Georgia Tech

College of Computing

Georgia Institute of Technology

CS 6250: Computer Networking: Spring 2014

Quiz I

There are 13 questions (and one bonus question) and 11 pages in this quiz booklet (including this page). Answer each question according to the instructions given. You have **85 minutes**.

If you find a question ambiguous, write down any assumptions you make. **Be neat and legible.** If I can't understand your answer, I can't give you credit! There are three pretty challenging questions (clearly marked); you may want to look through the whole quiz and save those for last.

Use the empty sides of this booklet if you need scratch space. You may also use them for answers, although you shouldn't need to. *If you do use the blank sides for answers, make sure to clearly say so!*

Note well: Write your name in the space below AND your initials at the bottom of each page of this booklet.

THIS IS AN "CLOSED BOOK" QUIZ.
YOU ARE PERMITTED ONE DOUBLE-SIDED SHEET OF PAPER FOR NOTES.
ABSOLUTELY NO EMAIL OR MESSAGING OF ANY KIND!
MAKE SURE YOU'VE READ ALL THE INSTRUCTIONS ABOVE!

Initial here to indicate that (1) you've read the instructions and (2) you agree to abide by the Georgia Tech Honor Code:

The last page has easy bonus questions, which you can answer outside of the allotted time. Rip the last page off of your quiz for five bonus points. Turn it in anonymously if you like.

Do not write in the boxes below

1-5 (xx/20)	6-12 (xx/49)	13-15 (xx/16)	Bonus (xx/5)	Total (xx/85)
20	49	16	5	90.

Name: George Burdell (Key)

I Warmup

1. [4 points]: From the Dave Clark paper, *Design Principles of the DARPA Internet Protocols*, which was the first and foremost fundamental design goal of the Internet?

(Circle the BEST answer)

A. Security of end hosts and traffic.

B. Multiplexed utilization of existing interconnected networks.

C. Cost-effectiveness.

D. East of management

E. None of the above.

2. [4 points]: Which of the following are characteristics of packet switching?

(Circle ALL that apply)

A. Variable delay.

B. "Busy signals"

C. Sharing of network resources among multiple recipients.

D. Dedicated resources between each pair of sender and receiver.

E. None of the above.

3. [4 points]: Which of the following most accurately describes the *most common* uses for eBGP, iBGP, and IGP?

(Circle the BEST answer)

A. eBGP is used within an AS for external destinations, iBGP is used between ASes for external destinations, and IGP is used within an AS for internal destinations.

B. eBGP is used between ASes for external destinations, iBGP is used within an AS for external destinations, and IGP is used within an AS for destinations within an AS.

C. eBGP is used between ASes for external destinations, iBGP is used within an AS for internal destinations, and IGP is used within an AS for external destinations.

D. None of the above

Name:

4. [4 points]: Which of the following is true about required router buffer sizing if TCP senders are *not* synchronized?

(Circle ALL that apply)

A. The amount of buffering to sustain complete utilization is more than the bandwidth-delay product.

B. The amount of buffering required to sustain complete utilization is less than the bandwidth-delay product.

C. Packets from different TCP flows will experience packet drops at different times.

D. The total amount of packets in the bottleneck buffer at any time will be a normal random variable whose standard deviation is inversely proportional to the square root of the number active flows.

E. None of the above

5. [4 points]: Which of the following are characteristics of interdomain routing policies that are commonly applied?

(Circle ALL that apply)

A. Given multiple routes to the same IP prefix, an AS will prefer a route through a provider over a route through its customer.

B. Given multiple routes to the same IP prefix, an AS will prefer a route through a customer over a route through its peer.

C. An AS will not advertise a route that it learns via a provider to a peer.

D. An AS will not advertise a route that it learns via a provider to another provider.

E. All of the above

Name:

II Potpourri

6. [5 points]: What is the main difference between simulation and emulation? Describe two advantages of using an emulation tool like Mininet over a simulator.

(Answer legibly in the space below.)

Main difference: Emulations run in real time.

Advantages:

- Emulation can run real software.
- Can run real control programs and transfer to real network unchanged.

7. [4 points]: The paper *Dynamics of DNS Scam Hosting Infrastructure* describes certain characteristics of DNS records for scam sites that are different from the DNS records for "legitimate" sites. What is one such difference? What would be a reason for the host of that scam DNS domain to use DNS records be different in this way?

(Answer legibly in the space below.)

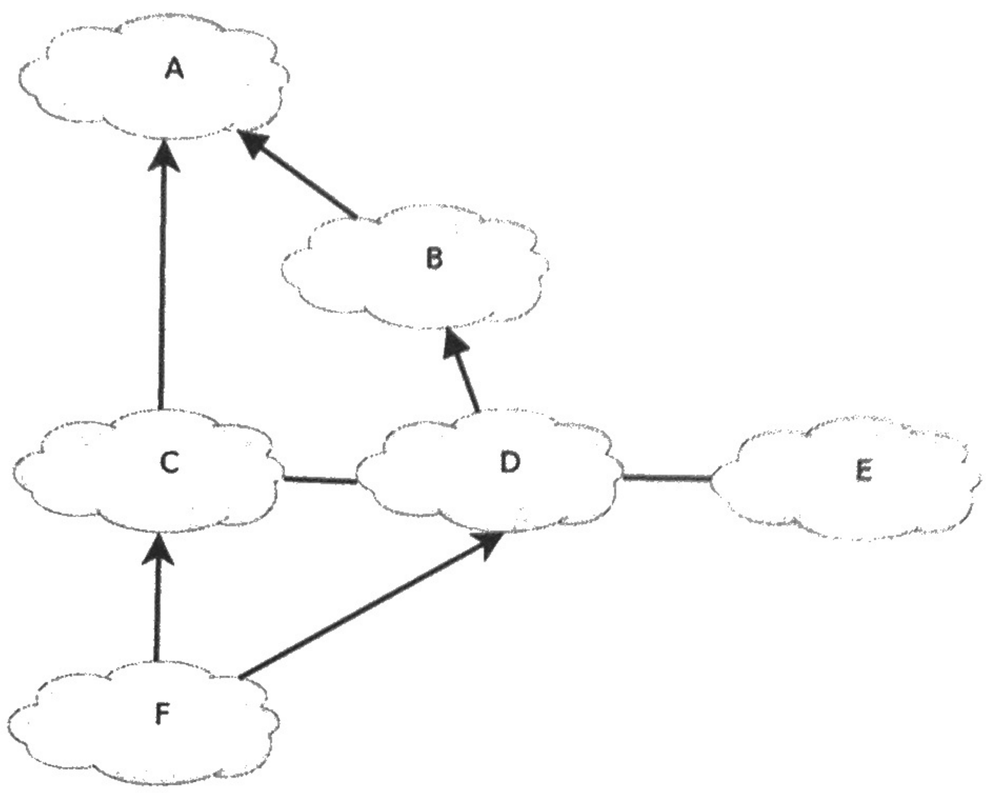
- TTLs for IP for NS records are shorter.
- TTLs are shorter in general.
- The # of IP addresses for a given domain over time becomes quite large.

(other answers possible)

Reason: "Agility" scammers need to move to evade detection.

Name:

8. [10 points]: Consider the AS graph below, which shows a set of ASes and their business relationships. Consider the following questions about their relationships.



A. Would the stub AS F readvertise routes it learned from provider C to its other provider, D? Why or why not?

B. Would E ever learn a route to a destination advertised by F? If so, what would be the AS path of the route it learned? If not, why would it not learn a route?

C. If A does not set any local preference values on routes that are advertised by F, and all ASes advertise routes according to common route export rules, then what is the AS path of the route that A will prefer to a destination that is advertised by F?

D. Suppose that AS F wants AS A to use the route $ABDF$ to reach an IP prefix that F advertises. Describe one way that AS F can try to cause AS A to send traffic for the prefix along that path. Will the approach guarantee that AS A always chooses that path? Why or why not?

(Answer legibly in the space below.)

Name:

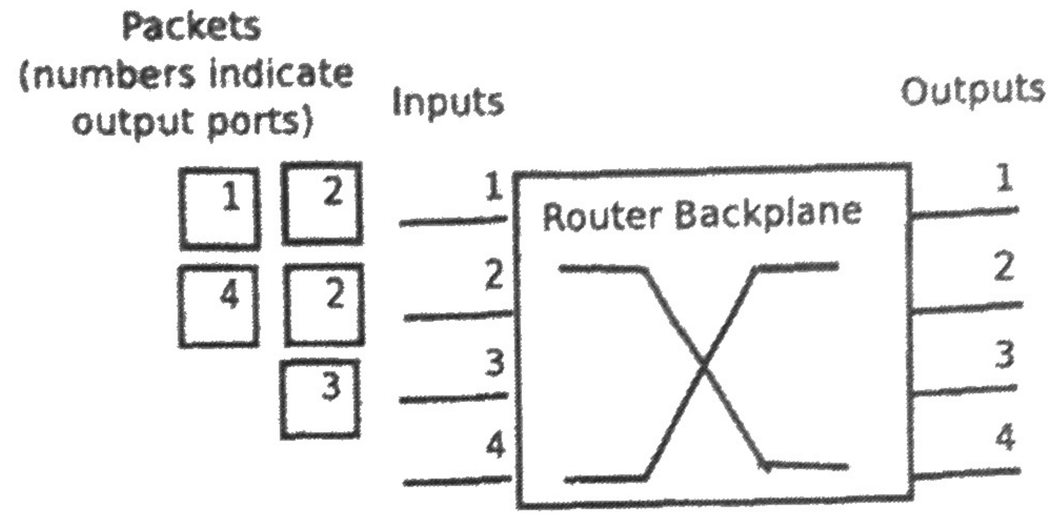
A. No. Provider routes never advertised to another provider.
AS F would pay twice! (Upstream & downstream).

B. Yes. E D F.

C. A C F (shortest AS path length)

D. Two possible answers:
- IP prefix splitting (yes, guaranteed; Longest pfx match)
- AS path prepend (no, not guaranteed; Local pref might

9. [8 points]: Consider the router backplane below, with packets arriving as shown. The number on each packet designates its intended output port. Suppose that each input and output port have a rate of 1 Gigabit per second.



A. Suppose the router has a ***bus backplane*** with throughput of 5 Gigabits per second. What is the total maximum throughput that the router can achieve? Why?

B. The example shows an example of *head-of-line blocking*. Explain why, and explain how virtual output queueing can fix the problem.

C. Now suppose the router has a *crossbar switch backplane* with a throughput of 10 Gigabits per second (a "speedup" of 2) and virtual output queueing. Given the packet arrival pattern shown in the figure, give a sequence of matchings of input ports to output ports that results in 100% utilization (to save time, simple notation like "Round 1: $1 \rightarrow 2$" is sufficient to indicate that you match input one to output two in round one). Your solution should have two rounds.

(Answer legibly in the space below.)

A. 4 Gbps. Only one input-output pair can use the bus at any time; only four inputs.

B. There are two packets for output 2 at the heads of queues. One of those results in either 1 or 4 being blocked, even though there could be a match to the output. (e.g., $1 \rightarrow 1$, $2 \rightarrow 2$, $3 \rightarrow 3$)

C. Rnd 1: $1 \rightarrow 1$, $2 \rightarrow 2$, $3 \rightarrow 3$
Rnd 2: $1 \rightarrow 2$, $2 \rightarrow 4$. [many possible correct answers]

Name:

10. [5 points]: Consider a link that has a capacity of 20 Mbps and receives five traffic flows with respective demands: { 2 Mbps, 4 Mbps, 6 Mbps, 10 Mbps, 15 Mbps }. Suppose that the router wishes to allocate rates to each of these flows in a *max-min* fair manner.

Give the resulting max-min fair allocation of flows, in the form { x_1 Mbps, x_2 Mbps, ...}, where x_i are the resulting flow rates in a max-min fair allocation.

(Answer legibly in the space below.)

{ 2, 4, , 4.67, 4.67, 4.67 }

How to compute:

① Fair share is 20/5 = 4.

② x_1 has excess 2. split across remaining 3 (2/3 = 0.67 each) who have excess demand.

11. [5 points]: Consider the following longest prefix match forwarding table for 4-bit addresses:

Prefix	Port
0*	A
01*	B
0101	C
1*	D
111*	E

A. Assuming longest prefix match, what port would be used for destination address 0111?

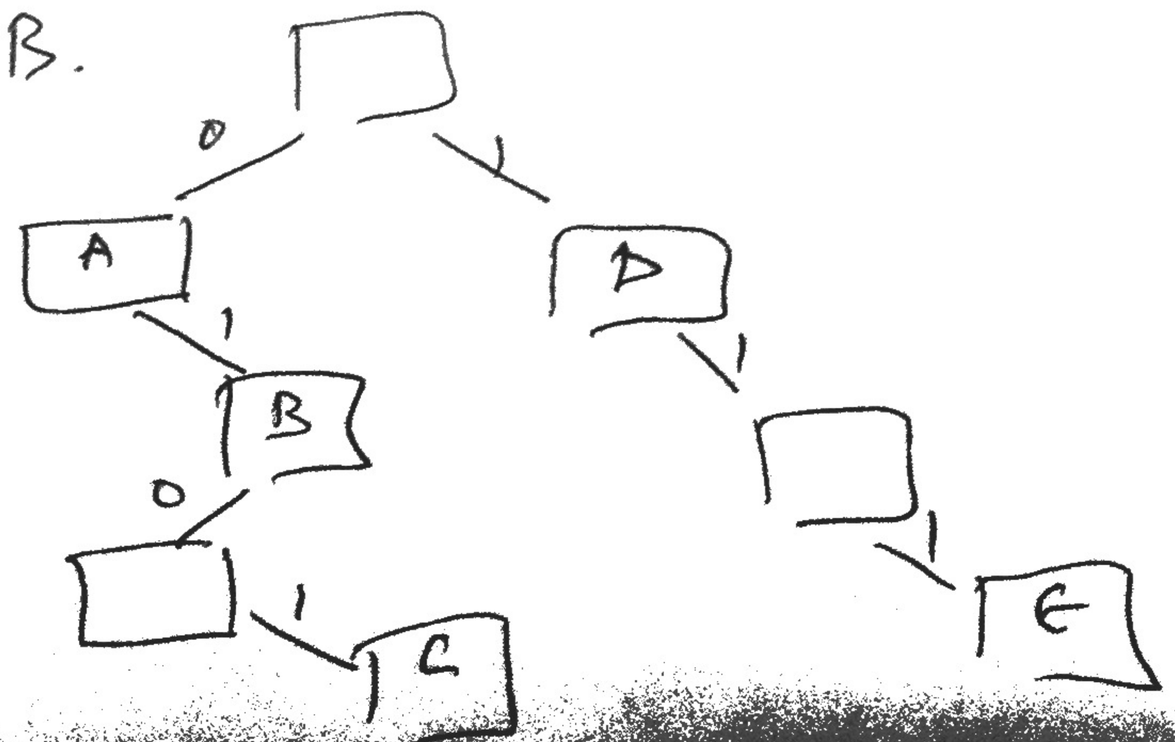
B. Draw a simple *one-bit trie* representing the table.

C. Draw a simple *two-bit trie* representing the table.

(Answer legibly in the space below.)

A. B

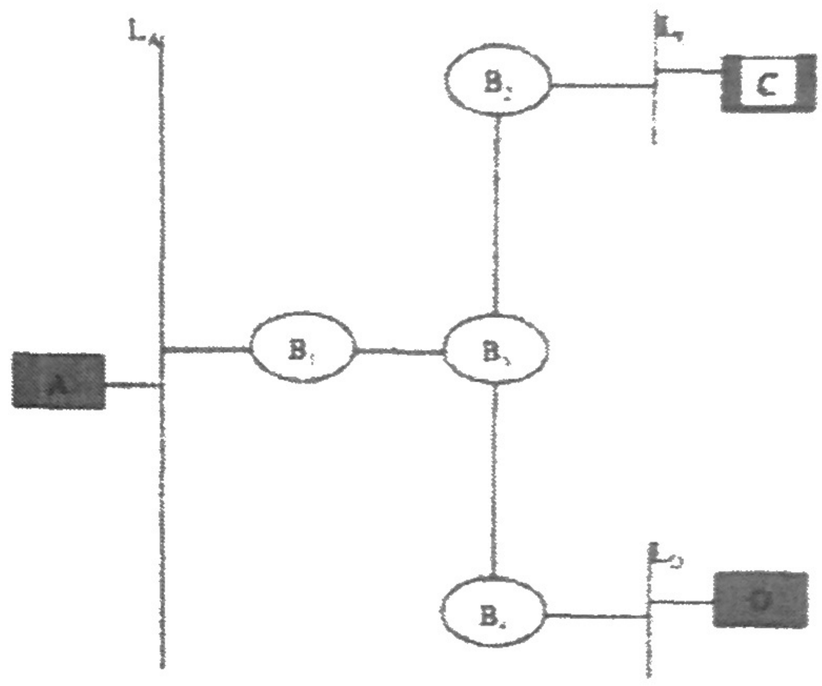
B.



C.

Name:

12. [12 points]: Consider the bridge topology shown the figure below. Assuming that all of the forwarding tables are initially empty, write out the forwarding tables at each of the four bridges B_1 through B_4 at the conclusion of the following transmissions:



1. A sends to D
2. D sends to A
3. C sends to A

In the forwarding table at each node, identify the port by the unique LAN segment (L_A, L_C, or L_D) reachable using that port, unless there isn't one, in which case use the identifier of the neighboring bridge to identify the port.

After A sends to D:

B_1		B_2		B_3		B_4	
Destination	Port	Destination	Port	Destination	Port	Destination	Port
A	L_A	A	B_3	A	B_1	A	B_3
C	—	C	—	C	—	C	—
D	—	D	—	D	—	D	—

After D sends to A:

B_1		B_2		B_3		B_4	
Destination	Port	Destination	Port	Destination	Port	Destination	Port
A	L_A	A	B_3	A	B_1	A	B_3
C	—	C	—	C	—	C	—
D	B_3	D	—	D	B_4	D	L_D

After C sends to A:

B_1		B_2		B_3		B_4	
Destination	Port	Destination	Port	Destination	Port	Destination	Port
A	L_A	A	B_3	A	B_1	A	B_3
C	B_3	C	L_C	C	B_2	C	—
D	B_3	D	—	D	B_4	D	L_D

Name:

III Network Neutrality

13. [4 points]: Define *network neutrality*. Suppose that network neutrality is *not* enforced. Describe one benefit to users, one benefit to ISPs, and one benefit to content providers.

(Answer legibly in the space below.)

Net neutrality: ISP cannot discriminate against one type of traffic or another (nor charge more for certain types of traffic.)

(many answers possible)

Users: pay only for what you use

ISPs: ~~[illegible]~~ more profit!

Content providers: could pay more to get better service.

14. [4 points]: Explain why the lack of network neutrality might give an unfair advantage to an ISP like Comcast, who also owns NBC, a major provider of content such as television shows.

(Answer legibly in the space below.)

Comcast could, for example, give priority to video streams of NBC content, or charge more for streaming non-NBC content.

Name:

15. [8 points]: A recent court ruling against the FCC suggested that although ISPs did not need to remain neutral, they needed to be *transparent*, meaning that they would have to be clear about their traffic prioritization and differential pricing policies.

A. George Burdell wants to design a system to enforce transparency for ISPs in Atlanta. He starts off by using a tool like `iperf` (which you used in the assignments) to measure TCP throughput from his laptop at home to a server running in San Francisco. He notices that the output of `iperf` does not match the downstream throughput rate that his ISP advertises. Ben Bitdiddle suggests that he should instead try using `iperf` to a server that is located in Atlanta and he might see `iperf` achieve a higher rate. Is Ben right? Why or why not?

B. *Open-ended.* George begins sending traffic to the server in Atlanta and notices that `iperf` *still* doesn't yield a throughput that is close to what his ISP advertises. Ben suggests that other factors, such as George's laptop wireless card, the amount of load on his machine, "cross traffic" from other devices in his home, etc. may be interfering with George's measurement. Help George make changes to his method that would better help isolate these effects. *Hint:* You can consider collecting additional data, changing the vantage points that George is measuring to or from, and so forth.

(Answer legibly in the space below.)

A. He is right. Several possible reasons:

- TCP throughput is inversely proportional to RTT.
- wide-area path might traverse congested peering links.

B. ① Collect performance data directly from the router.
② collect performance data from many homes subscribed to the same ISP. Compute means, medians, etc.
(other correct answers exist)

Name: