DNS Specifications

• Domain Names – Concepts and Facilities
  - RFC 1034, November 1987
  - Introduction to the system and its components
  - Explains the concept of the Domain Name Space and zones

• Domain Names – Implementation and Specification
  - RFC 1035, November 1987
  - Details of protocols and algorithms
Domain Name System Structure

• Probably the world's largest distributed database system
• Purpose: map human-readable names to other information (especially addresses)
• Major components:
  – Domain Namespace
  – Resource Records (RRs)
  – Resolvers
  – Name Servers
Domain Name Space

- **Tree-structured namespace** with a single root
  - The root's name is "" (the empty string)
  - Tree structure provides:
    - Scalability (in the usual way)
    - **Distributed authority**: control over subtrees can be delegated

- Each **Fully-Qualified Domain Name (FQDN)** is a node in the tree
  - Each branch in the tree has a label (e.g. "com")
    - Labels no more than 64 bytes long
    - currently subset of ASCII-only
  - FQDN represented by sequence of labels from node to root:
    e.g. "protocols.netlab.uky.edu."
Domain Name Space

"generic" Top-level Domains (gTLD's)

2-letter ISO standard country codes
Delegation of Naming Authority

• For each node in the namespace tree there is one (and only one) authority
  – The authority controls what goes in the subtree
• A subtree for which authority has been delegated is called a zone
• The boundary between the containing zone and the subzone is called a "cut"
• E.g. netlab.uky.edu zone is delegated from uky.edu
• The authority for a zone is responsible for:
  – Maintaining the authoritative database information (RRs) that describe the zone
  – Providing for at least two independent nameservers
Resource Records (RRs)

- The database is viewed as a logical set of Resource Records
- Each RR defines a binding between a FQDN and some other information
  - Each RR has a TYPE according to the kind of information in the binding
    - A: the information is a four-byte IPv4 Address
    - NS: the information is the FQDN of a Name Server
    - MX: the information is the FQDN of a server that accepts mail for the domain
    - SOA: the information marks the beginning and end of a ZONE
    - etc.
Resource Records (RRs)

- The standard defines **details of representation** of the information in the RR's (i.e. how it is stored in the database)!
  - This ensures it is simple to go back and forth between database and wire format
- Example: A record has 32-bit IP address in network byte order
### General DNS Message Format

<table>
<thead>
<tr>
<th></th>
<th>Questions</th>
<th>Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Query ID</strong></td>
<td>Flags etc.</td>
<td></td>
</tr>
<tr>
<td># Questions</td>
<td># Answer RRs</td>
<td></td>
</tr>
<tr>
<td># Authority RRs</td>
<td># Add'l Info RRs</td>
<td></td>
</tr>
<tr>
<td><strong>Questions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Answers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Authorities</strong></td>
<td>(NS RRs for above Answers)</td>
<td></td>
</tr>
<tr>
<td><strong>Additional Info</strong></td>
<td>(A records for Nameserver RRs)</td>
<td></td>
</tr>
</tbody>
</table>

- Query/Answer flag
- Opcode
- Authoritative Answer flag
- Recursion Desired flag
- Recursion available flag
- Return code
DNS Zone RRs - Example

netlab.uky.edu        SOA  tosh.netlab.uky.edu         [marks beginning of zone]
                      serial = 2006110301
                      ttl =  3600 ...
netlab.uky.edu        NS  tosh.netlab.uky.edu
netlab.uky.edu        NS  peter.netlab.uky.edu
netlab.uky.edu        NS  ncc.uky.edu
netlab.uky.edu        NS  nic.net.uky.edu
netlab.uky.edu        NS  emulab.netlab.uky.edu
netlab.uky.edu        NS  ns1.emulab.netlab.uky.edu
netlab.uky.edu        SOA                                [marks end of zone]
Model of Operation - Iterative

Host in "netlab.uky.edu" domain

DNS Query:
- domain: munnari.oz.au
- type: A

DNS Response:
- domain: munnari.oz.au
- type: A
- Answer: (nothing)
- Authority:
  - . (root) NS C.ROOT-SERVERS.NET
- Additional Info:
  - C.ROOT-SERVERS.NET A 192.33.4.12
Model of Operation - Iterative

Host in "netlab.uky.edu" domain

DNS Query:
Domain: munnari.oz.au
  type = a

DNS Response:
Domain: munnari.oz.au
  type: A
  Answer: (nothing)
  Authority: au NS dns1.telstra.net
  Add'l Info: dns1.telstra.net A 203.50.5.200
Model of Operation - Iterative

Host in "netlab.uky.edu" domain

DNS Query:
Domain: munnari.oz.au
Type: A
Answer: (nothing)
Authority: oz.au NS au2ld.CSIRO.au
Add'l Info: au2ld.CSIRO.au A 130.116.2.21

DNS Response:
Domain: munnari.oz.au
Type: A
Answer: (nothing)
Authority: oz.au NS au2ld.CSIRO.au
Add'l Info: au2ld.CSIRO.au A 130.116.2.21
Model of Operation - Iterative

Host in "netlab.uky.edu" domain

DNS Query:
Domain: munnari.oz.au
Type: A

DNS Response:
Domain: munnari.oz.au
Type: A
Answer: munnari.oz.au A 202.12.74.196
Authority: oz.au NS au2ld.CSIRO.au
Add'l Info: au2ld.CSIRO.au A 130.116.2.21