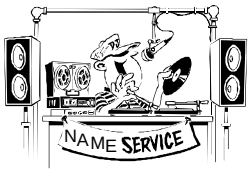
Domain Name System (DNS)



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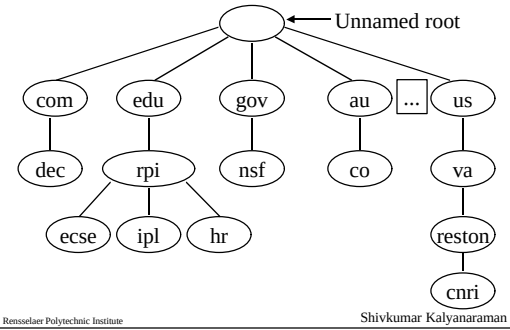
- Naming hierarchy
- Server hierarchy
- Name resolution
- Other information in name servers
- Ref: Chap 14, RFC 1034

Why Names?

- Computers use addresses
- Humans cannot remember IP addresses
  ⇒ Need names
  Example, “shiva” for 128.113.50.56
- Simplest Solution: Each computer has a unique name and has a built in table of name to address translation (mapping)
- Problem: Not scalable
- Solution: DNS (Adopted in 1983)
- Hierarchical Names: shiv.ecse.rpi.edu

Name Hierarchy



Name Hierarchy

- Unique domain suffix is assigned by Internet Authority
- The domain administrator has complete control over the domain
- No limit on number of sub-domains or number of levels
- computer.site.division.company.com
- Domains within an organization do not have to be uniform in number of subdomains or levels

Name Hierarchy (Continued)

- Name space is not related to physical interconnection, e.g., ecse.rpi.edu and ipl.rpi.edu could be on the same floor or in different cities
- Geographical hierarchy is also allowed, e.g., cnri.reston.va.us
- A name could be a *subdomain* (eg: ecse.rpi.edu) or an individual *object* (eg: cortez.rpi.edu)

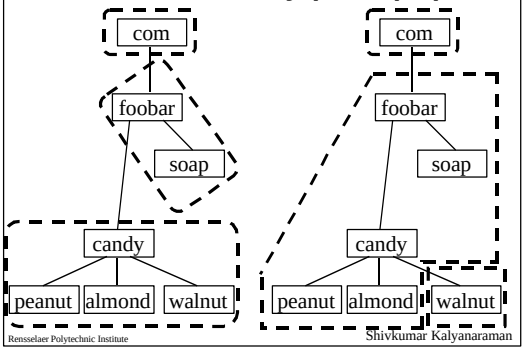
Top Level Domains

Domain Name	Assignment
com	Commercial
edu	Educational
gov	Government
mil	Military
net	Network
org	Other organizations
arpa	Advanced Research Project Agency
country code	au, uk, ca

Server Hierarchy

- Servers are organized in a hierarchy
- Each server has an authority over a part of the naming hierarchy
- It needs to know other servers who are responsible for other subdomains
- A single node in the naming tree cannot be split among multiple servers
- A given level of hierarchy can be partitioned into multiple servers

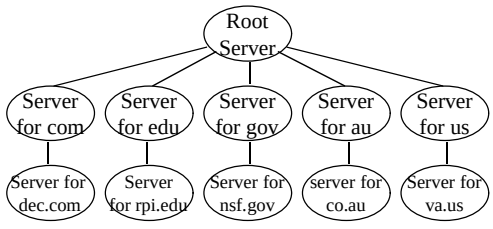
Server Hierarchy (Example)



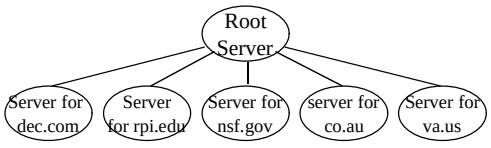
Server Hierarchy (Continued)

- Authority ⇒ has the name to address translation table
- Responsible ⇒ Either has the name to address translation table or knows the server who has
  - But such a reply is called “non-authoritative” reply
- Root server knows about servers for top-level domains, e.g., com
- Each server knows the root server

Server Hierarchy: Example



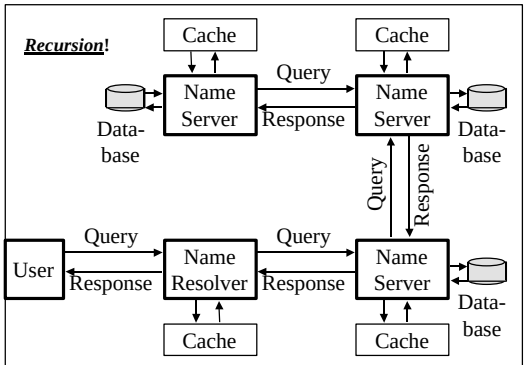
Server Hierarchy: Better



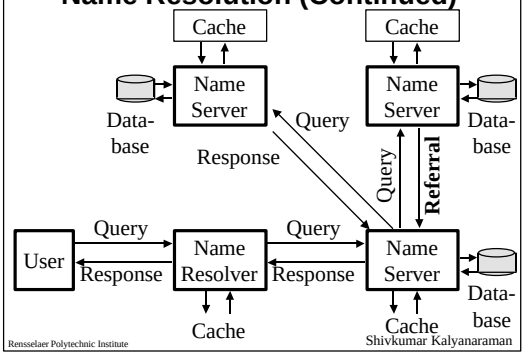
- Fewer servers
- More entries/links per server
- Fewer levels to traverse before resolving a name

Name Resolution

- Each computer has a name resolver routine, e.g., *gethostbyname* & gethostbyaddr in UNIX
- Each resolver knows the IP address of a local DNS server
- Resolver sends a DNS request to the server
- DNS server either gives the answer, forwards the request to another server, or gives a referral
- Referral = Next server to whom request should be sent
- Recursive Query:
  Give me an answer (Don't give me a referral)



Name Resolution (Continued)



DNS Optimization

- Spatial Locality: Local computers referenced more often than remote
- Temporal Locality: Same set of domains referenced repeatedly ⇒ Caching
- Each entry has a time to live (TTL)
- Replication: Multiple servers. Multiple roots. Ask the geographically closest server.

DNS Message Format

Identification	Parameter
Number of Questions	Number of Answers
Number of Authority	Number of Additional
Question Section ...	
Answer Section ...	
Authority Section ...	
Additional Information Section ...	

Format (Continued)

- Format of the query section entries:

Query Domain Name ...	
Query Type	Query Class

- Format of other section entries:

Resource Domain Name	
Type	Class
Time to live	
Resource Data Length	Resource Data

DNS Message Format (Continued)

Bit	Meaning
0	Operation: 0=Query, 1=Response
1-4	Query type: 0=Standard, 1=Inverse, 2,3 obsolete
5	Set if answer authoritative
6	Set if message truncated
7	Set if recursion desired
8	Set if recursion available
9-11	Reserved
12-15	Response type: 0=No error, 1=Format error, 2=Server Failure, 3=Name does not exist

Types of DNS Entries

- DNS used other types of resolution
- Eg: also for finding mail server, pop server, responsible person, etc for a computer
- DNS database has multiple ***"types"***
  - Record type A ⇒ Address of X
  - Record type MX ⇒ Mail exchanger of X

Types of DNS Entries (Continued)

- DNS database may also have multiple ***"classes"***
  - Can support name resolution for multiple protocols eg: IP, SNA, DECbit etc
- Pointer queries: given IP address find name

Resource Record Types

Type	Meaning
A	Host Address
CNAME	Canonical Name (alias)
HINFO	CPU and O/S
MINFO	Mailbox Info
MX	Mail Exchanger
NS	Authoritative name server for a domain
PTR	Pointer to a domain name (link)
RP	Responsible person
SOA	Start of zone authority (Which part of naming hierarchy implemented)
TXT	Arbitrary Text

Summary

- DNS: Maps names to addresses
- Names are hierarchical. Administration is also hierarchical.
- No standard for number of levels
- Replication and caching is used for performance optimization.