Quiz 1

You can ask the course staff any *specific* and *factual* questions you like *during* the quiz, and we will answer them! You are responsible only for reasoning, not knowing facts. Examples of factual questions include details of how an algorithm works, any formulas, and definitions of terms. Specific means that you need to know what question you may ask.

For essay questions, try to keep your answers as brief as possible while covering all the important points.

Wingternet

Cooville is a remote village high up in the mountains. The terrain makes it impossible to lay any kind of wire, or even use radio transmissions. Homer and Returno are two enterprising people who want to use carrier pigeons to connect Cooville to the internet (or Wingternet, as they have named their service).

Returno lives in Cooville and Homer lives in Buffering Heights, a neighboring village that is slightly more accessible, and hence enjoys some internet service. They have trained 100 carrier pigeons. 50 of those will return to Cooville if released from Buffering Heights, and the other 50 return to Buffering Heights if released from Cooville. We'll call them C-class and B-class pigeons respectively, depending on the village to which they return.

To send a message from Buffering Heights to Cooville, Homer can tie something small (say, less than 1 oz or ~30 g) to a C-class

1 Essay 1 point

What assumptions does IP make about its underlying network, and does FeatherNet satisfy them?

For example, what if a pigeon gets lured into an all-you-can-eat sunflower seed buffet and never arrives — does that violate any requirements that IP relies on?

Do we need a parallel owl network for nighttime delivery in order to meet IP's expectations?

100%

5 min / 400 max (word limit)

Must use at least 5 words

pigeon's leg and release it. It will reach its coop in Cooville where Returno can retrieve the message.

Every morning, Returno makes a trip carrying any C-class pigeons to Buffering Heights, and returns with any B-class pigeons that he sent the previous day. Pigeons only fly between sunrise and sunset, so the service is shut down at night.

They read an IETF proposal called "A Standard for the Transmission of IP Datagrams on Avian Carriers" that described a physical+link layer protocol that operates below IP. However, they failed to note that the date of publication was *April 1*, 1990 and took the proposal literally. However, what they lack in wisdom, they make up in enthusiasm, mettle and technical skill. They have asked for your help in designing their protocol, FeatherNet.

PS: This question is less made-up than you may think 😃

2 Essay 1 point

FeatherNet can use up to 50 pigeons per day in each direction. Each pigeon can carry a small item and takes 15 minutes to cover the distance. How would you design the system to maximize throughput and minimize latency, given these constraints?

100%

5 min / 400 max (word limit)

Must use at least 5 words

3 Essay 1 point

Will higher-layer protocols or applications need changes to work well over FeatherNet? If so, why?

Note: Higher means higher than IP. We are not expecting you to know specific details about how they work. Just try to think what assumptions they are likely to make about internet paths and how they may need to adapt.

100%

5 min / 400 max (word limit)

Must use at least 5 words

4 Essay 1 point

How would you allocate IP addresses within Cooville? Do you need to do anything special? How will routing work? You can assume that the machines in Cooville all have electrical power and are connected using a normal network.

100%

Convergence

A link-state protocol computes the shortest path between every pair of nodes. It can be configured to use any definition of path length, as long as the user specifies the length of each edge. This definition is programmed into the router, which then uses it when advertising its distance to its immediate neighbors. Assume that the network topology has stabilized (i.e., links are no longer going up or down). For each definition given on the right, write **true** if the protocol will eventually converge to a fixed set of routes for all possible topologies, and **false** otherwise.

5 True or False 0.5 points

To compute the length of the link between routers with IP addresses **X** and **Y**, each address is first interpreted as a 32-bit unsigned integer. The link length is then calculated as (X + Y) % 5 + 1

- True
- False

6 True or False 0.5 points

The total number of bytes enqueued on the link between the two routers.

- True
- False

7 True or False 0.5 points

1 / (amount of traffic going between the two routers)

- True
- False

8 True or False 0.5 points

The number of seconds it takes for light to cover the physical distance on the fiber optic cable between the two links.

- True
- False

Routing table

Suppose a router has the following routing table. It can forward packets to routers R1, R2, or R3.

Subnet	NextHop
128.83.0.0/24	R1
128.83.1.0/24	R2
128.83.2.0/24	R3
128.83.3.0/24	R3

9 Multiple Choice 1 point

The router receives a packet with a destination of 128.83.2.154. Which action would it take?

- Forward to R3
- Forward to R1
- Drop
- Forward to R2

Clear my selection

10 Fill in the Blank 1 point

The router has limited on-device memory space, so you need to reduce the memory usage. Complete the alternative 3-entry forwarding table below that makes the same forwarding decisions as the given table.

Subnet	NextHop

11 Essay 1.5 points

Suppose an AS A advertises to AS B a route to an IP prefix X. What are the implications if AS A does each of the following?

1) Drop all packets from AS B with destination to X.

2) Drop some packets from AS B with destination to X.

3) Drop all packets from AS C with destination to X.

Discuss any important differences between these cases

100%

5 min / 400 max (word limit) Must use at least 5 words

Faulty channel

Consider a communication link that randomly flips about 0.1% of the bits passing through it. The protocol you are designing uses a strong 64-bit checksum that, for all practical purposes, detects every error. Each packet consists of N bits total, where the first **(**N – 64) bits contain the message and the last 64 bits contain the checksum. If the checksum fails, the packet is retransmitted.

The questions on the right will guide you through picking a good value of N

12 Multiple Choice 1 point

What is the probability that the packet is transmitted correctly (i.e. accepted by the receiver)? Other questions in this segment will refer to this quantity as Q

- $1 - 0.001N$
- 0.999^{N-64}
- $1 - 0.001(N - 64)$
- $(0.999)^N$

Clear my selection

13 Multiple Choice 1 point

What is the efficiency of transmission? As in, what is the ratio: (number of bits accepted) / (number of bits transmitted)?

Here, Q is the probability that the packet is accepted by the receiver (the quantity we calculated above)

- $1 - Q$
- Q
- $Q\frac{N-64}{N}$
- $Q\frac{N-64}{64}$

Clear my selection

14 Numeric 1 point

To maximize the efficiency, what is the value of N that we must pick. Answers that are within 10% of the correct answer will be accepted

Answer

15 Numeric 1 point

Two endpoints are communicating over a wired link. Say that the transmitted signal is $f(t)$ and the received signal is $f(t) + \eta(t)$, where $\eta(t)$ is noise. We are constrained to maintain $0V \leq f(t) \leq 2V$ at all times, and we know that $0V \leq \eta(t) \leq 0.0625V$ at all times. Further, the receiver cannot sense any voltages outside the range $0V$ to $2V$. Suppose that we transmit information by encoding it into symbols as discussed in class. What is the maximum number of bits that we can pack into a symbol?

Answer

16 Essay 1 point

In an ethernet network, what happens if the spanning tree algorithm fails to remove enough edges, and a cycle persists?

100%

5 min / 400 max (word limit) Must use at least 5 words

17 True or False 1 point

Alice is transmitting a radio signal to Bob over a wireless channel. Unfortunately, also in the room is a faulty microwave oven where the front grill is broken. When it is turned on, it scrambles 99% of the bits. That is, with probability 0.99, Bob simply receives a random bit. 1% of the time, he receives the bit that Alice transmitted.

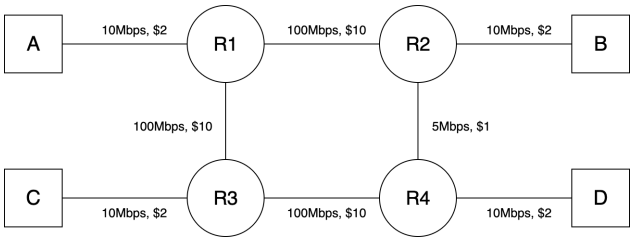
Can Alice and Bob communicate with the oven turned on?

- True
- False

Link state with two cost metrics

Consider the network topology below.

- All the routers are running a link state protocol, and they learn the complete global topology.
- Each link has two properties, bandwidth and dollar amount (shown as "bandwidth, dollar amount" in the figure). The reliable flooding protocol ensures everyone can see both properties
- R1, R3, and R4 are configured to optimize for paths with the lowest total dollar amount (i.e., sum of the dollar amounts along the path).
- R2 is configured to optimize for paths with the highest bottleneck bandwidth. A bottleneck bandwidth is the smallest bandwidth on a path.



18 True or False 1 point

The traffic from C to B can reach its destination.

- True
- False

19 True or False 1 point

The traffic from A to D can reach its destination.

- True
- False

20 Essay 1 point

Does this network topology converge to a valid routing state? Why or why not? If there are any loops or dead ends, list one of them and explain why it occurs. If there aren't, prove it.

100%

40 max (word limit)

21 Multiple Answer 1 point

Which of these routing algorithms always ensures that packets follow the shortest path between any two points, after the routes have converged?

- [ ] BGP
- [ ] Spanning tree algorithm
- [ ] Link state routing
- [ ] Distance vector routing