CS3600 — Systems and Networks

NORTHEASTERN UNIVERSITY

Lecture 16: DNS

Prof. Alan Mislove (amislove@ccs.neu.edu)

Slides used with permissions from Edward W. Knightly,
T. S. Eugene Ng, Ion Stoica, Hui Zhang

Human Involvement

- Just like your friend needs to tell you his phone number for you to call him
- Somehow, an application needs to know the IP address of the communication peer
- There is no magic, some out-of-band mechanism is needed
  - Word of mouth
  - Read it in the advertisement in the paper
  - Etc.
- But IP addresses are bad for humans to remember and tell each other
- So need names that makes some sense to humans

Internet Names & Addresses

- Names: *e.g. www.northeastern.edu*
  - human-usable labels for machines
  - conforms to “organizational” structure
- Addresses: *e.g. 155.33.17.68*
  - computer-usable labels for machines
  - conforms to “network” structure
- How do you map from one to another?
  - Domain Name System (DNS)

DNS: History

- Initially all host-addess mappings were in a file called hosts.txt (in /etc/hosts)
  - Changes were submitted to SRI by email
  - New versions of hosts.txt ftp'd periodically from SRI
  - An administrator could pick names at their discretion
  - Any name is allowed: alansdesktopatccsbuilding

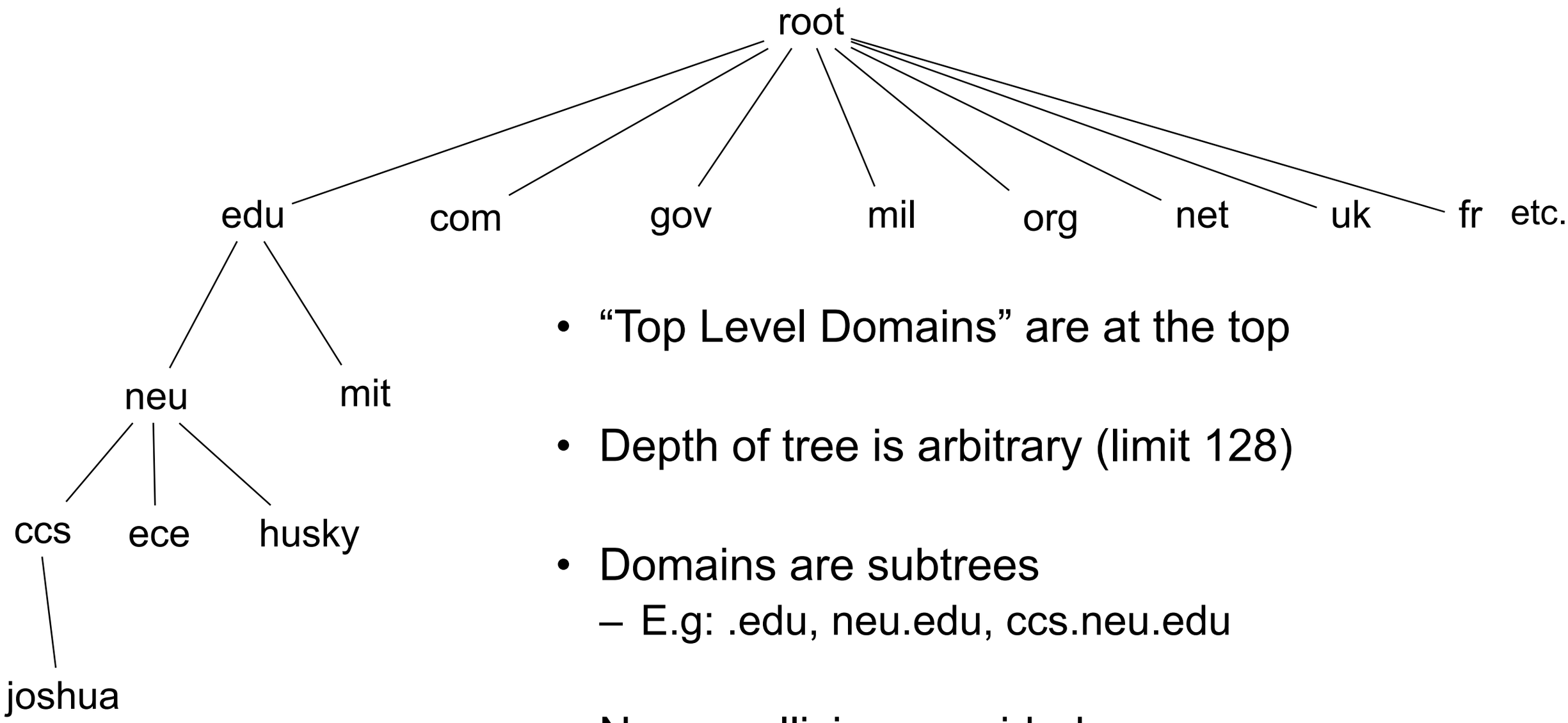
- As the Internet grew this system broke down because:
  - SRI couldn't handled the load
  - Hard to enforce uniqueness of names
  - Many hosts had inaccurate copies of hosts.txt

- Domain Name System (DNS) was born

Basic DNS Features

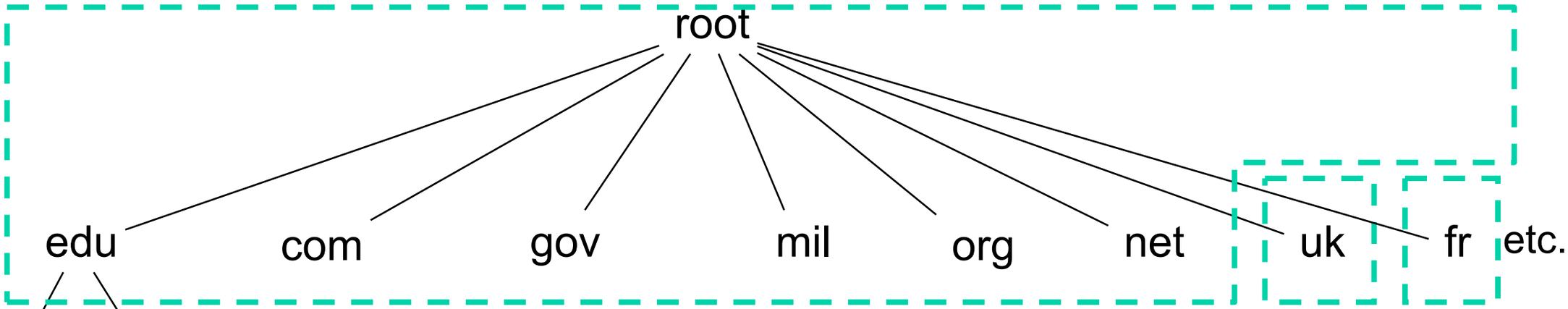
- Hierarchical namespace
  - as opposed to original flat namespace
- Distributed storage architecture
  - as opposed to centralized storage (plus replication)
- Client--server interaction on UDP Port 53
  - but can use TCP if desired

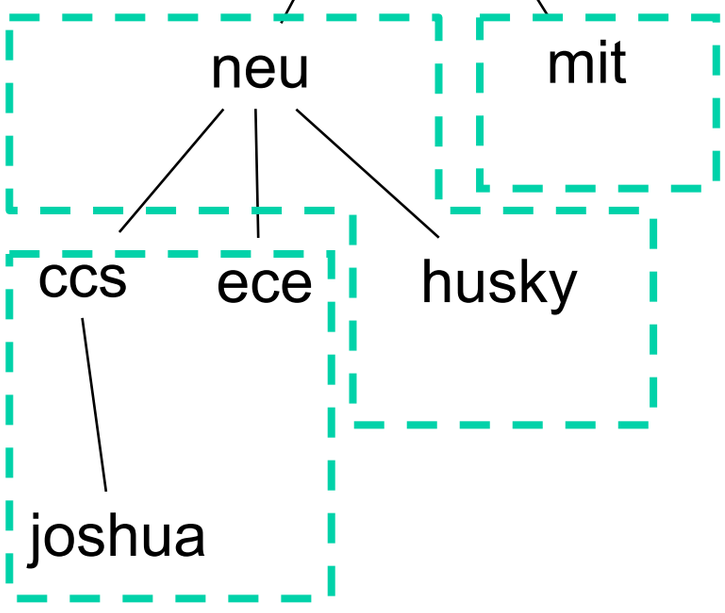
Naming Hierarchy



- "Top Level Domains" are at the top
- Depth of tree is arbitrary (limit 128)
- Domains are subtrees
  - E.g: .edu, neu.edu, ccs.neu.edu
- Name collisions avoided
  - E.g. neu.edu and neu.com can coexist, but uniqueness is job of domain

Host names are administered hierarchically





A **zone** corresponds to an administrative authority that is responsible for that portion of the hierarchy

E.g. Alan controls names: x.ccs.neu.edu and y.ece.neu.edu

E.g. The President controls names: x.neu.edu and y.husky.neu.edu

Server Hierarchy

- Each server has authority over a portion of the hierarchy
  - A server maintains only a subset of all names
- Each server contains all the records for the hosts or domains in its zone
  - might be replicated for robustness
- Every server knows the root
- Root server knows about all top-level domains

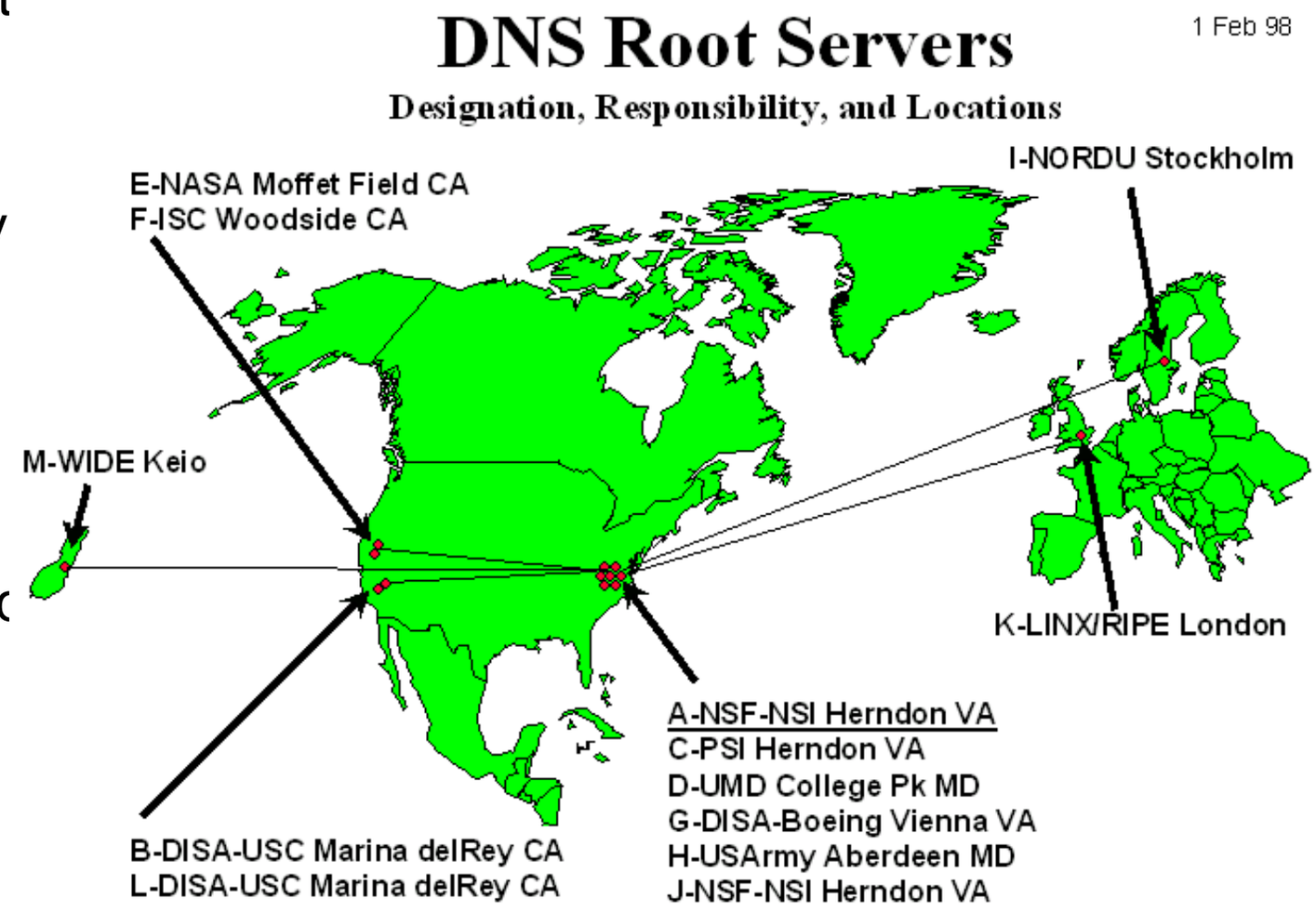
DNS Name Servers

- Local name servers:
  - Each ISP (company) has local default name server
  - Host DNS query first goes to local name server
  - Local DNS server IP address usually learned from DHCP
  - Frequently cache query results

- Authoritative name servers:
  - For a host: stores that host's (name, IP address)
  - Can perform name/address translation for that host's name

DNS: Root Name Servers

- Contacted by local name server that can not resolve name
- Root name server:
  - Contacts authoritative name serv if name mapping not known
  - Gets mapping
  - Returns mapping to local name server
- ~ Dozen root name servers worldwic



Basic Domain Name Resolution

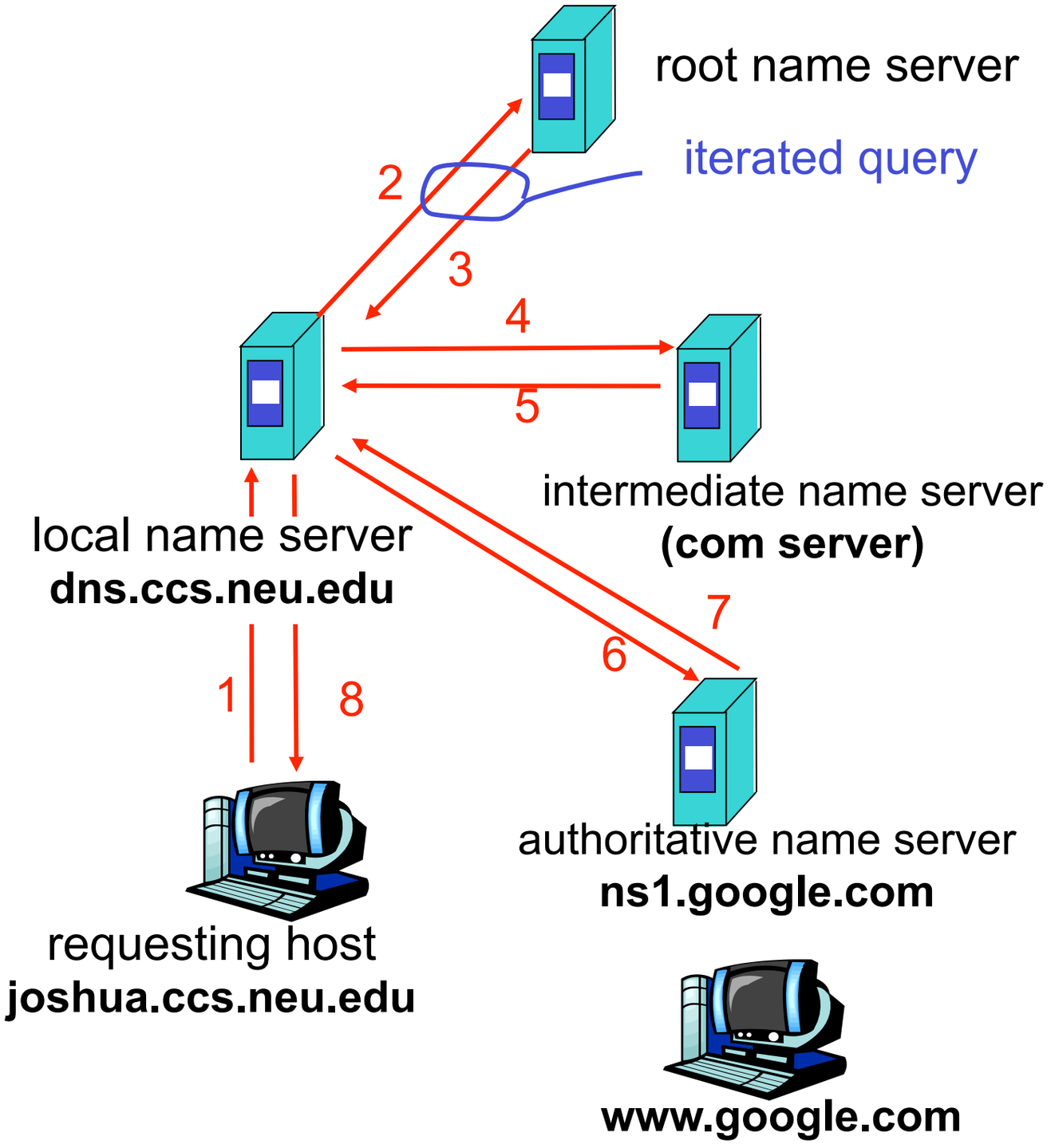
- Every host knows a local DNS server
  - Through DHCP, for example
  - Sends all queries to a local DNS server
- Every local DNS server knows the ROOT servers
  - When no locally cached information exists about the query, talk to a root server, and go down the name hierarchy from the root
  - If we lookup www.neu.edu, and we have a cached entry for the .edu name server, then we can go directly to the .edu name server and bypass the root server

Example of Iterated DNS Query

Iterated query:

- Contacted server replies with name of server to contact
- "I don't know this name, but ask this server"

This is how today's DNS system behaves



DNS Resource Records

- DNS Query:
  - Two fields: (name, type)

- Resource record is the response to a query
  - Four fields: (name, value, type, TTL)
  - There can be multiple valid responses to a query

- Type = A:
  - name = hostname
  - value = IP address

DNS Resource Records (cont'd)

- Type = NS:
  - name = domain
  - value = name of dns server for domain
- Type = CNAME:
  - name = hostname
  - value = canonical name
- Type = MX:
  - name = domain in email address
  - value = canonical name of mail server and priority