Domain Name System

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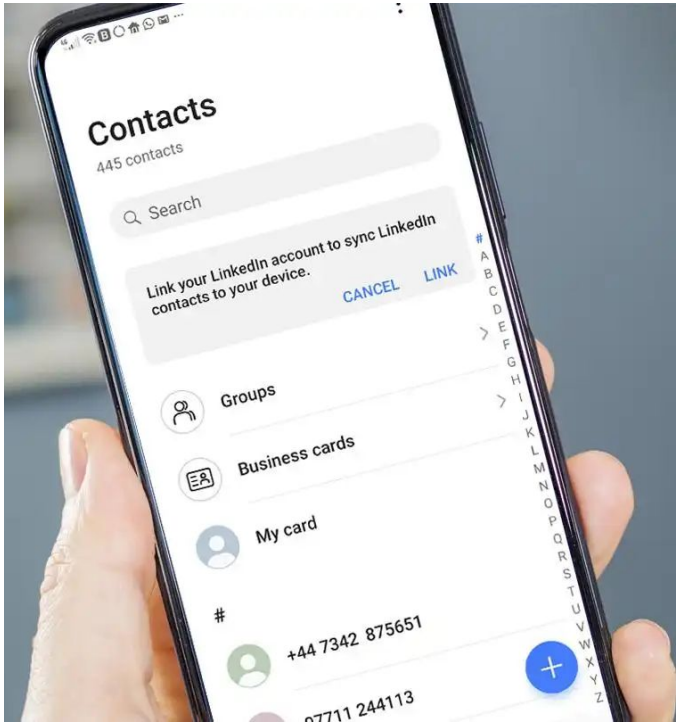
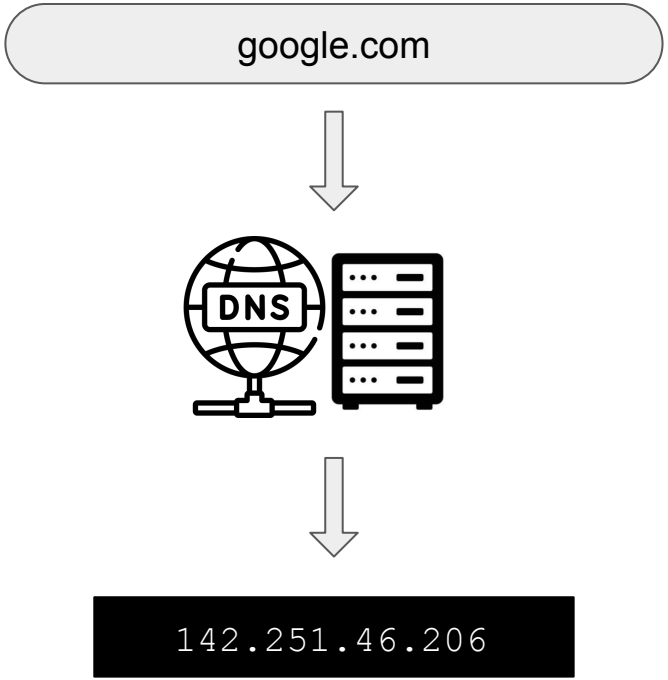




DNS is decentralized

A simple design for this process would have been one DNS server containing all mappings

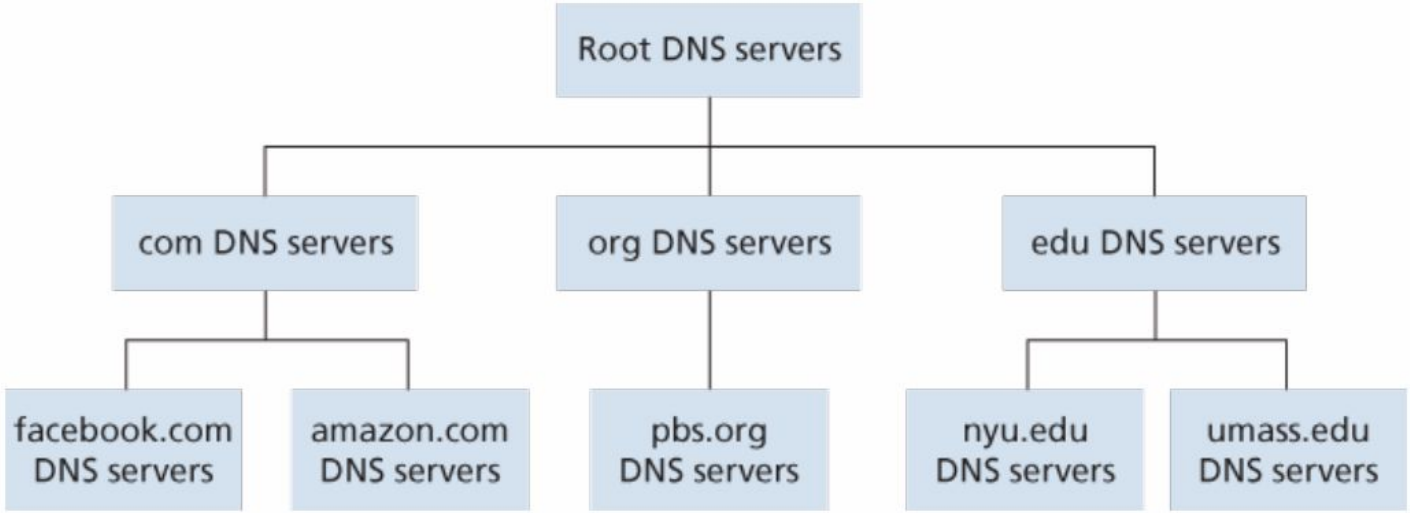
Issues with this idea:

- Single point of failure
- Traffic volume
- Distant database

That’s why they made DNS to be **distributed**!

The hierarchy of the DNS servers

1. root
2. top-level domain (TLD)
3. authoritative

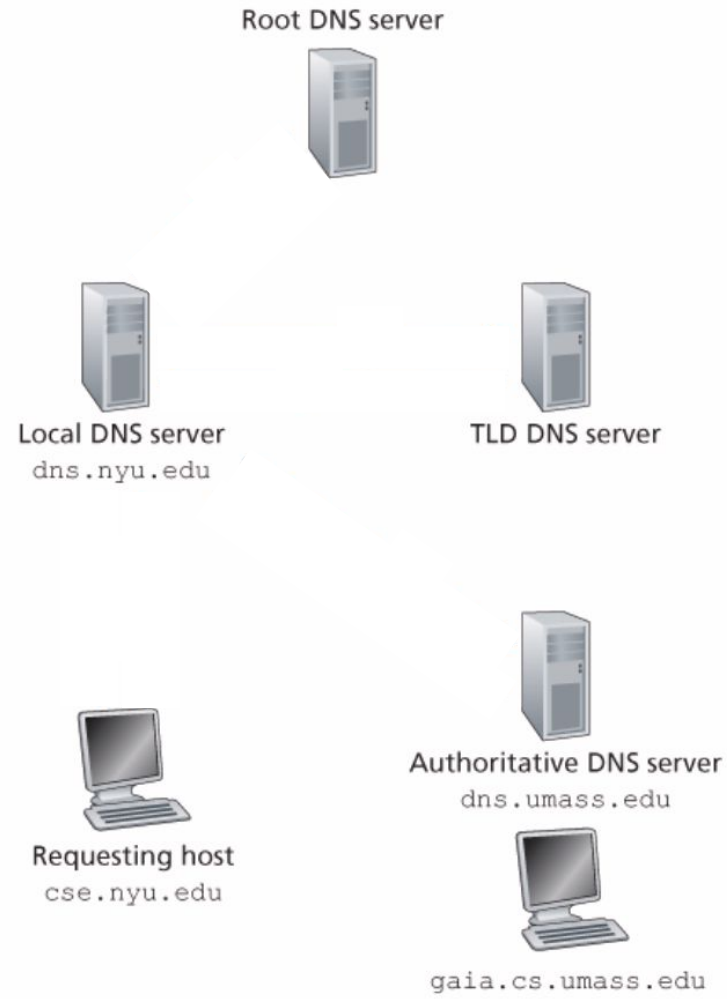


Local DNS Server

Not strictly in the hierarchy.

Each ISP has a local DNS Server, usually close to the host.

When a host makes a DNS query, it is sent to the local DNS server, which then forwards it into the DNS server hierarchy.

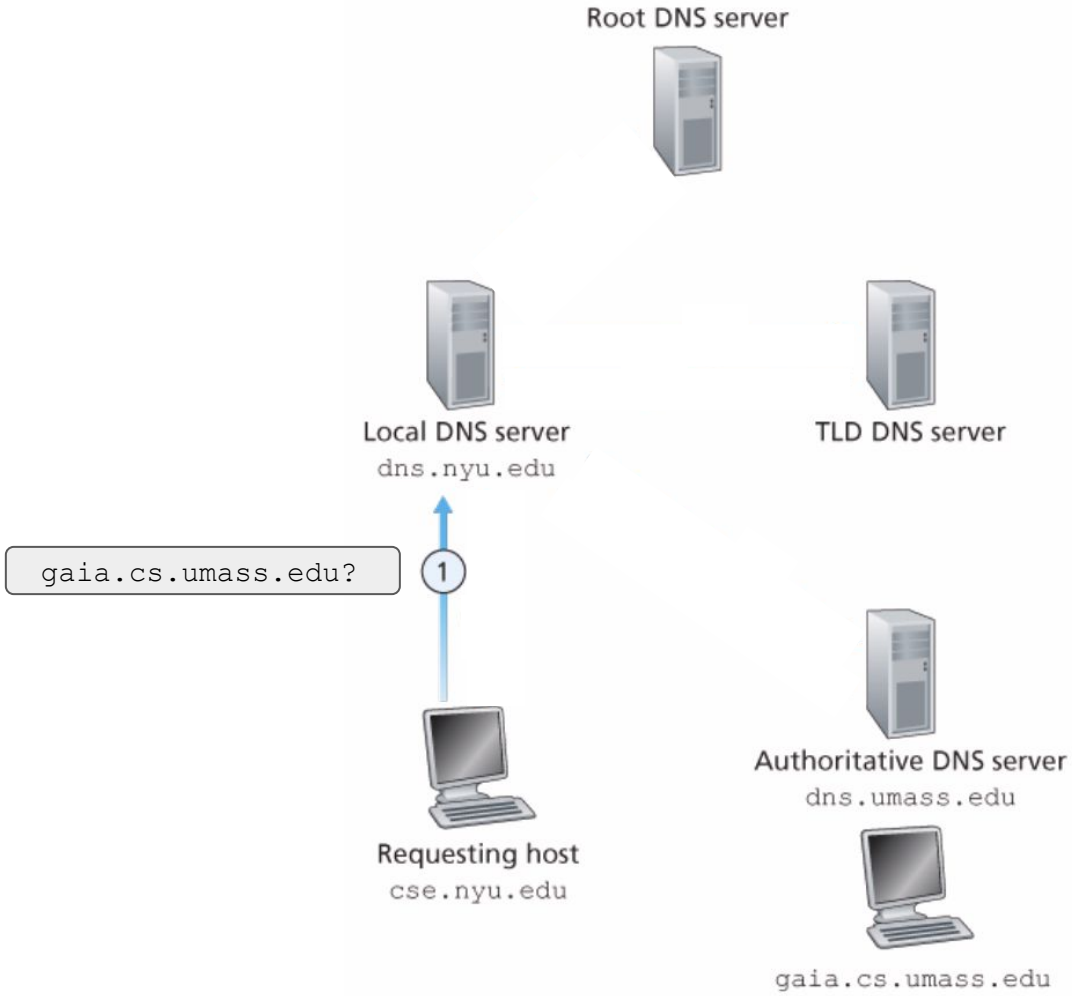


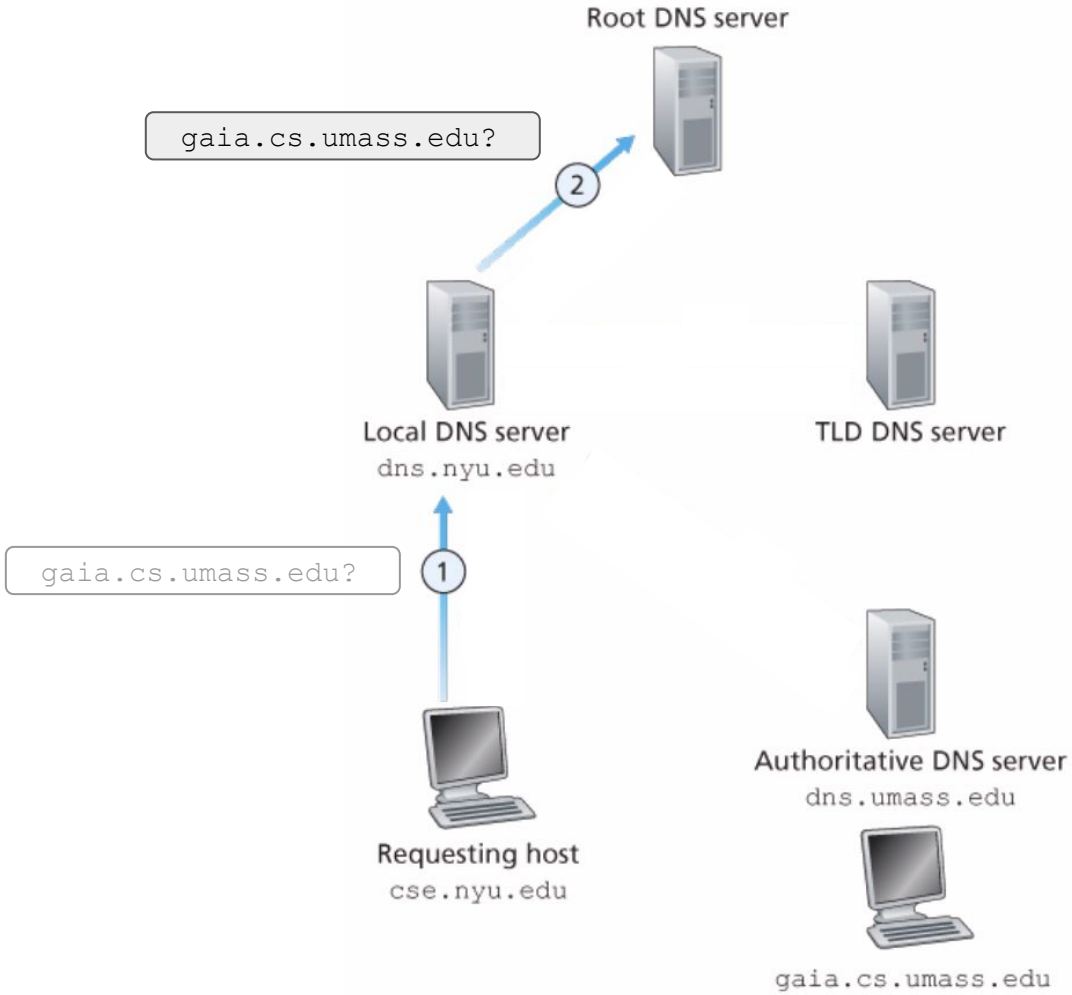
Example

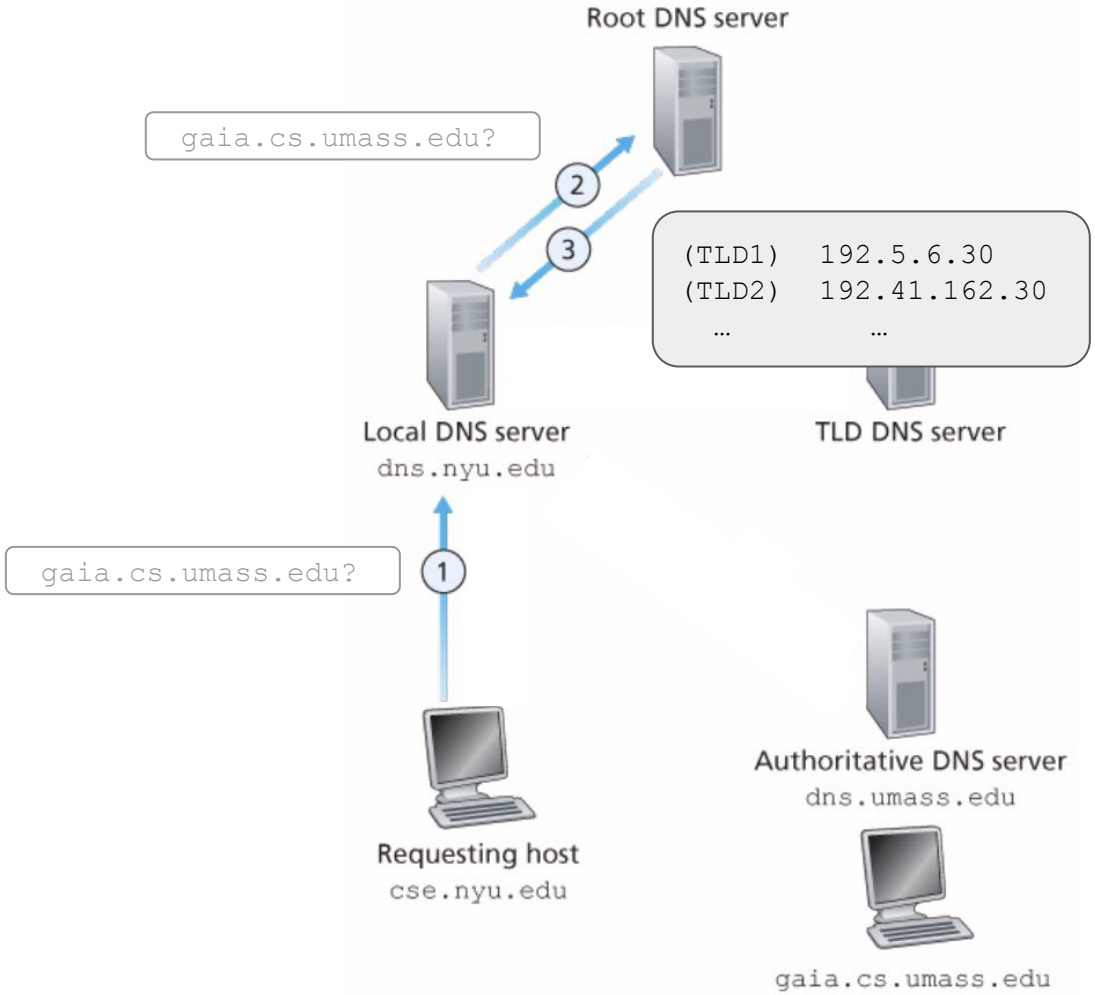
`cse.nyu.edu`

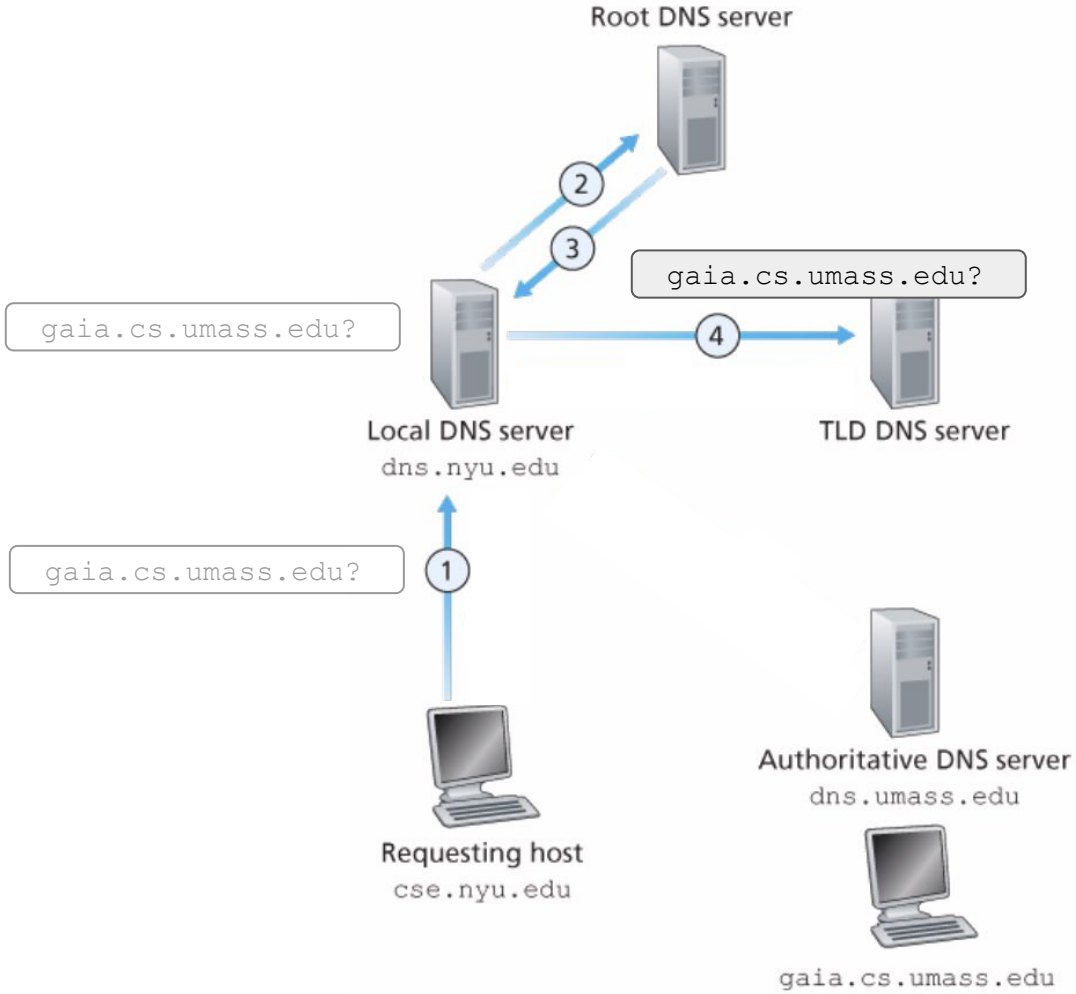
wants to get the IP address of

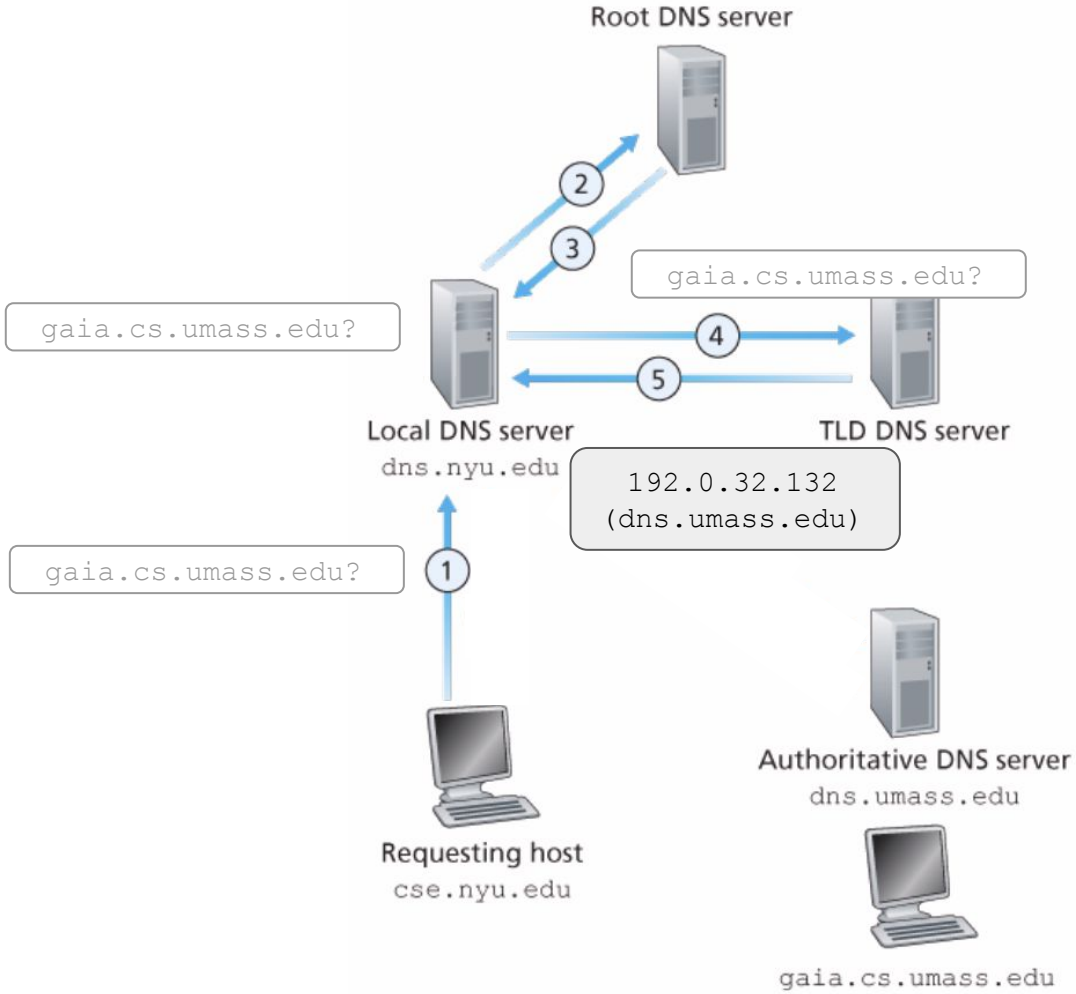
`gaia.cs.umass.edu`

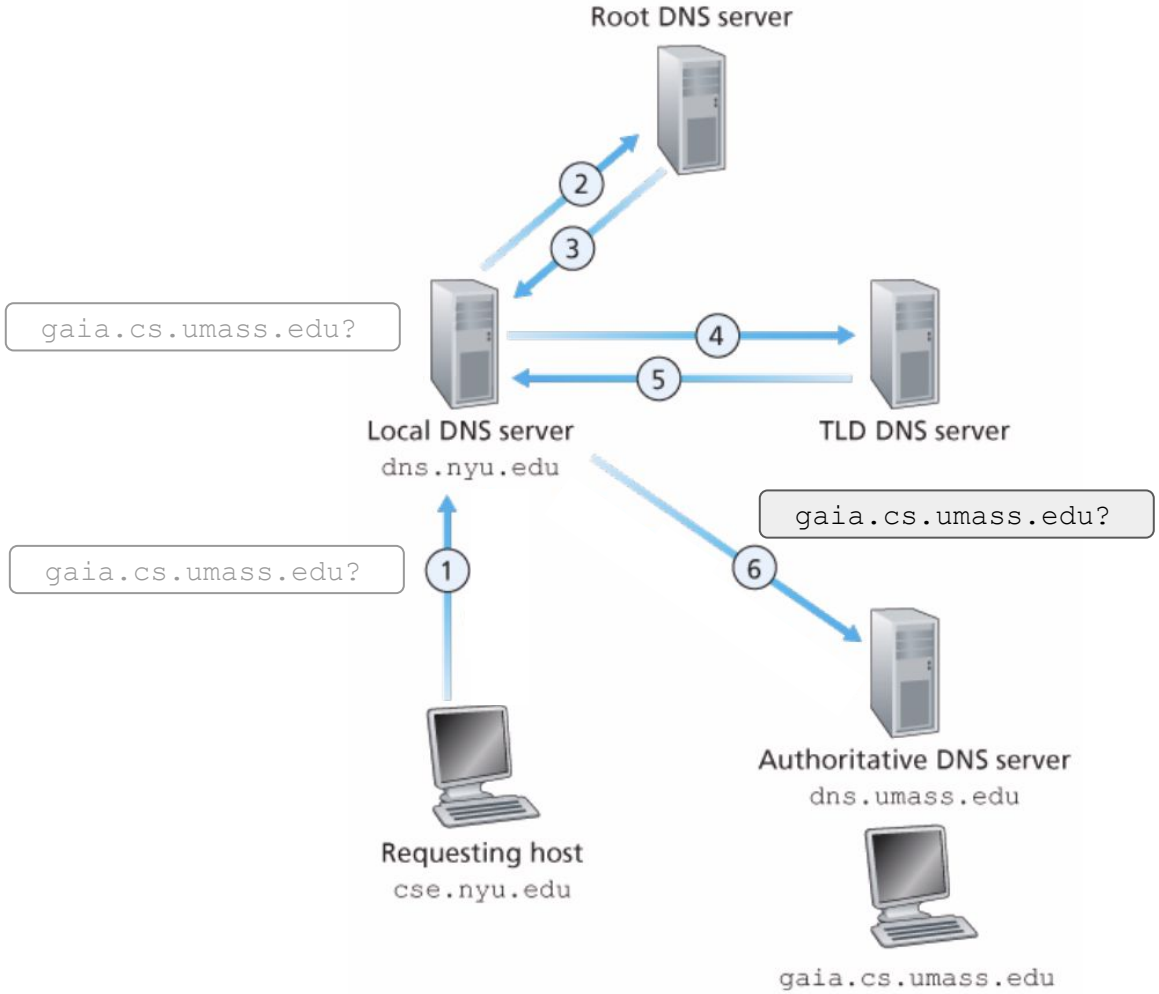

Root DNS server
Local DNS server
dns.nyu.edu
TLD DNS server
gaia.cs.umass.edu?
1
Authoritative DNS server
dns.umass.edu
Requesting host
cse.nyu.edu
gaia.cs.umass.edu

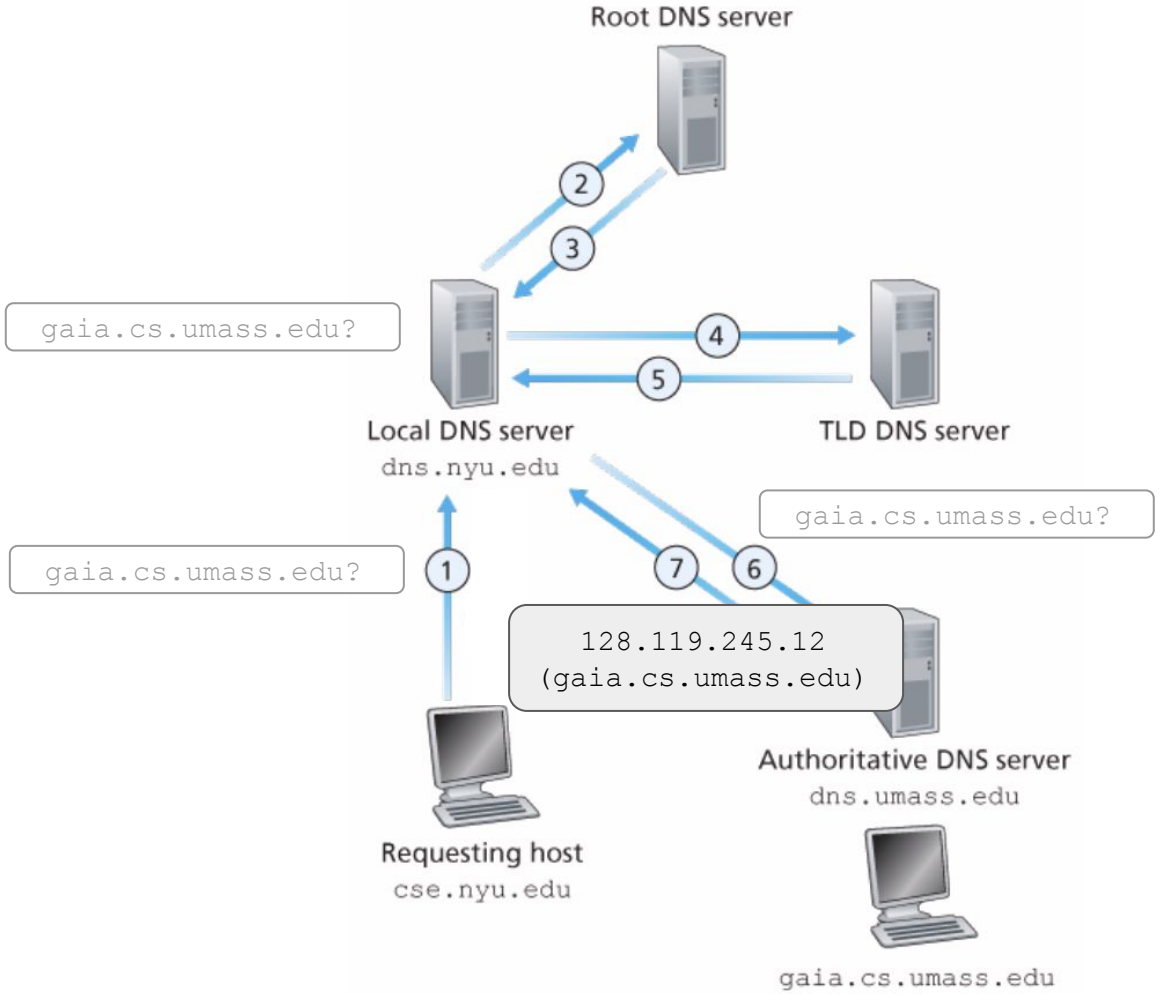

Root DNS server
gaia.cs.umass.edu?
2
Local DNS server
dns.nyu.edu
TLD DNS server
gaia.cs.umass.edu?
1
Authoritative DNS server
dns.umass.edu
Requesting host
cse.nyu.edu
gaia.cs.umass.edu

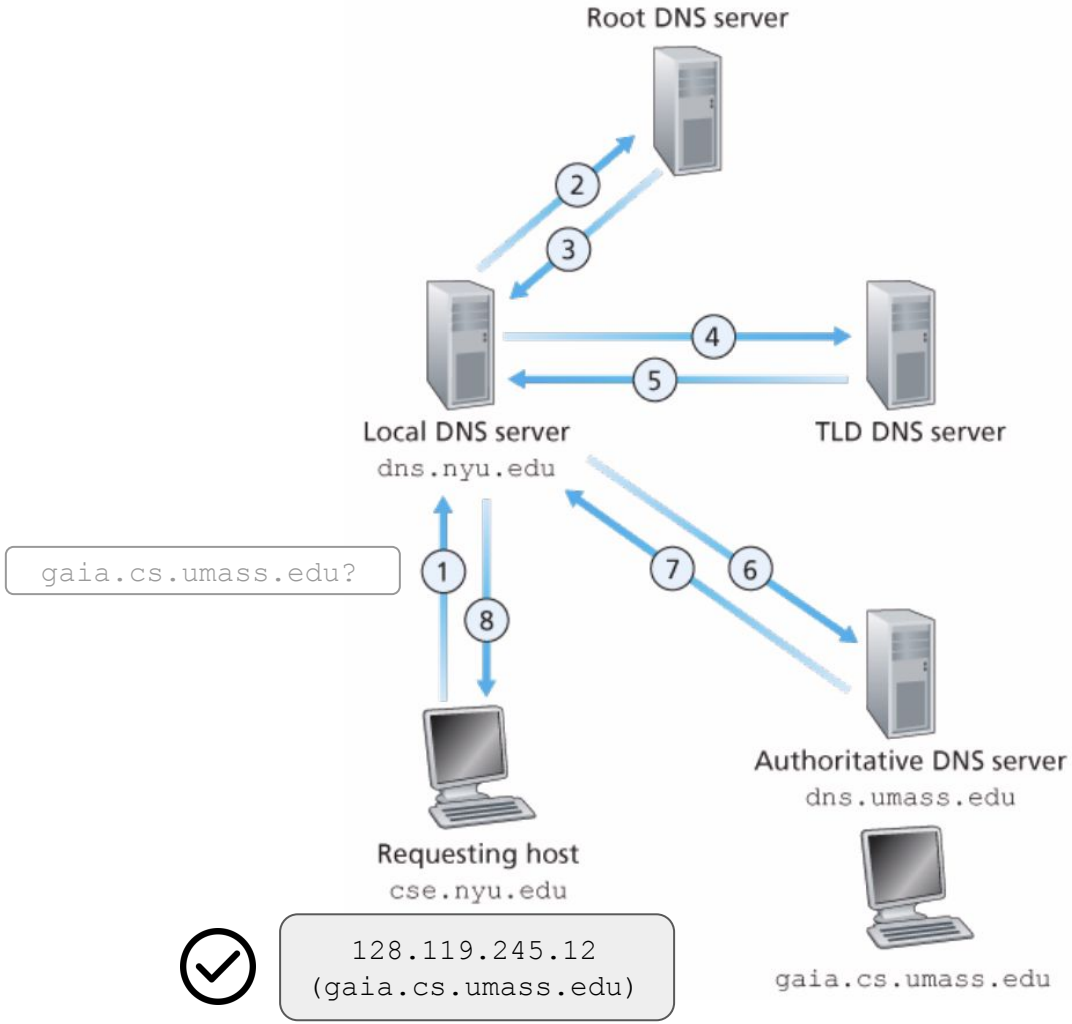

Root DNS server
gaia.cs.umass.edu?
2
3
(TLD1) 192.5.6.30
(TLD2) 192.41.162.30
… …
Local DNS server
dns.nyu.edu
TLD DNS server
gaia.cs.umass.edu?
1
Authoritative DNS server
dns.umass.edu
Requesting host
cse.nyu.edu
gaia.cs.umass.edu


Root DNS server
2
3
gaia.cs.umass.edu?
gaia.cs.umass.edu?
4
Local DNS server
dns.nyu.edu
TLD DNS server
gaia.cs.umass.edu?
1
Authoritative DNS server
dns.umass.edu
Requesting host
cse.nyu.edu
gaia.cs.umass.edu


Root DNS server
2
3
gaia.cs.umass.edu?
gaia.cs.umass.edu?
4
5
Local DNS server
dns.nyu.edu
TLD DNS server
192.0.32.132
(dns.umass.edu)
gaia.cs.umass.edu?
1
Authoritative DNS server
dns.umass.edu
Requesting host
cse.nyu.edu
gaia.cs.umass.edu


Root DNS server
2
3
gaia.cs.umass.edu?
4
5
Local DNS server
dns.nyu.edu
TLD DNS server
gaia.cs.umass.edu?
gaia.cs.umass.edu?
1
6
Authoritative DNS server
dns.umass.edu
Requesting host
cse.nyu.edu
gaia.cs.umass.edu


Root DNS server
2
3
gaia.cs.umass.edu?
4
5
Local DNS server
dns.nyu.edu
TLD DNS server
gaia.cs.umass.edu?
gaia.cs.umass.edu?
1
7
6
128.119.245.12
(gaia.cs.umass.edu)
Authoritative DNS server
dns.umass.edu
Requesting host
cse.nyu.edu
gaia.cs.umass.edu


Root DNS server
2
3
4
5
Local DNS server
dns.nyu.edu
TLD DNS server
gaia.cs.umass.edu?
1
8
7
6
Authoritative DNS server
dns.umass.edu
Requesting host
cse.nyu.edu
gaia.cs.umass.edu
128.119.245.12
(gaia.cs.umass.edu)

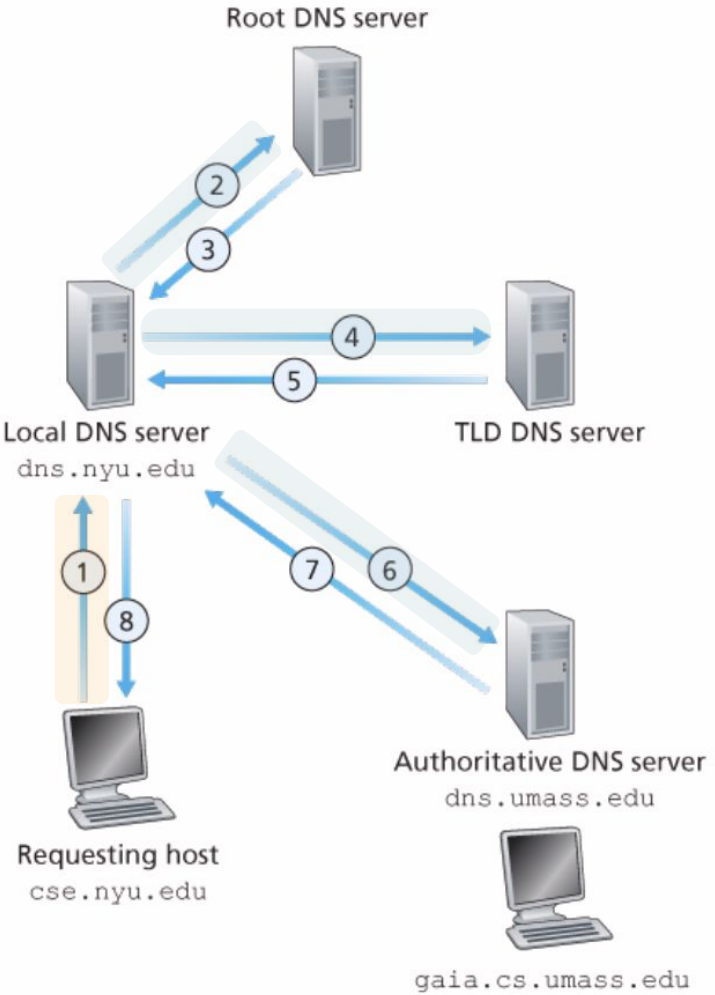
Query types

Recursive

The DNS server fully resolves the domain on behalf of the client, querying other servers as needed, and returns the final IP address.

Iterative

The replies are directly returned to the server initially querying, and the server keeps querying respecting the order of the DNS hierarchy until the hostname is resolved



DNS Caching

When a DNS server receives a DNS reply containing a mapping, it can cache the mapping in its local memory, temporarily.

This way, when a new request arrives for that mapping, it can provide the required information without contacting another DNS server.

DNS servers discard cached info after a period of time (often set to 2 days)

DNS Records

DNS servers store resource records (RRs)

Each DNS reply message carries one or more resource records.

```
(Name, Value, Type, TTL)
```

DNS Records

```
(Name, Value, Type, TTL)
```

Type	Name	Value
A	Hostname	IP of the hostname
NS	Domain (e.g. foo.com)	Hostname of authoritative DNS server
CNAME	Alias Hostname	True hostname
MX	Alias Hostname	True hostname (mail server)

DNS Records

Authoritative DNS server for hostname H contains a **Type A record for H**.

Not authoritative DNS server for hostname H contains

- **Type NS record for the domain of H**
- **Type A record with the IP address of the server in the Value field of the NS record**

DNS Records - Example

Authoritative DNS server for hostname H contains a **Type A record for H**.

Not authoritative DNS server for hostname H contains

- **Type NS record for the domain of H**
- **Type A record with the IP address of the server in the Value field of the NS record**

.edu TLD DNS Server		
Name	**Value**	**Type**
umass.edu	dns.umass.edu	NS
dns.umass.edu	128.119.40.111	A

dns.umass.edu DNS Server		
Name	**Value**	**Type**
umass.edu	128.119.10.1	A

DNS Records - Example

umass.edu?

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Name	**Value**	**Type**
umass.edu	dns.umass.edu	NS
dns.umass.edu	128.119.40.111	A

128.119.40.111

dns.umass.edu DNS Server		
Name	**Value**	**Type**
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DNS Records - Example

umass.edu?

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Name	**Value**	**Type**
umass.edu	dns.umass.edu	NS
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128.119.40.111

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umass.edu?

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umass.edu	dns.umass.edu	NS
dns.umass.edu	128.119.40.111	A

128.119.40.111

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umass.edu	128.119.10.1	A

DNS Records - Example

umass.edu?

dns.umass.edu?

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dns.umass.edu	128.119.40.111	A

128.119.40.111

dns.umass.edu DNS Server		
Name	**Value**	**Type**
umass.edu	128.119.10.1	A

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umass.edu?

dns.umass.edu?

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umass.edu?

128.119.40.111

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umass.edu?

128.119.40.111

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Name	**Value**	**Type**
umass.edu	dns.umass.edu	NS
dns.umass.edu	128.119.40.111	A

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dns.umass.edu DNS Server		
Name	**Value**	**Type**
umass.edu	128.119.10.1	A

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umass.edu?

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umass.edu?

128.119.40.111

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umass.edu?

128.119.40.111

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128.119.40.111

DNS Records - Example

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umass.edu?

128.119.40.111

128.119.40.111

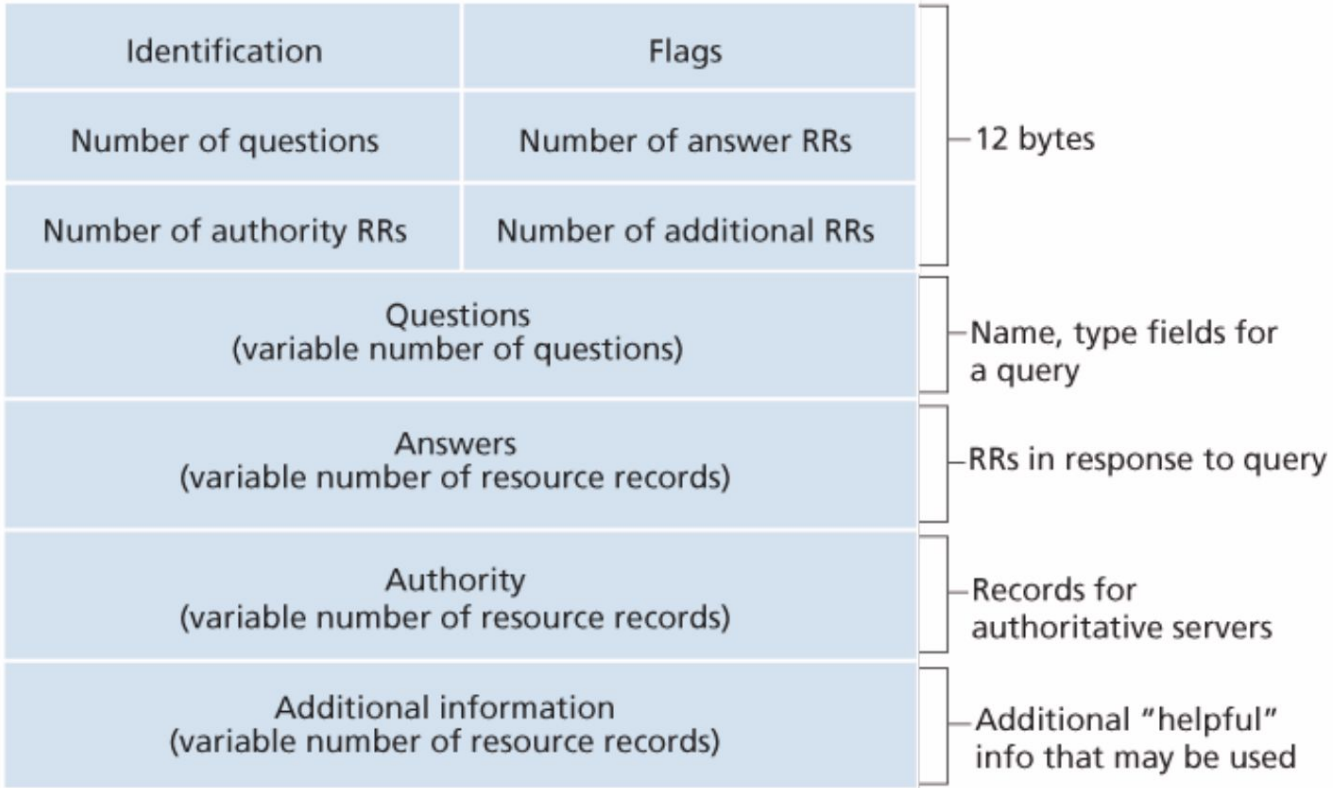
dns.umass.edu DNS Server		
Name	**Value**	**Type**
umass.edu	128.119.10.1	A

DNS Messages

Query

Reply

DNS Messages



Inserting Records

How is the DNS server filled in the first place?

Inserting Records - Example

You have created a startup, “**Network Utopia**”

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First, you register the domain name `networkutopia.com` at a registrar.

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Registrar: A commercial entity that verifies the uniqueness of the domain name, enters the domain name into the DNS database, in exchange for a small fee.

Inserting Records - Example

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You must, of course, also provide the names and addresses of your primary and secondary authoritative DNS servers.

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You must, of course, also provide the names and addresses of your primary and secondary authoritative DNS servers.

The registrar will enter a Type NS and a Type A record into the TLD .com servers for your primary and secondary DNS servers

Inserting Records - Example

You have created a startup, "**Network Utopia**"

First, you register the domain name **networkutopia.com** at a registrar.

The registrar will enter a Type NS and a Type A record into the TLD .com servers for your primary and secondary DNS servers.

.com TLD DNS Server

Name	Value	Type
networkutopia.com	dns1.networkutopia.com	NS
dns1.network.utopia.com	212.212.212.1	A
networkutopia.com	dns2.networkutopia.com	NS
dns2.networkutopia.com	212.212.212.2	A

Inserting Records - Example

You have created a startup, “**Network Utopia**”

First, you register the domain name `networkutopia.com` at a registrar.

You’ll also have to make sure that the Type A RR for you web server `www.networkutopia.com` and the Type MX RR for your mail server `mail.network.utopia.com` are in your authoritative DNS server.

Inserting Records - Example

You have created a startup, "**Network Utopia**"

First, you register the domain name **networkutopia.com** at a registrar.

You'll also have to make sure that the Type A RR for you web server **www.networkutopia.com** and the Type MX RR for your mail server **mail.network.utopia.com** are in your authoritative DNS server.

Your Primary Authoritative DNS Server (DNS1)

Name	Value	Type
www.networkutopia.com	212.212.1.1	A
networkutopia.com	mail.networkutopia.com	MX

Quiz

https://gaia.cs.umass.edu/kurose_ross/knowledgechecks/problem.php?c=2&s=4