# CSc 450/550
# Computer Networks
# Domain Name System

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# Review: Web/HTTP

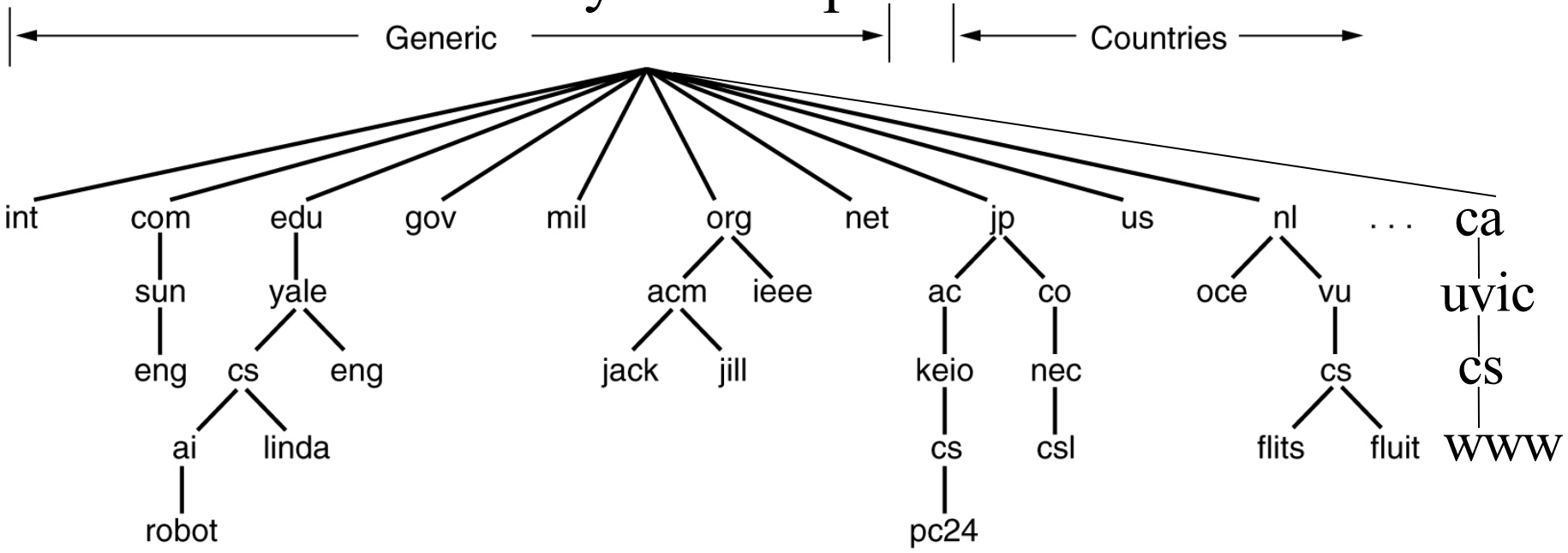
- Web
  - URI/URL, HTML tags, embedded objects
- HTTP
  - request and response
  - persistence, statefulness
  - web caching, content delivery
- DNS
  - essentially, a name-address mapping

# Today's topics

- More on DNS
  - how to register your name-address mapping
    - DNS resource records
  - how to get your name-address mapping resolved
    - DNS resolution queries
- DNS: more than just name resolution
  - DNS-based server selection
    - in content delivery networks

# DNS name space

- Hierarchical, distributed
  - gTLD: generic top-level domain
  - ccTLD: country-code top-level domain




Q: www.cs.uvic.ca

# DNS: client's view

- Local DNS resolver: gethostbyname()
  - /etc/host.conf
    - order hosts,bind
  - /etc/hosts
    - 1.2.3.4 nameserver
  - /etc/resolv.conf
    - nameserver 1.2.3.4
- Local DNS server: do the real job!
  - DNS “proxy”

# DNS resource records

```
; Authoritative data for cs.vu.nl
cs.vu.nl.        86400   IN  SOA     star boss (952771,7200,7200,2419200,86400)
cs.vu.nl.        86400   IN  TXT     "Divisie Wiskunde en Informatica."
cs.vu.nl.        86400   IN  TXT     "Vrije Universiteit Amsterdam."
cs.vu.nl.        86400   IN  MX      1 zephyr.cs.vu.nl.
cs.vu.nl.        86400   IN  MX      2 top.cs.vu.nl.

flits.cs.vu.nl.  86400   IN  HINFO   Sun Unix
flits.cs.vu.nl.  86400   IN  A       130.37.16.112
flits.cs.vu.nl.  86400   IN  A       192.31.231.165
flits.cs.vu.nl.  86400   IN  MX      1 flits.cs.vu.nl.
flits.cs.vu.nl.  86400   IN  MX      2 zephyr.cs.vu.nl.
flits.cs.vu.nl.  86400   IN  MX      3 top.cs.vu.nl.
www.cs.vu.nl.    86400   IN  CNAME   star.cs.vu.nl
ftp.cs.vu.nl.    86400   IN  CNAME   zephyr.cs.vu.nl

rowboat                  IN  A       130.37.56.201
                         IN  MX      1 rowboat
                         IN  MX      2 zephyr
                         IN  HINFO   Sun Unix

little-sister

laserjet
```

| Type | Meaning | Value |
|---|---|---|
| SOA | Start of Authority | Parameters for this zone |
| A | IP address of a host | 32-Bit integer |
| MX | Mail exchange | Priority, domain willing to accept e-mail |
| NS | Name Server | Name of a server for this domain |
| CNAME | Canonical name | Domain name |
| PTR | Pointer | Alias for an IP address |
| HINFO | Host description | CPU and OS in ASCII |
| TXT | Text | Uninterpreted ASCII text |

# SOA, NS

- dig soa cs.uvic.ca
  - cs.uvic.ca. 43200 IN SOA active.uvic.ca. gduncan.dns.engr.uvic.ca. 705181509 3600 300 604800 1800
    - origin = active.uvic.ca; mail addr = gduncan.dns.engr.uvic.ca; serial = 705181509; refresh = 3600 (60 minutes); retry = 300 (5 minutes); expire = 604800 (7 days); minimum = 1800 (0.5 hour)
    - replication consistency control
- dig ns cs.uvic.ca
  - cs.uvic.ca. 40800 IN NS dns1.uvic.ca.
  - cs.uvic.ca. 40800 IN NS active.uvic.ca.



Q: TTL?

- dig **mx** cs.uvic.ca
  - cs.uvic.ca. 43200 IN MX 0 mta.cs.uvic.ca.
    - priority = 0 (highest)
- dig **a** cs.uvic.ca
  - cs.uvic.ca. 43200 IN A 142.104.100.110
- dig **cname** www.cs.uvic.ca
  - www.cs.uvic.ca. 42383 IN CNAME thing2.cs.uvic.ca.
- dig **a** thing2.cs.uvic.ca
  - thing2.cs.uvic.ca. 43200 IN A 142.104.100.111
- dig **ptr** 111.100.104.142.in-addr.arpa
  - 111.100.104.142.in-addr.arpa. 43200 IN PTR thing2.cs.UVic.CA.



Q: why CNAME?

# DNS: servers

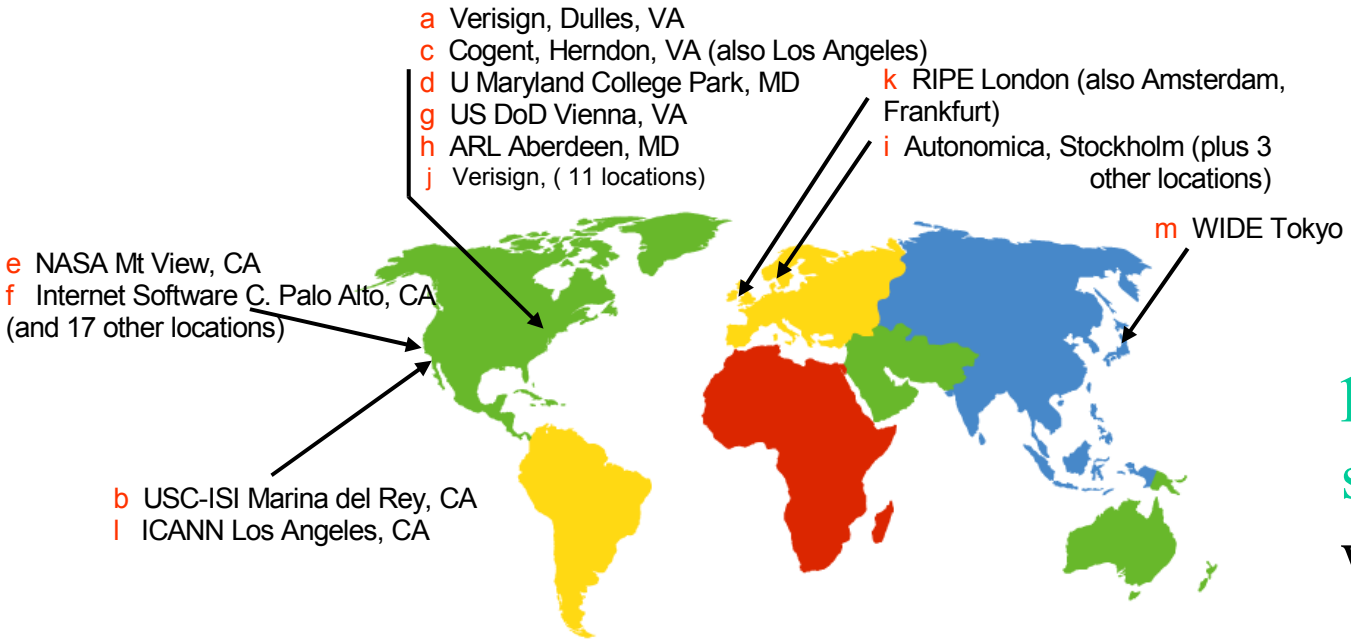
- Local DNS server
  - where's www.cs.uvic.ca.
- Root DNS server (.): {a..m}.root-servers.net
  - ask ca0{1..6}.cira.ca., ns-ext.isc.org
- TLD DNS server (.ca.): ca0{1..6}.cira.ca
  - ask dns{1|2}.uvic.ca., ns3.uvic.ca., ns.pinc.com
- Authoritative DNS server
  - primary, secondary



Q: why so many NS servers?

# Root DNS servers

- {a..m}.root-servers.net.




13 root name servers worldwide



Q: one server, multiple locations?

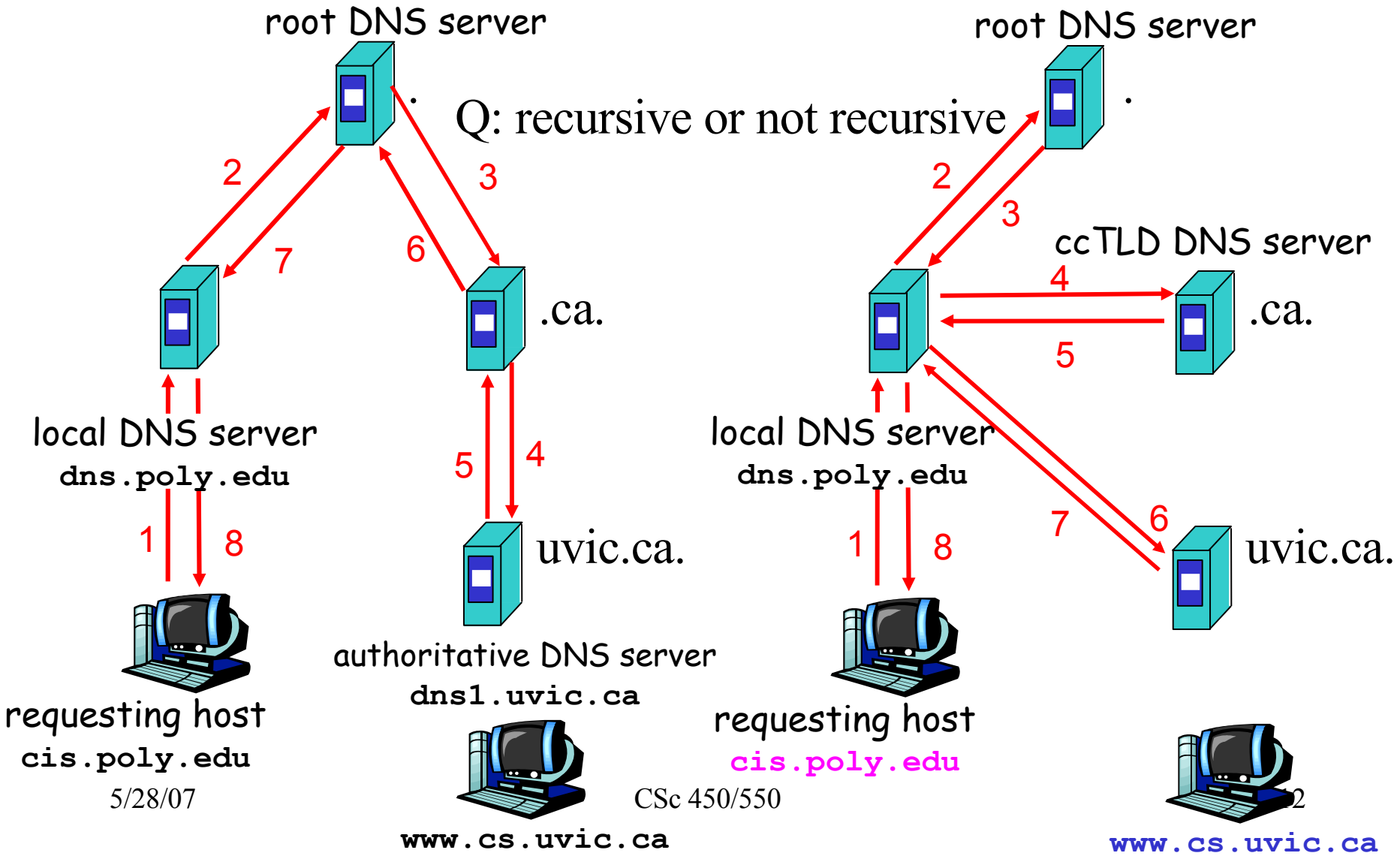
# DNS queries

- Local DNS resolver-server

#nslookup
>set debug
>www.cs.uvic.ca
QUESTIONS
    www.cs.uvic.ca, type = A, class = IN
ANSWERS
    -> www.cs.uvic.ca
    canonical name = thing2.cs.uvic.ca.
    -> thing2.cs.uvic.ca
    internet address = 142.104.100.111

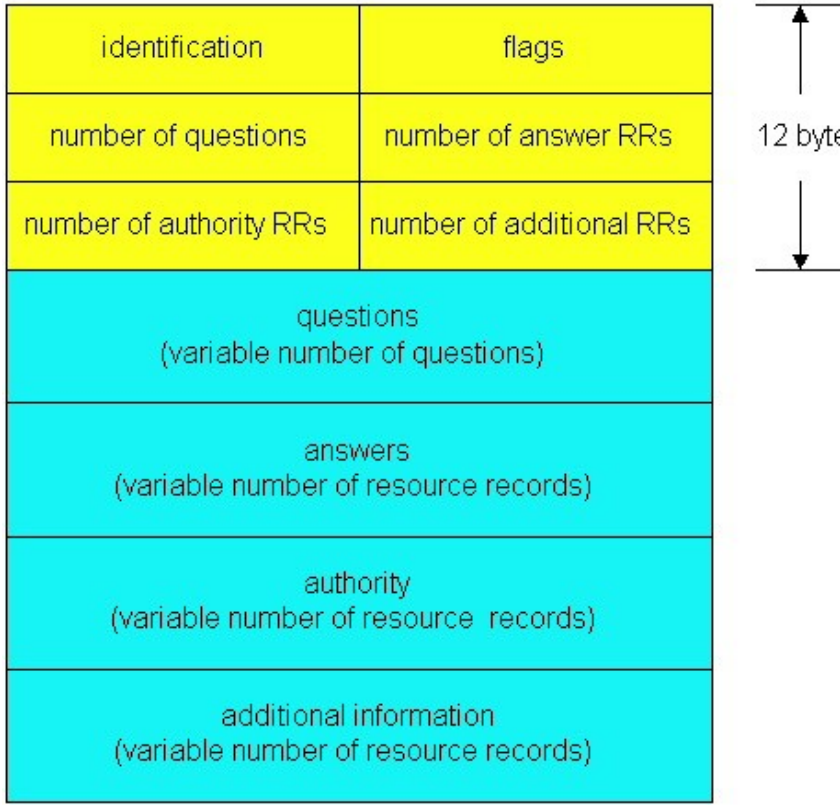
AUTHORITY RECORDS
    -> cs.uvic.ca
    nameserver = active.uvic.ca.
    -> cs.uvic.ca
    nameserver = dns1.uvic.ca.
ADDITIONAL RECORDS
    -> dns1.uvic.ca
    internet address = 142.104.6.1
    -> active.uvic.ca
    internet address = 142.104.96.2

# Recursive vs iterative



# DNS queries: more

- Local DNS server and higher hierarchy
  - recursive vs iterative
- Reply cache
  - time-to-live (TTL)
- Services required
  - commonly by UDP
- Attacks on DNS
  - cache poisoning

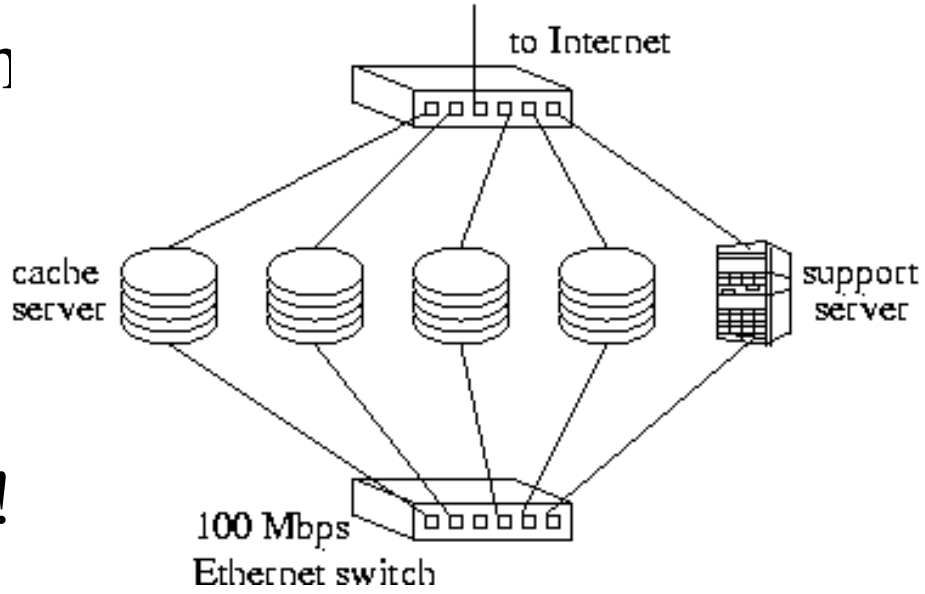


# DNS: reality check

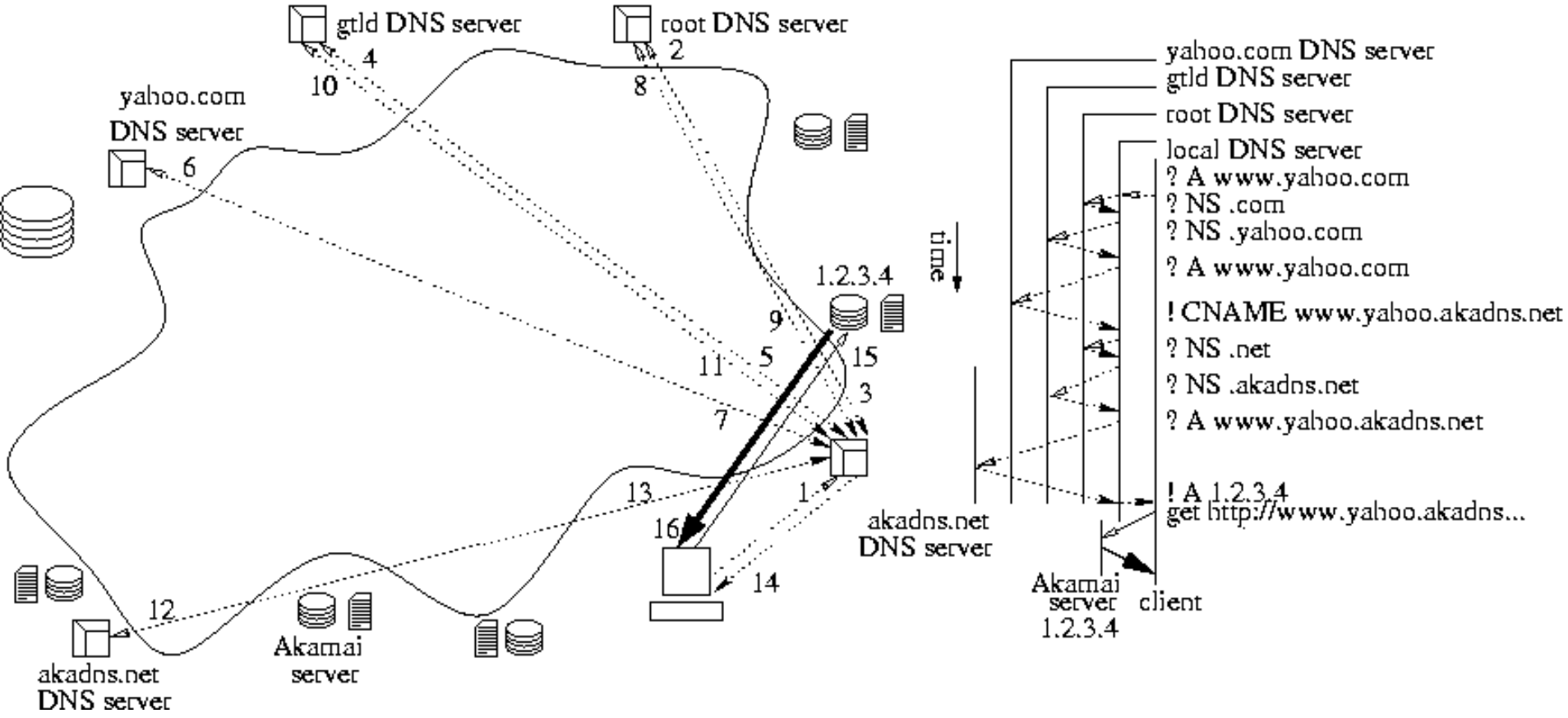
- Design goals
  - distributed, hierarchical, low overhead, robust
- Protocol mechanisms
  - cache, weak consistency, redundancy
    - e.g., at least two NS servers per domain in different subnets for redundancy; reality: many are on the same subnet due to poor provisioning
    - e.g., stable name-address mapping for caching efficiency; reality: very short TTL in CDN
- Secure DNS

# Akamai content delivery

- Akamai EdgePlatform
  - 15,000+ servers
  - 1,100+ networks
  - 69 countries
  - up to 15% web traffic!
- Server selection
  - DNS-based
  - for site or object delivery



# Site delivery



# AkaDNS.net

*akadns.net* DNS servers

| Server | IP address | Access network | Location |
|---|---|---|---|
| ZA | 216.32.65.105 | exodus.net | Washington, DC |
| ZB | 216.52.46.145 | bbnplanet.net | Denver, CO |
| ZC | 63.241.199.50 | att.net | Dallas, TX |
| ZD | 206.132.160.36 | glbx.net | Santa Clara, CA |
| ZE | 12.47.217.11 | att.net | Parsippany, NJ |
| ZF | 63.215.198.79 | level3.net | San Jose, CA |
| ZG | 204.248.36.131 | sprintlink.net | |
| ZH | 63.208.48.42 | level3.net | St. Louis, MO |

*akadns.net NS* and *A* TTL

| Ask | | Answer | | |
|---|---|---|---|---|
| Name | Server | Refer | *NS*-TTL (s) | *A*-TTL (s) |
| net. | {a..m}.root-servers.net | {a..m}.gtld-servers.net | 172,800 | 172,800 |
| akaDNS.net. | {a..m}.gtld-servers.net | z{a..g}.akadns.net | 172,800 | 172,800 |
| yahoo... | z{a..g}.akadns.net | – | 90,000 | 90,000 |
| www... | z{a..g}.akadns.net | – | – | 300 |

# DNS-based server selection

- Transparent to end-users
- Issues
  - effectiveness (who's making the decision)
  - overhead (low TTL)
  - granularity (hostname vs. service name)
  - proximity (client, local DNS, CDN server)
  - accuracy (*network positioning*)
- Bottom-line: avoid the worst, hope for the best

# This lecture

- DNS (2)
  - DNS resource records
  - DNS resolution queries
    - recursive, iterative
- DNS-based server selection
  - "site delivery": mechanisms, pros and cons
- Explore further
  - CDN: "object delivery"

# Next lectures

- May 31: 1st in-class midterm exam
- In June: TCP and UDP