Carnegie Mellon
Computer Science Department.
15-441 Fall 2006
Midterm

Name: ______________________________

Andrew ID: ______________________________

INSTRUCTIONS:

There are 16 pages (numbered at the bottom). Make sure you have all of them.

Please write your name on this cover and at the top of each page in this booklet **except the last.**

If you find a question ambiguous, be sure to write down any assumptions you make.

It is better to partially answer a question than to not attempt it at all.

Be clear and concise. Limit your answers to the space provided.

Question	A	B	C	D	E
Points	/ 34	/ 24	/ 22	/ 16	/ 4

A True/False

+2pts for each correct answer, -2pts for each wrong answer, 0 pts if left blank, 0pts minimum per section

1. Which of the following is true about BGP? (Circle all letters that apply)

T F BGP uses path vector instead of distance vector to remove routing loops.

T F A BGP router always picks the path with the least number of router hops to the destination.

T F A BGP router always picks the path with the least number of AS hops to the destination.

T F BGP prefers less specific prefixes to more specific ones.

T F An Autonomous System will announce routes learned from its customers to its peers.

T F An Autonomous System will announce routes learned from its peers to other peers.

T F If an Autonomous System learns of 5 different routes to a destination prefix, it will announce all 5 routes to its neighbors.

Solution: T - BGP is a path vector protocol

F - area hierarchies prevent hop count optimization

F - policy routing prevents AS hop optimization

F - routing always prefers more specific routes

T - this is how peers learn about their neighbor's routes

F - this will violate valley free routing

F - BGP only advertises routes that it uses

2. Which of the following is true about RIP and OSPF? (Circle all letters that apply)

T F RIP and OSPF are intra-AS (used inside of an AS) routing protocols.

T F In OSPF, higher costs can be set proportional to link capacity to offload low bandwidth links.

T F Each router using RIP or OSPF maintains information about the entire topology.

T F Both RIP and OSPF have each node send periodic advertisements to inform the network of updates.

T F RIP and OSPF are distance vector protocols.

T F In OSPF, an LSA from a router should be delivered to all other routers within the same AS (or area).

Solution: T - they are IGPs

T - link weights are often used for this purpose

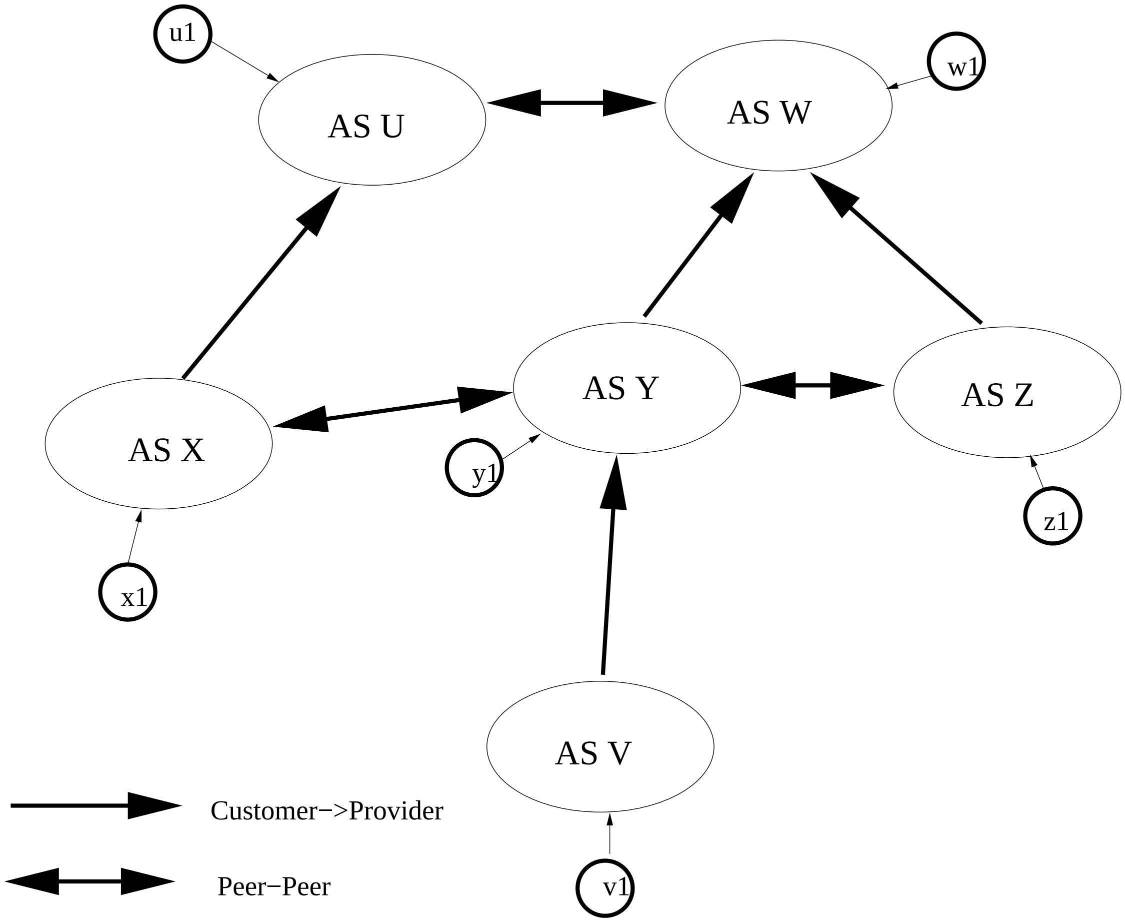
F - RIP only obtains distance information from its neighbors

T - soft state refresh is used by both protocols

F - OSPF is a link state protocol

T - LSA should be reliably flooded

3. In the network depicted below:



which paths may packets take between a pair of end-hosts under valley-free routing?

T F x1 → AS X → AS U → AS W → w1

T F v1 → AS V → AS Y → AS Z → AS W → w1

T F v1 → AS V → AS Y → AS Z → z1

T F x1 → AS X → AS Y → AS Z → z1

Solution: T -

F - goes over a peering link from Y to Z before going to Z's provider, which violates valley-free routing.

T -

F - goes through 2 peering hops

B Short Answer

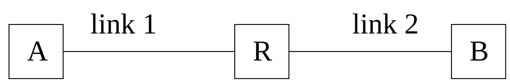
4. Give **one** reason that DNS lookups are run over UDP rather than TCP: (3 points)

Solution: OK: Connection-setup overhead, short-duration interaction NOT OK: Header overhead

5. Give **one** reason that streaming multimedia is run over UDP rather than TCP: (3 points)

Solution: OK: Variable delays from reliability, loss tolerant applications, drastic congestion control NOT OK: connection setup overhead

6. For the next two questions, consider the following network topology, with hosts A and B connected through router R:



Router R operates in store-and-forward mode. Links 1 and 2 are both one megabit per second links with 10ms one-way latency.

(a) How long does it take to send a 1000 bit packet from A to B? (5 points)

Solution: prop_delay_packet = 1000bits/(10^6bits/s) = .001s = 1ms
latency=10ms
2*(prop_delay_packet+latency) = 2*(1ms+10ms) = 22ms

(b) Using stop-and-wait flow control, how long does it take for A to send a 100,000 bit file to B? Assume that ACKs are 100 bits long and that the data packets are 1000 bits long. (4 points)

Solution: packet_time=22ms
prop_delay_ack=100bits/(10^6bits/s)=.1ms
ack_time=2*(prop_delay_ack+latency)=20.2ms
100*(packet_time+ack_time) = 100*(22ms+20.2ms) = 4220ms = 4.2s

7. (a) After finishing 441, you create a new networking startup that is housed in an abandoned Pittsburgh steel mill. You want a gigabit (1000Mbps) network. The size of your factory building necessitates that your cables be as long as 500 meters. The maximum backoff and retry attempts for your network is set to 8. To save money, you decide to twist your own ethernet cables using steel instead of copper. For purposes of this question, assume that electromagnetic waves propagate through your steel wires at a speed of $1.5 * 10^8$ m/s. What should the minimum packet size be for this network? (5 points)

Solution: 2*(1000*10^6 bps)*(500m)/1.5*10^8mps = 6667bits

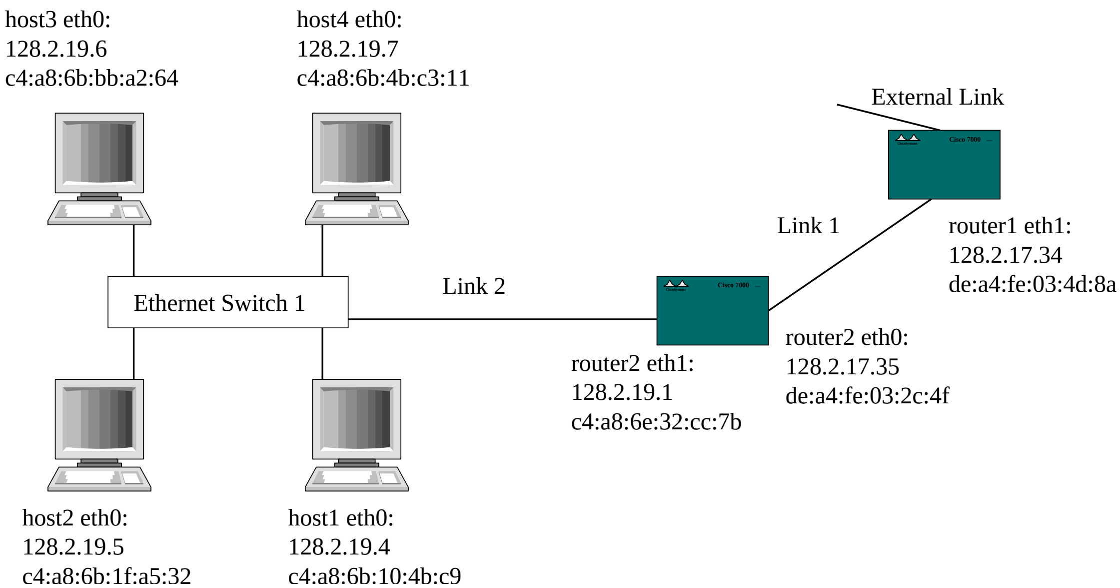
(b) One day a disgruntled employee decides to cause trouble. He uses a special device that reads ethernet packets as they arrive and if the first 160 bits show your MAC address as a source, he begins transmitting a packet of his own to cause a collision. Your ethernet card reports that collisions are detected after the card has transmitted 660 bits of the ethernet frame. How far away from you (along the steel ethernet cable) is the attacker?

(Assume that both of your ethernet cards/devices are infinitely fast and add no processing delay for these calculations.) (4 points)

Solution: 660bits=2x+160
x=250
prop_delay=250bits/(10^9bits/sec)
speed=1.5*10^8m/s
distance=prop_delay*speed=37.5m

v

C Routing and Bridging and Bears, oh my!



In the partial network topology shown above, a well-formed IP packet with a destination IP of 128.2.19.5 and TTL of 8 arrives at router1 via the external link. Link1 uses the subnet 128.2.17.34/31 and Link2 has the subnet 128.2.19.0/25 .

The hosts and routers on the ethernet subnet are all connected to their own port on an ethernet switch (a learning bridge).

8. What is the subnet mask of eth0 on host1? (2 points)

Solution: 255.255.255.128

9. What are the forwarding entries used by each router to forward the packet to 128.2.19.5? (5 points)

Router	Destination	Mask	Next-Hop	Interface
router1				
router2	128.2.19.0	255.255.255.128 (/25)	directly connected	eth1

Solution:

Router	Destination	Mask	Next-Hop	Interface
router1	128.2.19.0	255.255.255.128	128.2.17.35	eth1

10. If this packet (from the outside to 128.2.19.5) is the first packet to be forwarded on the network, ARP requests will be sent out on both Link1 and Link2. Fill in the following ARP header fields. (4 points)

Link	MAC Source Address	MAC Destination Address	IP address queried for
Link1			
Link2			

Solution:

Link	MAC Src Addr	MAC Dest Addr	IP address queried
Link1	de:a4:fe:03:4d:8a	ff:ff:ff:ff:ff:ff	128.2.17.35
Link2	c4:a8:6e:32:cc:7b	ff:ff:ff:ff:ff:ff	128.2.19.5

11. Circle all of the header fields in the following list that router2 will change between when it receives the packet on eth0 and when it transmits the packet on eth1. (4 points)

Ethernet Header:

A. Source address

B. Destination address

C. EtherType

D. None

IP Header:

A. Source address

B. Destination address

C. Protocol

D. IP TTL

E. IP Header Length

F. IP Header Checksum

G. IP ID

H. None

Solution: Ethernet source address, Ethernet destination address, IP TTL, IP Header Checksum

12. Circle all of the header fields in the following list that will change from when the switch receives the packet on the port connected to router2 and when it transmits the packet on an outgoing port. (4 points)

Ethernet Header:

A. Source address

B. Destination address

C. EtherType

D. None

IP Header:

A. Source address

B. Destination address

C. Protocol

D. IP TTL

E. IP Header Length

F. IP Header Checksum

G. IP ID

H. None

Solution: None/None

13. Assume that no packets have been transmitted on the network until the first packet to host2 arrives. In this question, assume that a host "sees" a packet if it is transmitted on its local medium by any device other than itself, but does not "see" packets that it generates.

    Select the correct answer below to indicate how many packets host2 sees and how many packets all other hosts on the network see. Include both ARP packets and data packets. (3 points)

    A. host2 = 1 All others = 0
    B. host2 = 1 All others = 1
    C. host2 = 2 All others = 0
    D. host2 = 2 All others = 1
    E. host2 = 2 All others = 2

    Solution: D. All hosts will see a single ARP request from the router. Only host 2 will see the data packet.

D DNS

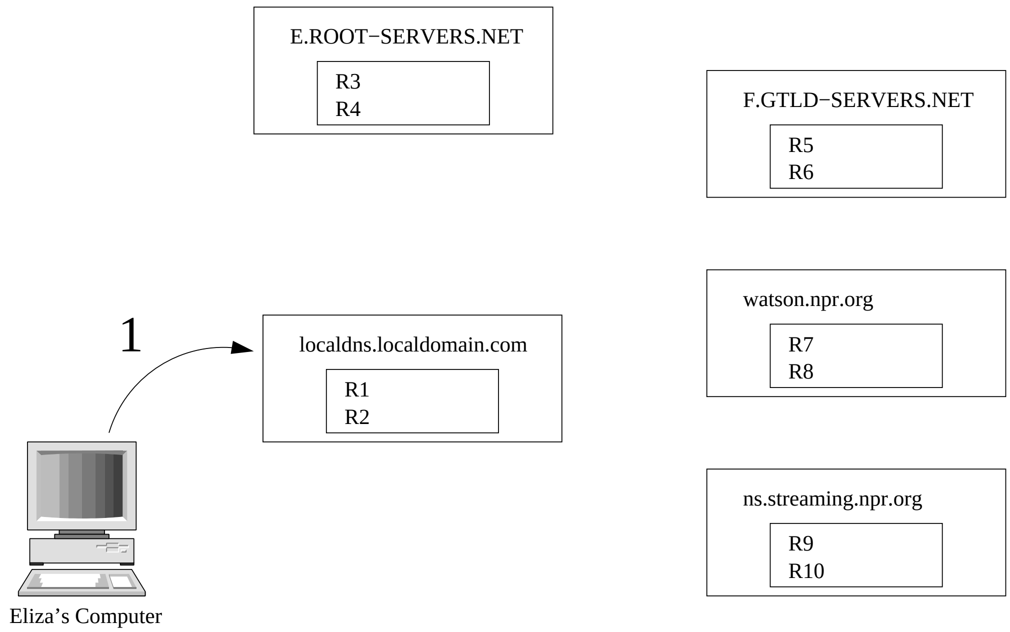
Elisa wants to listen to the National Public Radio news over the Internet. She starts her favorite audio player and points it to ra1.streaming.npr.org. The audio player calls gethostbyname() with the given name to obtain the IP address of the server. As a result of the gethostbyname() call, the local resolver in Elisa's machine contacts the local DNS server to translate the host name into an IP address. The local DNS server performs an iterative lookup. The table below contains the DNS distributed database. A row corresponds to a DNS record. The records are grouped by DNS server.

Record #	Name	TTL (sec)	IN	Type	Value
		`localdns.localdomain.com`			
R1	.	262542	IN	NS	`E.ROOT-SERVERS.NET.`
R2	`E.ROOT-SERVERS.NET.`	348942	IN	A	192.203.230.10
		`E.ROOT-SERVERS.NET`			
R3	org.	172800	IN	NS	`F.GTLD-SERVERS.NET`
R4	`F.GTLD-SERVERS.NET`	172800	IN	A	192.35.51.30
		`F.GTLD-SERVERS.NET`			
R5	`npr.org`	172800	IN	NS	`watson.npr.org.`
R6	`watson.npr.org.`	172800	IN	A	205.153.37.175
		`watson.npr.org`			
R7	`streaming.npr.org.`	172800	IN	NS	`ns.streaming.npr.org.`
R8	`ns.streaming.npr.org`	172800	IN	A	205.153.36.175
		`ns.streaming.npr.org`			
R9	`audio.streaming.npr.org.`	172800	IN	CNAME	`ra1.streaming.npr.org.`
R10	`ra1.streaming.npr.org.`	10	IN	A	205.153.36.175

14. In the figure below, draw arrows to indicate the sequence of queries and responses exchanged among the different machines. Label each arrow with a sequence number, and fill in the table below to indicate the following information: (12 points)

- Sequence number indicating the ordering of the message exchanges.
- Message Type: use Q for Query or R for Response.
- Data: For queries use the value of the question data. For responses, specify the record ID(s) returned, if any, from the first column in Figure 1, e.g., R1, R2 ....
- You may use abbreviations for host names, e.g. "ra1" rather than ra1.streaming.npr.org.

The figure already contains an arrow indicating the first message from the local resolver to the local DNS server. The sequence number is 1 (first message), type = Q (query) and the data is the host name the application wants to resolve (ra1.streaming.npr.org). To make your sequence as simple as possible, assume the server includes both the A and NS records when applicable, so include both of them in the corresponding message.



Seq	Type	Data
1	Q	ra1.streaming.npr.org(A)

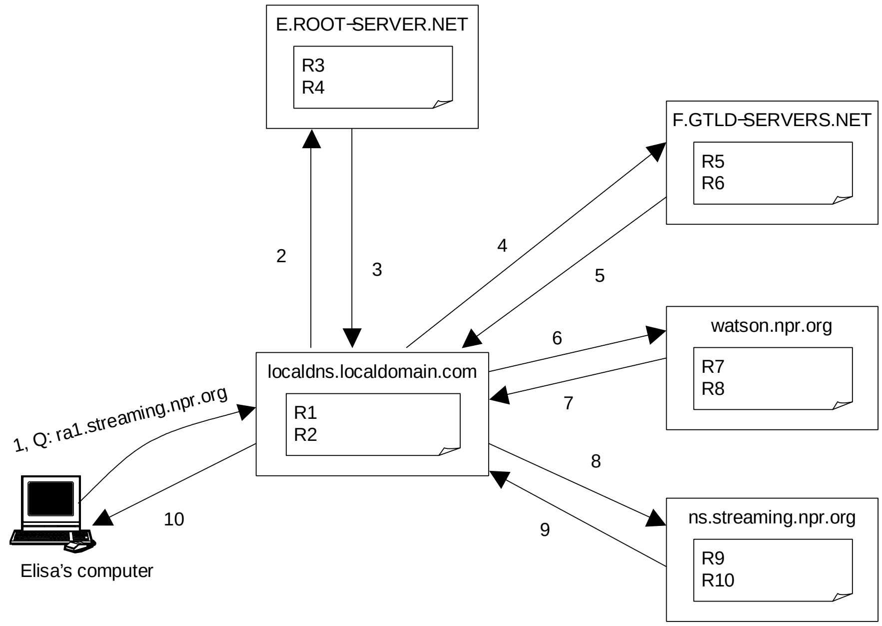


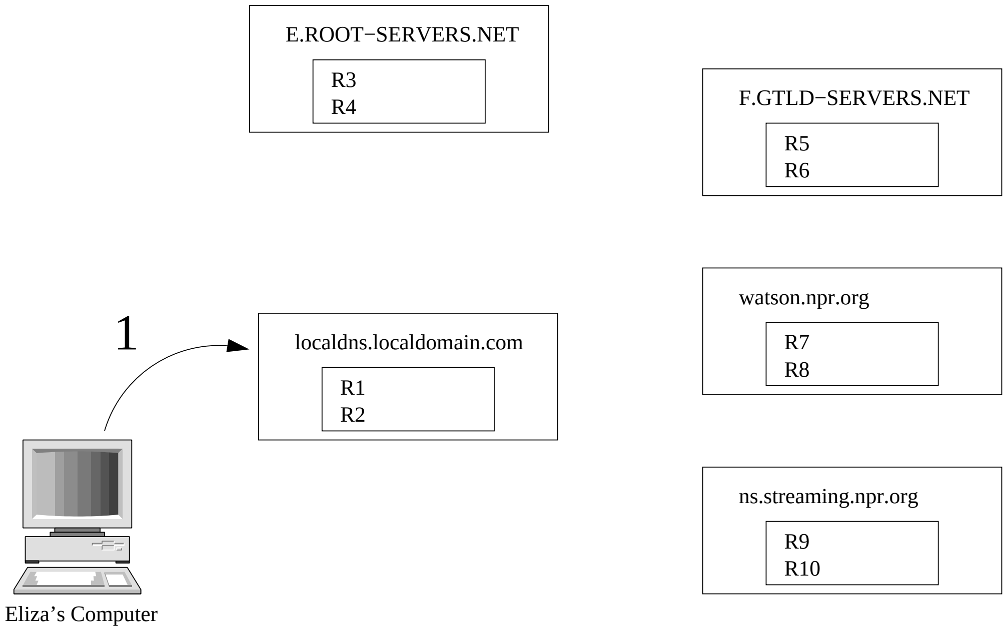
Figure 2: DNS Query & Response sequence.

Seq #	*Type*	*Data*
1	*Q*	*ra1.streaming.npr.org (A)*
2	*Q*	*ra1.streaming.npr.org (A)*
3	*R*	*R3 (NS), R4 (A)*
4	*Q*	*ra1.streaming.npr.org (A)*
5	*R*	*R5 (NS), R6 (A)*
6	*Q*	*ra1.streaming.npr.org (A)*
7	*R*	*R7 (NS), R8 (A)*
8	*Q*	*ra1.streaming.npr.org (A)*
9	*R*	*R10 (A)*
10	*R*	*R10 (A)*

The local DNS server exchanges a total of 10 messages.
Points were deducted as follows:
−2 pts for missing or incorrect message.
−2 pts for missing record in a message.
−Message 9 should contain only R10. −1 pt if R9 was included.
−Message 10 should contain only R10. −1 pt if R9 was included.

Solution: *−Iterative from the client (not the local dns server) −5 pts.*

15. Eliza repeats her query two minutes later. Show what happens for this subsequent query. (4 points)



Seq	Type	Data
1	Q	ra1.streaming.npr.org(A)

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The End – Phew!

E 4 Free Points for Tearing Off Page: Anonymous Feeback

List one thing you liked about the *class* and would like to see more of or see continued (any topic - lectures, homework, projects, bboards, topics covered or not covered, etc., etc.):

List one thing you would like to have changed or have improved about the class: