Domain Name System

Computer System and Network Administration

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2016 Fall

History of DNS

- Before DNS
  - ARPAnet
    - *HOSTS.txt* contains all the hosts' information
    - Maintained by SRI's Network Information Center
      - In SRI-NIC host
  - Problems: Not scalable!
    - Traffic and Load
    - Name Collision
    - Consistency

RFC Sourcebook:
http://www.networksorcery.com/enp/default0304.htm

- Domain Name System
  - Administration decentralization
  - 1984
    - Paul Mockapetris (University of Southern California)
    - RFC 882, 883 → 1034, 1035
      - 1034: Concepts
      - 1035: Implementation and Specification

DNS Introduction
– DNS Specification

- Make domain name system as
  - Tree architecture
    - Each subtree ➔ "*domain*"
    - Domain can be divided in to "*subdomain*"

  - Distributed database
    - Each site maintains segment of DB
    - Each site open self information via network

  - Client-Server architecture
    - Name servers provide information (Name Server)
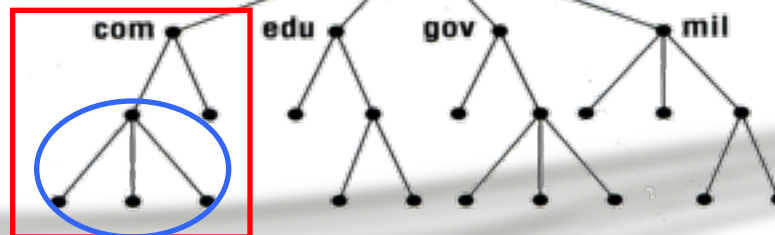   - Clients make queries to server (Resolver)

DNS Introduction – Domain and Subdomain

- DNS Namespace
  - A tree of domains
- Domain and subdomain
  - Each domain has a "domain name" to identify its position in database
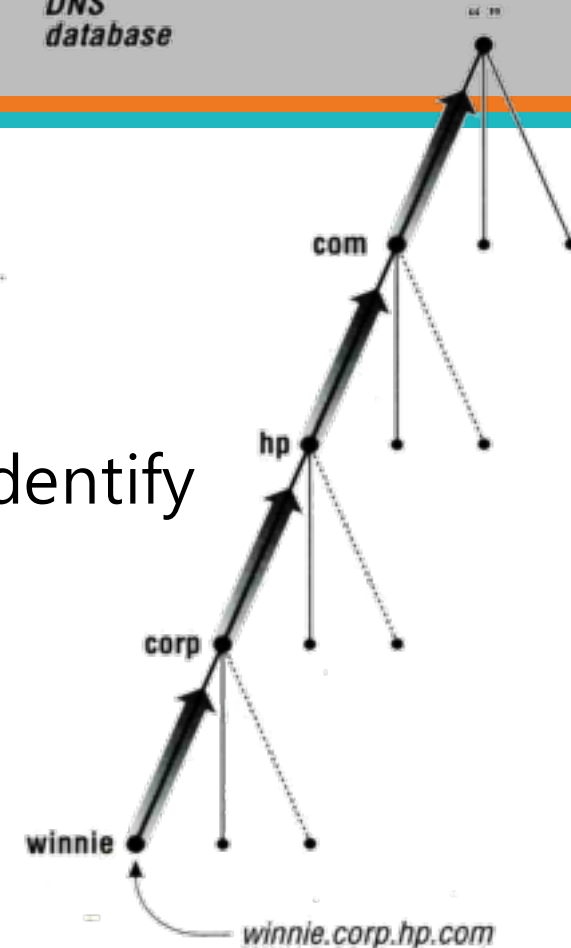   - EX: ncku.edu.tw
    - EX: csie.ncku.edu.tw
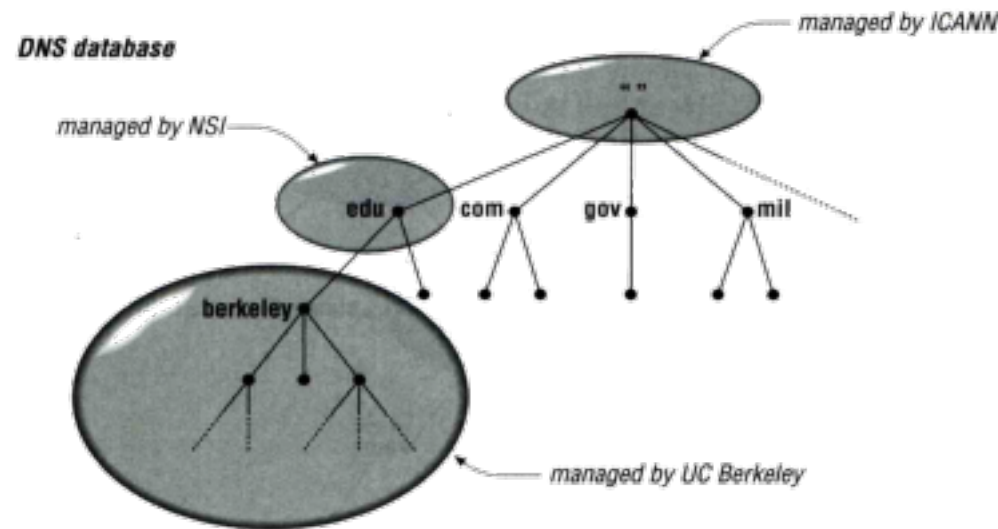
The DNS Namespace (1)

- An inverted tree (Rooted tree)
  - Root with label "."

- Domain level
  - Top-level or First level
    - Child of the root
  - Second-level
    - Child of a First-level domain
- Domain name limitation
  - 63-characters in each component and
  - Up to 255-characters in a complete name

The DNS Namespace (2)

- gTLDs
  - generic Top-Level Domains, including:
    - com: commercial organization, such as ibm.com
    - edu: educational organization, such as purdue.edu
    - gov: government organization, such as nasa.gov
    - mil: military organization, such as navy.mil
    - net: network infrastructure providing organization, such as hinet.net
    - org: noncommercial organization, such as x11.org
    - int: International organization, such as nato.int

ICANN – Internet Corporation for Assigned Names and Numbers
http://www.icann.org/

The DNS Namespace (3)

- New gTLDs launched in year 2000:
    - aero: for air-transport industry
    - biz: for business
    - coop: for cooperatives
    - info: for all uses
    - museum: for museum
    - name: for individuals
    - pro: for professionals

The DNS Namespace (4)

- Other than US, ccTLD
  - country code TLD (ISO 3166)
    - Taiwan → tw
    - Japan → jp
  - Follow or not follow US-like scheme
    - US-like scheme example
      - edu.tw, com.tw, gov.tw
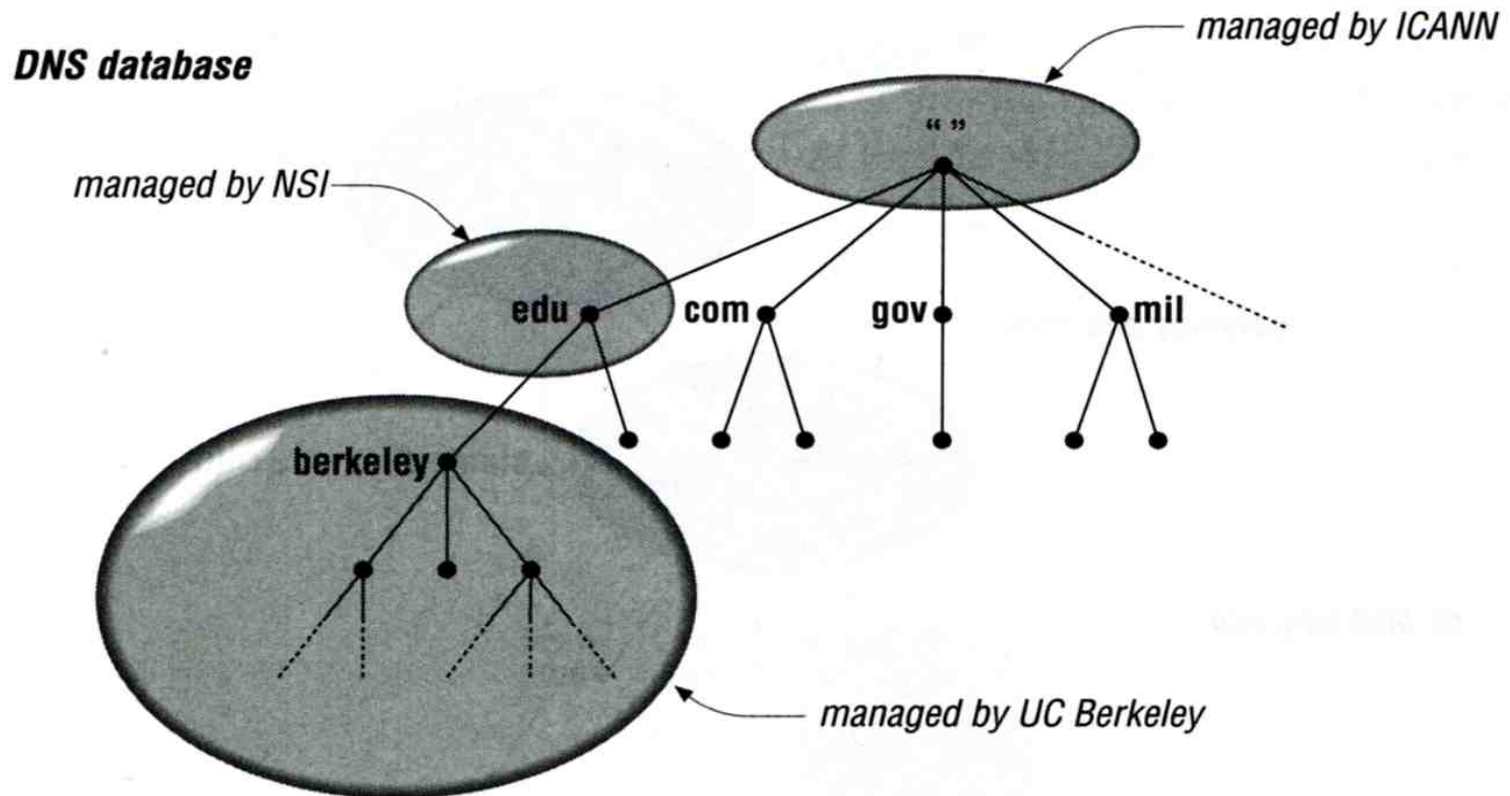   - Other scheme
      - co.jp, ac.jp

DNS Namespace (5)
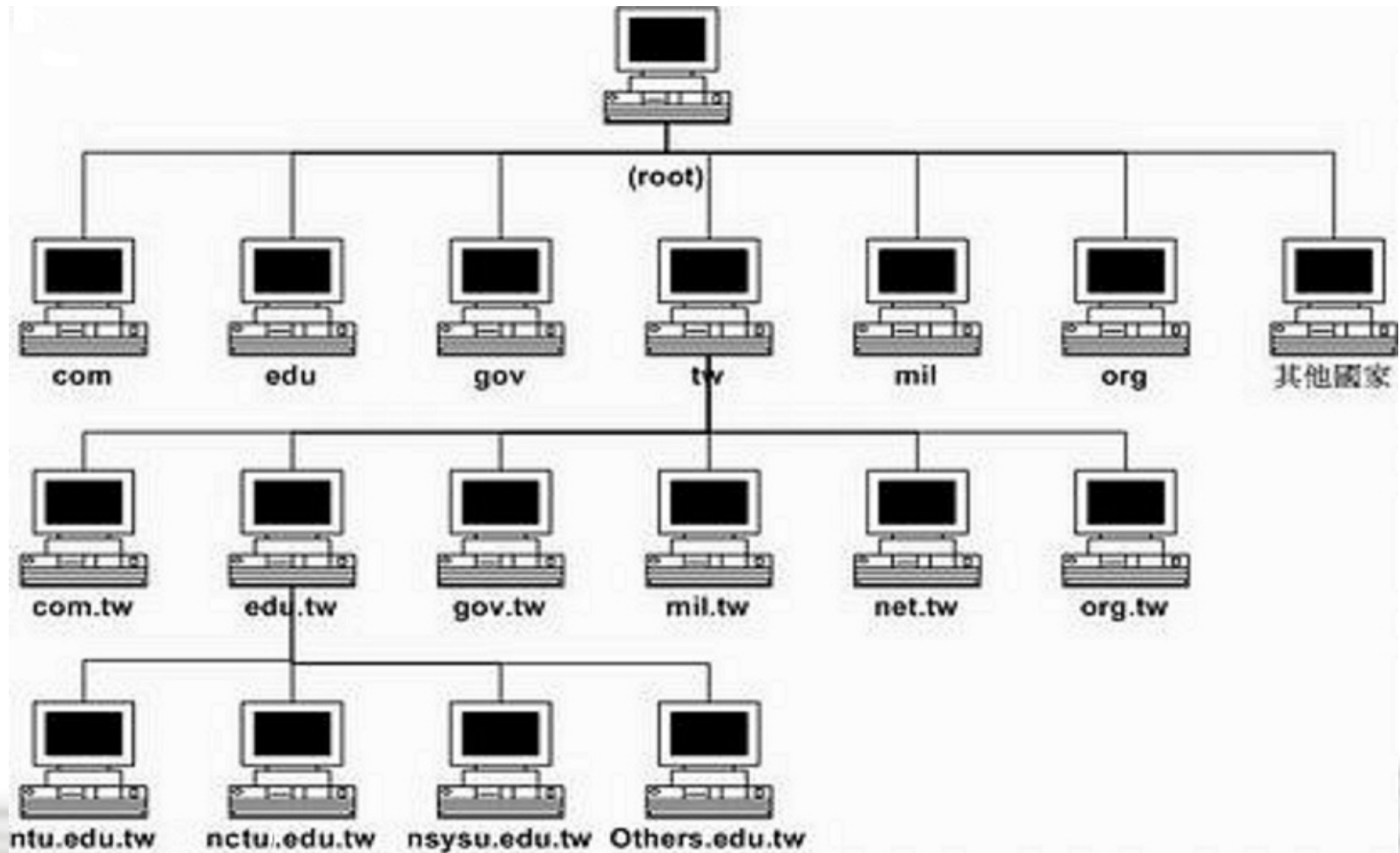
How DNS Works
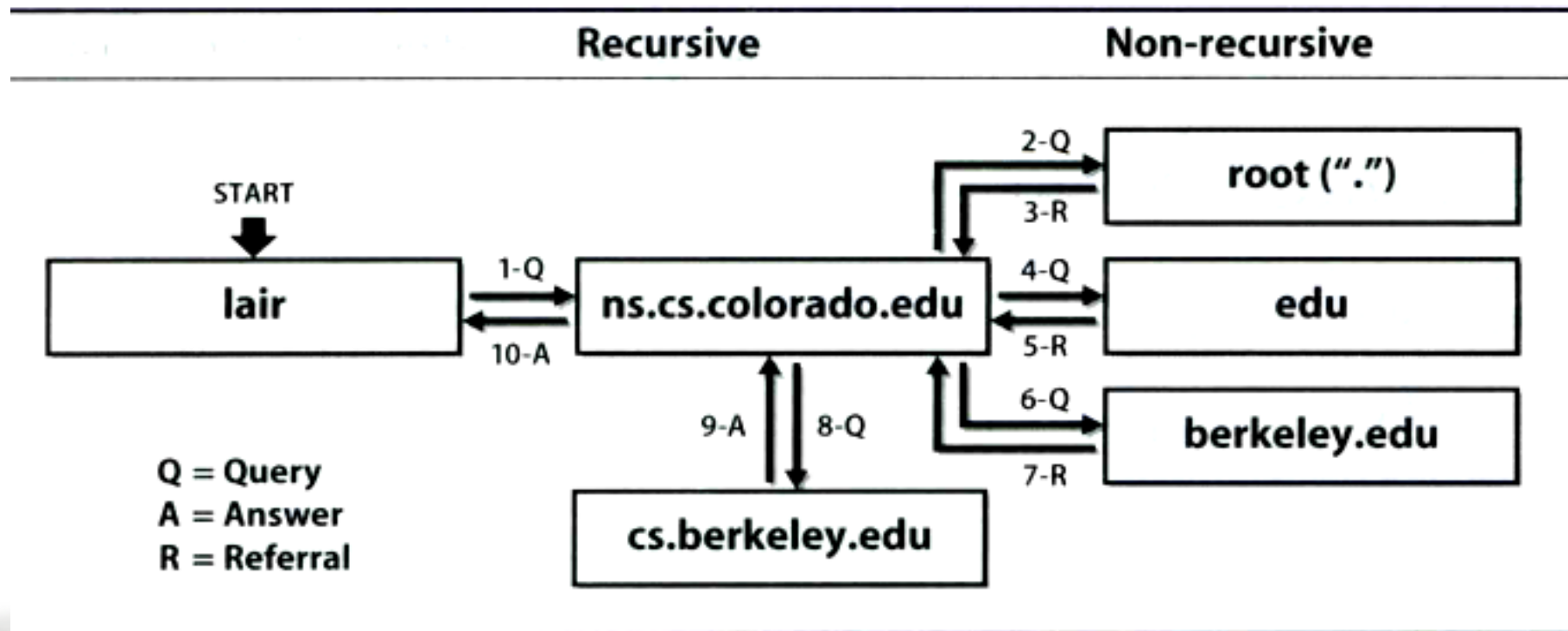## – DNS Delegation

- Administration delegation
 - Each domain can delegate responsibility to subdomain

- Recursive query process
  - Ex: query <u>lair.cs.colorado.edu → vangogh.cs.berkeley.edu</u>,
    name server "ns.cs.colorado.edu" has no cache data

DNS Delegation – Administrated Zone

- Zone
  - Autonomously administered piece of namespace
    - Once the subdomain becomes a zone, it is independent to it's parent
      - Even parent contains NS's A record
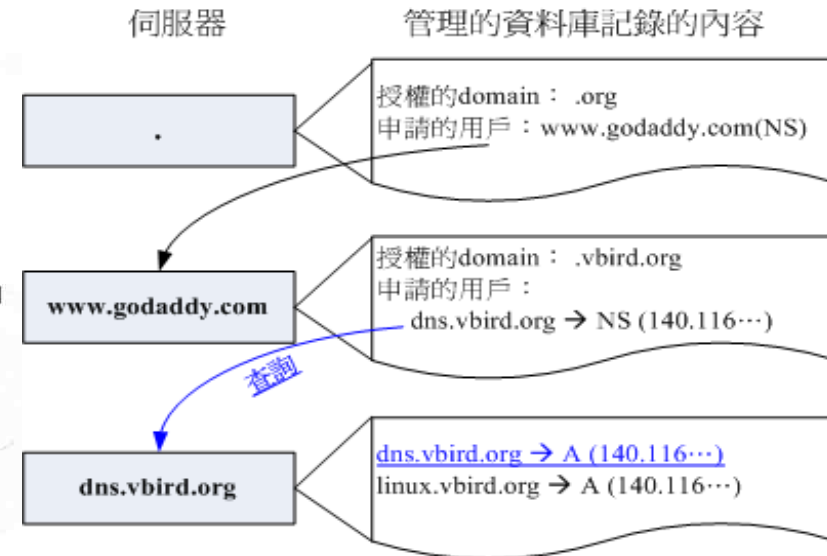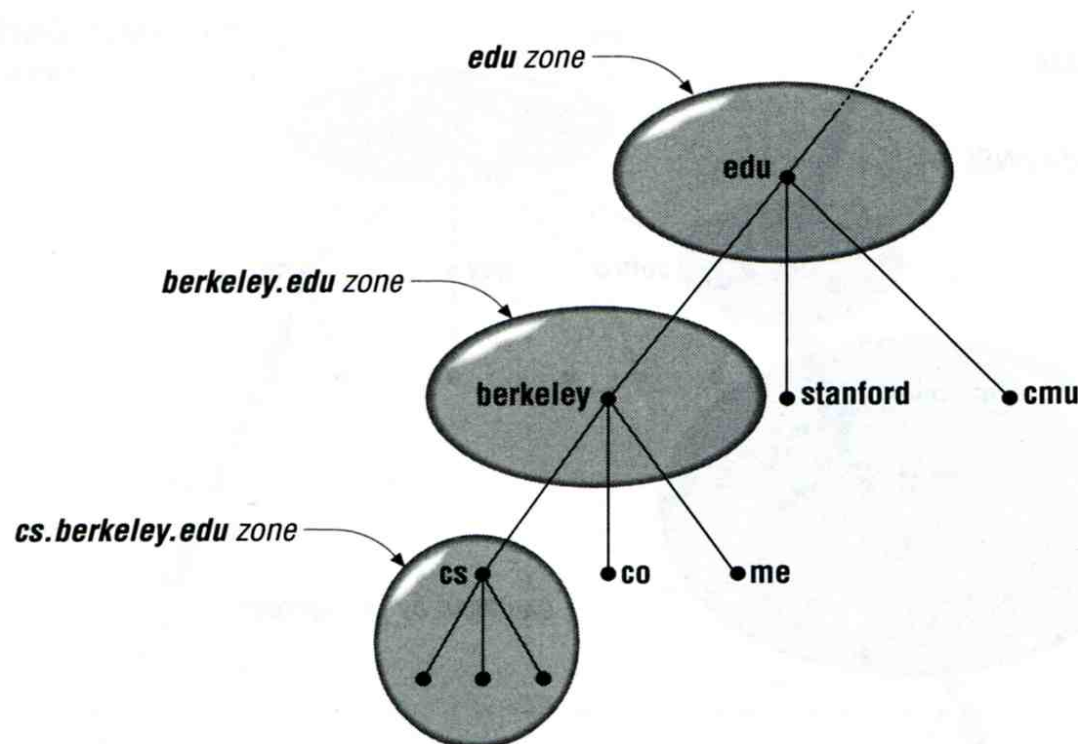
DNS Delegation – Administrated Zone

- Zone
  - Autonomously administered piece of namespace

- Two kinds of zone files
  - Forward Zone files
    - Hostname-to-Address mapping
    - Ex:
      - hungwei.imslab.org.   10800   IN   A   140.116.82.246
  - Reverse Zone files
    - Address-to-Hostname mapping
    - Ex:
      - 246.82.116.140 IN PTR imslab.csie.ncku.edu.tw.
  - Forward zone is necessary

The Name Server Taxonomy (1)

- Categories of name servers
  - Based on a name server's source of data
    - Authoritative: official representative of a zone
      - Master: get zone data from disk
      - Slave: copy zone data from master
    - Nonauthoritative: answer a query from cache
      - caching: caches data from previous queries
  - Based on the type of data saved
    - Stub: a slave that copy only name server data (no host data)
  - Based on the type of answers handed out
    - Recursive: do query for you until it return an answer or error
    - Nonrecursive: refer you to the authoritative server
  - Based on the query path
    - Forwarder: performs queries on behalf of many clients without cache

The Name Server Taxonomy (2)

- Nonrecursive referral
  - Hierarchical and longest known domain referral with cache data of other zone's name servers' addresses
  - Ex:
    - Query lair.cs.colorado.edu from a nonrecursive server
    - Whether cache has
      - Name servers of cs.colorado.edu, colorado.edu, edu, root
  - The resolver libraries do not understand referrals mostly. They expect the local name server to be recursive

The Name Server Taxonomy (3)

- Caching
  - Positive cache
  - Negative cache
    - No host or domain matches the name queried
    - The type of data requested does not exist for this host
    - The server to ask is not responding
    - The server is unreachable of network problem
- Negative cache
  - 60% DNS queries are failed
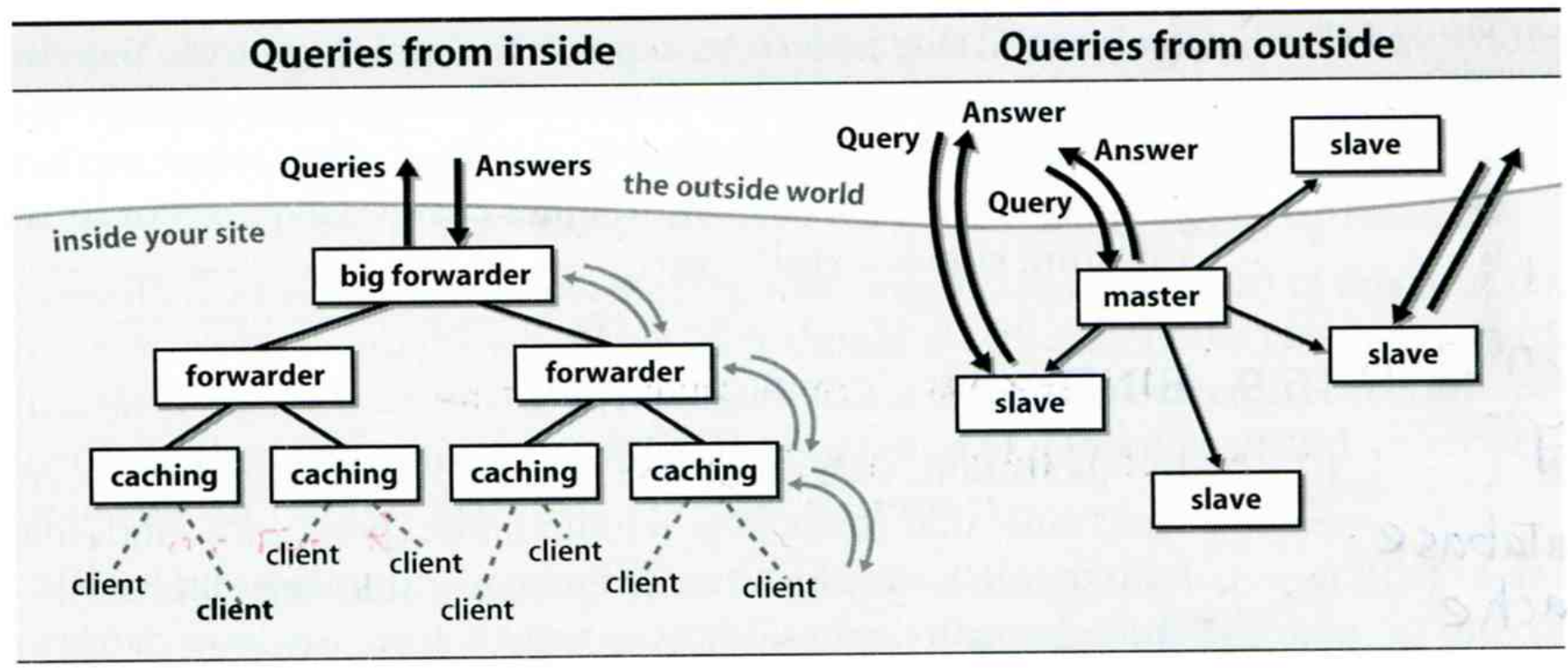 - To reduce the load of root servers, the authoritative negative answers must be cached

- Caching and forwarder DNS servers
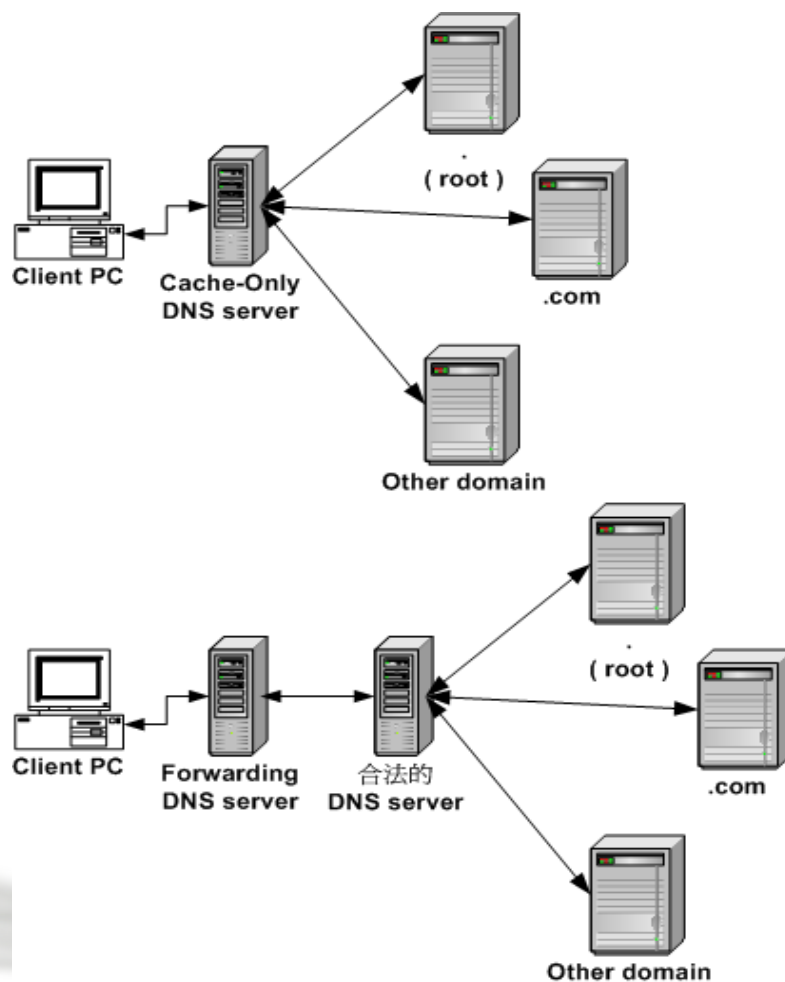
- How to arrange your DNS servers?
  - Ex:

- Root name servers list in named.root file of BIND

```
.                          3600000  IN  NS   A.ROOT-SERVERS.NET.
A.ROOT-SERVERS.NET.        3600000      A    198.41.0.4
.                          3600000      NS   B.ROOT-SERVERS.NET.
B.ROOT-SERVERS.NET.        3600000      A    192.228.79.201
.                          3600000      NS   C.ROOT-SERVERS.NET.
C.ROOT-SERVERS.NET.        3600000      A    192.33.4.12
.                          3600000      NS   D.ROOT-SERVERS.NET.
D.ROOT-SERVERS.NET.        3600000      A    128.8.10.90
.                          3600000      NS   E.ROOT-SERVERS.NET.
E.ROOT-SERVERS.NET.        3600000      A    192.203.230.10
.                          3600000      NS   F.ROOT-SERVERS.NET.
F.ROOT-SERVERS.NET.        3600000      A    192.5.5.241
.                          3600000      NS   G.ROOT-SERVERS.NET.
G.ROOT-SERVERS.NET.        3600000      A    192.112.36.4
.                          3600000      NS   H.ROOT-SERVERS.NET.
H.ROOT-SERVERS.NET.        3600000      A    128.63.2.53
.                          3600000      NS   I.ROOT-SERVERS.NET.
I.ROOT-SERVERS.NET.        3600000      A    192.36.148.17
.                          3600000      NS   J.ROOT-SERVERS.NET.
J.ROOT-SERVERS.NET.        3600000      A    192.58.128.30
.                          3600000      NS   K.ROOT-SERVERS.NET.
K.ROOT-SERVERS.NET.        3600000      A    193.0.14.129
.                          3600000      NS   L.ROOT-SERVERS.NET.
L.ROOT-SERVERS.NET.        3600000      A    198.32.64.12
.                          3600000      NS   M.ROOT-SERVERS.NET.
M.ROOT-SERVERS.NET.        3600000      A    202.12.27.33
```

DNS Client

- /etc/resolv.conf
  - nameserver, domain, search
- /etc/host.conf
- /etc/hosts

> cat /etc/resolv.conf
domain imslab.org
nameserver   140.116.246.2
nameserver   140.116.245.253
nameserver   8.8.4.4
search imslab.org csie.ncku.edu.tw
ncku.edu.tw

> cat /etc/host.conf
Auto-generated from nsswitch.conf
hosts
dns