COMPUTER NETWORKS

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Application Layer

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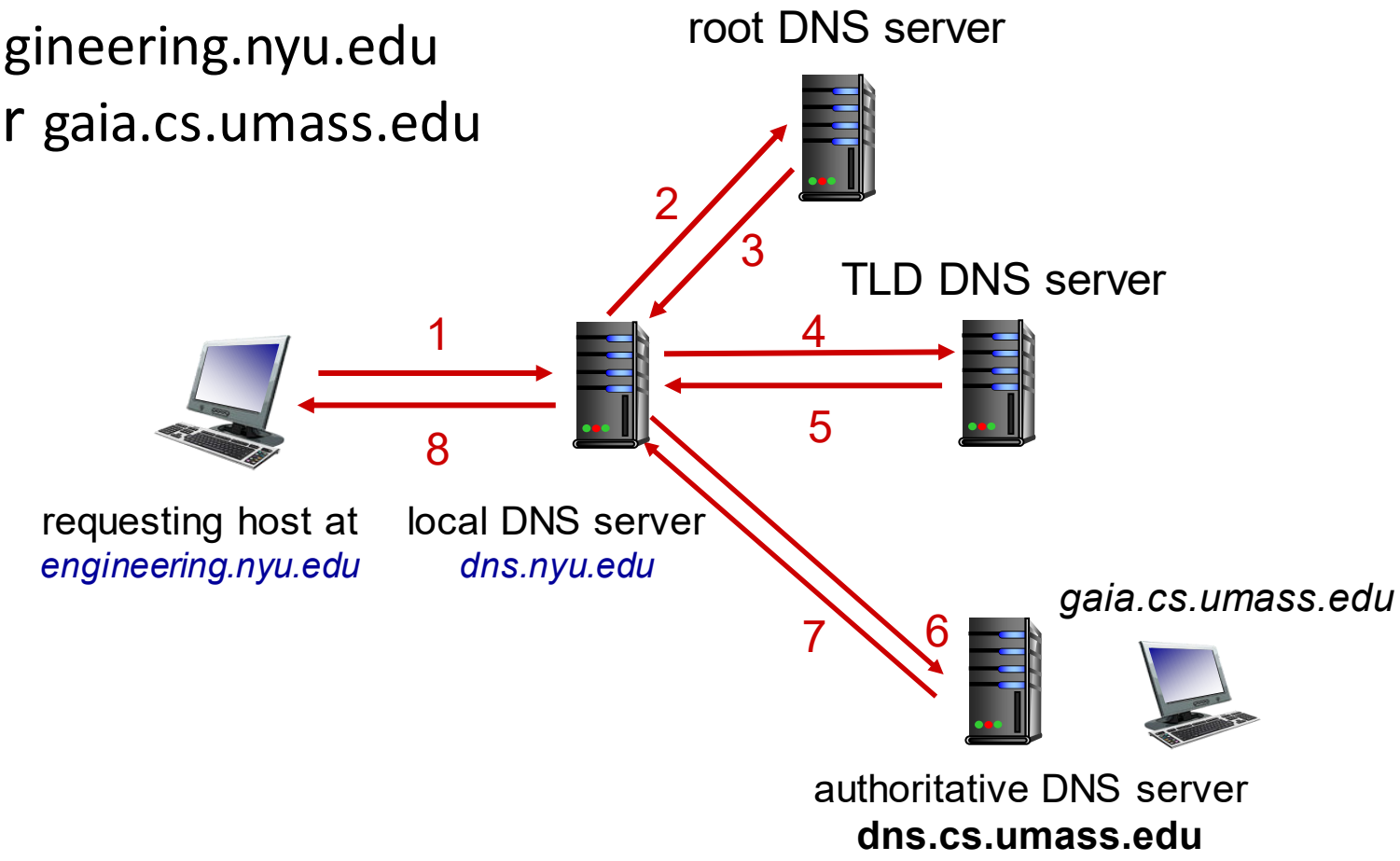
Unit – 2 Application Layer

DNS name resolution: iterated query

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

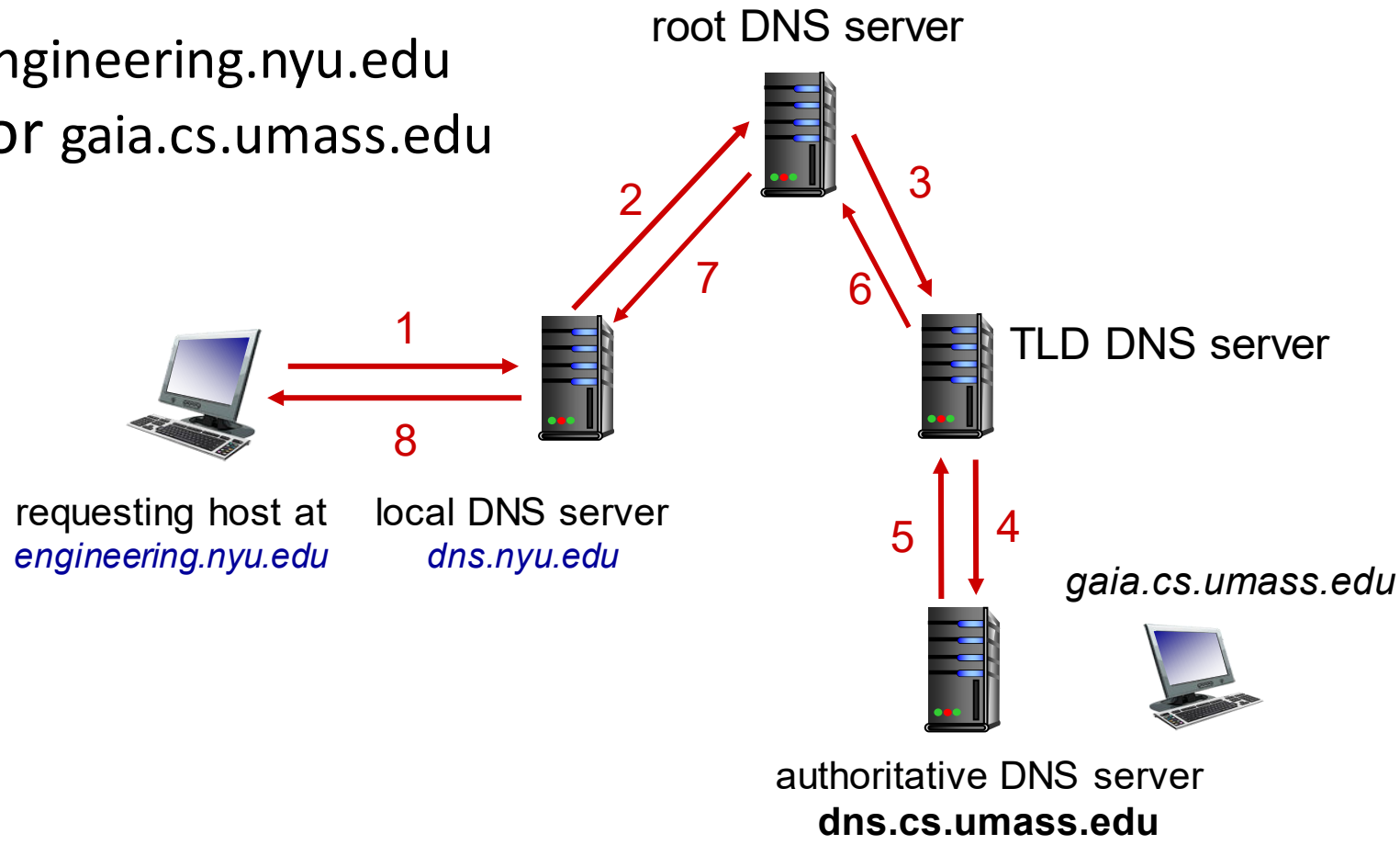


Iterated query:

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

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?

Caching and Updating DNS Records

- Suppose that a host **apricot.nyu.edu** queries **dns.nyu.edu** for the IP address for the hostname **cnn.com**. After an hour later, another NYU host, say, **kiwi.nyu.edu**, also queries **dns.nyu.edu.**
- once (any) name server learns mapping, it *caches* mapping
  - cache entries timeout (disappear) after some time (TTL)
  - TLD servers typically cached in local name servers
    - thus root name servers not often visited
- cached entries may be *out-of-date* (best-effort name-to-address translation!)
  - if name host changes IP address, may not be known Internet-wide until all TTLs expire!
- update/notify mechanisms proposed IETF standard
  - RFC 2136

DNS Records

DNS: distributed database storing resource records (RR)

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

type=A

- name is hostname
- value is IP address

relayl.bar.foo.com, 145.37.93.126, A

type=NS

- name is domain (e.g., foo.com)
- value is hostname of authoritative name server for this domain

foo.com, dns.foo.com, NS

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

ibm.com, servereast.backup2.ibm.com, CNAME

type=MX

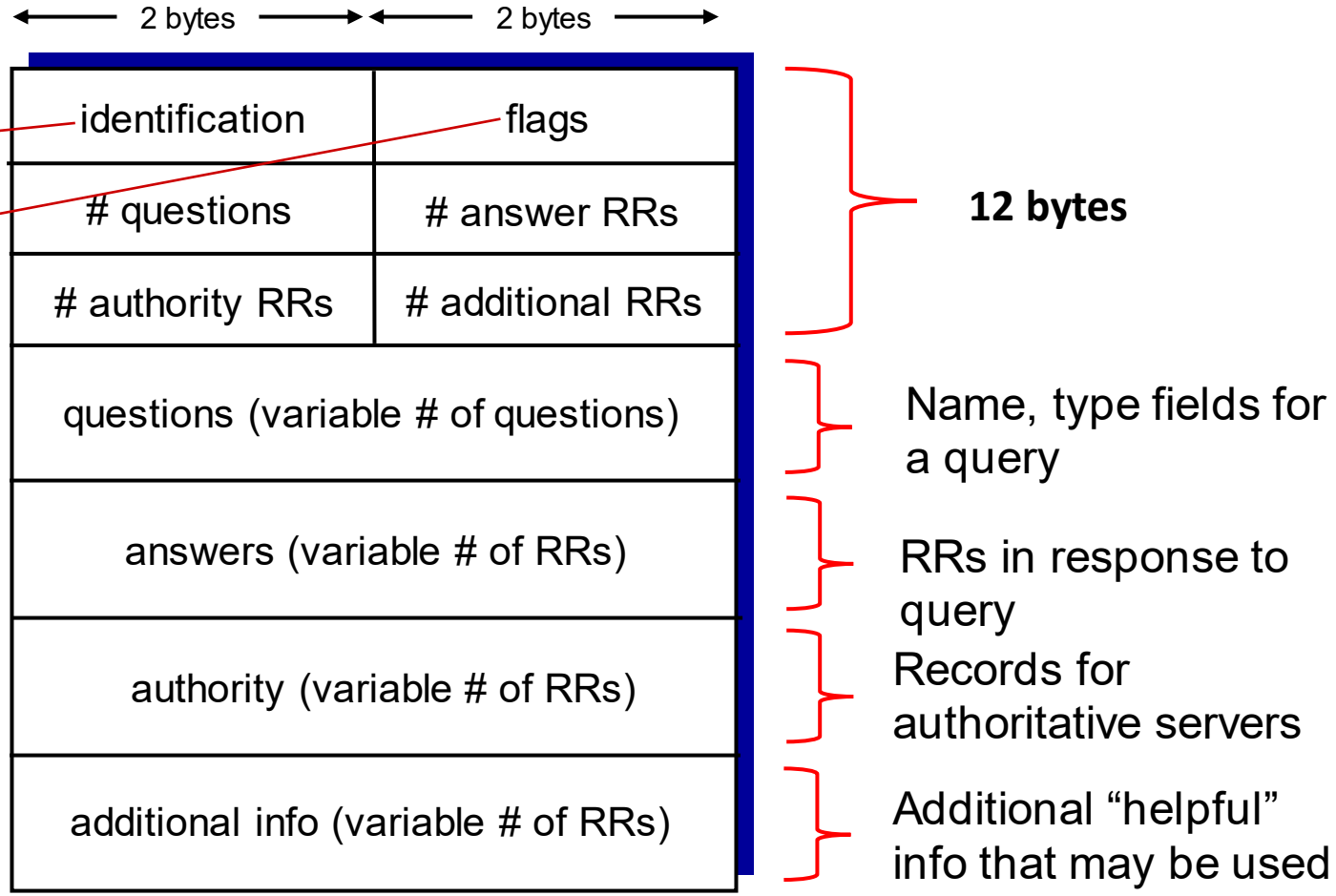
- value is canonical name of a mailserver associated with alias hostname name

example.com, mail.example.com, MX

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

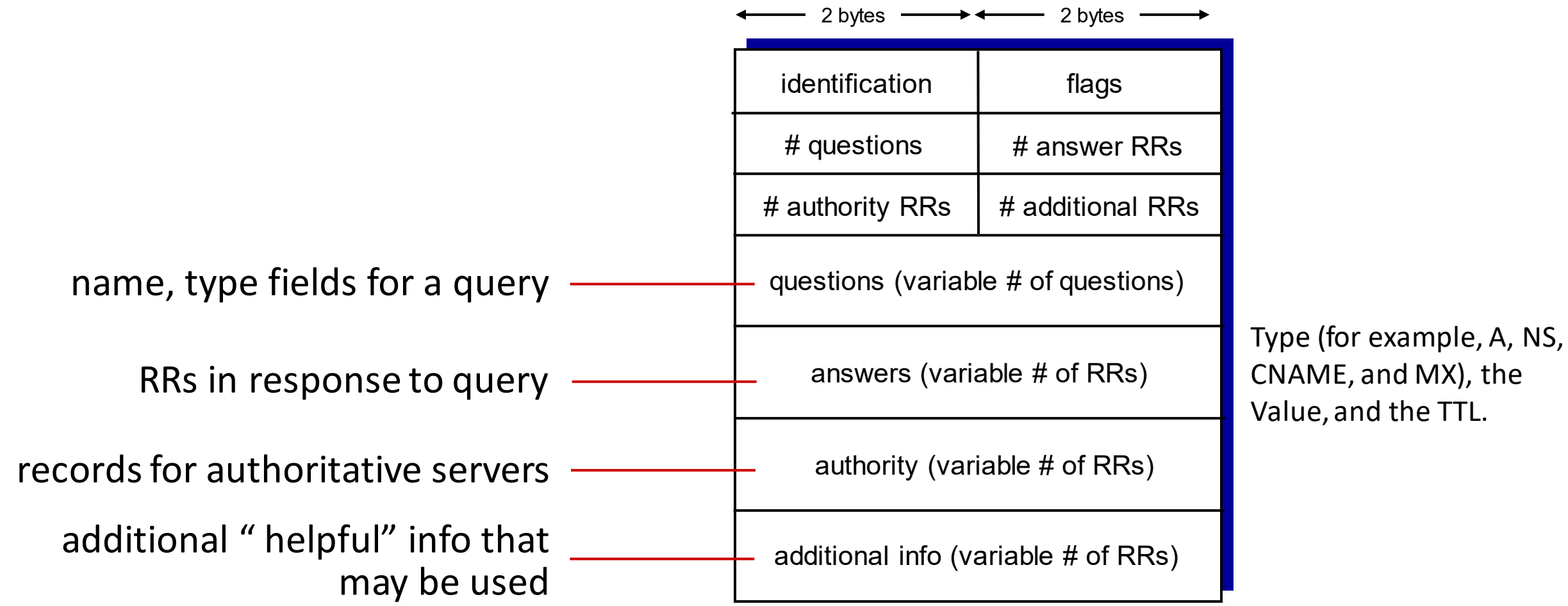
message header:

- identification: 16 bit # for query, reply to query uses same #
- flags:
  - query or reply (1-bit)
  - recursion desired
  - recursion available
  - reply is authoritative



DNS Protocol Messages

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



Emulating Local DNS Server (Step 1: Ask Root)

Directly send the query to this server.

```
seed@ubuntu:~$ dig @a.root-servers.net www.example.net

(Only a portion of the reply is shown here)
;; QUESTION SECTION:
;www.example.net.               IN      A

;; AUTHORITY SECTION:
net.                    172800  IN      NS      m.gtld-servers.net.
net.                    172800  IN      NS      l.gtld-servers.net.
net.                    172800  IN      NS      k.gtld-servers.net.

;; ADDITIONAL SECTION:
m.gtld-servers.net.     172800  IN      A       192.55.83.30
l.gtld-servers.net.     172800  IN      A       192.41.162.30
k.gtld-servers.net.     172800  IN      A       192.52.178.30
```

No answer (the root does not know the answer)

Go ask them!

Steps 2-3: Ask .net & example.net servers

```
seed@ubuntu:~$ dig @m.gtld-servers.net www.example.net

;; QUESTION SECTION:
;www.example.net.               IN      A

;; AUTHORITY SECTION:
example.net.            172800  IN      NS      a.iana-servers.net.
example.net.            172800  IN      NS      b.iana-servers.net.

;; ADDITIONAL SECTION:
a.iana-servers.net.     172800  IN      A       199.43.132.53
b.iana-servers.net.     172800  IN      A       199.43.133.53
```

Ask a .net nameservers.

Go ask them!

```
seed@ubuntu:$ dig @a.iana-servers.net www.example.net

;; QUESTION SECTION:
;www.example.net.               IN      A

;; ANSWER SECTION:
www.example.net.        86400   IN      A       93.184.216.34
```

Ask an example.net nameservers.

Finally got the answer

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Summary

Inserting records into DNS

Example: new startup “Network Utopia”

- register name **networkuptopia.com** at *DNS registrar* (e.g., Network Solutions)
  - provide names, IP addresses of authoritative name server (primary and secondary)
  - registrar inserts NS, A RRs into .com TLD server:

  (networkutopia.com, dns1.networkutopia.com, NS)

  (dns1.networkutopia.com, 212.212.212.1, A)
- create authoritative server locally with IP address 212.212.212.1
  - type A record for www.networkuptopia.com
  - type MX record for networkutopia.com

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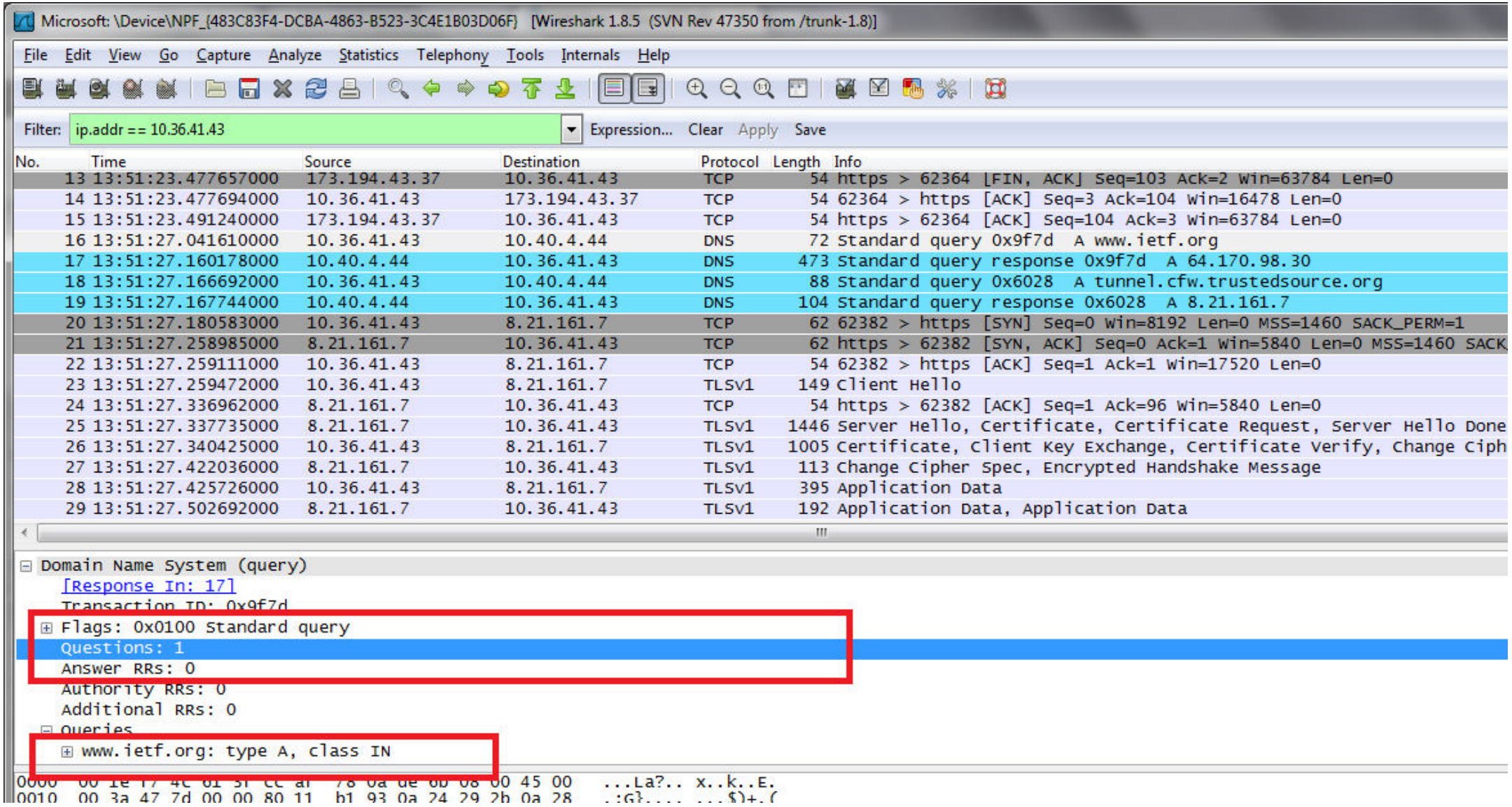
DNS Request - Wireshark Packet Capture



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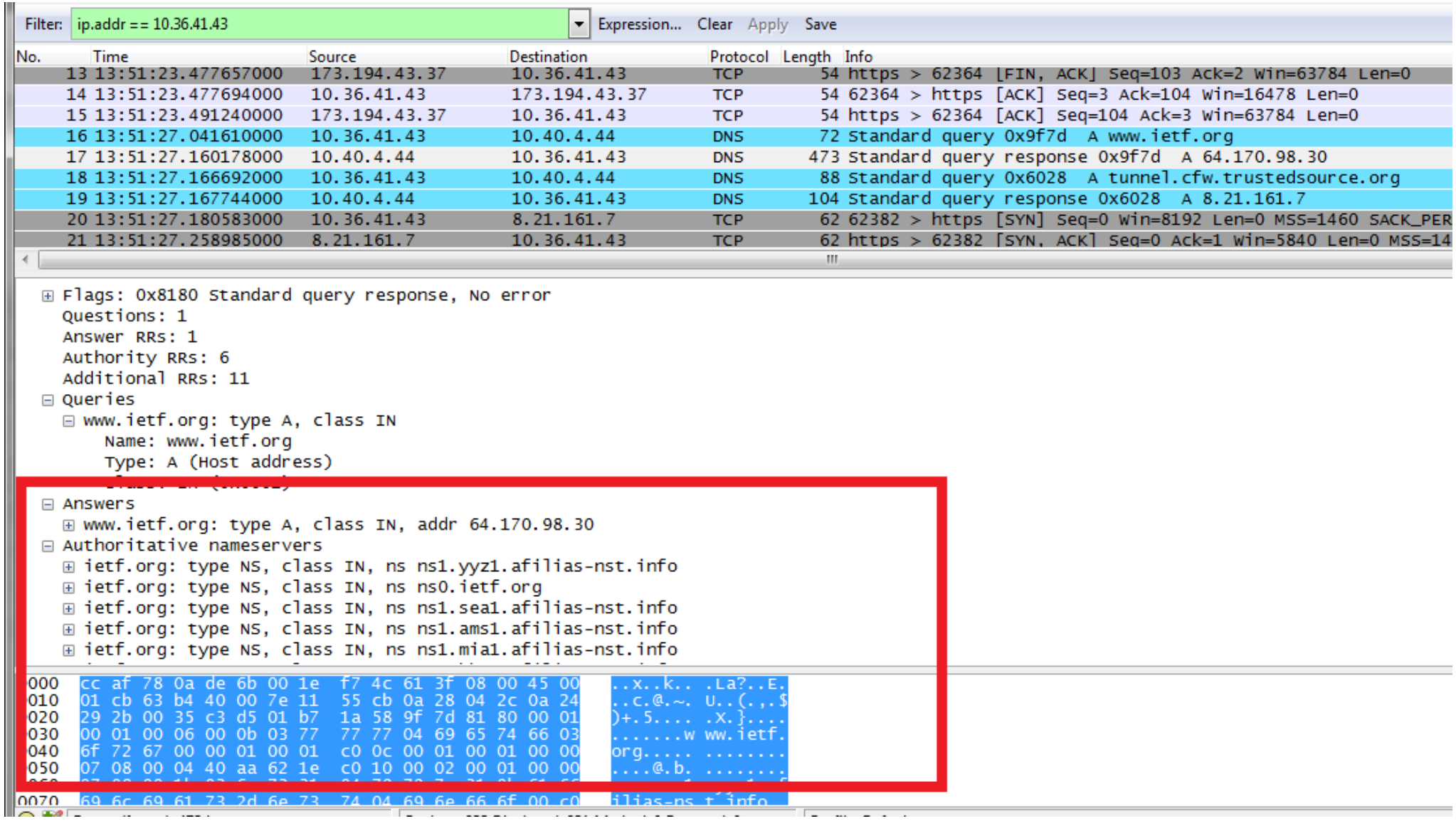
DNS Response - Wireshark Packet Capture



Suggested Readings

- DNS (Domain Name System) – Explained – https://youtu.be/JkEYOt08-rU
- How a DNS Server (Domain Name System) works – https://youtu.be/rdVPflECed8
- Wireshark Lab: DNS v7.0 – http://www-net.cs.umass.edu/wireshark-labs/Wireshark_DNS_v7.0.pdf

Thank You
For Your Attention

THANK YOU

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