CMSC 417 Computer Networks **Fall 2020**

Final Exam

Open book and notes *Friday, December 18th, Due at 4p EST*

⊕ *Do not forget to write your name on the first page. Initial each subsequent page.*
⊕ *Be* **neat** *and* **precise. I will not grade answers I cannot read.**
⊕ *You should draw simple figures if you think it will make your answers clearer.*
⊕ *Good luck and remember, brevity is the soul of wit*

- All problems are mandatory
- I cannot stress this point enough: **Be precise.** If you have written something incorrect along with the correct answer, you should **not** expect to get all the points. I will grade based upon what you **wrote**, not what you **meant**.
- Maximum possible points: 50 + bonus.

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Problem	Points
1	
2	
3	
4	
5	
Total	

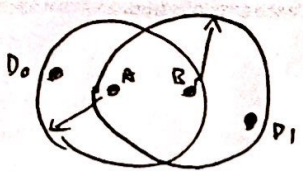
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536

D.P

1. Nomenclature

(a) Describe the following terms: (2 points each)

- Exposed Node



A is trying to send to Do and B is trying to send to D1. A & B think the transmission fails because they can hear each other. However, though the waves can disruptly interefere, once the disruption passes, Do and D1 can still receive the transmission. Thus the transmission still works.

- Subnetting

It solves the address assignment inefficiency problem and decrease the forwarding table size. Allowing large networks divided into smaller networks. It works by using a subnet mask: a router would operate an AND operation between the mask and dest IP address; if it matches a given subnet number, it will deliver the data to that subnet's interface.

- MSL (Maximum Segment Lifetime)

A time which IP promises to expire a packet e.x. 2 mins.

TCP uses it to provide reliability if segments are reordered by not repeating a sequence number within a MSL.

TCP also uses it in the time-wait by not allowing same 5-tuple be reused in 2MSL.

- Glue Record

Solves the problem of delegation in DNS.

ex.

umd.edu	NS	ns1.umd.edu
ns1.umd.edu	A	128.1.1.4

} This pair of records, known as glue records, delegate umd zone from edu zone.

- Genesis block

First block in the block chain.

NULL (prev block)	
{ϕ}	{puzzle}
PKsatoshi	

No previous block.

No transactions.

Have puzzle.

For the BitCoin case, its public key is Satoshi. It's what makes BitCoin different from other coins like 417 coin.

~~The genesis~~

D.P

2. Network and Transport

(a) (How) does CIDR help with better address usage in IPv4? (3 points)

Unlike "classic IP" or subnets which used exact match, CIDR breaks the concept of class and only mapped the destination address to the # of prefixes. It allows us to handle out addresses space in chunks at any size now; thus reducing the routing table size and allows small companies to have a single large network by combining multile addresses together.

(b) Give an example showing how AS Path prepending can be used to affect BGP path selection. (3 points)

Suppose UMD wants most of its incoming traffic is carried by Comcast instead of Cogent, it could do so by use AS path prepending when sending to Cogent, thus increasing the ASP Length. BGP will choose the shorter ASP, which is Comcast.

(c) Without using timestamps or window scaling, what is the maximum end-to-end throughput, in kilobits per second, a TCP socket can achieve on a 100ms RTT path? Why? (2 points)

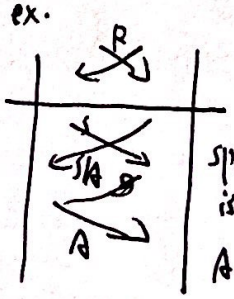
Since advertisement window is only 65535 bytes and the sender has to wait the receiver a RTT to get a new empty window (suppose the receiver is infintely fast).

100ms RTT = 10RTT/s

65535 x 8 x 10 / 1000 = 5242.8 kilobits per second.

(d) Suppose a process binds to port 2323, and services TCP connections. The process exits, but upon re-start, the bind fails with "Error: Address already in use" (EADDRINUSE). Why does this happen and for how long? (2 points)

Because the TCP that sends a FIN before receiving a FIN must go into the time wait, which holds the connection for 2 MSL to ensure the same 5-tuple is not used again. ex.



even connection closed.

sys a new connection is set up and not in TW.

A message from old connection may leak in!

D.P

3. MAC protocols, Error Detection

(a) (Does) a 802.11 node that joins the network have to wait DIFS time before transmitting even if the medium is free? Why or why not? (2 points)

Yes. Because suppose you're a new node in the network, you could sense the channel to be free. But other nodes may be in the SIFS state (between DATA and ACK). Since |DIFS|>|SIFS|, you will know ACK must show up and safely transmit.

(b) Suppose 10Mbps Ethernet (802.3), as we discussed in class, had a minimum payload of 0 bytes. How would the rest of the protocol have to change such that collisions could still be detected? (3 points)

Eternet frame size will be: 64−46 = 18 bytes.= 144 bits.

Transmitting in 10Mbps takes: 14.4μs.

Theoretial longest segment: 2×10^8 m/s × 14.4μs = 2.88km distance

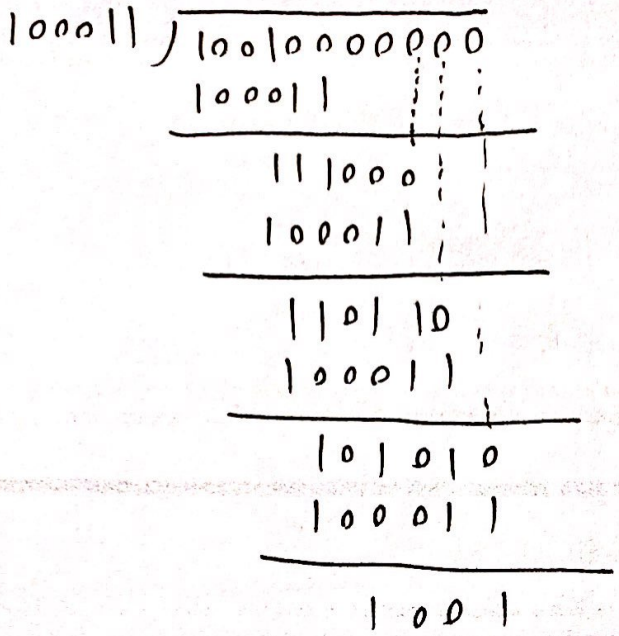
To have 2x safety factor, we need to have 1.44km round trip,

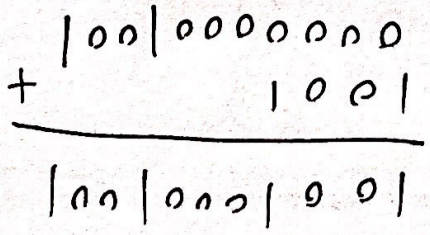
use approximately 0 repeaters.

(c) What does a Maranello receiver send to a "normal" 802.11 node when there is a CRC error? (2 points)

NAK, which looks like a malformed ACK to 802.11 node.

(d) Assume a CRC polynomial $x^5 + x + 1$. What should be transmitted for message 00100100? Show your work. (3 points)





4. Applications

(a) A "pure" NAT device only translates addresses, but not ports. Show an example of two simultaneous connections that can be established with a port-mapping NAT device (a NAPT device) but not with a "pure" NAT device. Explain your assumptions. (2 points)

Suppose both L_0 and L_1 are sending to Google, port 80.
When packets come back from Google, it looks like

src	dst	sp	dp
G	F	80	P_0

NAT want be able to distinguish to send to L_0 or L_1.
However, with port mapping, we can have P_0 for L_0 and P_1 for L_1, thus distinguish the packet.

(b) How many simultaneous connections can a NAPT device with a single public IP address theoretically sustain? Explain your assumptions and show your work. You should provide an algebraic expression, and not just an integer. (2 points)

Since it only has one IP address, the number of connections a NAPT is limited by its # of ports, which is 2^{16}. Because it need to use a different port for each connection.

(c) A, B, and C are arbitrary bit strings of the same length (say l) that need to be transmitted. Design a protocol that transmits at most 4 bitstrings of length l (plus a constant sized header with each string) such that if any 3 strings are received, then A, B, and C can be recovered at the receiver. Show what would be transmitted and how A, B, and C could be recovered from the received strings. Hint: consider the addition operator in GF(2). (3 points)

We define a new bitstring D as A+B+C where the addition uses GF(2) addition operator. We transmit A, B, C, D and any of them could be recovered as long as we got three of them.

ex.

A: 101 A+B=100

B: 001 D=(A+B)+C=000

C: 100

sps. A lost:

B+C=101

D-101=000-101=101

sps B lost:

A+C=001

D-001=000-001=001

sps C lost:

A+B=100

D-100=000-100=100.

D.P

(d) A Bitcoin client has received valid blocks including and up to block 10001. It thereafter receives a different block 10000, which is consistent with blocks 0-9999 but conflicts with the previous block 10000. How should a legal client treat this new block? Explain your assumptions. (3 points)

It should ignore it because nodes will accept the first "legal" block that extends the chain. Here we already have a valid block 10000 thus we ignore the later one.

5. Applications

(a) We want to implement support for a DHT-based *tracker* for BitTorrent. Assume we have a DHT that provides operations such as Get(Key) → Value and Append(Key, Value). What would you use as "Key"? What should change in the torrent file to support this? (3 points)

The Key would be the infohash of the file you want to download from.

Instead of using the announce-url of a tracker, the torrent file should include the address and port of a node in DHT. Similar to the join node in Chord.

(b) Explain how the client would use the DHT operations and results to initiate a BitTorrent download. (3 points)

The client would send GET(infohash of the torrent it wants to download) the request to the node in DHT, getting a set of IP-addresses (peers it can talk with).

Then it would find which piece to download and do the peer-wise communication to start the download.

When it finishes download (start seeding), it can send APPEND(same infohash, own IP address and port) to the node it talked before.

D.P

(c) The function `mainloop` takes `mother`, a blocking socket that has been bound. As many as `N` clients are served simultaneously by forking and serving each client in a separate process. Identify and explain the errors below. (4 points)

```
1  /* all necessary headers */
2  void mainloop(int mother) {
3
4    pid_t kids[N];
5    size_t pidcnt = 0;
6
7    for(;;) {
8
9      if (pidcnt == N) {
10       int wstatus;
11       waitpid(kids[pidcnt], &wstatus);
12       if (!WIFEXITED(wstatus)) abort();
13       --pidcnt;
14     }
15
16     int s = accept(mother, NULL, 0);
17     if (s<0) abort();
18     pid_t pid = fork();
19     if (pid < 0) abort();
20     if (pid == 0) { /* child */
21       serve_child(s);
22     } else { /* parent */
23       kids[pidcnt++] = pid;
24     }
25   }
26 }
```

waitpid takes three parameters instead of 2.

the third parameter should be a pointer.

this may not destroy everything if it doesn't use a exit in serve_child.