+1$

$\Rightarrow 1/2^{r-1} \Rightarrow$ how many 6bits burst error consitude

$r = 5 \quad \therefore \frac{1}{2^{5-1}} = \frac{1}{2^4} = \frac{1}{16}$

detect a burst error of length 6: $1 - \frac{1}{16} = \frac{15}{16}$

≈ 0.9375

13. (12 points total) Consider the Hamming Code for correcting 1-bit errors. Assume we want to correct all 1-bit errors on occurring in every 8 bits of data.

(a) (4 points) How many check bits are needed for 8 data bits? Show your work.

Checkbit $m + r + 1 \leq 2^r$

data bit, checksum

$\Rightarrow r + 9 \leq 2^r$

$r = 4$

$\therefore$ 4 checksum bits

(b) (4 points) Compute the value of the check bits for the following data bits: 10011101 (Use **even** parity.)

0 0 0 0 - 0
0 0 0 1 - 1
0 0 1 0 - 2
0 0 1 1 - 3
0 1 0 0 - 4
0 1 0 1 - 5
0 1 1 0 - 6
0 1 1 1 - 7
1 0 0 0 - 8
1 0 0 1 - 9
1 0 1 0 - 10
1 0 1 1 - 11
1 1 0 0 - 12

1	1	1	0	0	0	1	1	1	1	0	1
1	2	3	4	5	6	7	8	9	10	11	12

$\boxed{4 + 8 = 12}$

(c) (4 points) Assume the following bits, numbered as described in class, of a codeword are flipped during transmission: 4, 6, 7. Which bit will the code report to be in error? Explain briefly.

$\oplus$ 4 = 0 1 0 0
$\oplus$ 6 = 0 1 1 0
7 = 0 1 1 1

0 1 0 1 $\Rightarrow$ 5

5 bit will be the code report to be in error.

14. (4 pts.) A new error correcting code is developed that will correct all 4-bit errors in a data string. What is the minimum distance of this code?

Correct d bit errors $\Rightarrow 2d + 1$ → 4-bit

$\Rightarrow$ minimum distance

$2 \cdot 4 + 1 = 9$

15. (8 points) Consider a new multiple access protocol that, like Slotted Aloha, requires frames to be transmitted on slot boundaries. However, the length of a slot is exactly half the length of a frame. Assume that all frames are the same length, arrivals are Poisson, and the arrival rate of frames (new and retransmitted) is G. What is the maximum throughput S of this system, measured in frames per frame time? Show your work.

P_0 = probability that a frame does not suffer a collision

S is new frames generated per frame time

G is new and retransmitted frames generated per frame time

$S = GP_0$

$S_p = Ge^{-2G} = 2 * T$ $\quad$ $S_{slotted} = Ge^{-G}$

max $= \frac{1}{e}$ frames / frame-time

16. (6 pts) A data plot discussed in class shows that the 0.01-persistent CSMA protocol achieves much higher throughput than 1-persistent CSMA. Yet, the most popular MAC technology in the world, Ethernet, is based on 1-persistent CSMA. Briefly explain this apparent contradiction.

17. (6 points) In the CSMA/CD protocol, the binary exponential backoff algorithm was used to resolve collisions. Consider two nodes that both come ready to send while a third node is transmitting. Each will wait until the channel goes idle, then transmit, resulting in a collision. Assuming that only these two nodes are trying to transmit, what is the probability that they will suffer **exactly** 4 collisions (including the first one mentioned above) before one acquires the channel? Show your work.