Domain Name System

Lecture 5

http://www.cs.rutgers.edu/~sn624/352-F24

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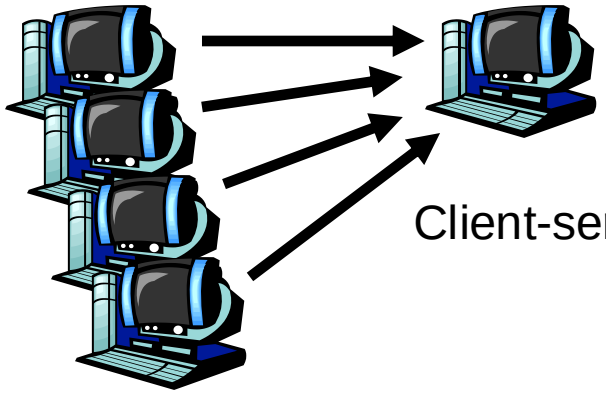
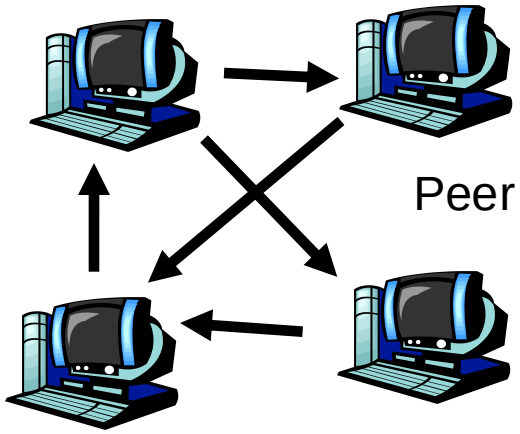
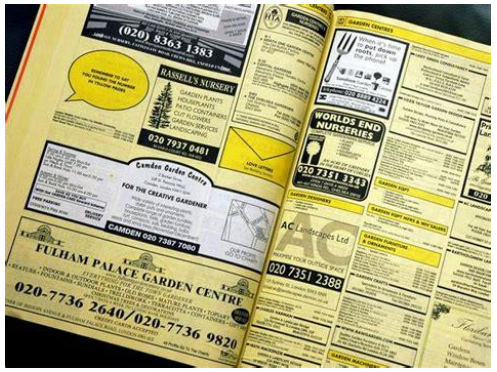
Review

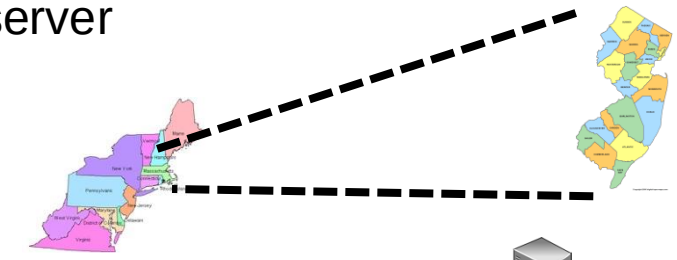


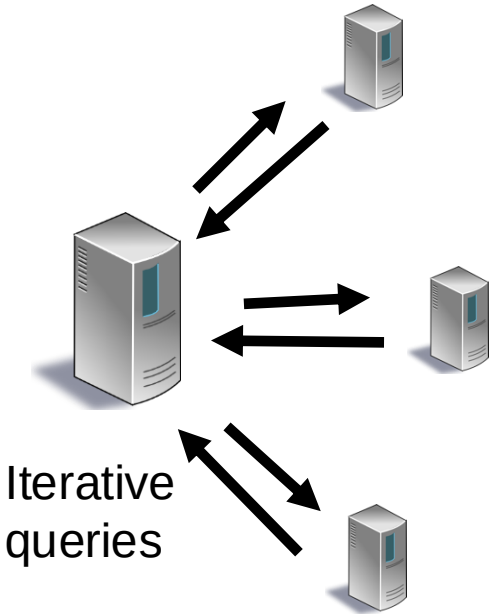
Client-server



Peer to peer







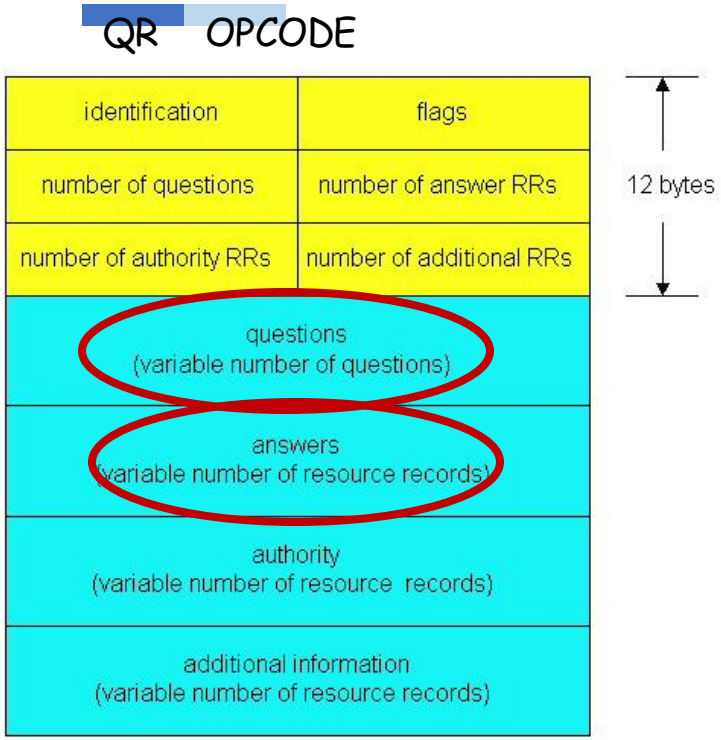
Iterative queries

Domain Name System

Human readable → IP addresses

Hierarchical, distributed database

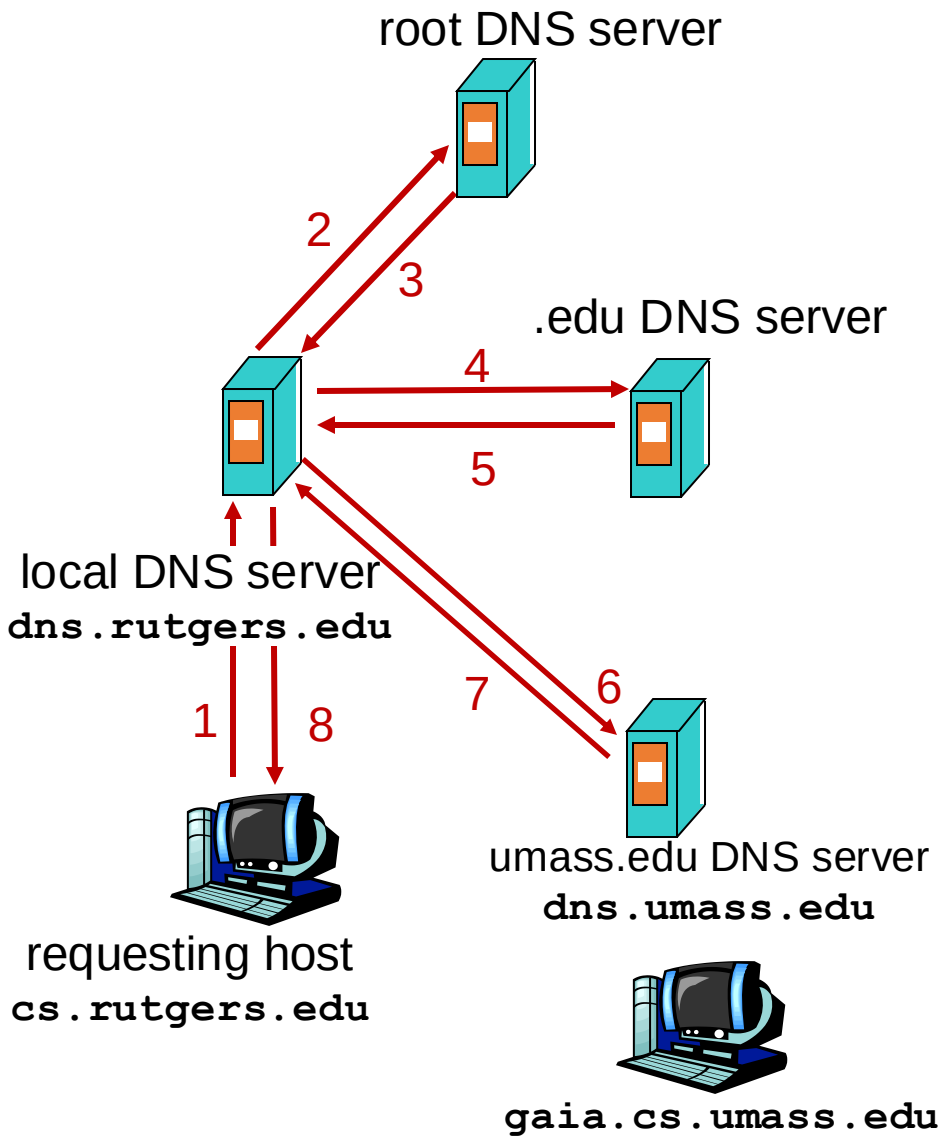
Root server, TLD server, Authoritative name server



Example

- Host at cs.rutgers.edu wants IP address for gaia.cs.umass.edu

- Local DNS server
- Root DNS server
- TLD DNS server
- Authoritative DNS server



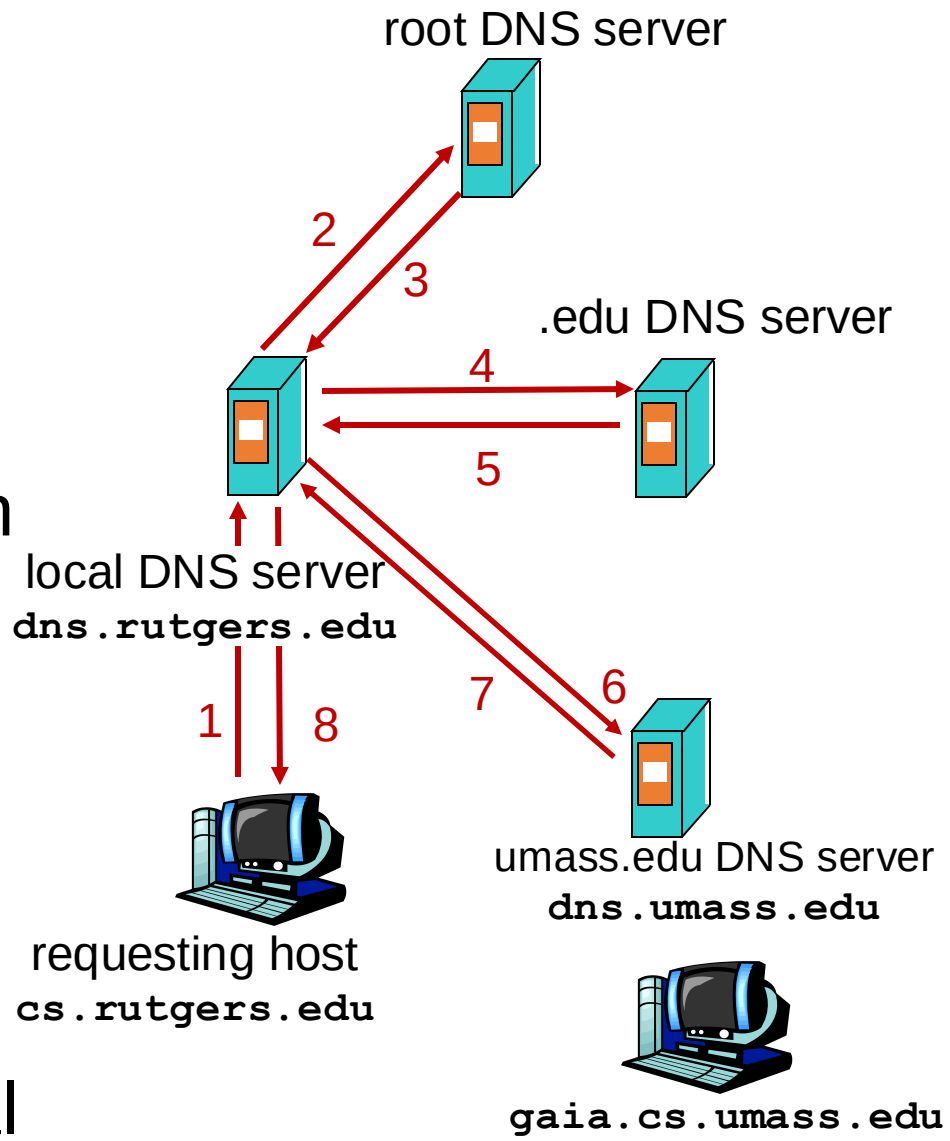
Query type

- Iterative query

- Contacted server replies with name of server to contact

- “I don’t know this name, but ask this other server”

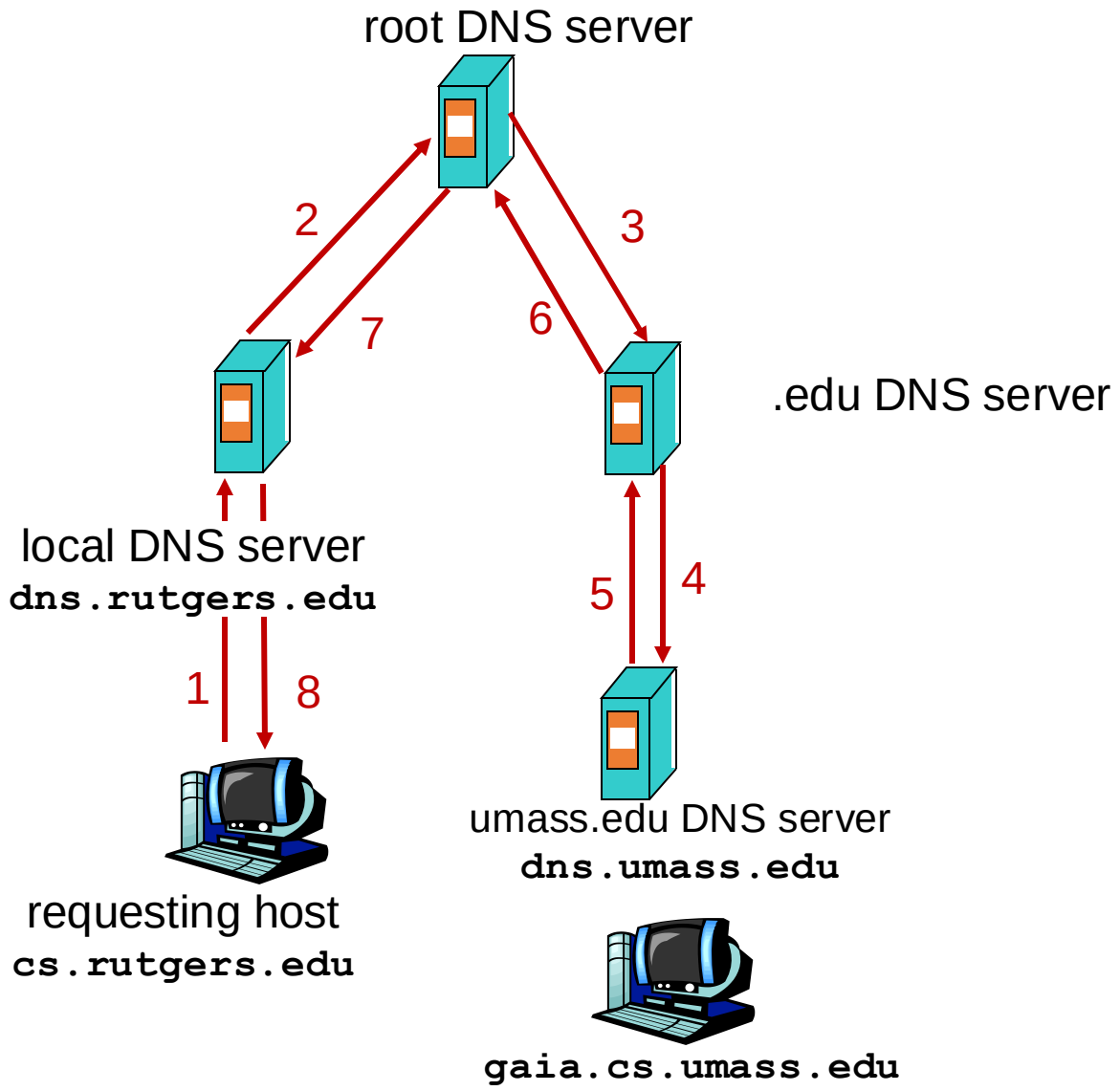
- Queries 2,4,6 are iterative from point of view of the local DNS server



Query type

Recursive query:

- Puts burden of name resolution on the contacted (e.g., root) name server
- Query 2 (to root DNS server) is recursive from the local server
- In general, recursive is not preferred for higher levels of the DNS hierarchy



Problem: Load on Higher Levels of DNS

Think about the query load on the root DNS server (regardless of recursive/iterative)

- Must root server answer every DNS query?

DNS caching

- Once (any) name server learns a name to IP address mapping, it *caches* the mapping
  - Cache entries timeout (disappear) after some time
  - TLD servers typically cached in local name servers
  - In practice, root name servers aren't visited often!
- Caching is pervasive in DNS

Bootstrapping DNS

- How does a host contact the name server if all it has is the domain name and no (name server) IP address?
- IP address of at least 1 nameserver (usually, a local name server) must be known a priori
- The local name server may be bootstrapped “statically”, e.g.,
  - File `/etc/resolv.conf` in unix
  - `Start -> settings-> control panel-> network ->TCP/IP -> properties` in windows
- The local DNS server or with another protocol!
  - DHCP: Dynamic Host Configuration Protocol
- The local DNS server must know the root servers

DNS may seem “basic”, low level, but …

Gone in Minutes, Out for Hours:
Outage Shakes Facebook

Akamai DNS outage knocks many major websites and services offline: PSN, Steam, Fidelity, more [U]

Overloaded Azure DNS Servers to Blame For Microsoft Outage

April 5, 2021

POSTED ON OCTOBER 5, 2021 TO NETWORKING & TRAFFIC

More details about the October 4 outage

DNS Resource Records

DNS is a distributed database

- DNS stores resource records (RRs)
- (Incomplete) message format for each resource record (RR):
  - Class, type, name, value, TTL
- You can read all the gory details of the message format at https://www.iana.org/assignments/dns-parameters/dns-parameters.xhtml

DNS records

Type=A

- **name** is hostname
- **value** is IPv4 address

Type=AAAA

- **name** is hostname
- **value** is IPv6 address

- Type=NS
  - **name** is domain (e.g. foo.com)
  - **value** is hostname of authoritative name server for this domain

Type=CNAME

- **name** is alias name for some "canonical" (the real) name

  e.g., www.ibm.com is really servereast.backup2.ibm.com
- **value** is canonical name

Type=MX

- **value** is name of mailserver associated with **name**

More complete info at https://www.iana.org/assignments/dns-parameters/dns-parameters.xhtml

DNS record example

RRs in response to query

NAME	Design.cs.rutgers.edu
TYPE	A
CLASS	IN
TTL	1 day(86400)
ADDRESS	192.26.92.30

records for authoritative servers Information about nameserver

NAME	Cs.rutgers.edu
TYPE	NS
CLASS	IN
TTL	1 day(86400)
NSDNAME	Ns-lcsr.rutgers.edu

DNS serves as a general repository of information for the Internet!

DNS record types

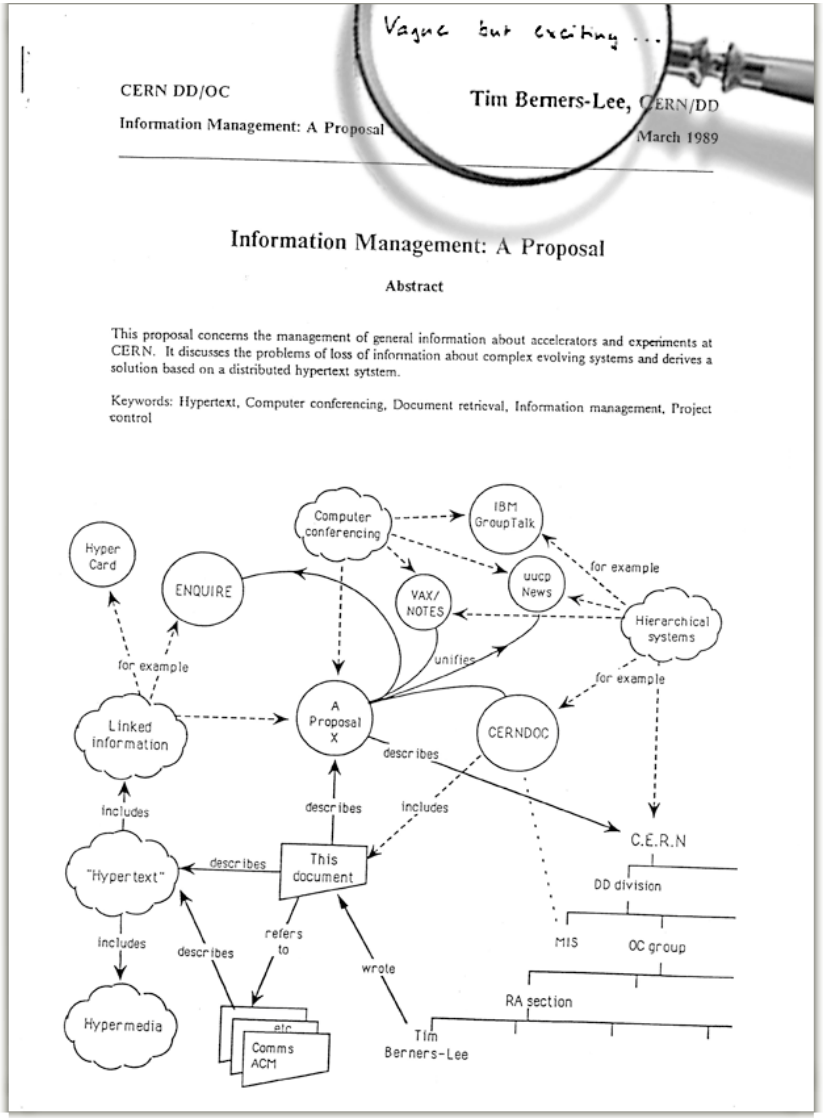
- `dig -t <type> <domain-name>`

Summary of DNS

- Hostname to IP address translation via a global network of servers
- Embodies several scaling principles
  - Partition through a hierarchy to silo query load
  - Replication to scale out at each level of hierarchy
  - Caching to reduce query load
- Once you have a reliable DB, can implement many useful things on top!
- Example 1: Scaling large web services, e.g., google search, by redirecting different clients to different servers (IP addresses)
  - Reliability, load balancing, performance optimization
- Example 2: Associating certificates, keys (security info) with domain names
  - https://www.rfc-editor.org/rfc/rfc8162.html
  - https://datatracker.ietf.org/doc/draft-ietf-dnsop-svcb-https/00/

The Web (HTTP)

The Web: Humble origins



Tim Berners-Lee: a way to manage and access documents at CERN research lab

Info containing links to other info, accessible remotely through a standardized mechanism independent of the heterogeneity of the underlying machines

“Hypertext”