# SOFTWARE ARCHITECTURE
# 9. NAME RESOLUTION

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lecture URL

https://vu5.sfc.keio.ac.jp/slide/

# OSI Reference Model

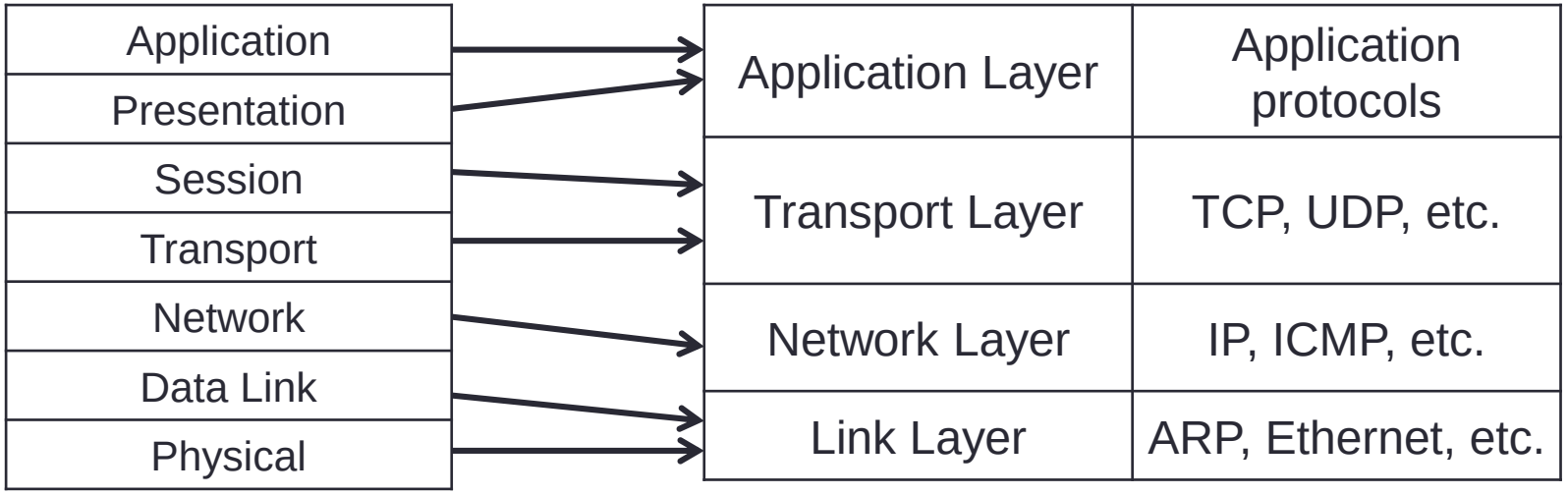
- Open Systems Interconnect
  - ISO defined around 1984.

| | |
|---|---|
| Application Layer | Semantics<br>Initiates a request or accepts a request |
| Presentation Layer | Data Representation<br>Adds formatting, display and encryption information to the packet |
| Session Layer | Dialog Coordination<br>Adds traffic flow information to determine when the packet is sent |
| Transport Layer | Reliable Transfer Data<br>Adds error-handling information |
| Network Layer | Routing and Relaying<br>Adds sequencing and address information to the packet |
| Data Link Layer | Note-to-Node Data Transfer<br>Adds error-checking information and prepares data for going on to the physical connection |
| Physical Layer | Electrical and Optical Connection<br>Sends packet as a bitstream |

# TCP/IP Protocol

- TCP/IP Protocol
  - TCP = Transmission Control Protocol
  - IP = Internet Protocol
  - Not defined by experts like OSI
  - Experimental purpose
  - Developed around 1982

- Four layer instead of OSI seven layer



# What TCP/IP Provides:

- Create communication channel
  - End-to-end data communication
  - ARP (Address Resolution Protocol)
  - Routing protocols
- Multiplexing
  - Use one network channel for multiple purposes
  - Socket = IP address + port number (16 bit)
- Reliable communication
  - TCP only
    - Data reach correctly
    - Error handling
    - No duplication
    - Sequencing data

| **TCP**<br>**Transmission Control Protocol** | **UDP**<br>**User Datagram Protocol** |
|---|---|
| • Error handling<br>• Create session<br>• Stream data | • Data may not reach<br>• No session<br>• For light weight protocols<br>• RPC at-least-once |

# Application Protocols

- Name resolution
  - DNS
- Remote connection
  - telnet
  - rlogin
  - ssh
- File sharing
  - NFS
  - AFS
- Electric mail
  - SMTP
  - POP
  - IMAP
- File transfer
  - ftp
  - rcp
  - scp
- Web
  - HTTP
  - WebDAV
- Window system
  - X protocol
- IP telephone
  - SIP

# NAME RESOLUTION

# Host Name

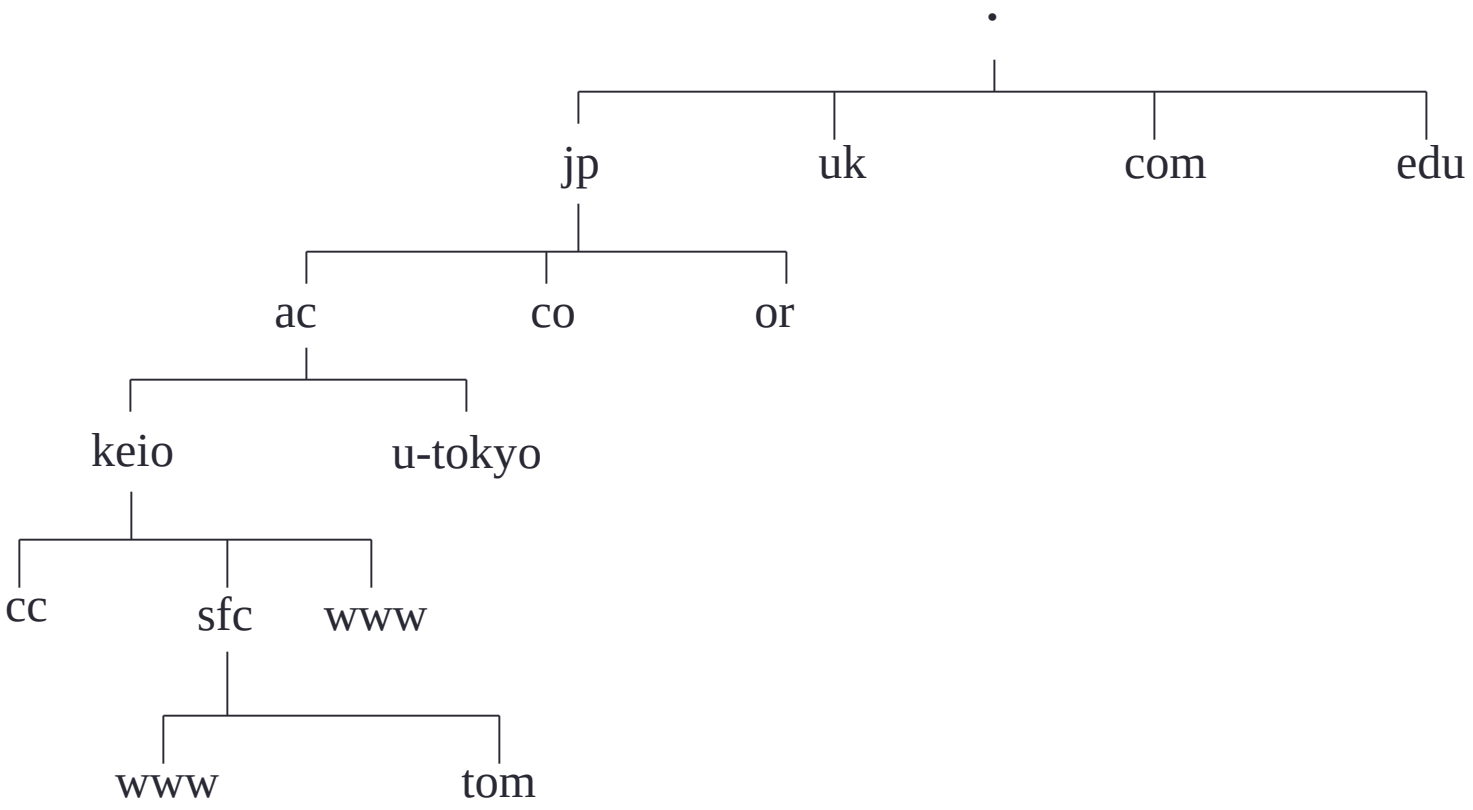
- Each host (computer) has a name and an address.
  - It may have multiple names and addresses.
- Host name
  - Name of the host
  - Each organization can freely decide names of hosts.
- IP address
  - Address in the network.
  - Addresses are assigned to the organization.
  - Need to be unique in the world.
    - Local addresses are used only locally.
    - IPv4: 192.168.xxx.xxx, 172.16-31.xxx.xxx, 10.xxx.xxx.xxx

# Host Name and IP Address

- Each computer holds the mapping of host names and addresses.
  - /etc/hosts
  - LMHOSTS
- Share the mapping in the organization.
  - NIS (or YP)
- Hierarchically manage in the internet.
  - DNS (Domain Name System)

# Hierarchy of Names

- www.sfc.keio.ac.jp



# Domain Name Space

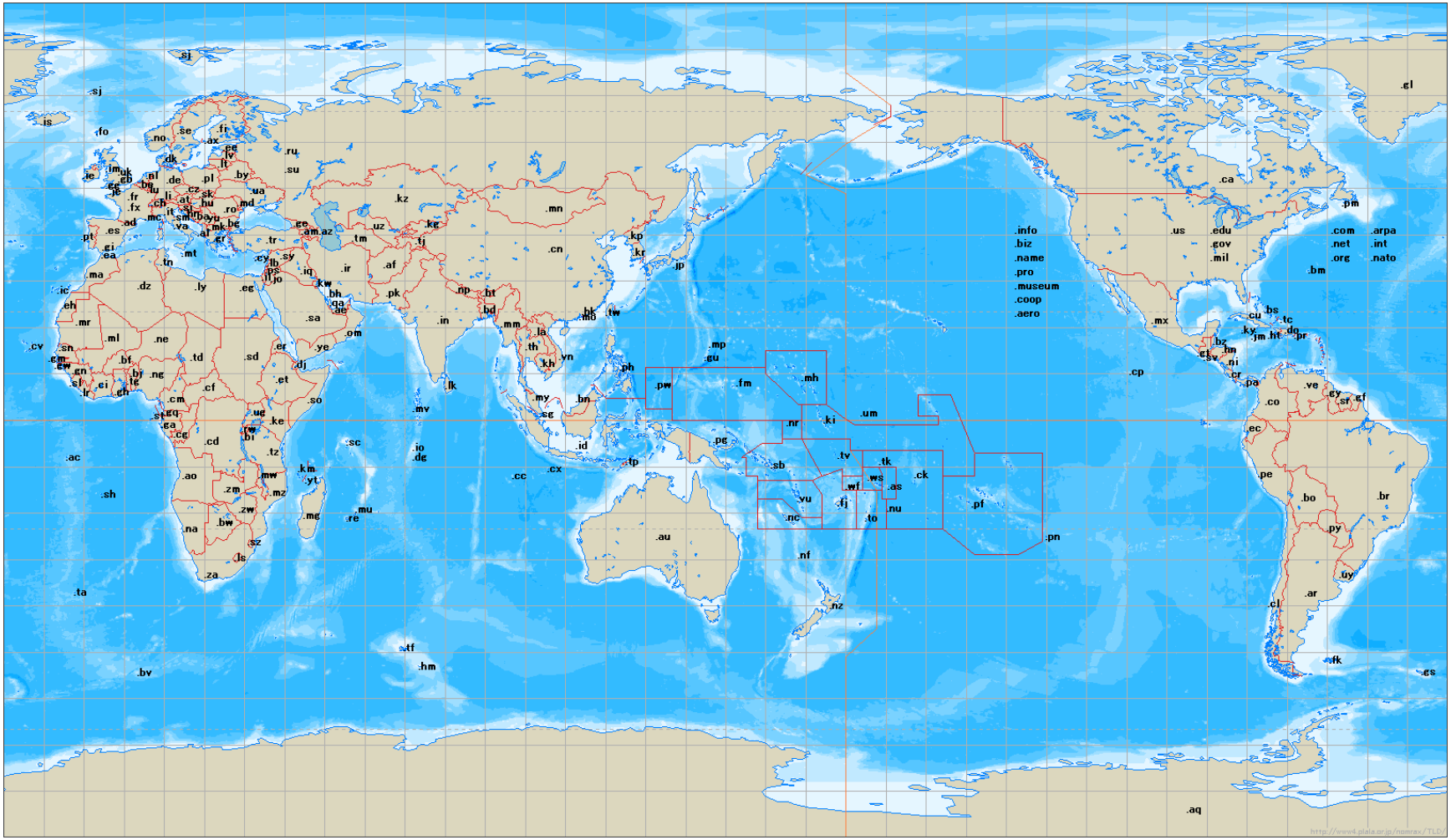
- Domain space
  - Tree structured name space
- Root domain
  - Root of the tree
  - Represented as .
- Label
  - Each tree node has a label of maximum 63 characters.
- Domain name
  - Listing labels from a node to the root node
- Domain
  - A subtree of the domain space

# Top Level Domain (TLD)

## Highest level domains

- gTLD: generic
  - com: commercial
  - net: network organization
  - org: organization, group
  - info: no specific purpose
  - biz: business
  - name: personal
  - pro: layer, medical doctors, accountants
- sTLD: sponsored
  - aero: air line company and airport
  - coop: cooperation
  - museum: museum
  - jobs: job management
  - travel: travel agency
  - mail: electric mail
  - cat: Catalan language
  - post: postal service
  - asia: APEC companies
  - mobi: for mobile
  - tel: IP telephone
  - xxx: for adults
- ccTLD: country code
  - jp, kr, cn, uk, etc.
- iTLD: international
  - int: UN, EU, NATO
- Special purpose
  - gov: government organization
  - mil: military organization
  - edu: educational organization
  - arpa: reverse name lookup
  - example: example
  - invalid: error
  - localhost
  - test

# Country Code



# JP Domain

- Organizational type jp domains
  - ac.jp: academic institutions (e.g. universities)
  - co.jp: companies
  - go.jp: government organizations
  - or.jp: registered organizations
  - ad.jp: JPNIC members
  - ne.jp: network service providers
  - gr.jp: groups
  - ed.jp: schools for young people (younger than 18 years old)
  - lg.jp: local government authorities
- Geographical type jp domains
  - generic local domains：example.shinjuku.tokyo.jp etc.
  - local government domains: pref.hokkaido.jp, city.yokohama.jp and etc.
- Generic JP domain
  - private or official organization in Japan

# Domain Name Registration

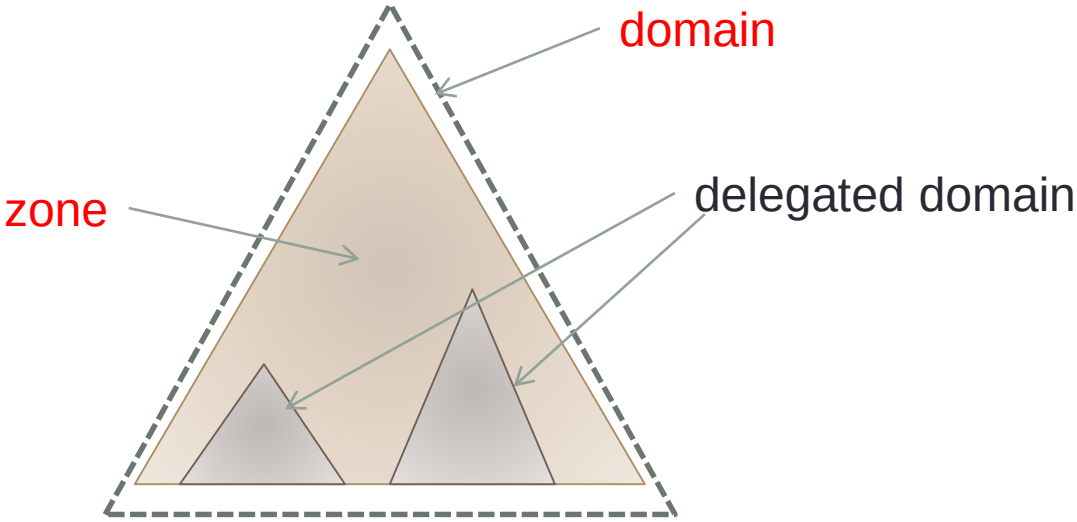
- ICANN (The Internet Cooperation for Assigned Names and Numbers
  - gTLD (global Top Level Domain)
    - com, net, org, info, biz, name, pro, museum, coop, aero, edu, gov, mil, arpa, int, nato
  - ccTLD (country code Top Level Domain)
    - jp
    - JPRS manages jp names.
    - Three types of domains
      - Generic JP domain
      - Organizational type JP domains
        - co, or, ne, ac, ad, ed, go, gr, lg
      - Geographical type jp domains

# Japanese Domain Name

- Allow unicode characters (including kanji) in domain names
  - 慶應義塾大学.jp
- Extend DNS with unicode characters
  - Not allow to use UTF-8 encoding for DNS
  - Use punycode
    - 7 bit
    - Use 37 ASCII characters only
    - http://www-serv.jprs.jp/ace_chk/index_mini.html
    - 慶應義塾大学.jp ⇒ xn--vns4ou9ck7j4lai49l.jp
    - 慶應.jp ⇒ xn--hju2g.jp
    - 慶應SFC.jp ⇒ xn--sfc-2b5fjo.jp

# Name Server

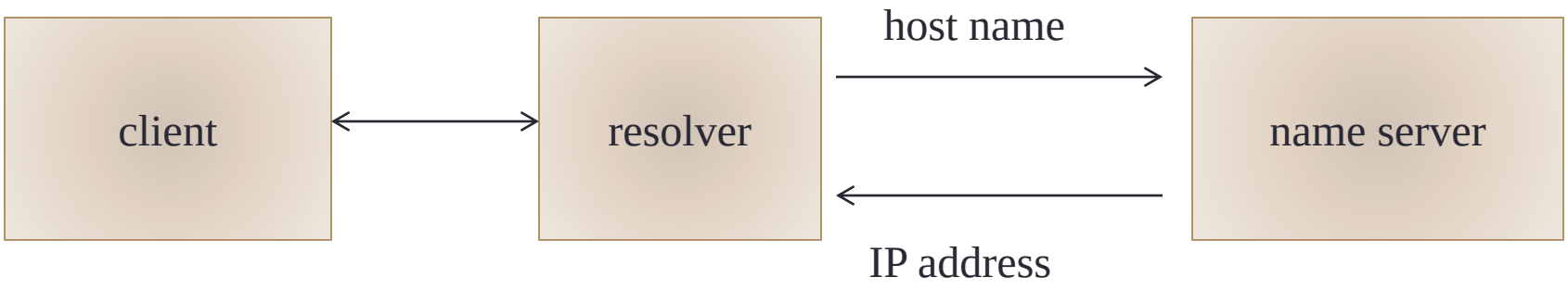
- Program to handle domain name space information
  - Manage information of a DNS zone
  - A DNS zone is the same as domain except that delegated domains are removed.
  - Name server
    - primary master
    - secondary master



# Resolver

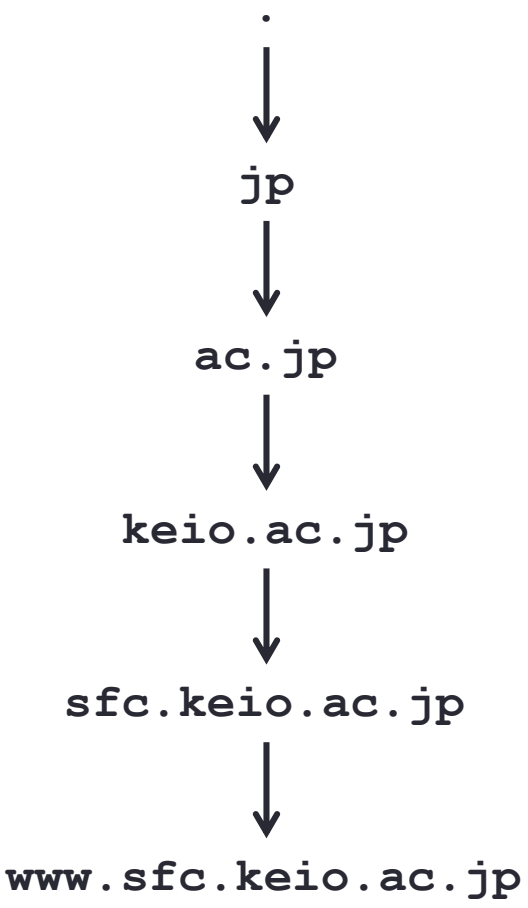
- A client program which accesses name servers to resolve names
  - Send queries to name servers
  - Analyze replies from name servers
  - Send information to applications

- BIND library
  - Used in telnet, ftp, and so on.
  - Library for resolving domain names
  - stub resolver



# Name Resolution

- Find the address of www.sfc.keio.ac.jp
  1. Send a query to the root name server.
     - Get a reply of asking jp name server.
  2. Send a query to jp name server.
     - Get a reply of asking ac name server.
  3. Send a query to ac name server.
     - Get a reply of asking keio name server.
  4. Send a query to keio name server.
     - Get a reply of asking sfc name server.
  5. Send a query to sfc name server.
     - Get a reply of www IP address.



# Record Caching

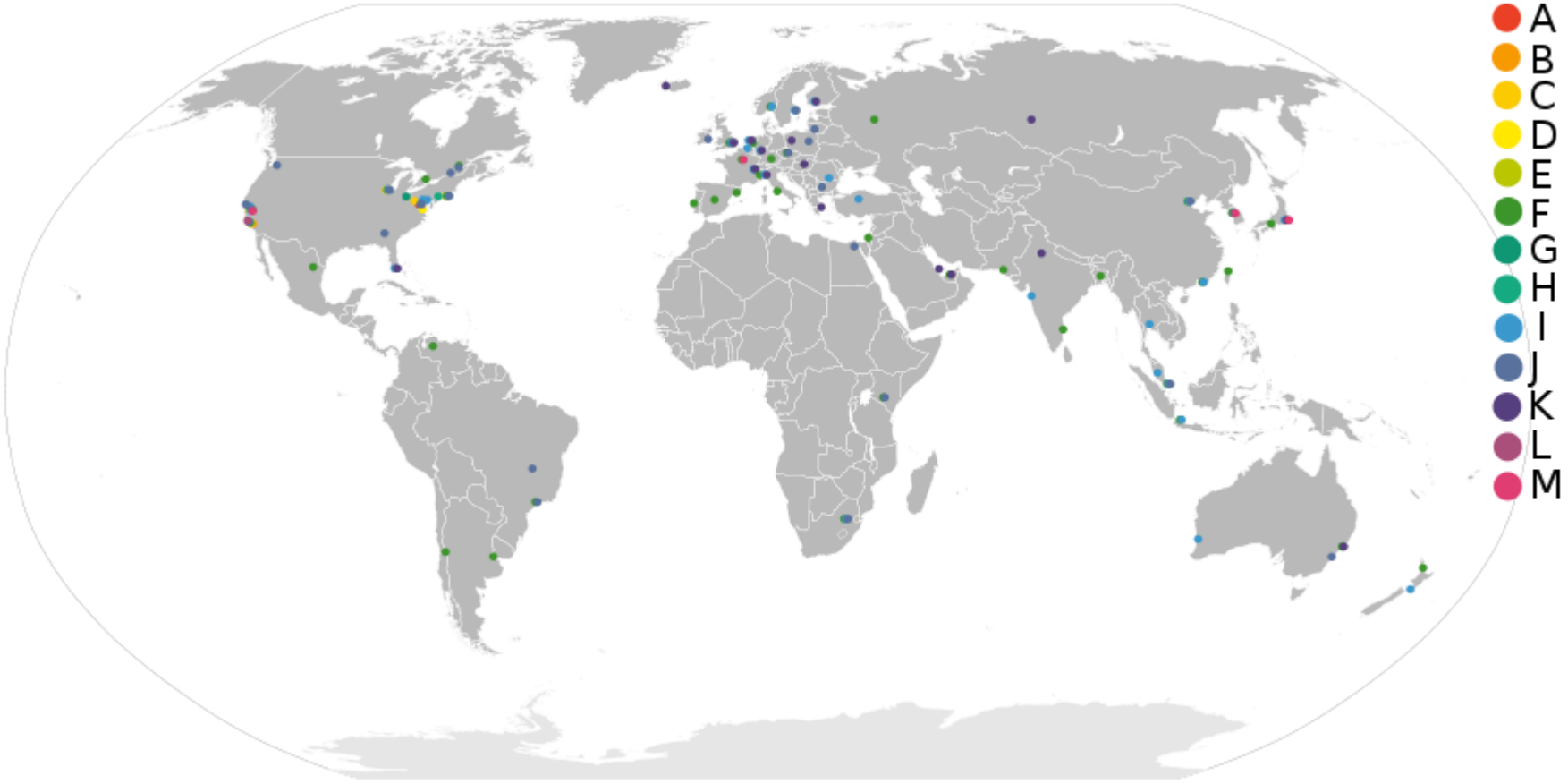
- Reduce queries to name servers.
  - Cache result records.
  - Each cached record has TTL (Time to Live).
  - After the TTL, the cached record is cleared.
  - Negative cache: record non existence of names.

- TTL is usually set about one day.
  - TTL is long → reduce the number of queries to name servers
  - TTL is short → easy to change addresses of machines.
  - IP addresses should not be changed often.

# Root Name Server

| Letter | IPv4 address | IPv6 address | Operator | Location |
|---|---|---|---|---|
| A | 198.41.0.4 | 2001:503:ba3e::2:30 | Verisign (US) | anycast |
| B | 192.228.79.201 | 2001:500:84::b | UCS-ISI (US) | Marina Del Rey, California, USA |
| C | 192.33.4.12 | 2001:500:2::c | Cognet Communications (US) | anycast |
| D | 128.8.10.90 | 2001:500:2d:d | University of Maryland (US) | College Park, Maryland, USA |
| E | 192.203.230.10 | 2001:500:a8::e | NASA (US) | Mountain View, California, USA |
| F | 192.5.5.241 | 2001:500:2f::f | ISC (US) | anycast |
| G | 192.112.36.4 | 2001:500:12::d0d | U.S. DoD NIC | anycast |
| H | 128.63.2.53 | 2001:500:1::53 | U.S. Army Research Lab | Aberdeen, Proving Ground, Maryland, USA |
| I | 192.36.148.17 | 2001:7fe::53 | Netnod (Sweden) | anycast |
| J | 192.58.128.30 | 2001:503:c27::2:30 | Verisign (US) | anycast |
| K | 193.0.14.129 | 2001:7fd::1 | RIPE NCC (Holand) | anycast |
| L | 199.7.83.42 | 2001:500:3::42 | ICANN (US) | anycast |
| M | 202.12.27.33 | 2001:dc3::35 | WIDE Project (Japan) | anycast |

# Location of Root Name Server

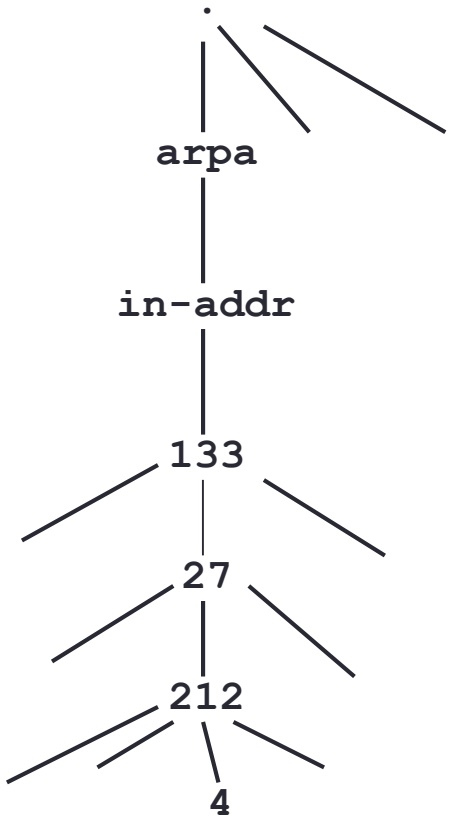



http://en.wikipedia.org/wiki/Root_name_server

# Mapping of Address to Name

- From IP address to host name
  - Reverse name lookup
  - Check whether an IP address is reliable or not.
- Use **`in-addr.arpa`** domain
  - To check host name of 133.27.4.212 use:

    212.4.27.133.in-addr.arpa
- Problems
  - in-addr.arpa sub domains may not match with sub nets.

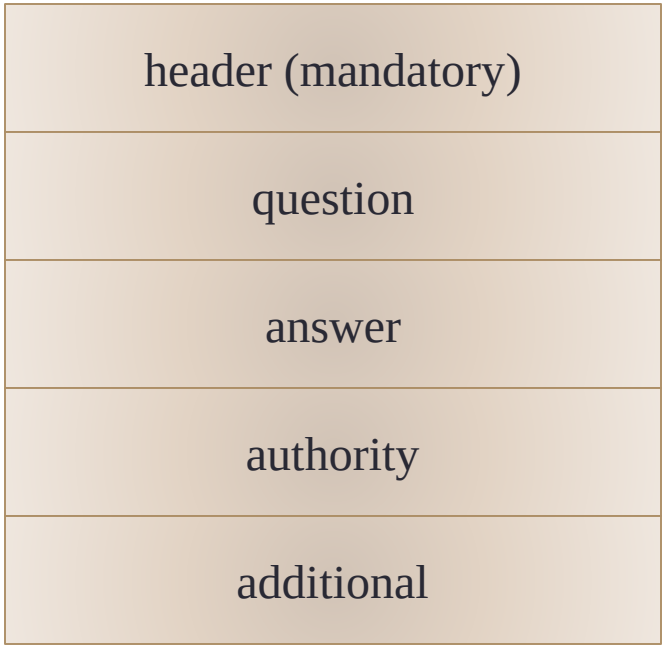


# Information Managed by Name Server

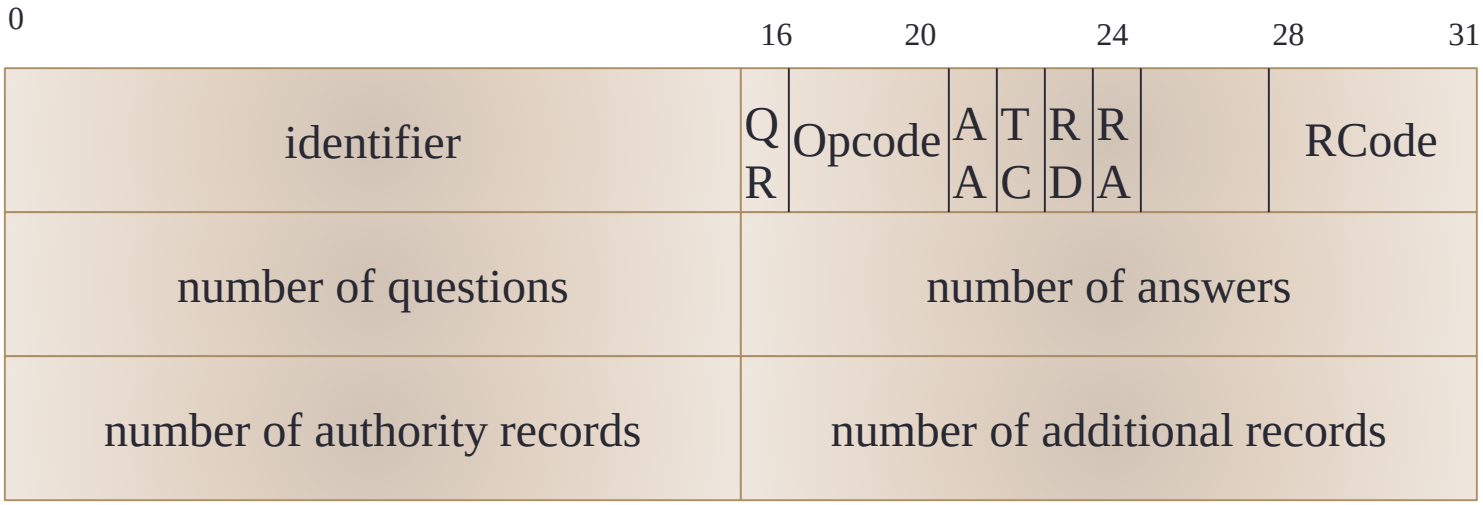
- RFC1035
  - A: a host address
  - NS: an authoritative name server
  - CNAME: the canonical name for an alias
  - SOA: marks the start of a zone of authority
  - WKS: a well known service description
  - PTR: a domain name pointer
  - HINFO: host information
  - MINFO: mailbox or mail list information
  - MX: Mail exchange
  - TXT: text strings
- RFC1183
  - AFSDB: AFS database
  - ISDN: ISDN address
  - RP: responsible person
  - RT: route through
  - X25: X.25 address
- RFC 3596
  - AAA: IPv6 address record

# DNS Protocol

- UDP port 53
- DNS message format

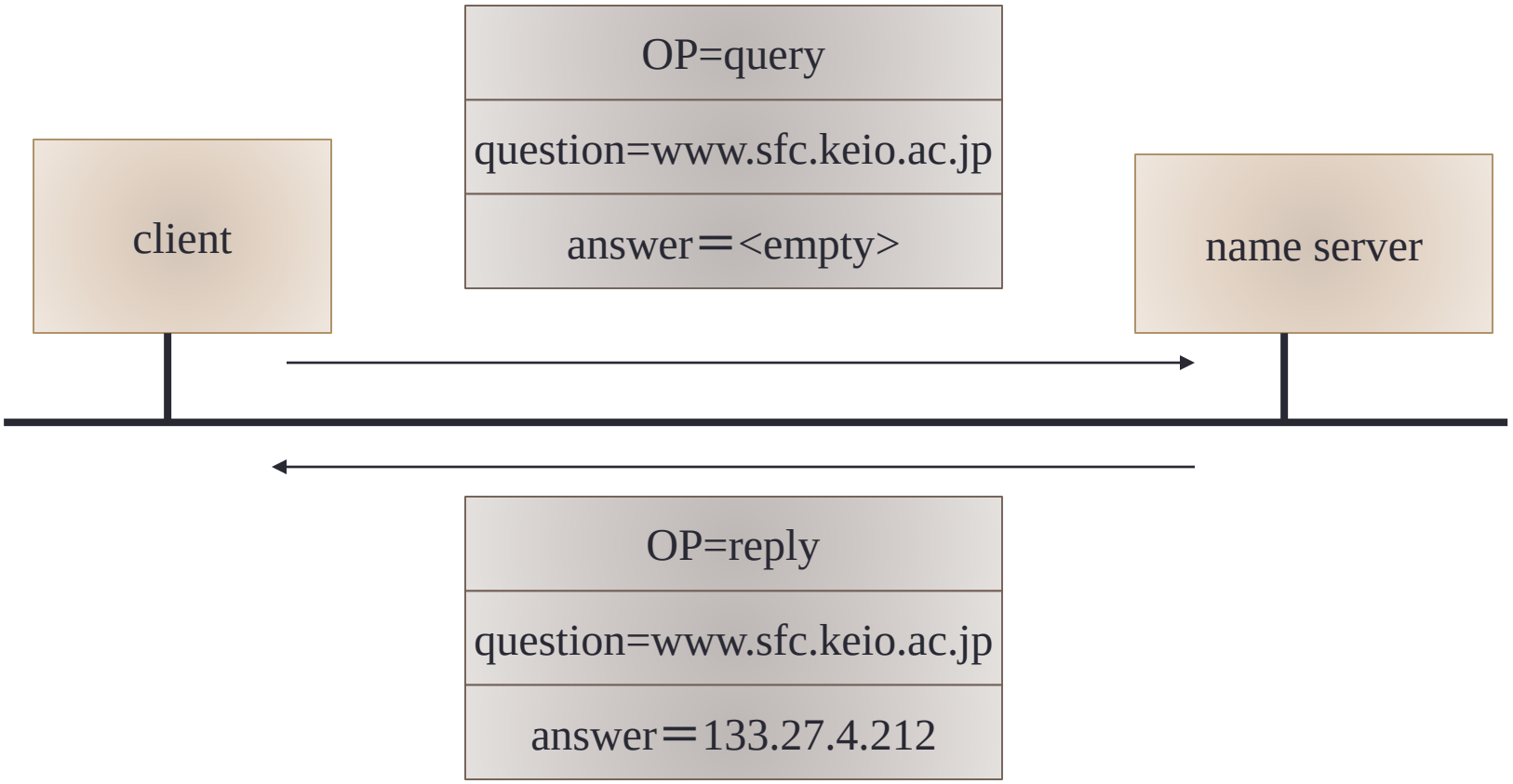


# DNS Message Header




- identifier: can be used freely
- Opcode: name service operation code (0=query, 1=reply, 2=status)
- QR: 0=query, 1=reply
- AA: authoritative answer, TC: truncation
- RD: recursive desire, RA: recursion available
- RCode: return code (0=success, 3=error)

# DNS Query and Reply



# Summary

- Internet Protocol
  - TCP/IP
  - IPv4 and IPv6
- Application Protocol
- Hierarchical Name Management
  - DNS
  - Root Server
    - 13 root name servers
    - Use of anycast
  - Use cache
  - Mail address resolution