Computer Networks

(RCS-601)

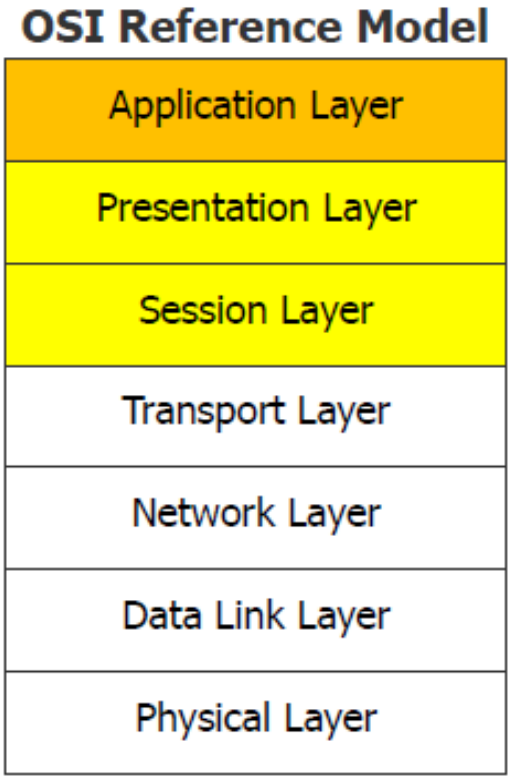
UNIT 5

Application Layer

APPLICATION LAYER DESIGN ISSUES

Design Issues

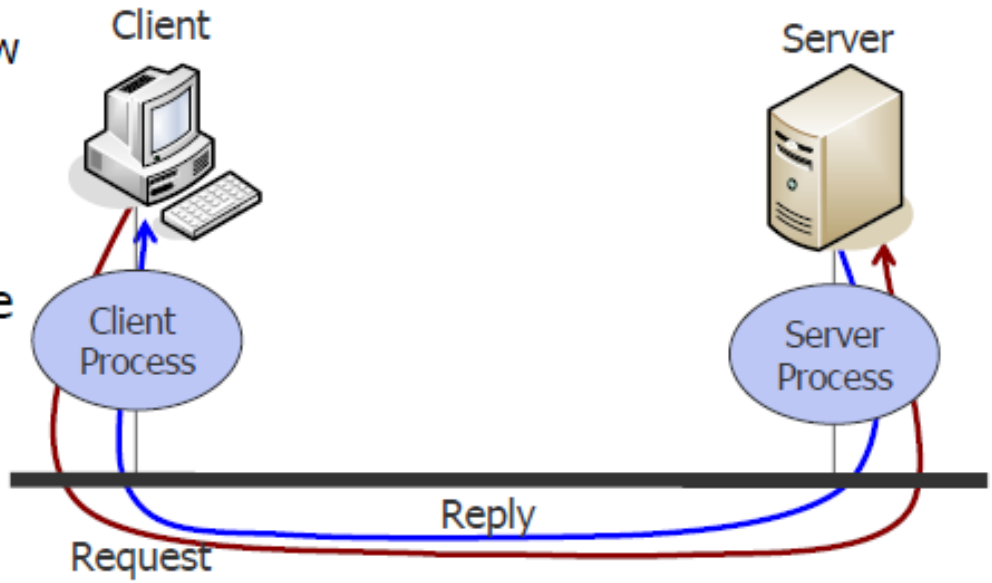
- Lower layers
  - The meaning of all lower layers is to provide a communication facility for applications
  - Are not really designed for end users
- Application layer
  - Application layer protocols work on top of the transport layer protocols
  - Implement applications for end users
  - A large set of different applications (protocols) with totally different requirements and assumptions
  - According to ISO/OSI three layers, but in the Internet exists only one layer



APPLICATION LAYER DESIGN ISSUES

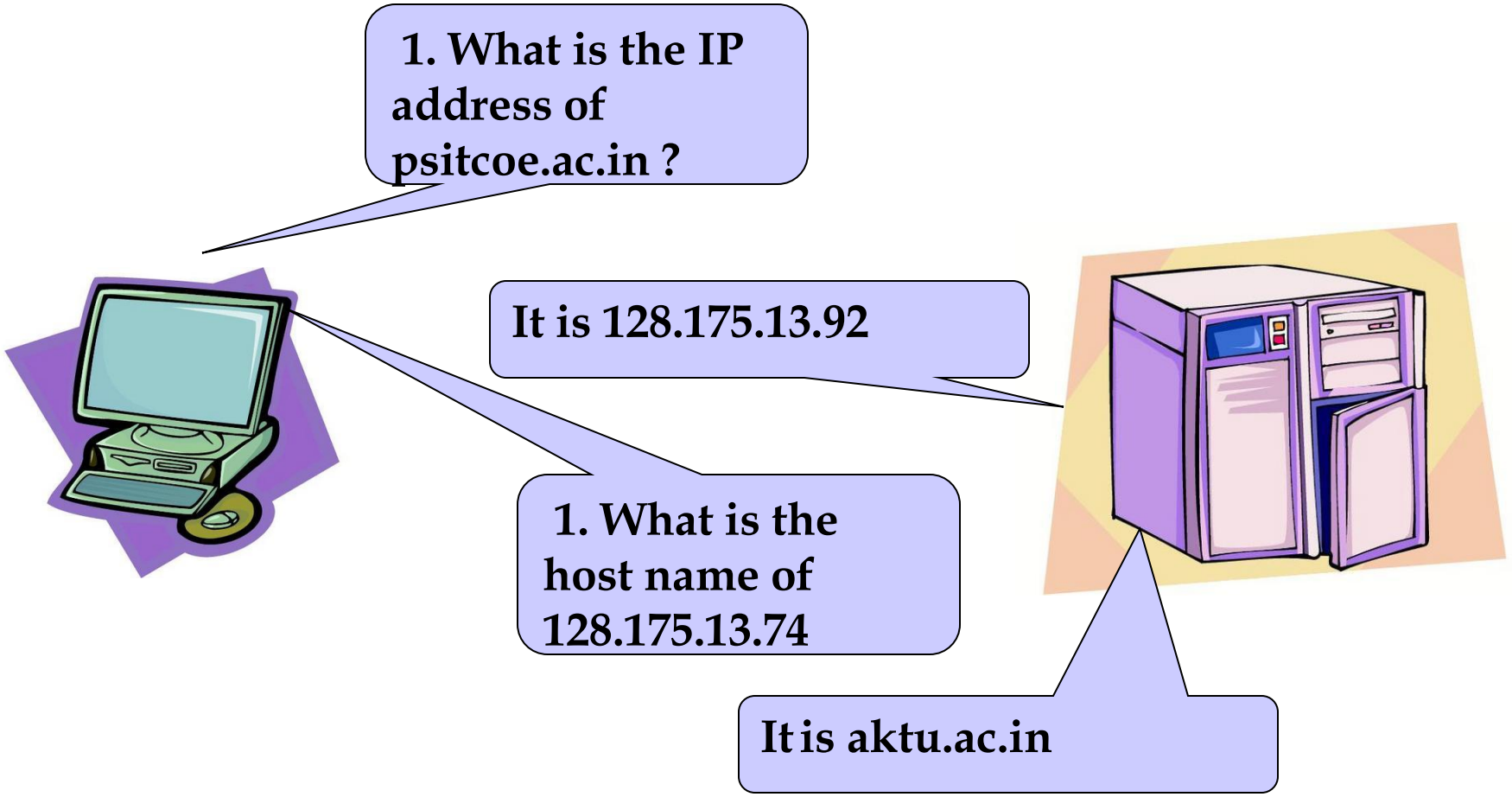
Application Protocols in the TCP/IP Reference Model

- Protocols of the application layer are common communication services
- Protocols of the application layer are defined for special purposes and specify ...
  - the types of the messages
  - the syntax of the message types
  - the semantics of the message types
  - rules for definition, when and how an application process sends a message resp. responses to it
- Usually **client/server** structure
- Processes on the application layer use TCP(UDP)/IP-Sockets



NEED OF DNS

- To identify an entity, the Internet uses the IP address, which uniquely identifies the connection of a host to the Internet. However, people prefer to use names instead of addresses. Therefore, we need a system that can map a name to an address or an address to a name.


1. What is the IP address of psitcoe.ac.in ?
It is 128.175.13.92
1. What is the host name of 128.175.13.74
It is aktu.ac.in

Design Principles of DNS

- The naming system on which DNS is based is a hierarchical and logical tree structure called the *domain namespace*.
- An organization obtains authority for parts of the name space, and can add additional layers of the hierarchy
- In practice, allocation of the domain names generally follows the allocation of IP address, e.g.,
  - All hosts with network prefix 128.143/16 have domain name suffix virginia.edu
  - All hosts on network 128.143.136/24 are in the Computer Science Department of the University of Virginia

NAME SPACE

- A name space that maps each address to a unique name can be organized in two ways:

a. **FLAT NAME SPACE**

In this, a name is assigned to an address. A name in this space is a sequence without structure.

Disadvantage: Cannot be used in large systems like Internet because it must be centrally controlled to avoid ambiguity and duplication.

b. HIERARCHIAL NAME SPACE

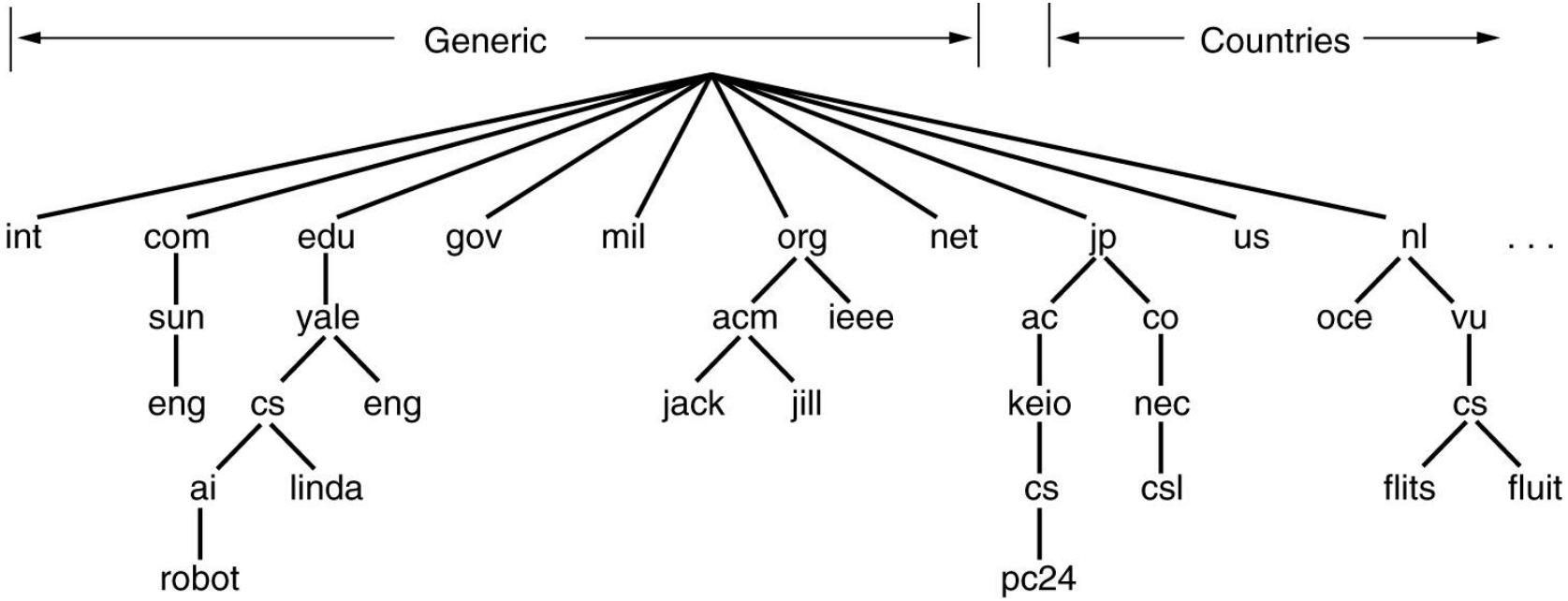
Each name is made of several parts.

The first part can define the nature of organization, the second part can define the name, the third part can define departments and so on.

The authority to assign and control the name spaces can be decentralized.

DOMAIN NAME SPACE

- To have a hierarchical name space, Domain Name Space was designed. In this design, the names are defined in an inverted-tree structure with the root at the top. The tree can have only 128 levels: level 0 (root) to level 127. Each level of the tree defines a hierarchical level.



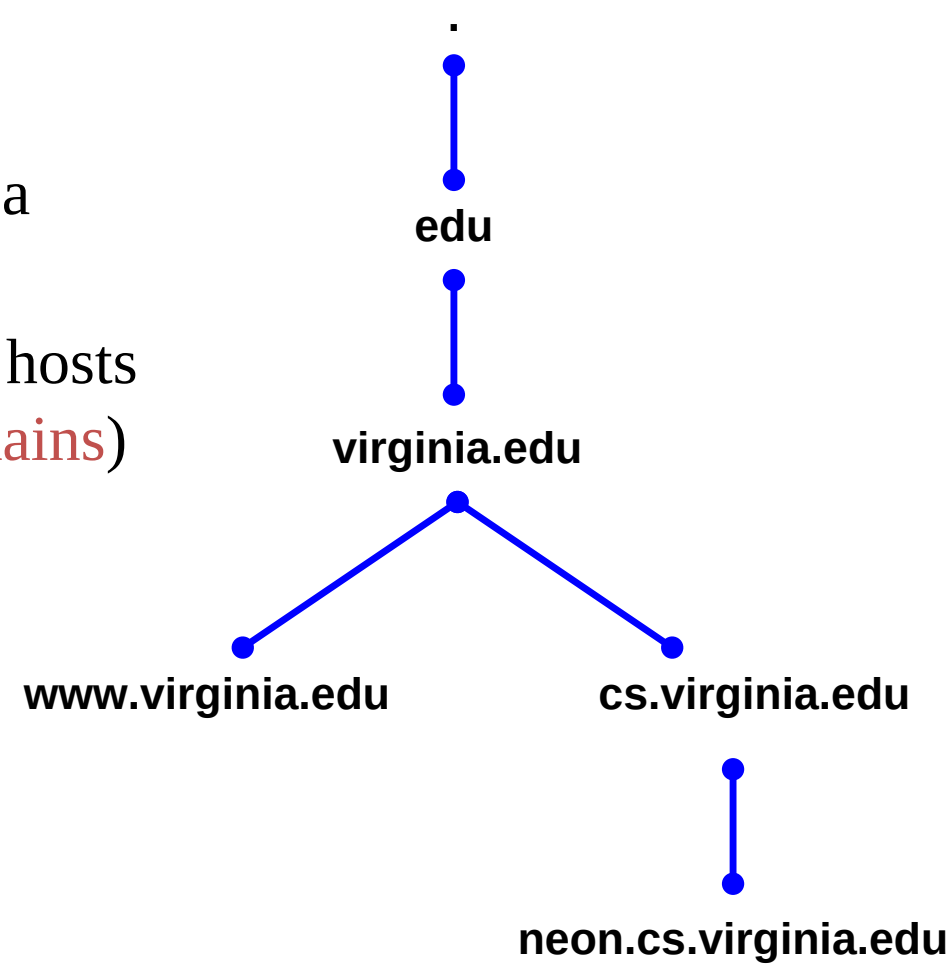
- **LABEL:** Each node in a tree has a label, which is a string with a maximum of 63 characters. The root label is a null string. DNS requires that children of a node have different labels, which guarantees the uniqueness of the domain names.

- **DOMAIN NAME:** Each node in the tree has a domain name. A full domain name is a sequence of labels separated by dots(.). The domain names are always read from the node upto the root.

Domain name system

- Each node in the DNS tree represents a DNS name
- Each branch below a node is a DNS domain.
  - DNS domain can contain hosts or other domains (subdomains)

- Example:
  DNS domains are
  ., edu, virginia.edu,
  cs.virginia.edu



- **FULLY QUALIFIED DOMAIN NAME (FQDN):**
  - Every node in the DNS domain tree can be identified by a unique Fully Qualified Domain Name (FQDN). The FQDN gives the position in the DNS tree.
  - In this, the label is terminated by a null string.
  - It is a domain name that contains the full name of the host.
  - It contains all labels, from the most specific to the most general, that uniquely define the host.

Example

A device with the hostname *myhost* in the parent domain *example.com* has the **fully qualified domain name *myhost.example.com***. The FQDN uniquely distinguishes the device from any other hosts called *myhost* in other domains.

- **PARTIALLY QUALIFIED DOMAIN NAME (PQDN)**
  - In this, the label is not terminated by a null string.
  - A PQDN starts with a node but does not reach the root.
  - It is used when the name to be resolved belongs to the same site as the client.

Organizational top-level domains

com	Commercial organizations
edu	Educational institutions
gov	Government institutions
int	International organizations
mil	U.S. military institutions
net	Networking organizations
org	Non-profit organizations

Authority and Delegation

- Authority for the root domain is with the **Internet Corporation for Assigned Numbers and Names** (ICANN).
- ICANN delegates to **accredited registrars** (for gTLDs) and countries for country code top level domains (ccTLDs) .
- Authority can be delegated further
- Chain of delegation can be obtained by reading domain name from right to left.
- Unit of delegation is a “zone”.

❖ TLD - Top Level Domain

Hierarchy of Name Servers

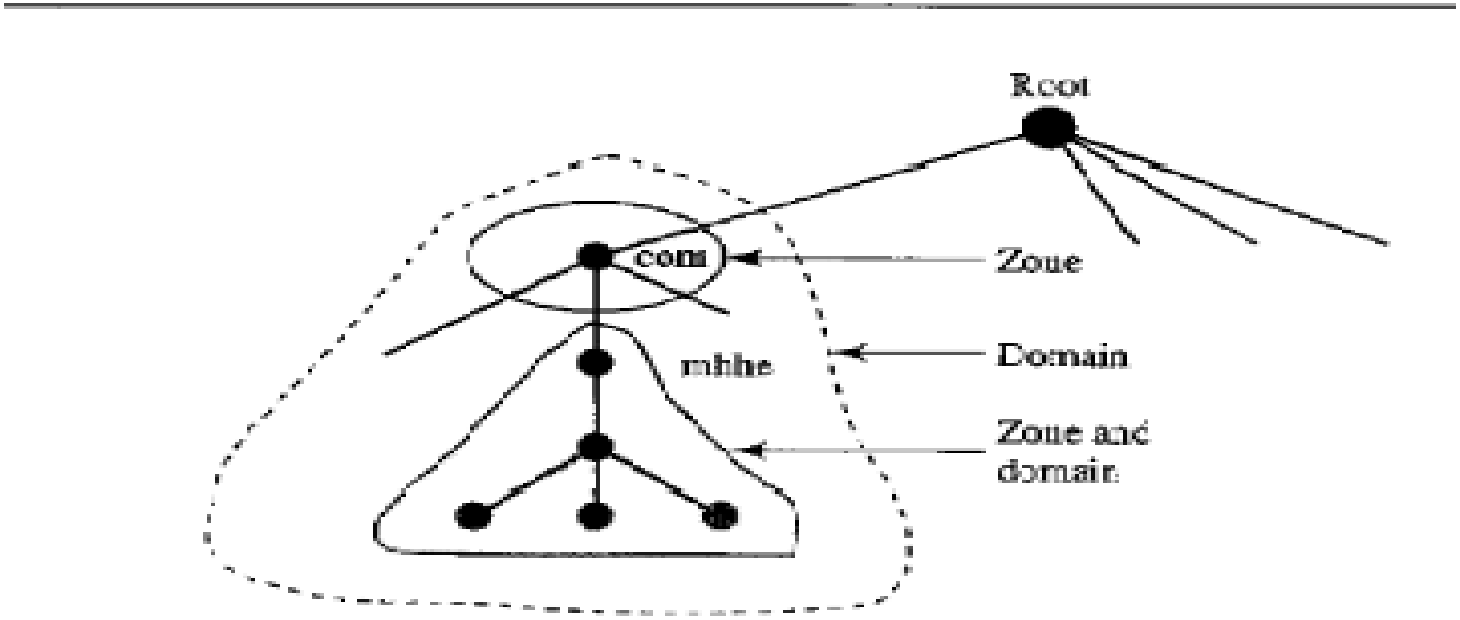
- It is inefficient to store complete information of domain name and their corresponding IP addresses into one computer . So to solve this problem, the information is distributed among many computers called DNS servers.
- So we let the root stand alone and create as many domains as they are first level nodes.
- DNS allows domain to be divided further into smaller domains.
- Each server can be responsible for either a large or small domain.

- **Zone:**

Since the complete domain name hierarchy cannot be stored on a single server, it is divided among many servers.

A zone is a server responsible for or has authority over domain server.

The server makes a database called a zone-file and keeps all the information for every node under that domain.



- **Root Server**

A root server is a server whose zone consists of a whole tree.

A root server usually does not store any information about domains but delegates its authority to other servers keeping references to those servers.

Primary and Secondary Name Servers

- For each zone, there must be a primary name server and a secondary name server
  - The primary server (master server) maintains a zone file which has information about the zone. Updates are made to the primary server
  - The secondary server copies data stored at the primary server.

Adding a host:

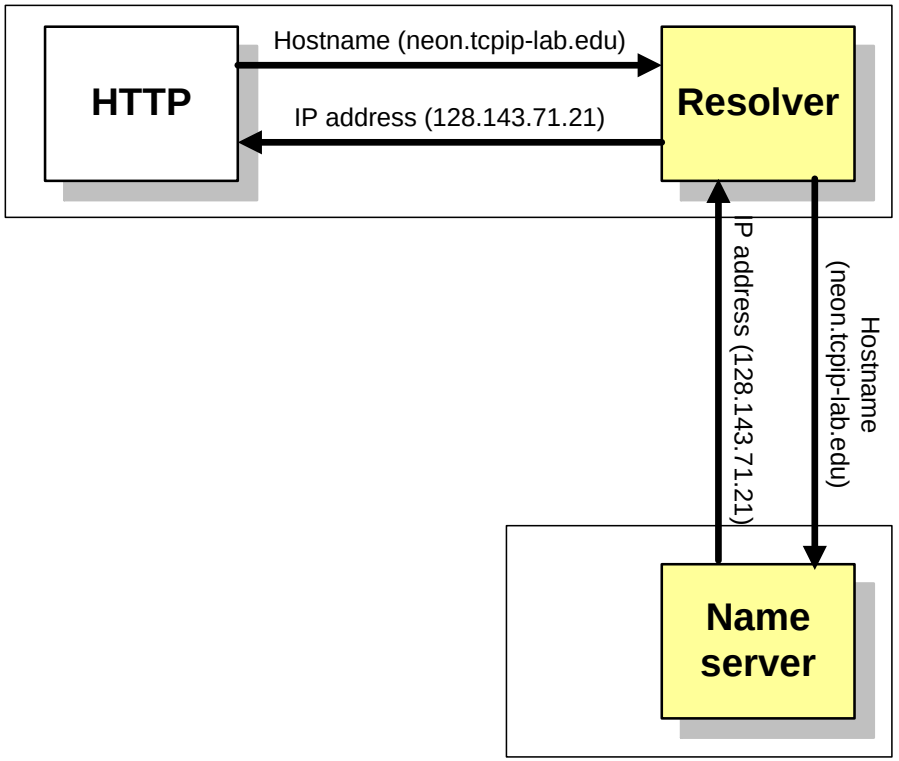
- When a new host is added ("gold.cs.virginia.edu") to a zone, the administrator adds the IP information on the host (IP address and name) to a configuration file on the primary server

RESOURCE RECORDS

- The database records of the distributed data base are called resource records (RR)
- Resource records are stored in configuration files (zone files) at name servers.

Domain Name Resolution

1. User program issues a request for the IP address of a hostname
2. Local resolver formulates a DNS query to the name server of the host
3. Name server checks if it is authorized to answer the query.
   a) If yes, it responds.
   b) Otherwise, it will query other name servers, starting at the root tree
4. When the name server has the answer it sends it to the resolver.



Types of Domain Name Resolution

- Recursive
- Iterative

1) **Recursive Resolution**

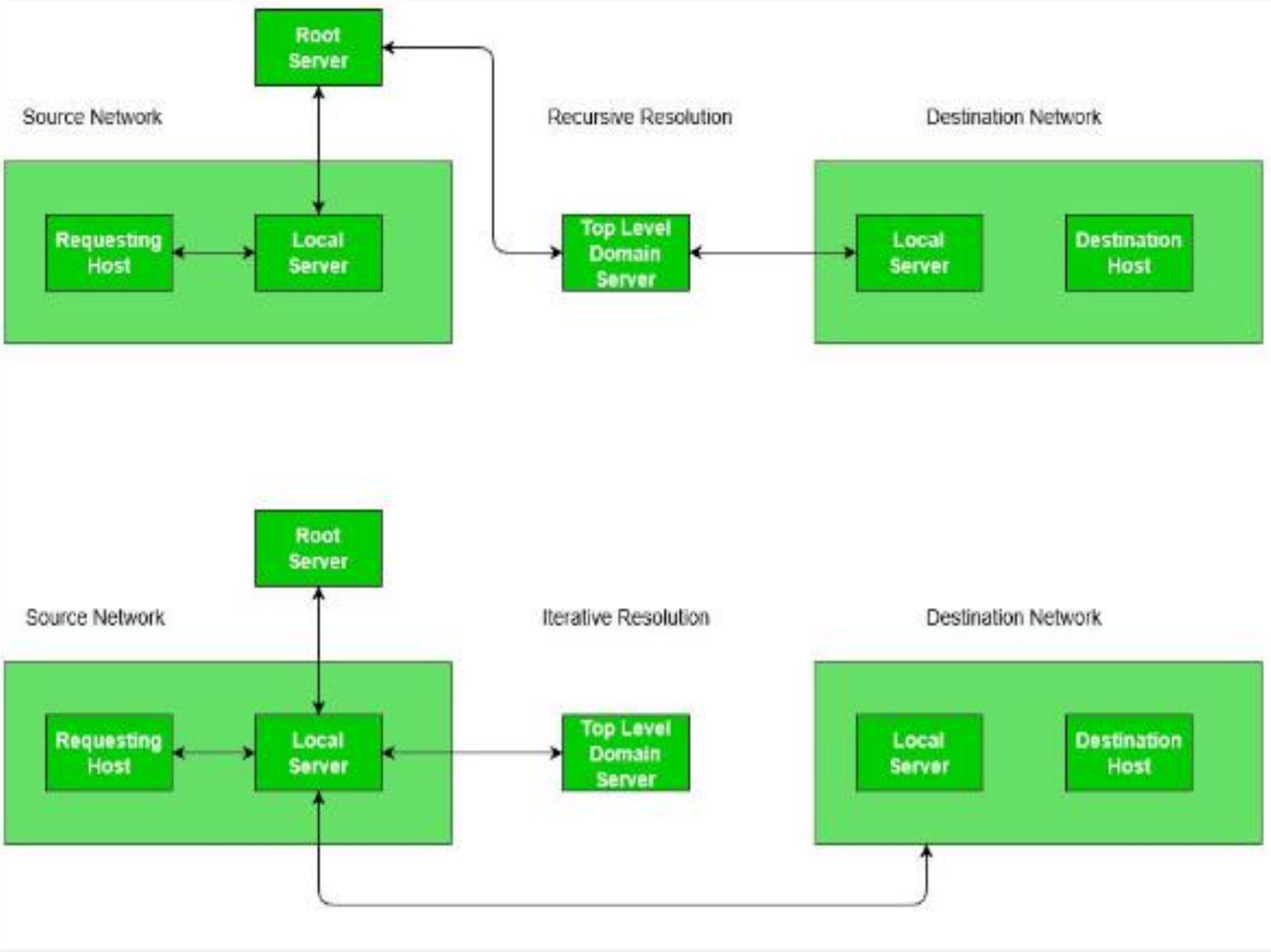
- Client requires the Local Server to give either the requested mapping or an error message. A DNS Query is generated by the application program to the resolver to fetch the destination IP Address. The Query is then forward to the local DNS Server. If it knows the IP Address, it sends a response to the resolver. Assuming, it does not know the IP Address, it sends the query to the root name server.

- The root name server contains information of about at least one server of Top Level Domain. The query is then sent to the respective Top-Level Domain server. If it contains the mapping, the response is sent back to the root server and then to host's local server.
- If it doesn't contain the mapping, it should contain the IP Address of destination's local DNS Server. The local DNS server knows the destination host's IP Address.
- The information is then sent back to the top-level domain server, then to the root server and then to the host's Local DNS Server and finally to the host

2) Iterative Resolution:

- The main difference between iterative and recursive resolution is that, here each server that does not know the mapping sends the IP Address of the next server to the one requested it.
- Here, client allows the server to return the best answer it can give as a match or as a referral.
- A DNS Query is generated by the application program to the resolver to fetch the destination IP Address. The Query is then forward to the local DNS Server. Assuming, it does not know the IP Address, it sends the query to the root name server.

- The root name server returns the IP Address of the Top-Level Domain Server to the Local Server. The Top-Level Domain server is contacted by Local Server and it returns either the IP of the destination host or its local DNS Server.
- If it returns the server's address, then by contacting the destination's Local DNS Server, we get the IP Address of the destination host.
- The response/mapping is then passed from host's local DNS server to the resolver and then finally to the host.


Root Server
Source Network
Recursive Resolution
Destination Network
Requesting Host
Local Server
Top Level Domain Server
Local Server
Destination Host
Root Server
Source Network
Iterative Resolution
Destination Network
Requesting Host
Local Server
Top Level Domain Server
Local Server
Destination Host