

COMPUTER NETWORKS LAB (CS315)

Assignment-4 DNS

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DNS: Domain Name System

people: many identifiers:

- SSN, name, passport #

Internet hosts, routers:

- IP address (32 bit) - used for addressing datagrams
- “name”, e.g., cs.umass.edu - used by humans

Q: how to map between IP address and name, and vice versa ?

Domain Name System (DNS):

- *distributed database* implemented in hierarchy of many *name servers*
- *application-layer protocol*: hosts, DNS servers communicate to *resolve* names (address/name translation)
 - *note*: core Internet function, implemented as application-layer protocol
 - complexity at network’s “edge”

Application Layer: 2-<number>



DNS: services, structure

DNS services:

- hostname-to-IP-address translation
- host aliasing
 - canonical, alias names
- mail server aliasing
- load distribution
 - replicated Web servers: many IP addresses correspond to one name

Q: *Why not centralize DNS?*

- single point of failure
- traffic volume
- distant centralized database
- maintenance

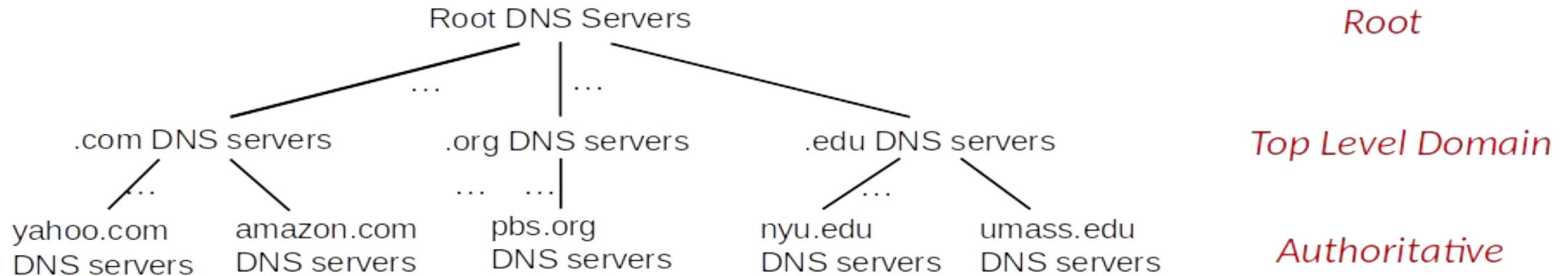
A: *doesn't scale!*

- Comcast DNS servers alone: 600B DNS queries/day
- Akamai DNS servers alone: 2.2T DNS queries/day

Application Layer: 2-<number>



DNS: a distributed, hierarchical database



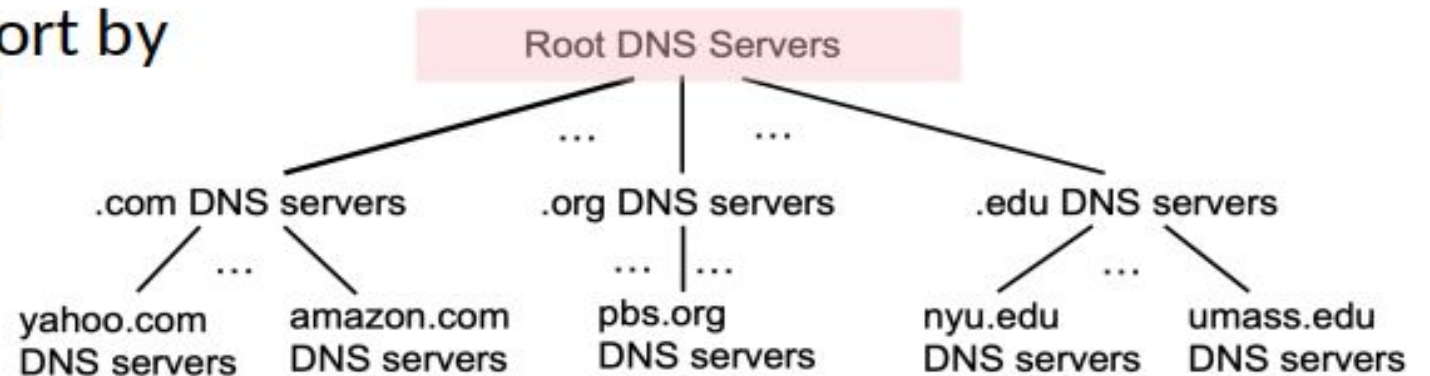
Client wants IP address for `www.amazon.com`; 1st approximation:

- client queries root server to find .com DNS server
- client queries .com DNS server to get amazon.com DNS server
- client queries amazon.com DNS server to get IP address for `www.amazon.com`

Application Layer: 2-<number>

DNS: root name servers

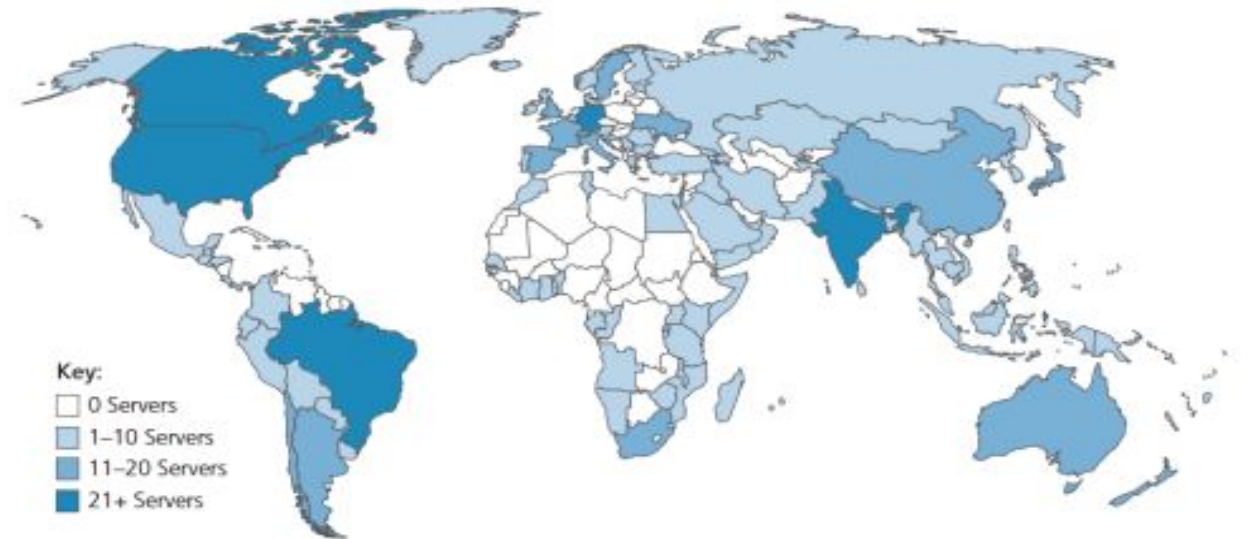
- official, contact-of-last-resort by name servers that can not resolve name



DNS: root name servers

- official, contact-of-last-resort by name servers that can not resolve name
- *incredibly important* Internet function
 - Internet couldn't function without it!
 - DNSSEC – provides security (authentication, message integrity)
- ICANN (Internet Corporation for Assigned Names and Numbers) manages root DNS domain

13 logical root name “servers”
worldwide each “server” replicated
many times (~200 servers in US)

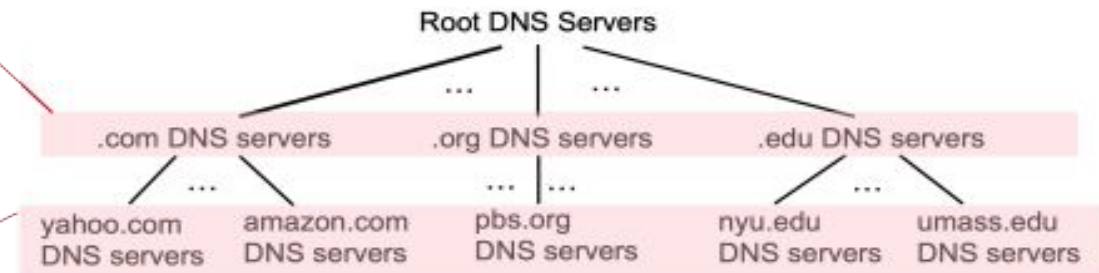


Application Layer: 2-<number>

Top-Level Domain, and authoritative servers

Top-Level Domain (TLD) servers:

- responsible for .com, .org, .net, .edu, .aero, .jobs, .museums, and all top-level country domains, e.g.: .cn, .uk, .fr, .ca, .jp
- Network Solutions: authoritative registry for .com, .net TLD
- Educause: .edu TLD



authoritative DNS servers:

- organization's own DNS server(s), providing authoritative hostname to IP mappings for organization's named hosts
- can be maintained by organization or service provider

Application Layer: 2-<number>



Local DNS name servers

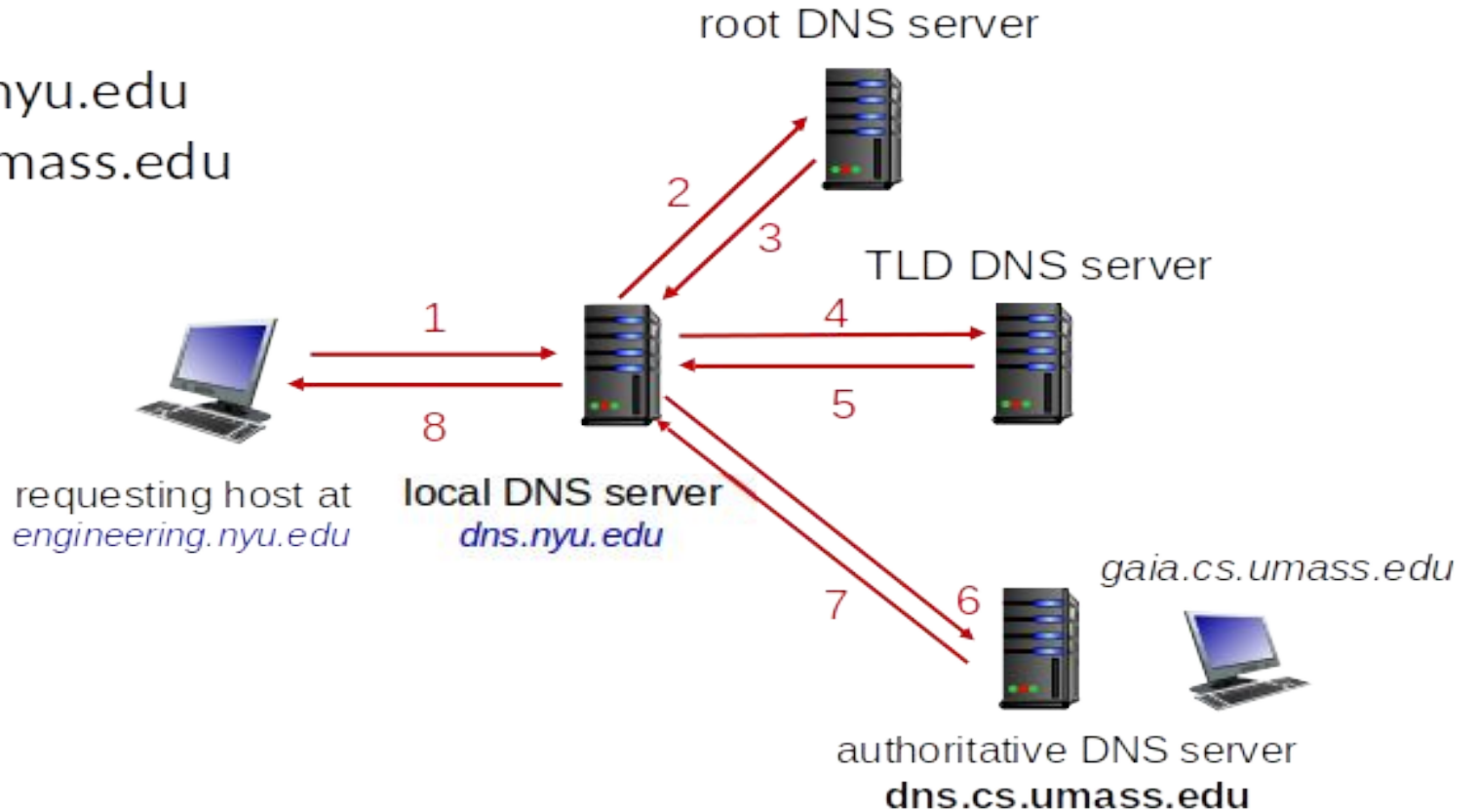
- when host makes DNS query, it is sent to its *local* DNS server
 - Local DNS server returns reply, answering:
 - from its **local cache** of recent name-to-address translation pairs (possibly out of date!)
 - forwarding request into DNS hierarchy for resolution
 - each ISP has local DNS name server; to find yours:
 - MacOS: `% scutil --dns`
 - Windows: `>ipconfig /all`
- local DNS server doesn't strictly belong to hierarchy

DNS name resolution: iterated query

Example: host at engineering.nyu.edu wants IP address for gaia.cs.umass.edu

Iterated query:

- contacted server replies with name of server to contact
- “I don’t know this name, but ask this server”



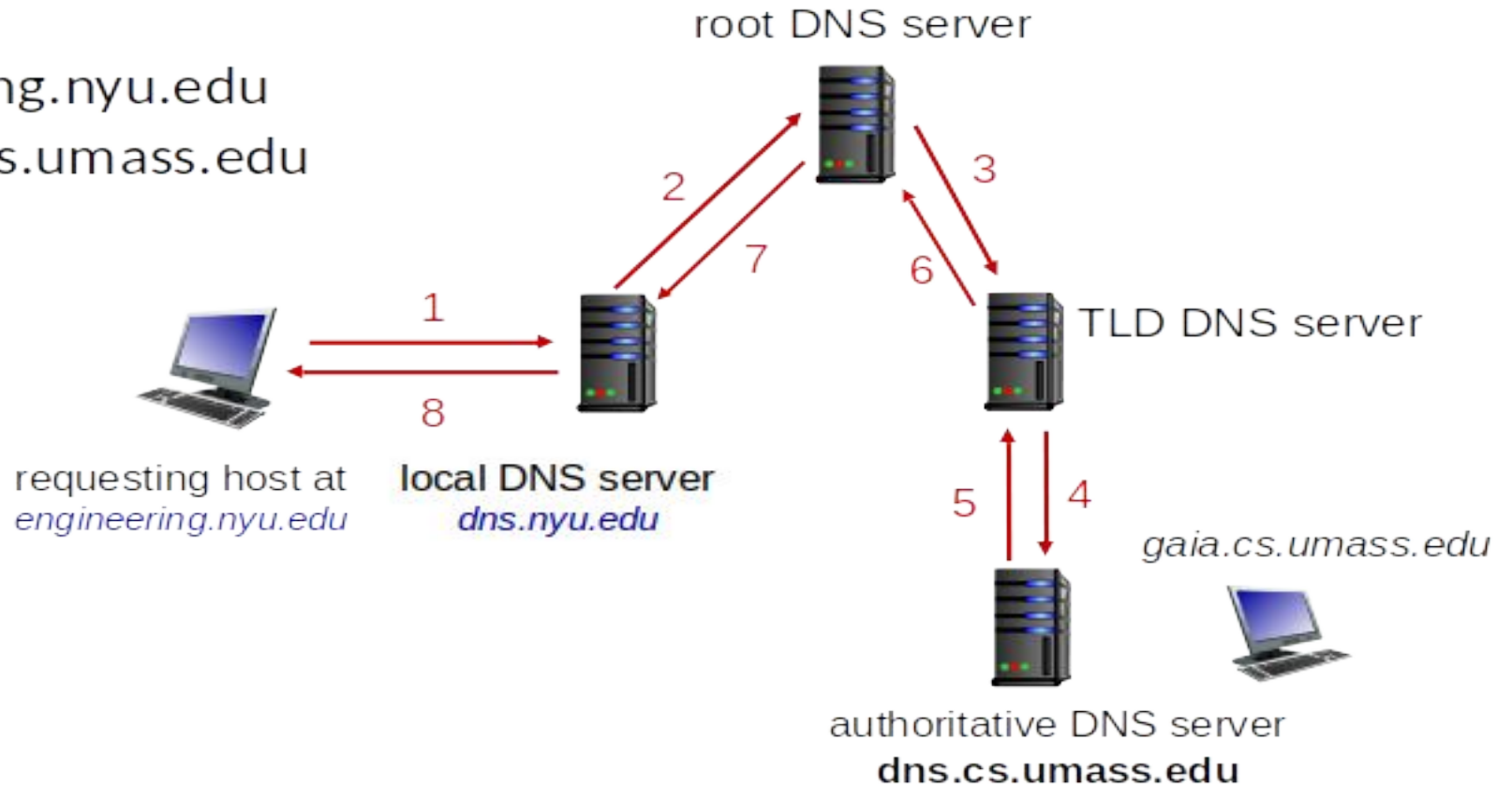
Application Layer: 2-<number>

DNS name resolution: recursive query

Example: host at engineering.nyu.edu wants IP address for gaia.cs.umass.edu

Recursive query:

- puts burden of name resolution on contacted name server
- heavy load at upper levels of hierarchy?



Application Layer: 2-<number>

Caching DNS Information

- once (any) name server learns mapping, it *caches* mapping, and *immediately* returns a cached mapping in response to a query
 - caching improves response time
 - cache entries timeout (disappear) after some time (TTL)
 - TLD servers typically cached in local name servers
- cached entries may be *out-of-date*
 - if named host changes IP address, may not be known Internet-wide until all TTLs expire!
 - *best-effort name-to-address translation!*

Application Layer: 2-<number>

DNS records

DNS: distributed database storing resource records (RR)

RR format: (name, value, type, ttl)

type=A

- name is hostname
- value is IP 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
- www.ibm.com is really servereast.backup2.ibm.com
- value is canonical name

type=MX

- value is name of SMTP mail server associated with name

Application Layer: 2-<number>

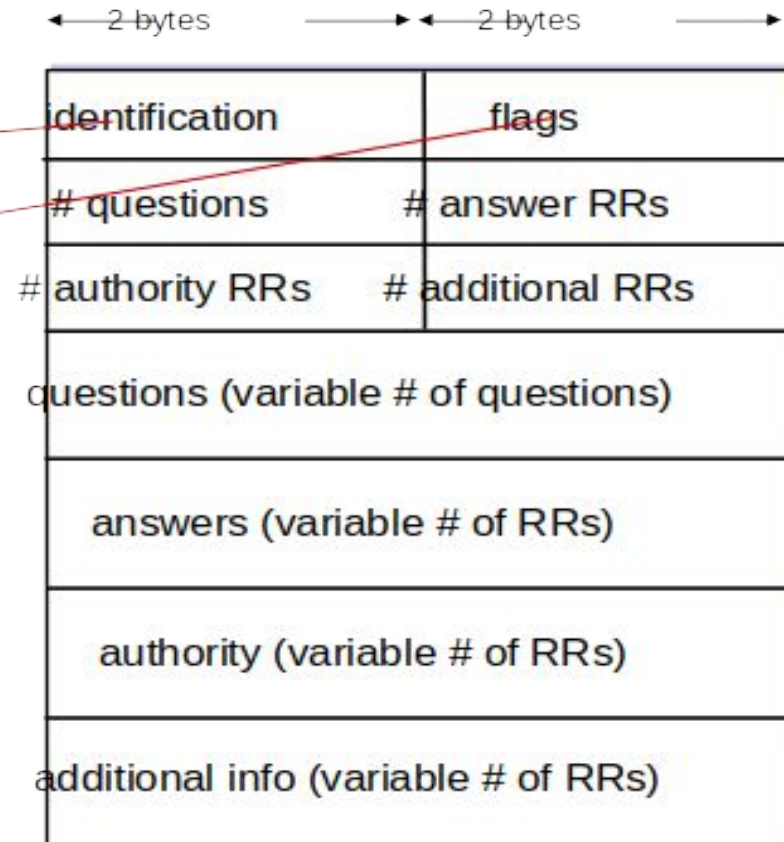


DNS protocol messages

DNS *query* and *reply* messages, both have same *format*:

message header:

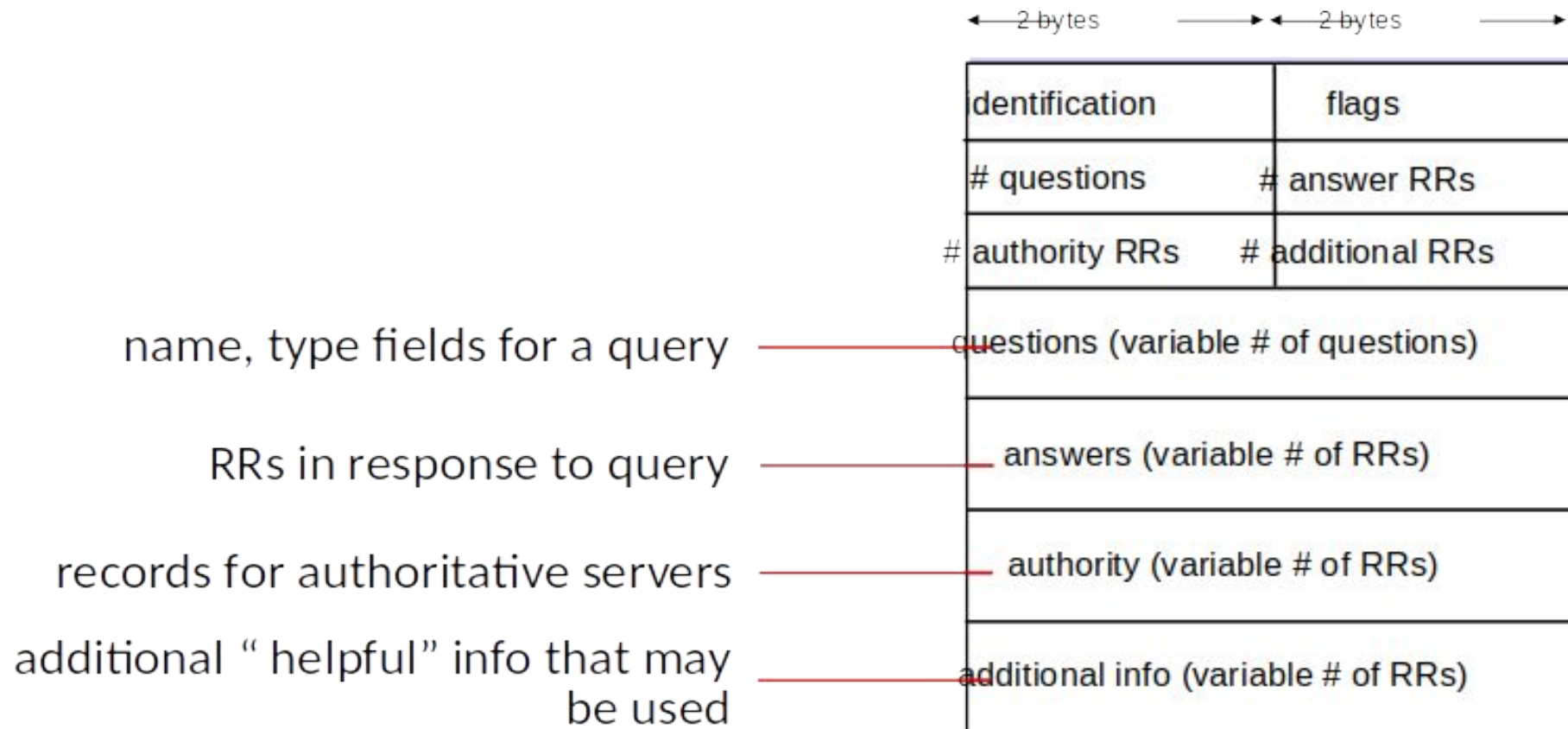
- **identification**: 16 bit # for query, reply to query uses same #
- **flags**:
 - query or reply
 - recursion desired
 - recursion available
 - reply is authoritative



Application Layer: 2-<number>

DNS protocol messages

DNS *query* and *reply* messages, both have same *format*:



Application Layer: 2-77

Thank you