TODAY: Domain Name System

- The directory system for the Internet
  - Used by other application layer protocols
  - ... via socket programming
- Maps a hostname to an IP address
  - Host names use natural, human, language
    - URL such as www.google.com
  - IP addresses are numerical locators used by computers (more detail in chapter 4)
    - 32 bits, 4 bytes, in "dot" notation

Domain Name Servers

- Root Name Server
- Top Level Domain
- Authoritative Server
- Local Name Server
  - Your computer looking for an IP address

DNS: a distributed, hierarchical database

...
**DNS: root name servers**
- The root name server is contacted by local name server in order to start finding the IP address of interest
- root name server:
  - contacts TLD name server if name mapping not known
  - gets mapping and returns mapping to local name server (which will continue seeking)

---

**TLD & Authoritative Servers**

*top-level domain (TLD) servers:*
- responsible for maintaining records mapping IP addresses for the DNS servers for .com, .org, .net, .edu, and all top-level country domains, e.g.: uk, fr, ca, jp
- Verisign Global Network Services maintains servers for .com TLD
- Educause for .edu TLD

*authoritative DNS servers:*
- organization’s own DNS server(s), providing authoritative hostname to IP mappings for organization’s named hosts
- can be maintained by organization or service provider

---

**Local DNS name server**
- (does not strictly belong to hierarchy)
- Each ISP (residential ISP, company, university) has its own local DNS server
  - also called “default name server”
- When a host makes a DNS query, the query is sent to its local DNS server
  - has local cache of recent name-to-address translation pairs (but may be out of date)
  - acts as proxy, forwards query into hierarchy
  - When you connect to network, your host is given the IP address of the local DNS server

---

**DNS name resolution example**
- host at www.smith.edu wants IP address for gaia.cs.umass.edu

*iterated query:*
- contacted server replies with name of server to contact
- “I don’t know this name, but ask this server”
DNS protocol, messages

- **query** and **reply** messages, both with same **message format**

  **Message header**
  - **identification**: 16 bit # for query, reply to query uses same #
  - **flags**:
    - query or reply
    - recursion desired
    - recursion available
    - reply is authoritative

  **Identification**
  - 16 bit #

  **Flags**
  - # questions
  - # answer RRs
  - # authority RRs
  - # additional RRs
  - questions (variable # of questions)
  - answers (variable # of RRs)
  - authority (variable # of RRs)
  - additional info (variable # of RRs)

HTTP request message: format

- **request line**
  - method
  - URL
  - version
  - request line

- **header lines**
  - header field name
  - value
  - cr if

- **Entity Body**

Mail message format

- Example of the actual message - NOT part of the SMTP handshaking process
- **header** lines, e.g.,
  - To:
  - From:
  - Subject: different from SMTP commands!

- **body**
  - the “message”, ASCII characters only
DNS protocol, messages

- Name, type fields for a query
- RRs in response to query
- Records for authoritative servers
- Additional "helpful" info that may be used

DNS record format

The distributed database stores resource records (RR)

RR format: \((\text{name}, \text{value}, \text{type}, \text{ttl})\)

- **Type=NS**
  - `name` is domain (e.g. smith.edu)
  - `value` is hostname of authoritative name server for this domain

- **Type=A**
  - `name` is hostname
  - `value` is IP address

- **Type=CNAME**
  - `name` is alias name for some "canonical" (the real) name
  - `value` is canonical name

- **Type=MX** (mail server)
  - `name` is name of mailserver associated with `value`

DNS records

**DNS:** distributed db storing resource records (RR)

**RR format:** \((\text{name}, \text{value}, \text{type}, \text{ttl})\)

- (hostname, IP address, A, ttl)
- (domain, hostname-DNS-author-server, NS, ttl)
- (alias hostname, canonical name, CNAME, ttl)
- (alias hostname, mail server cname, MX, ttl)
* Act out the DNS process *

**DNS protocol:** query and reply messages, both with same message format

**Message header**
- **identification:** 16 bit # for query, reply to query uses same #
- **flags**
- **Number of records in the message itself**

<table>
<thead>
<tr>
<th>identification</th>
<th>flags</th>
</tr>
</thead>
<tbody>
<tr>
<td>number of questions</td>
<td>number of answer RRs</td>
</tr>
<tr>
<td>number of authority RRs</td>
<td>number of additional RRs</td>
</tr>
</tbody>
</table>

| questions | (variable number of questions) |
| answers | (variable number of resource records) |
| authority | (variable number of resource records) |
| additional information | (variable number of resource records) |

**Summary of Application Design Elements**

**nslookup with Mac OS**

Enter an internet address to lookup:
andrew.cmu.edu -> 128.2.42.9