

## Homework 2

Bryan Lee  
922649673

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### Questions

1. (20 Points) Describe the three kinds of DNS servers and their functionalities in the hierarchy of DNS system. Suppose the host `cs.sfsu.edu` wants to know the IP address of `gaia.cs.umass.edu`. Also suppose that the local DNS server of SFSU is called `dns.sfsu.edu`, and an authoritative DNS server for `gaia.cs.umass.edu` is called `dns.umass.edu`. Describe the interaction of the host and DNS servers (including the local DNS server).

**Three kinds of DNS servers and their functionalities in the hierarchy of DNS system (from textbook):**

- (a) **Root DNS Servers** - These are the top-level DNS servers in the hierarchy responsible for directing DNS queries to the appropriate top-level domain (TLD) servers (e.g., `.com`, `.edu`). Although thousands of instances of root servers are distributed globally, they are all replicas of 13 root server identities, managed by 12 different organizations, and coordinated through the Internet Assigned Numbers Authority.
- (b) **Top-level domain (TLD) servers** - These servers are responsible for top-level domains such as `.com`, `.edu`, `.org`, etc., and all the country top-level domains such as `uk`, `fr`, `ca`, and `jp`. They respond with the IP address of the authoritative DNS server for the requested domain name.
- (c) **Authoritative DNS Servers** - These servers contains the actual DNS records for domain names under their authority. It is an organization's own DNS server (e.g., `sfsu.edu`). It provides authoritative hostname to IP mappings for organization's named host. For example, `dns.umass.edu` is the authoritative server for `gaia.cs.umass.edu`, meaning it knows the IP address of `gaia.cs.umass.edu`.

Now, if the host `cs.sfsu.edu` wants to know the IP address of `gaia.cs.umass.edu`, it will first query its local DNS server, `dns.sfsu.edu`, asking for the IP address. , `dns.sfsu.edu` doesn't know the IP address of `gaia.cs.umass.edu`, so it will query a root DNS server. The root server replies with the IP address of the `.edu` TLD server. Then, `dns.sfsu.edu` queries the `.edu` TLD DNS server, which replies with the IP address of the authoritative DNS server, `dns.umass.edu`. Finally, `dns.sfsu.edu` queries `dns.umass.edu`, which knows and returns the IP address of `gaia.cs.umass.edu`. The local DNS server then forwards this IP address back to

the original host, cs.sfsu.edu.

**Order of operation:**

- (a) cs.sfsu.edu  $\rightarrow$  dns.sfsu.edu
  - (b) dns.sfsu.edu  $\rightarrow$  root DNS server  $\rightarrow$  TLD server (.edu)  $\rightarrow$  dns.umass.edu
  - (c) dns.sfsu.edu  $\leftarrow$  IP address of gaia.cs.umass.edu  $\leftarrow$  dns.umass.edu
  - (d) cs.sfsu.edu  $\leftarrow$  IP address from dns.sfsu.edu
2. (15 Points) In the reliable data transfer protocols, why do we need to introduce sequence numbers? Why do we need to introduce ACK/NAK? Why do we need to introduce timers?

**We need to introduce sequence numbers to distinguish new packets from duplicate transmissions. Sequence numbers help identify each packet uniquely, especially when packets are retransmitted, and preserve order in the case of out-of-order delivery. This helps maintain the integrity of the data and avoid data corruption.**

**We need to introduce ACK/NAK to confirm the delivery of data packets. ACK (acknowledgment) confirms the successful receipt of a packet. On the contrary, NAK (negative acknowledgment) informs the sender that a packet was lost or contains an error. These acknowledgments provide feedback to the sender to determine whether it needs to be retransmitted or the next packet should be continued sending.**

**We need to introduce timers to set a timeout period for detecting packet loss. If an ACK is not received within the timeout, the sender retransmits the packet, assuming it was lost. This ensures that the transmission does not hang for too long.**

3. (40 Points) Visit the online animations for Go-Back-N and Selective Repeat.
- (a) Have the source send five packets, and then pause the animation before any of the five packets reach the destination. Then kill the first packet and resume the animation. Describe what happens and why.

**Answer**

- (b) Repeat the experiment, but now let the first packet reach the destination and kill the first acknowledgment. Describe again what happens and why.

**Answer**

- (c) Repeat a and b with the Selective Repeat and answer the above questions again.

**For Selective Repeat, when I dropped the first packet before it reached the destination, the receiver successfully received and buffered the other packets and sent out their respective ACKs. However, no ACK was sent for the first packet. After a timeout, the sender retransmitted the first packet, the receiver buffered it, and sent out its ACK. Once the sender received the ACK, it moved on to the next batch.**

For the other case where I dropped the first ACK, it does the same thing as when I dropped the first packet. However, the only difference is that it sends out a DUPACK, which once recieved by the sender, will then transmit the next batch.