# EE981 Network Switching & Routing

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## Identification

*People:* many identifiers:

- CNIC, name, passport #, License #

*Internet hosts, routers:*

- IP address (32 bit) - used for addressing datagrams
- "name", e.g., www.yahoo.com - used by humans

*Q:* how to map between IP address and name, and vice versa?

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# Domain Name System

- *Application-layer protocol*
- Hosts, name servers communicate to *resolve* names (address/name translation)
- Provides hostname to IP mapping

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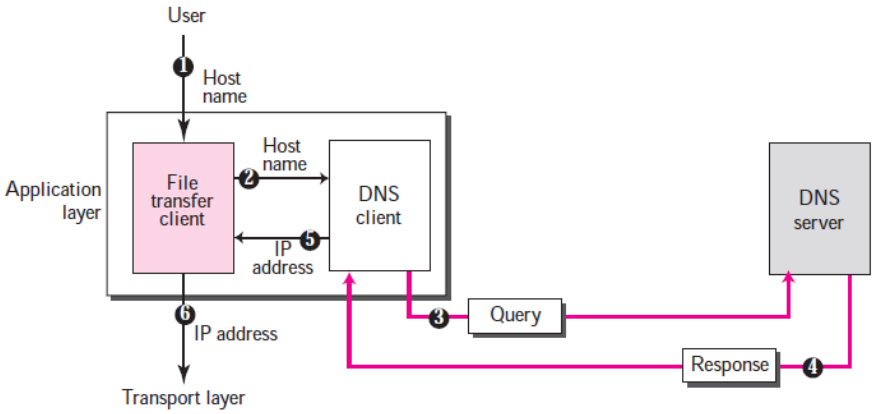
# DNS Working

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# Name Space

- A pool of names which can uniquely be associated with IP addresses
- Flat Name Space: A name has no structure.
- Hierarchical Name space: Each name has several parts. Each part signifies information

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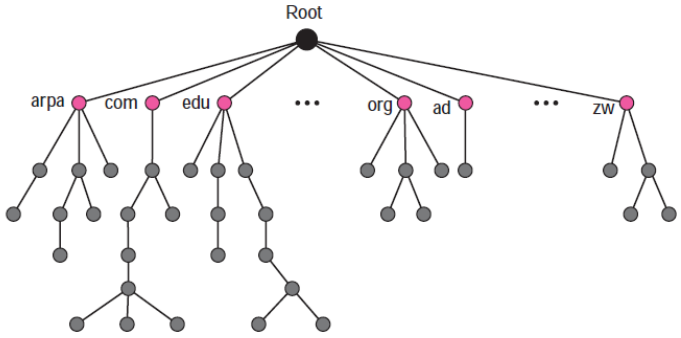
# Domain Name Space




- Each node has a name separated by a dot
- Full name is read from node to root
- Root is represented by . (dot) itself

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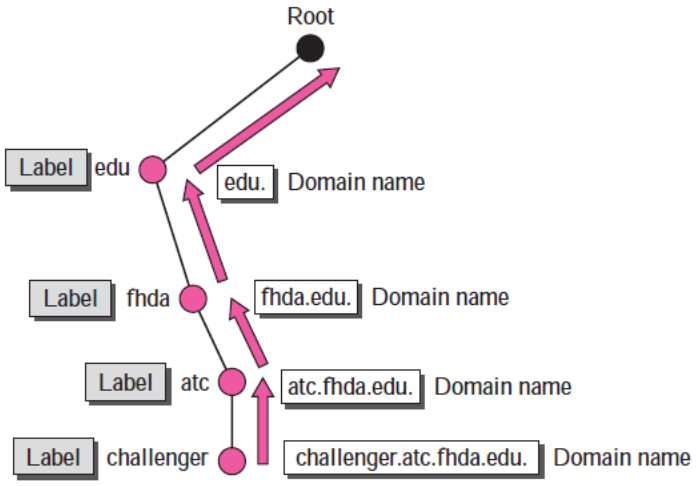
# Domain Name & Labels

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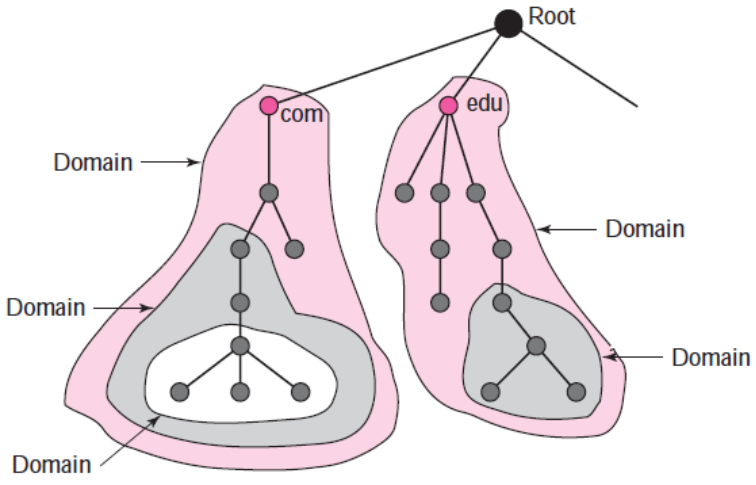
# Domain
## A sub tree of Domain Name Space

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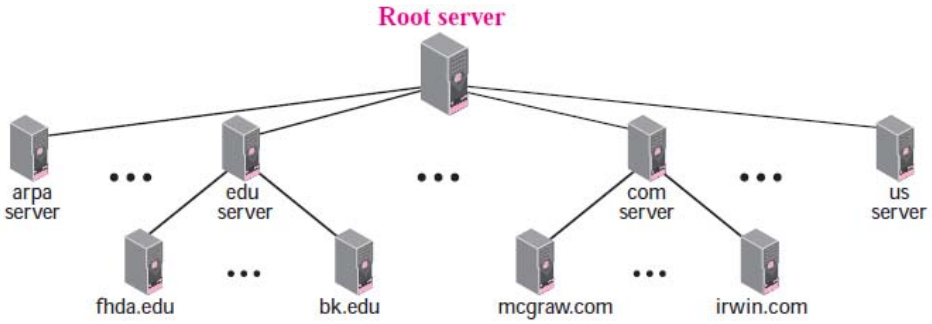
# DNS
## A distributed hierarchical structure

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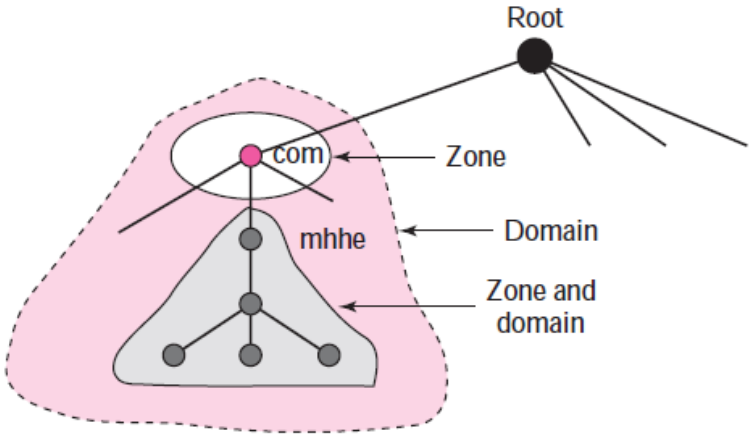
# Zone vs Domain

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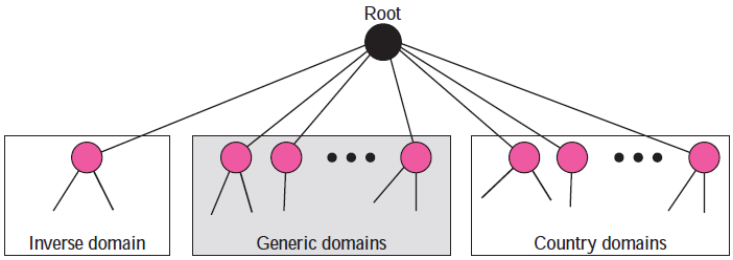
# Type of Domains

- Infrastructure top-level domain (ARPA)
- Generic top-level domains (gTLD)
- Country code top-level domains (ccTLD)

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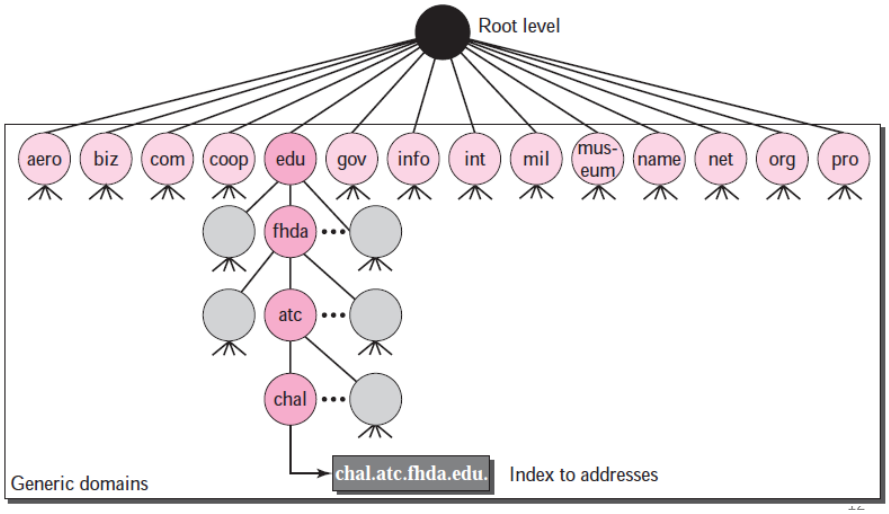
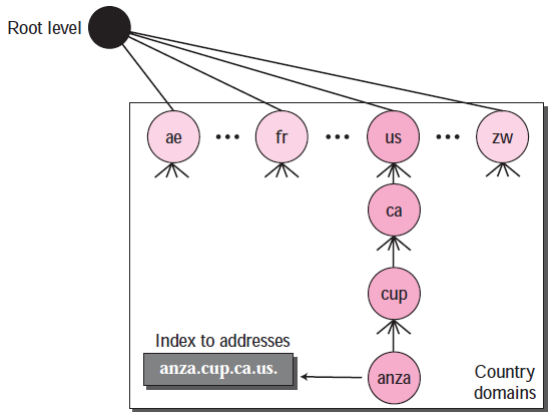
# Generic Domains



# Country Domains

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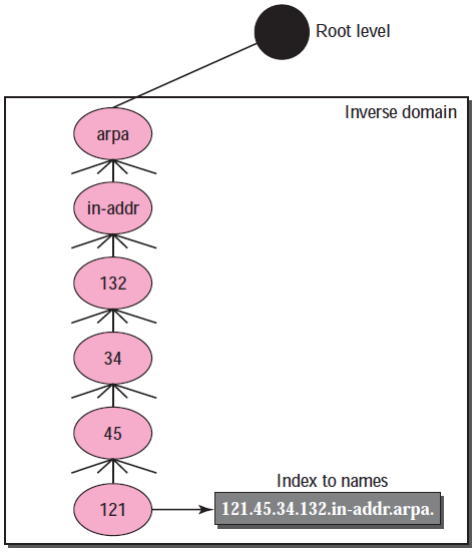
# Inverse Domain

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# Root Server

| Hostname | IP Addresses | Manager |
|---|---|---|
| a.root-servers.net | 198.41.0.4, 2001:503:ba3e::2:30 | VeriSign, Inc. |
| b.root-servers.net | 192.228.79.201, 2001:500:84::b | University of Southern California (ISI) |
| c.root-servers.net | 192.33.4.12, 2001:500:2::c | Cogent Communications |
| d.root-servers.net | 199.7.91.13, 2001:500:2d::d | University of Maryland |
| e.root-servers.net | 192.203.230.10 | NASA (Ames Research Center) |
| f.root-servers.net | 192.5.5.241, 2001:500:2f::f | Internet Systems Consortium, Inc. |
| g.root-servers.net | 192.112.36.4 | US Department of Defense (NIC) |
| h.root-servers.net | 198.97.190.53, 2001:500:1::53 | US Army (Research Lab) |
| i.root-servers.net | 192.36.148.17, 2001:7fe::53 | Netnod |
| j.root-servers.net | 192.58.128.30, 2001:503:c27::2:30 | VeriSign, Inc. |
| k.root-servers.net | 193.0.14.129, 2001:7fd::1 | RIPE NCC |
| l.root-servers.net | 199.7.83.42, 2001:500:3::42 | ICANN |
| m.root-servers.net | 202.12.27.33, 2001:dc3::35 | WIDE Project |

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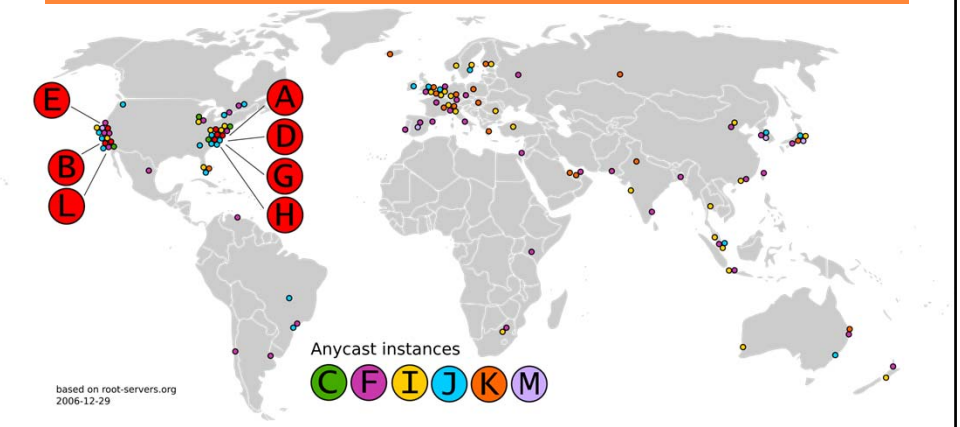
# Root Server




http://www.root-servers.org/

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# DNS Servers

- Authoritative DNS Server
  - Organization's own DNS server(s), providing authoritative hostname to IP mappings for organization's named hosts
  - Can be maintained by organization or service provider
- Local DNS Name Server
  - Does not strictly belong to hierarchy
  - Each ISP (residential ISP, company, university) has one
  - Also called "default name server"
  - When host makes DNS query, query is sent to its local DNS server has local cache of recent name-to-address translation pairs (but may be out of date!)
  - Acts as proxy, forwards query into hierarchy

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# Registrar

- Commercial Entities accredited by ICANN
- Responsible for authorizing Domain names and maintains mappings
- Examples
  - Godaddy
  - Register.com

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# Name Resolution Process

- Resolver: Process on client system that initiates the name resolution
  - Contacts Local DNS for resolution
- Names to Address
  - Query the Local DNS
  - If not resolved contact the DNS server higher in hierarchy
- Address to Names
  - Known as Pointer (PTR) Query

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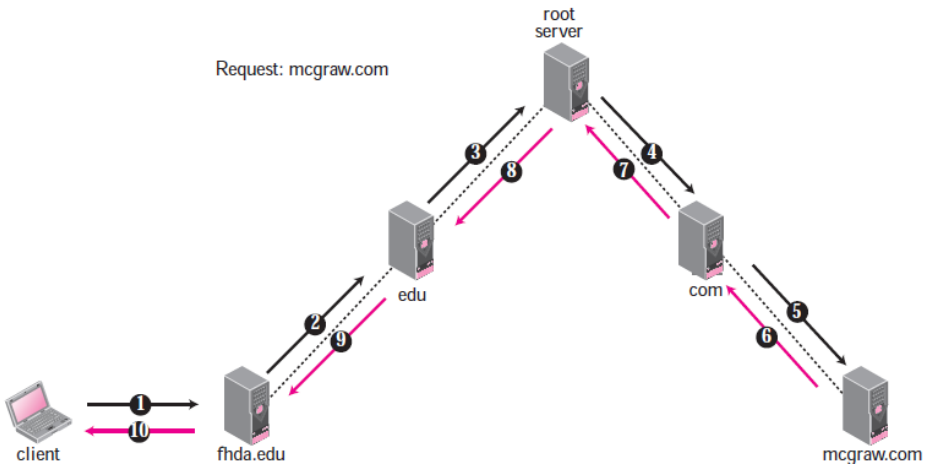
# Recursive Resolution

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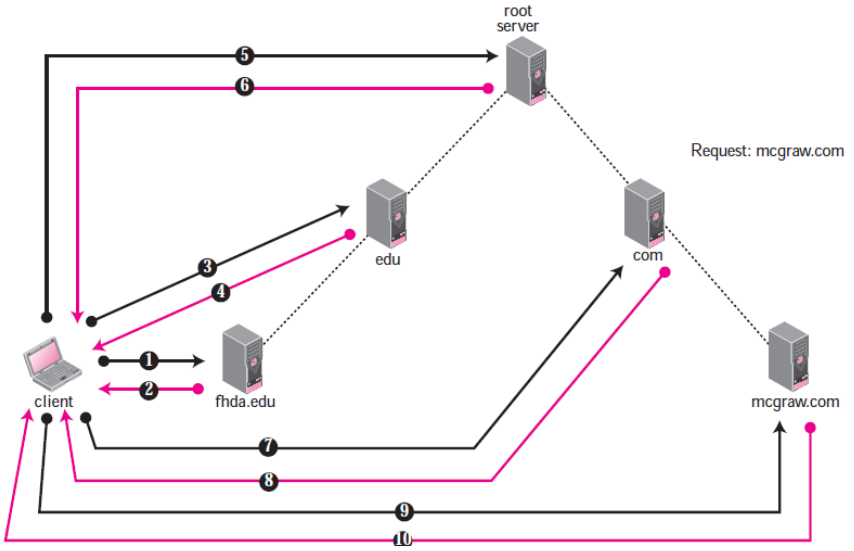
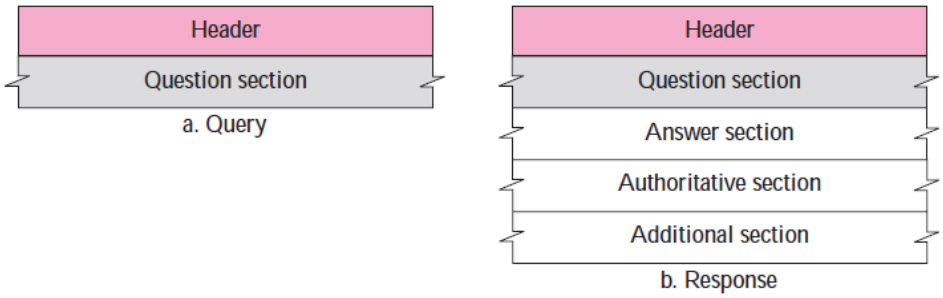
# Iterative Resolution




# DNS Message: Query/Response

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# Header Format

| Identification | Flags |
|---|---|
| Number of question records | Number of answer records (All 0s in query message) |
| Number of authoritative records (All 0s in query message) | Number of additional records (All 0s in query message) |

- Flags →

| QR | OpCode | AA | TC | RD | RA | Three 0s | rCode |
|---|---|---|---|---|---|---|---|

- Q/R: Query 0, Response 1
- OpCode: Type of query;0 standard, 1 inverse
- AA: Authoritative Server Responding
- TC: Response larger than 512 bytes & truncated
- RD: Recursion desired
- RA: Recursion available
- rCode: Error Code

| *Value* | *Meaning* | *Value* | *Meaning* |
|---|---|---|---|
| 0 | No error | 4 | Query type not supported |
| 1 | Format error | 5 | Administratively prohibited |
| 2 | Problem at name server | 6–15 | Reserved |
| 3 | Domain reference problem | | |

# Records

- Question Record
  - Used by the client to query the serve
  - Used as question
- Resource Records
  - Detailed information about resolution
  - Used in answers

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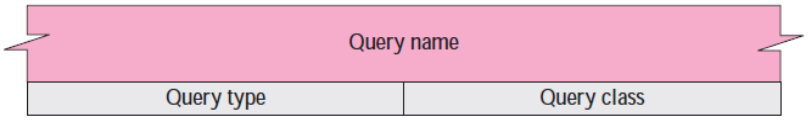
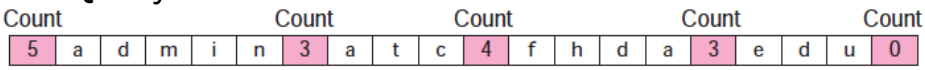
# Question Record




- Query Name Format




- Query Type
  - Different types of information about a domain name may exist
- Query Class
  - Defines the specific DNS protocol. 1 for IN

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# Question Record: Query Type

| *Type* | *Mnemonic* | *Description* |
|---|---|---|
| 1 | A | **Address.** A 32-bit IPv4 address. It converts a domain name to an address. |
| 2 | NS | **Name server**. It identifies the authoritative servers for a zone. |
| 5 | CNAME | **Canonical name**. It defines an alias for the official name of a host. |
| 6 | SOA | **Start of authority**. It marks the beginning of a zone. |
| 11 | WKS | **Well-known services**. It defines the network services that a host provides. |
| 12 | PTR | **Pointer.** It is used to convert an IP address to a domain name. |
| 13 | HINFO | **Host information.** It defines the hardware and operating system. |
| 15 | MX | **Mail exchange**. It redirects mail to a mail server. |
| 28 | AAAA | **Address.** An IPv6 address (see Chapter 26). |
| 252 | AXFR | A request for the transfer of the entire zone. |
| 255 | ANY | A request for all records. |

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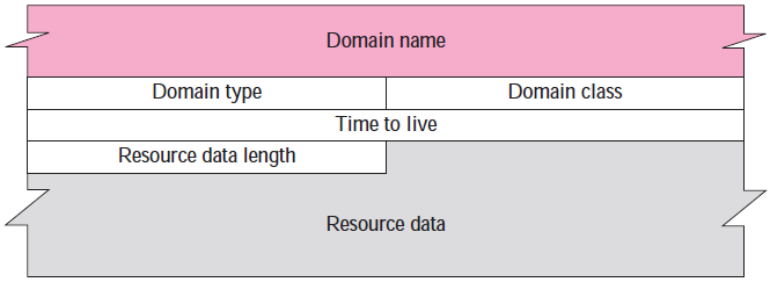
# Resource Record




- TTL: number of seconds for which answer is valid.
- Recourse Data: Answer to the query

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# Encapsulation

- DNS may use UDP or TCP on port 53
- UDP used if response less than 512 byte, otherwise TCP
- UDP can be used with TC flag, followed by TCP connection for complete response

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