

## Computer Network 2015 Mid-Term Exam.

### Question : ``Basic of Computer Networks and the Internet'

Please fill into the blanks (15%)

- a) The amount of time required to push all of a packet's bits into a link is called transmission time/delay
- b) The Internet's application layer includes many protocols, such as the HTTP protocol (which provides for Web document request and transfer), SMTP (which provides for the transfer of e-mail messages), and FTP/SFTP/P2P (which provides for the transfer of files between two end systems).
- c) How many IP Protocols are there in the Internet? 1 (IPv4) / 2 (IPv4, IPv6)
- d) An application-layer process sends messages into, and receives messages from, the network through a software interface called a socket. This is also referred to as an API which stands for Application Programming Interface.
- e) Internet protocols are defined in RFCs.
- f) In order to deal with the issue of scale, the DNS uses a large number of servers, organized in a hierarchical/layered fashion and distributed around the world. No single DNS server has all of the mappings for all of the hosts in the Internet. Instead, the mappings are distributed across the DNS servers. To a first approximation, there are three classes of DNS servers— root DNS servers, TLD (top-level domain) DNS servers, and authoritative DNS servers
- g) In a DNS server, a resource record is a four-tuple that contains the following fields: ( Name, Value, Type, TTL) The meaning of Name and Value depend on Type:
  - If Type = A, then Name is a hostname and Value is the IP address for the host-name. Thus, a Type A record provides the standard hostname-to-IP address mapping. As an example, ( relay1.bar.foo. com,145.37.93.126, A) is a Type A record.
  - If Type = NS, then Name is a domain and Value is the host-name of an authoritative DNS server that knows how to obtain the IP addresses for hosts in the domain. This record is used to route DNS queries further along in the query chain.

Answer each of the following questions *briefly, i.e., in at most a few sentences*

- a) (5%) (True or false) In a circuit switched network, all data belonging to a connection traverses the same route, whereas in a packet switched network, different packets belonging to the same connection may take different routes.  
True.

- b) (5%) (True or false) An IP header contains a source port and a destination port number that are each 2 bytes long.

False.

Port numbers are something in transport layer, which is above network layer. Thus, an IP header does not contain the port number.

- c) (5%) (True or false) Sequence numbers are necessary to tolerate losses, but are not needed to tolerate bit errors alone.

False.

Sequence numbers are to tolerate duplication, while timeout are to tolerate losses.

- d) (5%) Describe the use of the “If-Modified-Since” header in the HTTP protocol.

This header is used to specify whether the web content is modified since some time. It is useful for web caching.

- e) (10%) NTU Computer Center hires you as the p2p expert to reduce its rising bandwidth costs due the rising use of BitTorrent. How would you address their problem?

Index poisoning, content pollution, detecting the p2p protocol and banning the IP port or restricting the bandwidth, etc. (You should briefly explain your answer to get the full credit.)

- f) (20%) Consider an http client that wants to retrieve a WWW document at a given URL. The IP address of the http server is initially unknown. The WWW object at the URL has one embedded GIF image that resides at the same server as the original object.

- a. What transport and application layer protocols besides http are needed in this scenario?

DNS: for getting IP address of the server.

TCP: for connecting with the server.

UDP: for connecting with the DNS server.

- b. Suppose that the time needed to contact and receive a reply from any server (for any protocol) is RTT, and the time to transmit the WWW object and GIF image is T. How much time (in RTT and T) is needed from when the user first enters the URL until the complete document is displayed? Assume that non-persistent http is used. Consider the delays of all protocols in your answer, not just those of http.

1~4 RTT for DNS request.

2 RTT for TCP handshaking and requesting WWW object.

2 RTT for TCP handshaking and requesting GIF image.

2 T for transmitting WWW object and GIF image.

Total: 5~8 RTT + 2T

**Question 2: ``DHT``: Distributed Hash Table**

(a) (20%) Consider a circular Distributed Hash Table (DHT) with node identifiers in the range [0; 15]. Suppose there are seven peers with identifiers 1, 4, 7, 9, 11, 13 and 15.

- (i) Suppose that the following (key,value) pairs should be stored in the DHT: (2,0), (6,5), (8,13) and (14,7). Which peers will store which (key,value) pairs? Fill in the table below.

(key,value)	Identifier of the responsible peer
(2,0)	4
(6,5)	7
(8,13)	9
(14,7)	15

- (ii) Suppose that peer 7 learns that peer 9 has left the DHT. How does peer 7 update its successor state information? Which peer is now its first successor? Its second successor?

- (1) Peer 7 will periodically ping its two successors to check aliveness. If immediate successor (peer 9) leaves, peer 7 chooses next successor (peer 11) as new immediate successor, and asks peer 11 who its immediate successor is and makes peer 11's immediate successor as its second successor.
- (2) First successor: peer 11
- (3) Second successor: peer 13

(b) (10%) Explain how DHT improves search performance from  $O(n)$  to  $O(\log n)$ , where  $n$  is the total number hosts in DHT method.

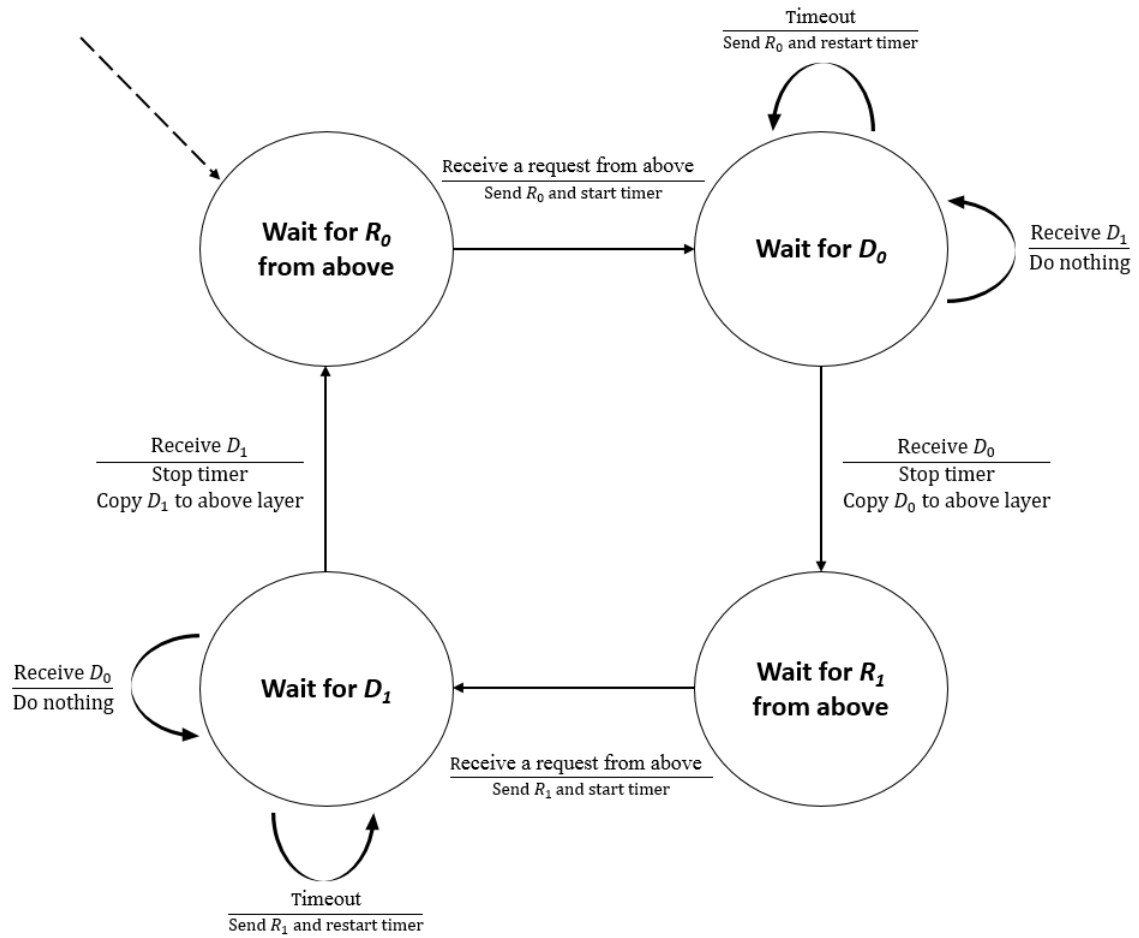
We can just add "shortcuts" into DHT peers. Each peer keeps track of IP addresses of predecessor, successor, and shortcuts. If each peer has  $O(\log n)$  shortcuts, then we can achieve  $O(\log n)$  search performance.

**Question : A reliable data transfer protocol**

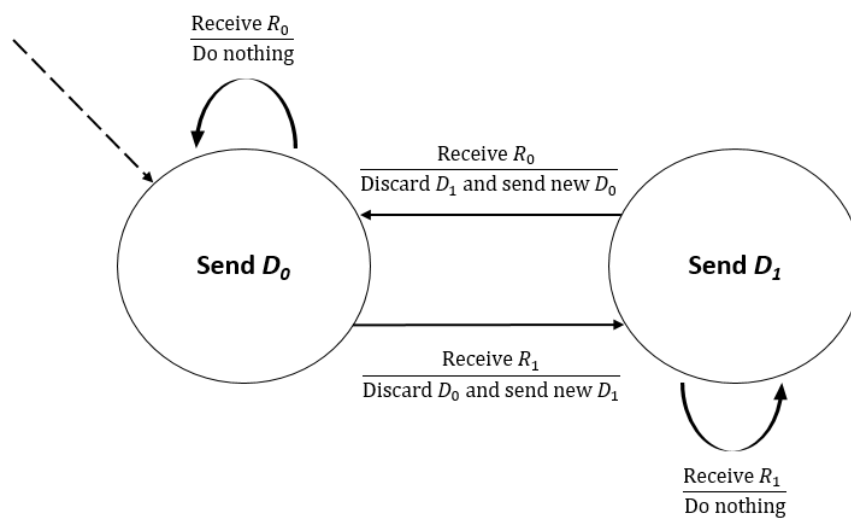
(25%) Suppose we have two network entities, A and B. B has a supply of data messages that will be sent to A according to the following conventions. When A gets a request from the layer above to get the next data (D) message from B, A must send a request (R) message to B on the A-to-B channel. Only when B receives an R message can it send a data (D) message back to A on the B-to-A channel. A should deliver exactly one copy of each D message to the layer above. R messages can be lost (but not corrupted) in the A-to-B channel; D messages, once sent, are always delivered correctly. The delay along both channels is unknown and variable. Assume no reordering occurs.

Design (give an FSM description of) a protocol that incorporates the appropriate mechanisms to compensate for the loss-prone A-to-B channel and implements message passing to the layer above at entity A, as discussed above. Use only those mechanisms that are absolutely necessary. Use a pencil or a rough sheet before finalizing your answer.

A:



B:



**Question : Homework Review:** These problems are not the same as homeworks, which means that we have modified some description. Please be careful when answering.

- (a) (15%) Consider two hosts, X and Y, connected by a single link of rate  $A$  bps. Suppose that the two hosts are separated by  $B$  meters, and suppose the propagation speed along the link is  $C$  meters/sec. Host X is to send a packet of size  $D$  bits to Host Y.

- (1) (5%) Ignoring processing and queuing delays, obtain an expression for the end-to-end delay in terms of  $A$ ,  $B$ ,  $C$ , and  $D$ . Remember to write the unit.

$$\frac{B}{C} + \frac{D}{A} \text{ (s)}$$

- (2) (5%) Suppose propagation delay is greater than transmission delay. At time  $t =$  transmission delay, where is the first bit of the packet?

The first bit is in the link and has not reached Host Y.

- (3) (5%) Suppose link rate  $A = 8$  Mbps, distance  $B = 120$  km, and packet size  $D = 30$  Bytes. Find the propagation speed  $C$  so that propagation delay equals transmission delay. Remember to write the unit.

$$\frac{B}{C} = \frac{D}{A}$$

$$\Rightarrow C = \frac{AB}{D} = \frac{(8 \times 10^6) \times (120 \times 10^3)}{30 \times 8} = 4 \times 10^9 \text{ (m/s)}$$

(Or you can argue that this speed is faster than the speed of light, so there is no solution.)

- (b) (15%) Answer true or false for each statement, and briefly explain your answer if it's false.

- (1) (5%) A user requests a Web page that consists of some text and four images. For this page, the client will send four request messages and receive four response messages.

False.

The client will send five request messages and receive five response messages

- (2) (5%) Two distinct Web pages (for example, `www.mit.edu/research.html` and `www.mit.edu/students.html`) can be sent over the same nonpersistent connection.

False.

In a nonpersistent connection, the connection closes after each connection, so two pages cannot be sent over the same connection.

- (3) (5%) With persistent connections between browser and origin server, it is possible for a single TCP segment to carry two distinct HTTP request messages. This question is originally to make sure that everyone knows the concept of persistent TCP connection. However, we use the “segment” instead of “connection”, and this makes the meaning of this question wrong. Therefore, we decide to give the credit if your answer is reasonable.

True. (For the one who views a TCP segment as a TCP connection.)

False. A single TCP segment can only carry one HTTP request messages.