15-441 Computer Networks (Fall 04)
Homework #3

DNS

The Andrew Linux machines provide a program, dig, that allows you to query Domain Name Service (DNS) servers around the Internet (some documentation is available if you type `man dig`). When running dig for the purposes of this question, you should use the following format:
`dig +norecurse @<name.of.dns.server> <record-type> <domain-name>`
where `<name.of.dns.server>` is the hostname of the DNS server you wish to query, such as A.ROOT-SERVERS.NET; `<record-type>` is the type of DNS record you wish to retrieve, such as ANY, MX, HINFO, A, or SOA; and `<domain-name>` is the name of the host or domain you seek information on.

The DNS is a distributed architecture that uses hierarchical delegation. At the top of the system are the "root" name servers, who know which DNS server is responsible for each second-level domain (such as CMU.EDU). If you send a root server a query for a particular machine, you will receive a reply listing the servers that have been delegated authority for that machine's second-level domain. It is common for a large domain such as CMU.EDU to further delegate to "departmental" or workgroup DNS servers, which you can discover by querying the second-level servers.

(a) In order to discover the chain of delegation in use at CMU, run a series of NS queries for UX1.SP.CS.CMU.EDU. You may start with any of the root servers, and you should continue your sequence of queries until you stop getting new delegations (in some domains, this is indicated by a DNS server returning you a delegation pointing to itself, and in other domains this is indicated by a DNS server returning you a SOA record instead).

Below is a delegation chain for AOL.COM.

Server queried	NS delegations to
B.ROOT-SERVERS.NET	A.GTLD-SERVERS.NET ... K.GTLD-SERVERS.NET
K.GTLD-SERVERS.NET	DNS-{01,02,06,07}.NS.AOL.COM
DNS-06.NS.AOL.COM	DNS-{01,02,06,07}.NS.AOL.COM

It was produced by running commands beginning with:

```
% dig +norecurse @b.root-servers.net NS aol.com
```

Generate the delegation chain for UX1.SP.CS.CMU.EDU. Present your results in the table form shown above. Each NS query will typically return two or more answers; choose among them at random. If you query a server and get a timeout, choose an alternate server.

(b) The DNS is also used to translate IP addresses into hostnames. Again, the database is distributed in a hierarchical fashion, with a wrinkle. The most-specific part of a domain name is on the left (i.e., UX1 in UX1.SP.CS.CMU.EDU), but the reverse is true of IP addresses (i.e., in 128.2.198.101, 128 is "top-level", 128.2 is CMU.EDU, and 128.2.198 belongs to CS.CMU.EDU). Thus, address-to-name mapping is handled by reversing the bytes of the IP address and making queries in a special domain. To turn 128.2.198.101 into a hostname, various servers are sent queries seeking PTR records for 101.198.2.128.in-addr.arpa. The first query would be:

```
% dig @a.root-servers.net PTR 101.198.2.128.in-addr.arpa
```

You will know you're done when your query gives you back a PTR record in addition to (or instead of) NS records.

Fill in a table like the one above showing a query chain for the IP address 192.58.107.193.

(c) Use the `novc` and `vc` options of `dig` to argue in favor of the proposition that UDP fulfills a useful function in the modern Internet.

TCP

From the textbook, pages 437–448, do questions 4, 9, 15, 30, and 39.

BGP

From the textbook, pages 355, do questions 47.

Congestion Control

From the textbook, pages 526, do questions 16, 17, 22, 28, 30.