15-441: Computer Networks
Homework 4

Assigned: Apr 23, 2008
Due: May 1, 2008
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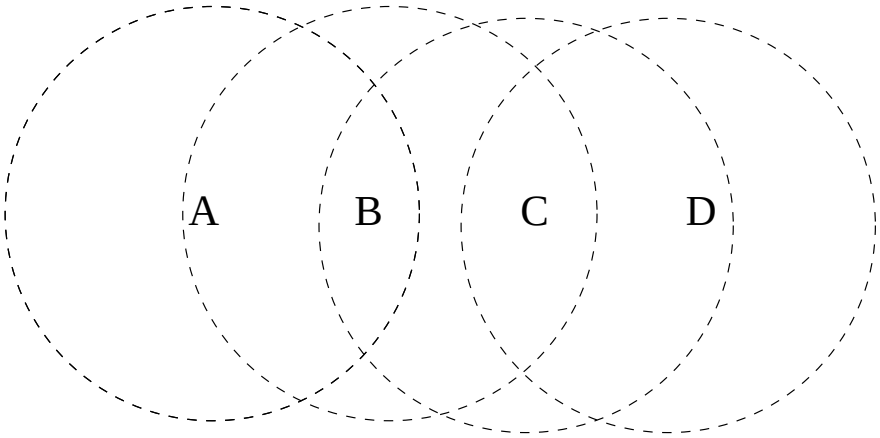
1. Consider the following topology of wireless laptops A, B, C and D. The dotted lines indicate the range of wireless transmissions from each node. For example, B is within range of A, A & C are within range of B, B & D are within range of C and only C is within range of D. Assume that each node uses an RTS/CTS based MAC protocol.



   (a) Use the figure to give an example of how RTS/CTS can help solve hidden terminal problem.

   > **Solution:** Consider when A transmits to B, and C transmits to D. Without RTS/CTS, there will be collisions on B (B is the hidden terminal). With RTS/CTS, B is no longer a hidden terminal because C can hear B's CTS.

   (b) RTS/CTS is usually disabled by default on commerical wireless routers, give one reason for this choice.

   > **Solution:** One answer is that RTS/CTS introduces overhead and current wireless traffic is mostly bursty (hidden terminal problem is not yet a very serious problem).

2. There are three forms of P2P lookup algorithms: centralized (napster), flooding-based (gnutella) and routing-based (DHTs). Which of the following statements is true about these algorithms?

   (a) Flooding-based and centralized systems can support much richer queries (regular expressions, wild-cards) than routing-based systems.

   (b) Routing-based systems are more scalable than flooding-based systems since they produce less traffic per search.

   (c) Routing-based systems ensure that a client finds the copy of a file that is closest to it in the network.

(d) Ring-based DHTs are not as flexible as other DHTs since they only allow routing in one dimension.

Solution: (a)(b)

3. Imagine a Chord system using 4-bit ids. Let there be 4 nodes participating with IDs 0, 3, 9, 11 and 12.

(a) Use the table below to fill in the finger table for node 0. Please assume clockwise data assignment.

ID pointed to	Node storing ID

Solution:

ID pointed to	Node storing ID
1	3
2	3
4	9
8	9

(b) Using the above Chord ring, what path would a request starting at node 0 take to find data item 12?

Solution: $0 \rightarrow 9 \rightarrow 11 \rightarrow 12$

4. Suppose you retrieve index.html from cnn.com and find that it has 3 embedded images that have been akamaized. Assume that your browser does not use persistent connections and that your DNS cache is empty. Assume that the only TTLs used for DNS are 1 day and 1 minute. In retrieving the 3 images (not the html file), how many connections will your browser make to:

(a) the original content provider

Solution: 0

(b) the DNS root/gTLD server

Solution: 1 (to resolve akamai's NS)

(c) the Akamai high-level DNS server

Solution: 1 (to a region)

(d) the Akamai low-level

Solution: 1 (1 minute TTL sufficient for image retrieval)

(e) the closest Akamai server

Solution: 3 (1 per image)

5. Consider 10 flows with arrival rates of 1,2,...,10 Mbps that traverse a link of 50Mbps. Calculate the max-min fair share on this link. What is the fair share if the link capacity is 60 Mbps?

Solution:

1. Flow 1 = 1 Mbps
2. Flow 2 = 2
3. Flow 3 = 3
4. Flow 4 = 4
5. Flow 5 = 5
6. Flow 6 = 6
7. Flow 7 = 7
8. Flow 8 = 7.33
9. Flow 9 = 7.33
10. Flow 10 = 7.33

If capacity is 60 Mbps, the capacity exceeds the sum of demands so

1. Flow 1 = 1 Mbps
2. Flow 2 = 2
3. Flow 3 = 3
4. Flow 4 = 4
5. Flow 5 = 5
6. Flow 6 = 6
7. Flow 7 = 7
8. Flow 8 = 8
9. Flow 9 = 9
10. Flow 10 = 10

6. Consider 10 wireless users associated with an access point, and they are sending data to the access point using transmit rates of 1,2,...,10 Mbps, respectively.

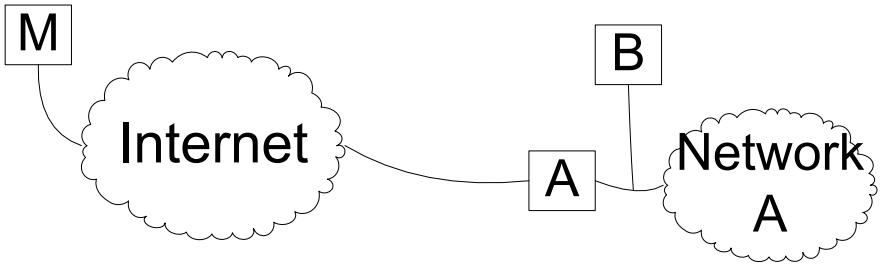
(a) Suppose all users are transmitting continuously with maximum frame size, e.g. 1500 bytes. Calculate the effective data rate for each wireless user, you can ignore the protocol overhead. (Hint: airwave is shared by all users and access point allocates equal link-layer throughput to every associated user.)

Solution:
All users will have the same throughput of $\frac{1}{\frac{1}{1}+\frac{1}{2}+...+\frac{1}{10}} Mbps = 341.42Kbps$

(b) From the previous problem we can see that the effective data rate is greatly limited by the slow users. Propose a simple idea to solve this problem (describe your idea, do not write a complete solution).

Solution: A simple solution is to let wireless routers allocate equal air time (instead of equal throughput) to all links.

7. Consider the following topology.



(a) You want to deploy both a firewall and an NIDS, where do you want to place each of them (choose from A and B)? Briefly explain your choice.

Solution: Firewall at A because it is fail-close. NIDS at B because it is fail-open.

(b) Suppose there is a malicious attacker M in the Internet, how to set the rule on the firewall to prevent traffic from M (use the following table)?

Rule	Dir	Src Addr	Src Port	Dst Addr	Dst Port
Ingress					

Solution:

Rule	Dir	Src Addr	Src Port	Dst Addr	Dst Port
Ingress	in	M's addr	any	any	any

(c) Suppose M knows the rule specified in (b), how can he evade such blocking, e.g. still be able to send packets to A?

Solution: IP address spoofing.

(d) Traditional rules only inspect the IP headers. What is the limitation of this approach? Proxy-based firewall is deployed where packet content is also inspected, what are the pros and cons of this approach?

Solution: The network is susceptible to higher-layer attacks, such as attacks to legitimate services. The pros of packet content inspection include security, and the cons include high inspection overhead.