The Domain Name System (DNS)

- DNS is the naming service of the Internet
  - Map host names to host addresses
- Domain name hierarchy partitioned into zones
- Each zone has two or more name servers.
- Each name server stores a collection of resource records.

Domain hierarchy partitioned into zones
**Hierarchy of name servers**

**Resource Records**

- A resource record is a 5-tuple (Name, Value, Type, Class, TTL)
- **Type**
  - A: Value is an IP address
  - NS: Value gives the name of the name server for the specified domain.
  - CNAME: Value gives the canonical name for a particular host; used to define aliases.
  - MX: Value gives the name of the mail server for the specified domain.
- **Class**
  - IN for Internet
- **TTL:** how long the resource record is valid
Root Name Server

(edu, a3.nstld.com, NS, IN)
(a3.nstld.com, 192.5.6.32, A, IN)
(com, a.gtld-servers.net, NS, IN)
(a.gtld-servers.net, 192.5.6.30, A, IN)
...

A root name server contains an NS record and an A record for each top-level domain name server

edu Name Server

<princeton.edu, dns.princeton.edu, NS, IN>
< dns.princeton.edu, 128.112.129.15, A, IN>
<umass.edu, dns.umass.edu, NS, IN>
< dns.umass.edu, 128.119.40.111, A, IN>
...

Princeton Name Server
(cs.princeton.edu, dns1.cs.princeton.edu, NS, IN)
(dns1.cs.princeton.edu, 128.112.198.35, A, IN)
(ee.princeton.edu, helios.ee.princeton.edu, NS, IN)
(helios.ee.princeton.edu, 128.196.28.166, A, IN)
(jupiter.physics.princeton.edu, 128.196.4.1, A, IN)
(saturn.physics.princeton.edu, 128.196.4.2, A, IN)
(venus.physics.princeton.edu, 128.196.4.4, A, IN)
...

CS Server (dns1.cs.princeton.edu)
(penguins.cs.princeton.edu, 128.112.155.166, A, IN)
(www.cs.princeton.edu, coreweb.cs.princeton.edu, CNAME, IN)
(coreweb.cs.princeton.edu, 128.112.136.35, A, IN)
(cs.princeton.edu, mail.cs.princeton.edu, MX, IN)
(mail.cs.princeton.edu, 128.112.136.72, A, IN)
...
Attribute-Based Naming

- An entity has a collection of attributes
  - An entity is described in terms of (attribute, value) pairs
- Attribute-based naming systems (aka directory services) allow users to look up entities based on attributes.
  - Lookup requires an exhaustive search
  - X.500 and LDAP.
Lightweight Directory Access Protocol (LDAP)

- X.500 (OSI standard) too complex for many applications
- LDAP: Simplified version of X.500
  - Application-level protocol, uses TCP
- Example LDAP implementations:
  - Microsoft’s Active Directory Service
  - Novell directory services
  - iPlanet directory services (Sun-Netscape Alliance)
  - OpenLDAP

A simple example of a LDAP directory entry using LDAP naming conventions.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Abbr.</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>C</td>
<td>NL</td>
</tr>
<tr>
<td>Locality</td>
<td>L</td>
<td>Amsterdam</td>
</tr>
<tr>
<td>Organization</td>
<td>O</td>
<td>Vrije Universiteit</td>
</tr>
<tr>
<td>OrganizationalUnit</td>
<td>OU</td>
<td>Comp. Sc.</td>
</tr>
<tr>
<td>CommonName</td>
<td>CN</td>
<td>Main server</td>
</tr>
<tr>
<td>Mail_Servers</td>
<td>—</td>
<td>137.37.20.3, 130.37.24.6, 137.37.20.10</td>
</tr>
<tr>
<td>FTP_Server</td>
<td>—</td>
<td>130.37.20.20</td>
</tr>
<tr>
<td>WWW_Server</td>
<td>—</td>
<td>130.37.20.20</td>
</tr>
</tbody>
</table>

Attribute-based search:
- To get a list of all main servers at the Vrije Universiteit, use the following search operation:
  answer = search("&(C=NL)(O= Vrije Universiteit)(OU=*)[CN=Main Server]"
The LDAP Name Space

Part of the directory information tree

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Value</th>
<th>Attribute</th>
<th>Value</th>
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</thead>
<tbody>
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<td>Country</td>
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</tr>
<tr>
<td>CommonName</td>
<td>Main server</td>
<td>CommonName</td>
<td>Main server</td>
</tr>
<tr>
<td>Host_Name</td>
<td>star</td>
<td>Host_Name</td>
<td>zephyr</td>
</tr>
<tr>
<td>Host_Address</td>
<td>192.168.201.40</td>
<td>Host_Address</td>
<td>192.168.201.10</td>
</tr>
</tbody>
</table>