Name Services

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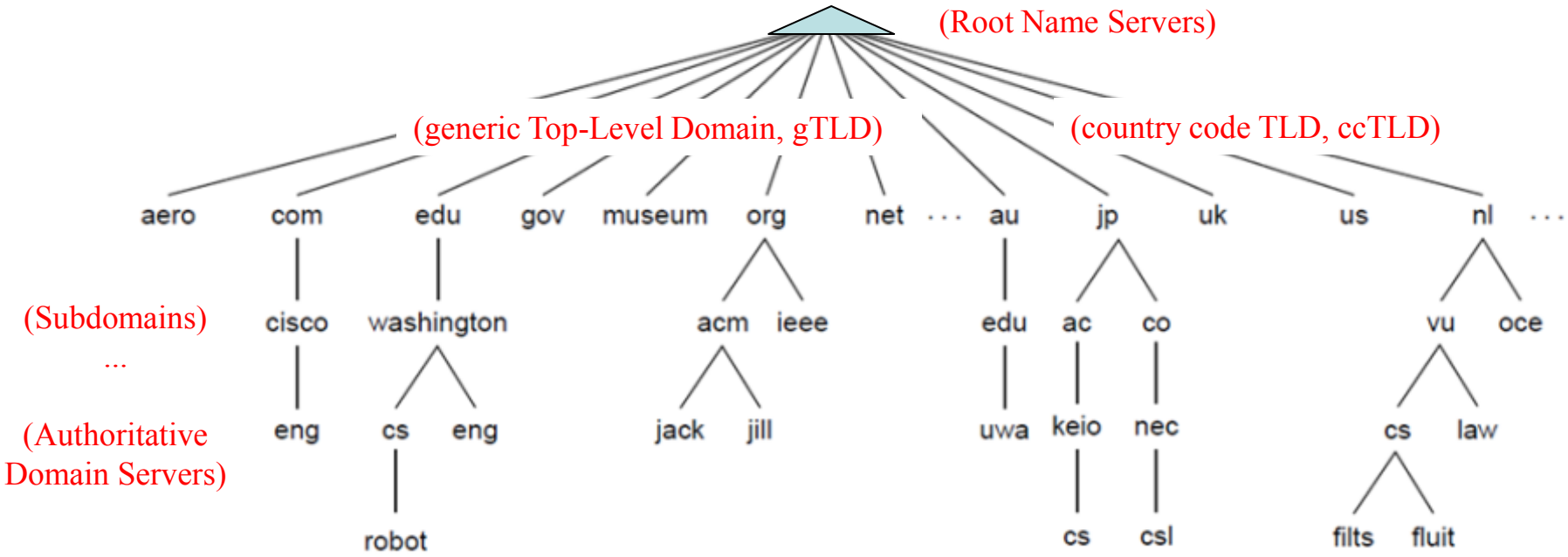
Domain name vs IP address

- IP Addresses
  - Not user friendly → 149.169.226.239
  - Reorganizing a network may change all IP addresses
- Domain Names
  - User Friendly → vlab.asu.edu
  - Hierarchical structure → Tree
    - openstack.mobicloud.asu.edu
  - Names can be used to obtain more information
  - Network services should use names instead of addresses

Domain Name Service (DNS)

- Definition
  - An Internet service that maps IP addresses and **fully qualified domain names (FQDN)** to one another.
  - A **distributed** database that manages the assignment of domain names to IP addresses.
- Components
  - Name space
  - Name servers
  - Resolvers

Domain Name Space



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Generic Top-Level Domains

Domain	Intended use	Start date	Restricted?
com	Commercial	1985	No
edu	Educational institutions	1985	Yes
gov	Government	1985	Yes
int	International organizations	1988	Yes
mil	Military	1985	Yes
net	Network providers	1985	No
org	Non-profit organizations	1985	No
aero	Air transport	2001	Yes
biz	Businesses	2001	No
coop	Cooperatives	2001	Yes
info	Informational	2002	No
museum	Museums	2002	Yes
name	People	2002	No
pro	Professionals	2002	Yes
cat	Catalan	2005	Yes
jobs	Employment	2005	Yes
mobi	Mobile devices	2005	Yes
tel	Contact details	2005	Yes
travel	Travel industry	2005	Yes

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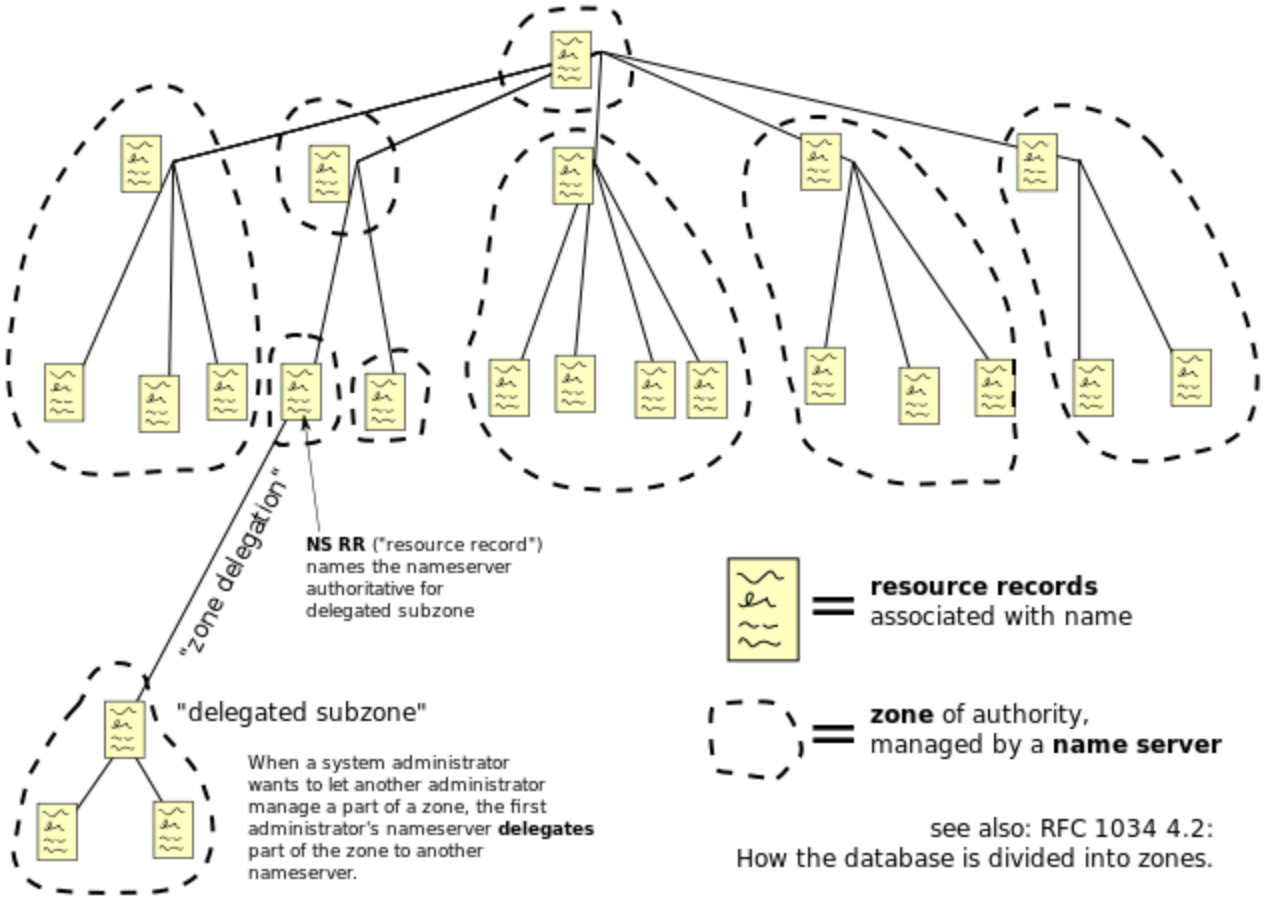
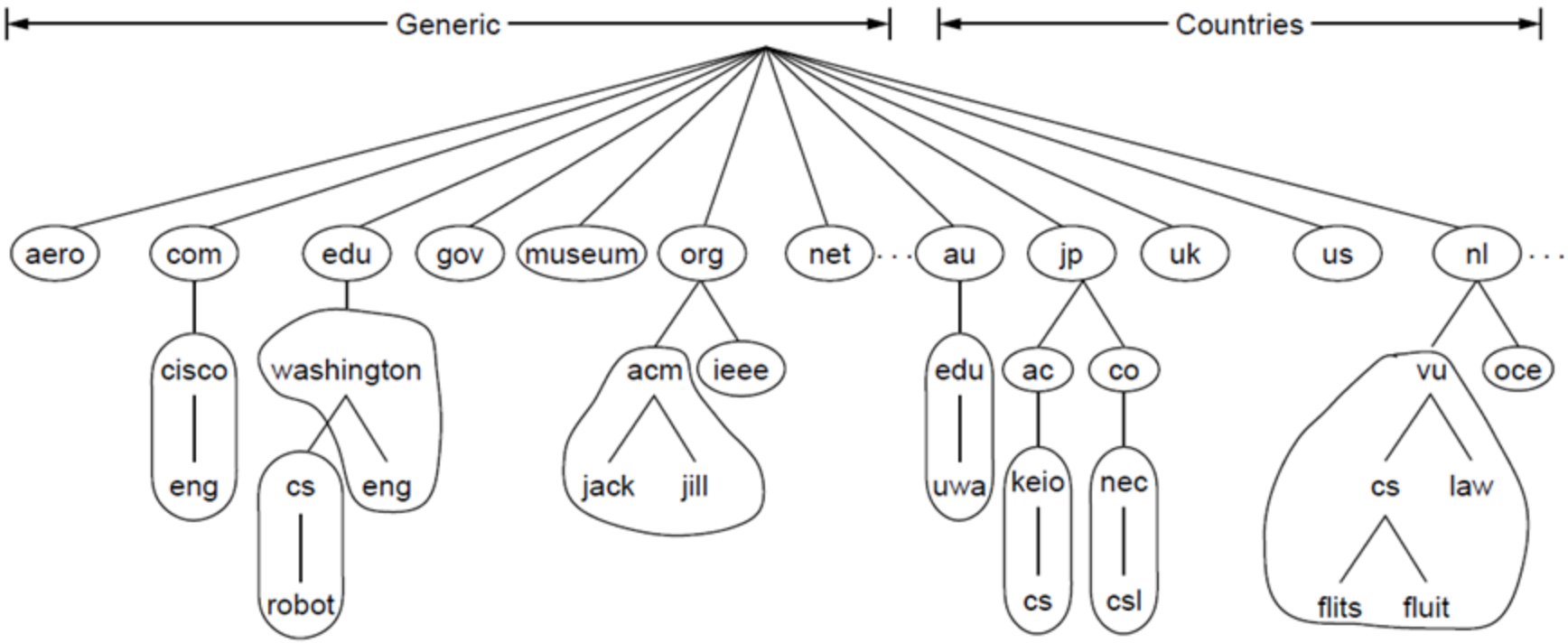
Domains vs. Zones



DNS Zones and Name Servers

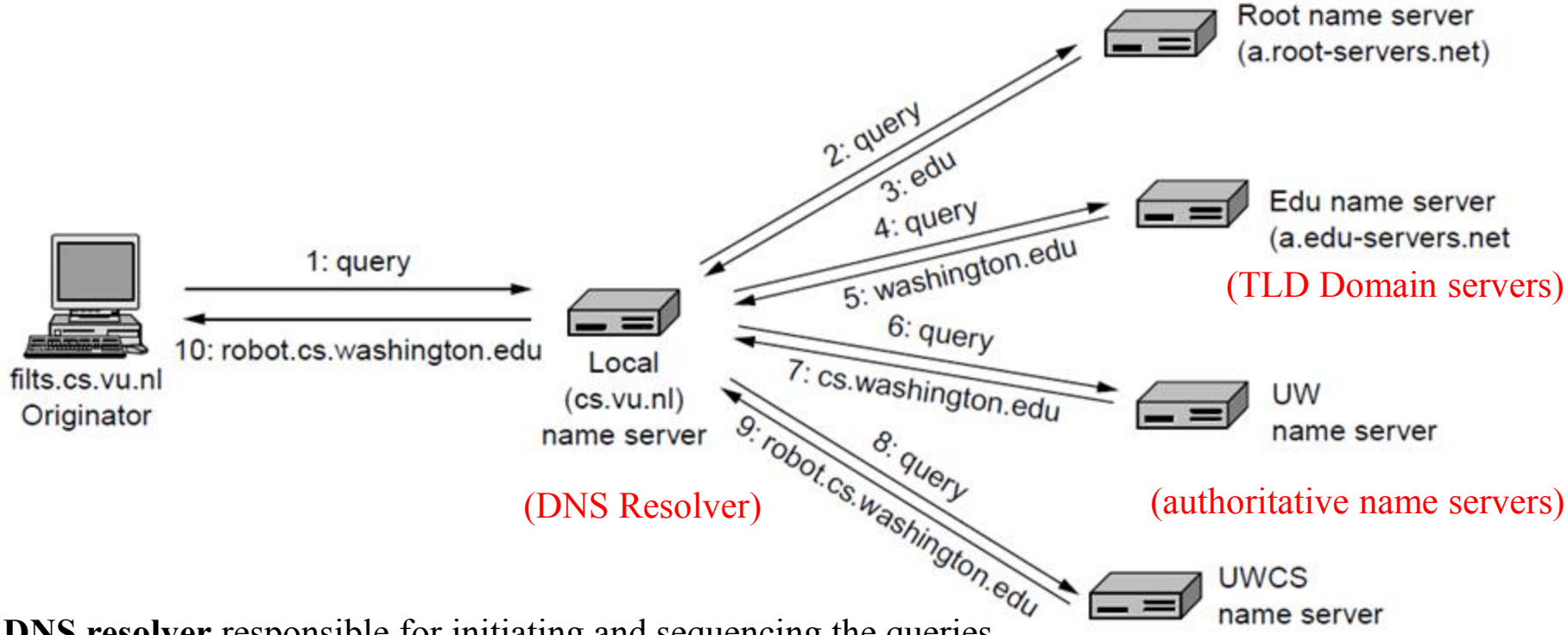


Root Name servers

- What are they?
  - Sources for the top level domain servers.
- Where are they?
  - 13 different root name servers spread across the Internet
- What do they do?
  - Provide access to authoritative name servers

Root Name Servers	Location(s)	Historical Name
A.ROOT-SERVERS.NET	Dulles, VA, USA	ns.internic.net
B.ROOT-SERVERS.NET	Marina Del Rey, CA, USA	ns1.isi.edu
C.ROOT-SERVERS.NET	Herndon, VA, USA; Los Angeles, CA, USA	c.psi.net
D.ROOT-SERVERS.NET	College Park, MD, USA	terp.umd.edu
E.ROOT-SERVERS.NET	Mountain View, CA, USA	ns.nasa.gov
F.ROOT-SERVERS.NET	Auckland, New Zealand; Sao Paulo, Brazil; Hong Kong, China; Johannesburg, South Africa; Los Angeles, CA, USA; New York, NY, USA; Madrid, Spain; Palo Alto, CA, USA; Rome, Italy; Seoul, Korea; San Francisco, CA, USA; San Jose, CA, USA; Ottawa, ON, Canada	ns.isc.org
G.ROOT-SERVERS.NET	Vienna, VA, USA	ns.nic.ddn.mil
H.ROOT-SERVERS.NET	Aberdeen, MD, USA	aos.arl.army.mil
I.ROOT-SERVERS.NET	Stockholm, Sweden Helsinki, Finland	nic.nordu.net
J.ROOT-SERVERS.NET	Dulles, VA, USA; Mountain View, CA, USA; Sterling, VA, USA; Seattle, WA, USA; Atlanta, GA, USA; Los Angeles, CA, USA; Amsterdam, The Netherlands	
K.ROOT-SERVERS.NET	London, UK; Amsterdam, The Netherlands	
L.ROOT-SERVERS.NET	Los Angeles, CA, USA	
M.ROOT-SERVERS.NET	Tokyo, Japan	

DNS Resolution Example



- **DNS resolver** responsible for initiating and sequencing the queries that translating a domain name into an IP address.
- **Authoritative Name Servers** manage a Zone and either provide IP address lookup information themselves, or delegate the lookup of zone/sub-zone information to other DNS name servers.

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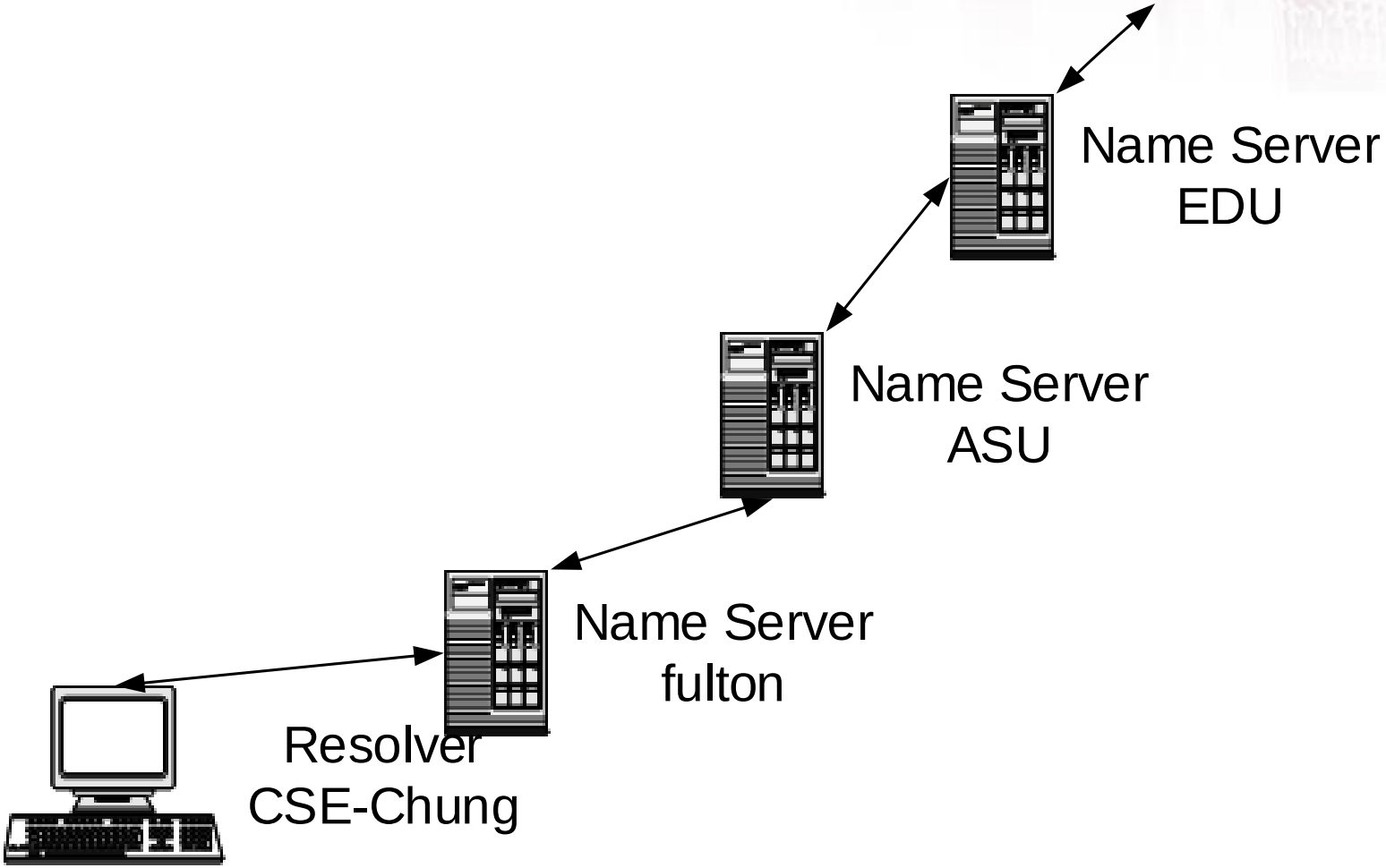
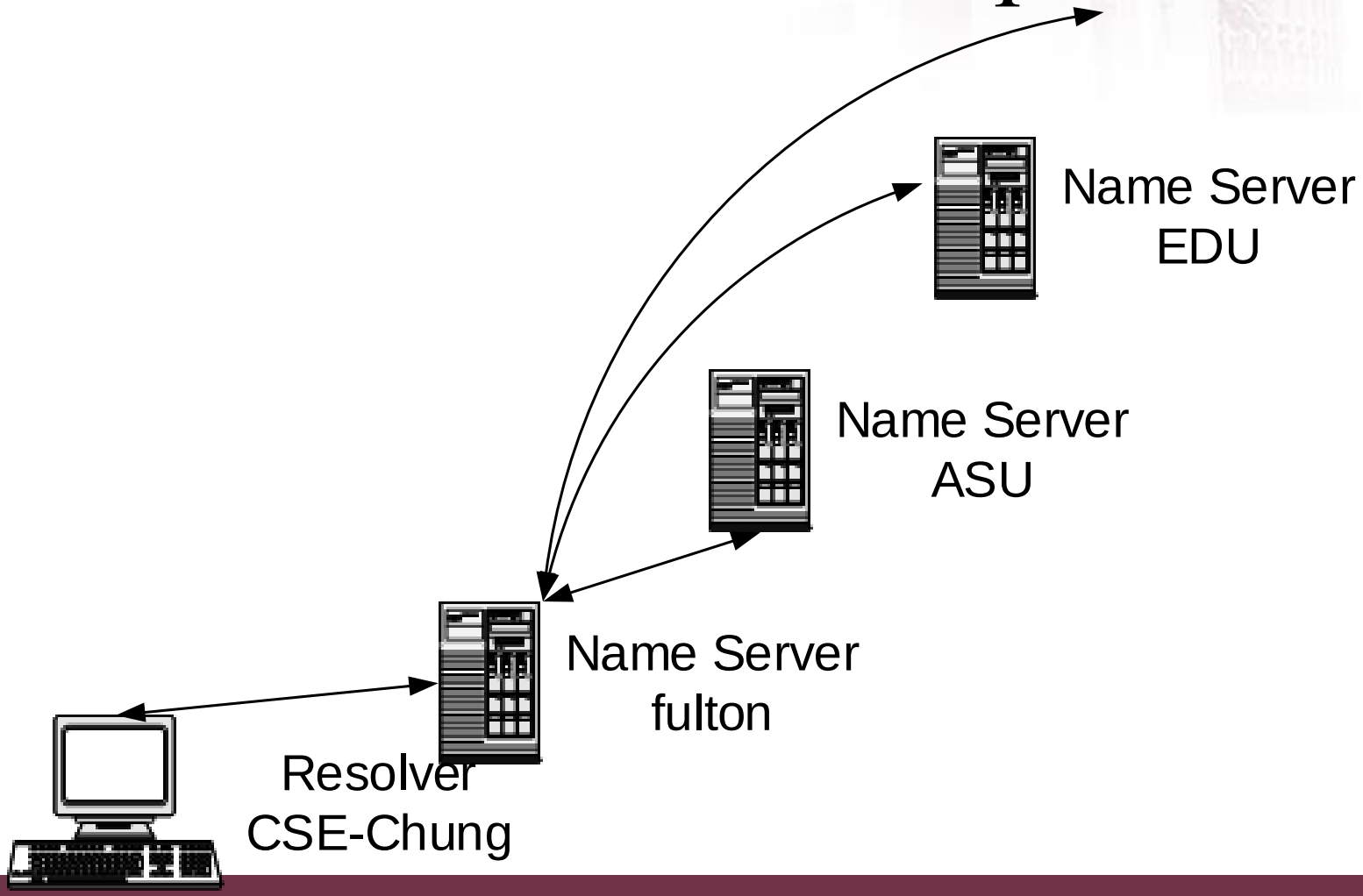
Address lookup process

- Recursive
  - Each request from a local name server is passed to the next higher NS until an answer is found (or no answer exists). The response is then passed down through the chain to the local NS
- Iterative
  - Each request from a local NS is returned to the local NS, which then resends the query to the next NS in the series.
- Caching
  - The way that temporarily store lookup information in a DNS server. (often configured to carryout recursive lookups.

Recursive Lookup



Iterative Lookup



Local Hostname Lookup

- A simple way to map hostname into IP address locally.
- Linux → /etc/hosts
- Windows → %Systemroot%\System32\Drivers\Etc\hosts

```
# For example:
#
#      102.54.94.97     rhino.acme.com          # source server
#       38.25.63.10     x.acme.com              # x client host
127.0.0.1       localhost
192.168.10.5    printer
192.168.10.12   fileserver
192.168.10.12   fs.home
150.10.1.20     mail.lon.mybank.com
150.10.2.20     mail.mybank.co.uk
150.10.2.20     mail.atl.mybank.com
150.10.2.21     www.mybank.com
150.10.2.21     webserver
```

- Change your hostname - /etc/hostname

Name Servers with BIND9

- BIND (Berkley Internet Naming Daemon)
  - A software service to provide Domain Name Service
- Installation – `sudo apt-get install bind9`
- Restart service – `sudo /etc/init.d/bind9 restart`
- Main configuration files:
  - /etc/bind/named.conf (primary config file, you don't need to change it)
  - /etc/bind/named.conf.options (setup forwarders)
  - /etc/bind/named.conf.local (define forward and reverse zone file)

```
[...]

zone "example.com" {
     type master;
     file "/etc/bind/db.example.com";
};

[...]
```

```
zone "1.168.192.in-addr.arpa" {
        type master;
        notify no;
        file "/etc/bind/db.192";
};
```

Forward Resolution Service

- /etc/bind/db.example.com
- Map from a specific host name to its IP address.

```
;
; BIND data file for local loopback interface
;
$TTL    604800
@       IN      SOA     ns.example.com. root.example.com. (
                              1         ; Serial
                         604800         ; Refresh
                          86400         ; Retry
                        2419200         ; Expire
                         604800 )       ; Negative Cache TTL
;
@       IN      NS      ns.example.com.
ns      IN      A       192.168.1.10

;also list other computers
box     IN      A       192.168.1.21
```

BIND9 Server Howto, https://help.ubuntu.com/community/BIND9ServerHowto

Domain Resource Records (RR)

Type	Meaning	Value
SOA	Start of authority	Parameters for this zone
A	IPv4 address of a host	32-Bit integer
AAAA	IPv6 address of a host	128-Bit integer
MX	Mail exchange	Priority, domain willing to accept email
NS	Name server	Name of a server for this domain
CNAME	Canonical name	Domain name
PTR	Pointer	Alias for an IP address
SPF	Sender policy framework	Text encoding of mail sending policy
SRV	Service	Host that provides it
TXT	Text	Descriptive ASCII text

Reverse Resolution Service

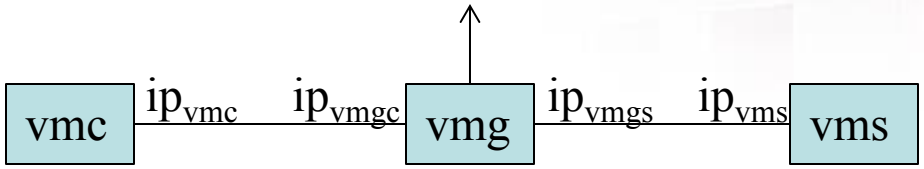
- /etc/bind/db.192
- Map from a specific host name to its IP address.

```
;
; BIND reverse data file for local loopback interface
;
$TTL    604800
@       IN      SOA     ns.example.com. root.example.com. (
                              2         ; Serial
                         604800         ; Refresh
                          86400         ; Retry
                        2419200         ; Expire
                         604800 )       ; Negative Cache TTL
;
@       IN      NS      ns.
10      IN      PTR     ns.example.com.

; also list other computers
21      IN      PTR     box.example.com.
```

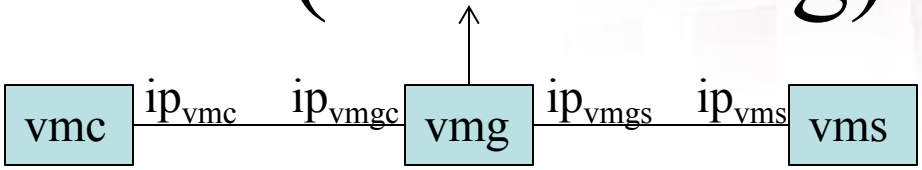
BIND9 Server Howto, https://help.ubuntu.com/community/BIND9ServerHowto

Enable IP forwarding



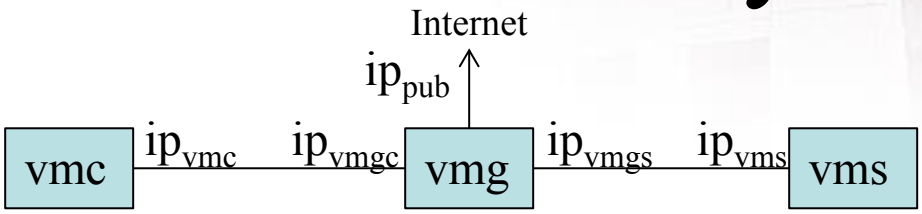
- Temporarily
  - `sudo -i`
  - `echo 1 > /proc/sys/net/ipv4/ip_forward`
- Permanently
  - Edit /etc/sysctl.conf
    - `net.ipv4.ip_forward = 1`
  - Enable the change, run
    - `sudo sysctl -p /etc/sysctl.conf`

Edit route (forwarding) table



- Show the route table
  - `Route -n`
- Edit the route table
  - delete a default gateway
    - `sudo route del default gw <ip>`
  - add a default gateway
    - `sudo route add default gw <ip>`

NAT or Proxy



- VMg is an entry point to your private network, it also control the traffic between private net and public net.
- Two ways to allow VMc and VMs talk to outside.
  - NAT (Network Address Translation) by iptables
    - `iptables --table nat --append POSTROUTING --out-interface eth0 -j MASQUERADE`
    - `iptables --append FORWARD --in-interface eth1 -j ACCEPT`
  - Proxy by Squid
    - `apt-get install squid`
    - Configure /etc/squid/squid.conf