

The Application Layer

the DNS system

School of Software Engineering
South China University of Technology

Dr. Chunhua Chen

chunhuachen@scut.edu.cn

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Reviewing the URL in Web application

http://www.baidu.com/img/bd_logo1.png

Host Name

globally unique

Path Name

Unique within Host

http://103.235.46.39/img/bd_logo1.png

IP address

globally unique

ping www.baidu.com → 103.235.46.39



```
管理员: C:\Windows\system32\cmd.exe
Microsoft Windows [版本 6.1.7601]
版权所有 (c) 2009 Microsoft Corporation。保留所有权利。

C:\Users\Administrator>ping www.baidu.com

正在 Ping www.a.shifen.com [103.235.46.39] 具有 32 字节的数据:
来自 103.235.46.39 的回复: 字节=32 时间=500ms TTL=47
来自 103.235.46.39 的回复: 字节=32 时间=510ms TTL=47
来自 103.235.46.39 的回复: 字节=32 时间=499ms TTL=47
来自 103.235.46.39 的回复: 字节=32 时间=497ms TTL=47

103.235.46.39 的 Ping 统计信息:
    数据包: 已发送 = 4, 已接收 = 4, 丢失 = 0 (0% 丢失),
    往返行程的估计时间(以毫秒为单位):
        最短 = 497ms, 最长 = 510ms, 平均 = 501ms

C:\Users\Administrator>
```

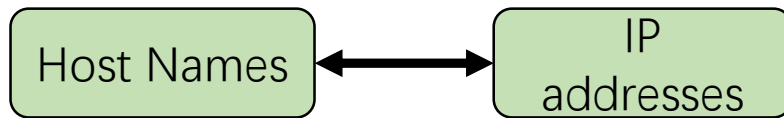
www.baidu.com
www.a.shifen.com
103.235.46.39

www.sohu.com
fgz.a.shou.com
14.18.240.6

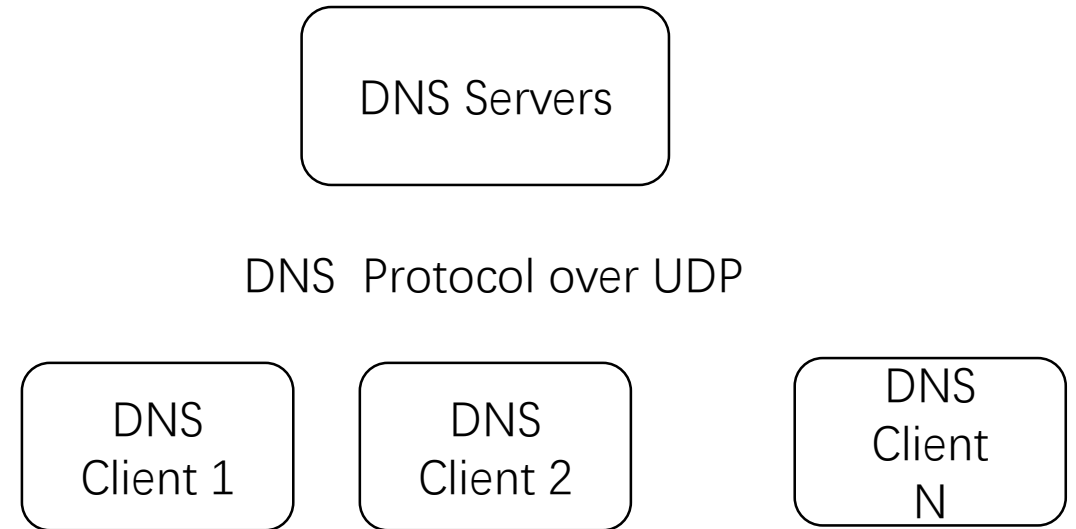
ping www.a.shifen.com ?

The Domain Name System (DNS)

- The Internet's directory service that translates hostnames to IP addresses.



- A public network application!



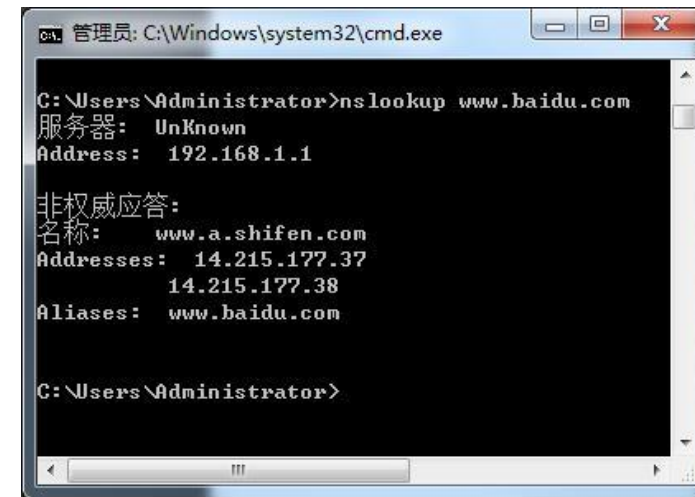
Other important services by DNS

- **Host aliasing (mnemonic)**

- Canonical hostname: www.a.shifen.com
- Alias hostname: www.baidu.com

- **Mail server aliasing**

- **Load distribution**



```
管理员: C:\Windows\system32\cmd.exe

C:\Users\Administrator>nslookup www.baidu.com
服务器:  Unknown
Address:  192.168.1.1

非权威应答:
名称:     www.a.shifen.com
Addresses: 14.215.177.37
           14.215.177.38
Aliases:  www.baidu.com

C:\Users\Administrator>
```

nslookup -query=a/mx/ns/cname/
hostname

Design of DNS

- Centralized design
 - i.e. one DNS server contains all the mappings
 - Problems:
 - a single point of failure
 - Traffic volume
 - Distant centralized database
 - Maintenance

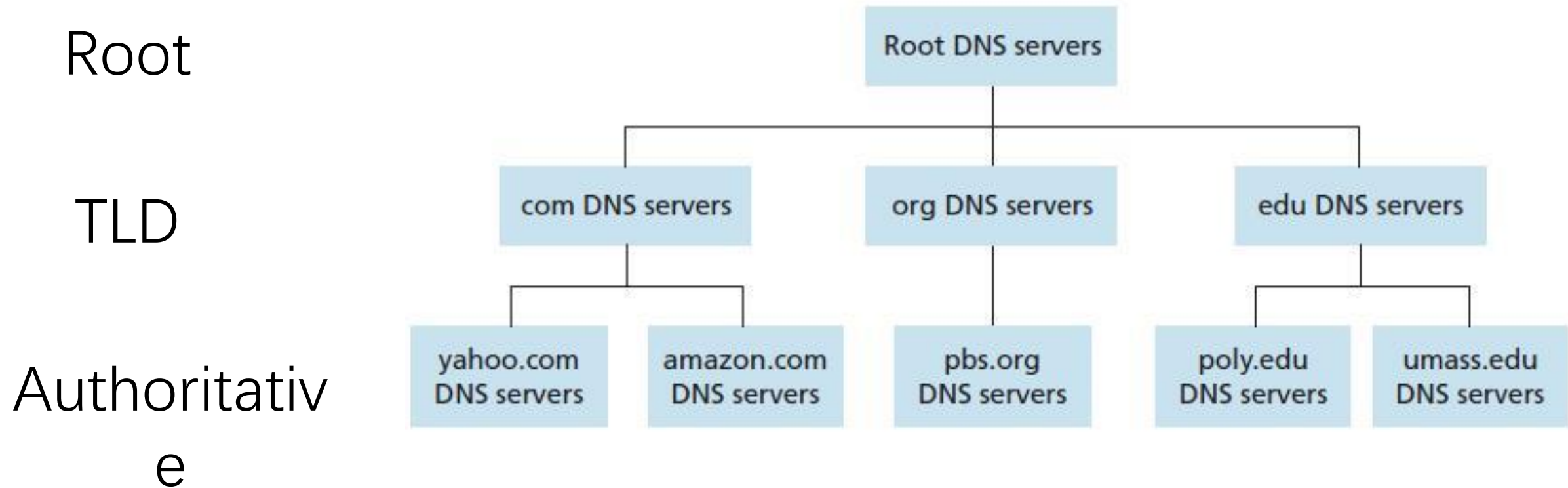
- **Distributed, Hierarchical Database**
 - i.e. a large number of servers, organized in a hierarchical fashion and distributed around the world.

Root DNS Servers

Top-level domain
(TLD) DNS servers

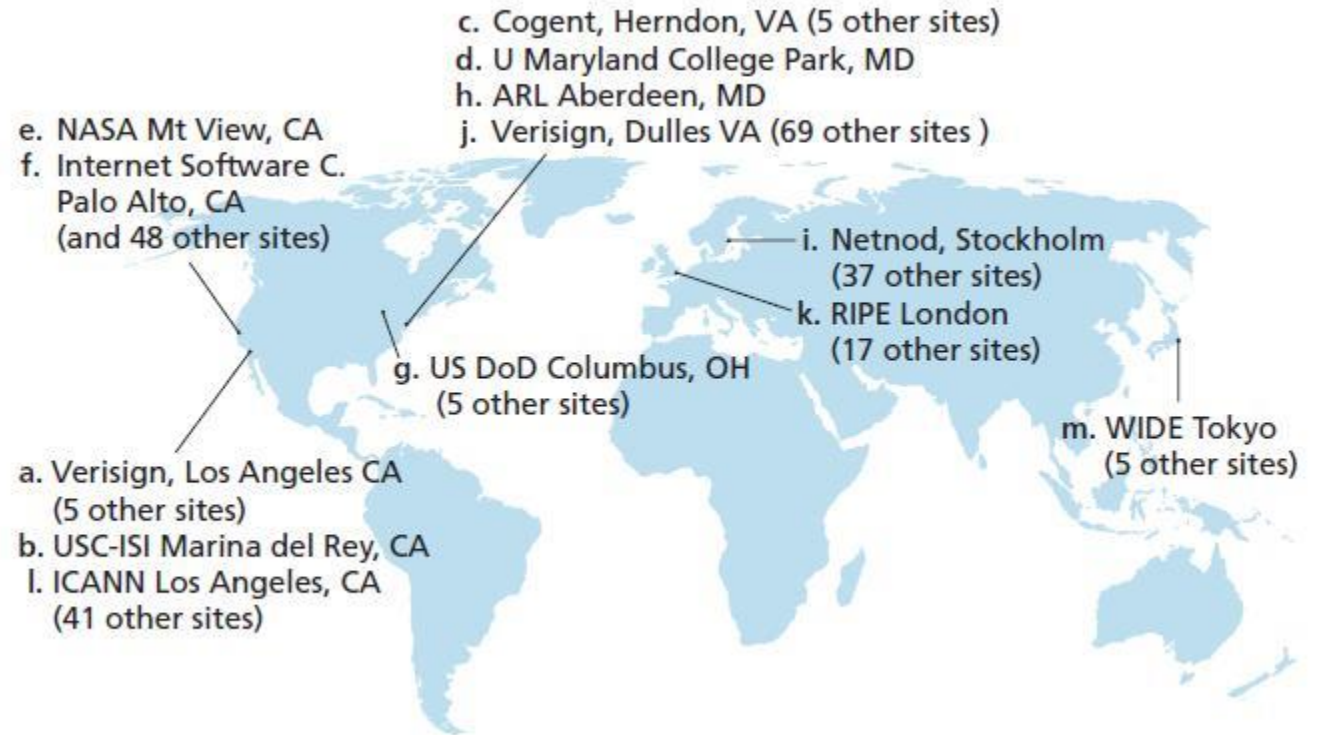
Authoritative DNS
servers

Portion of the hierarchy of DNS servers



Root DNS servers

- 13 root DNS servers (labeled A through M)
 - 247 root servers (fall 2011)
- Most located in North America



Top-level domain (TLD) servers

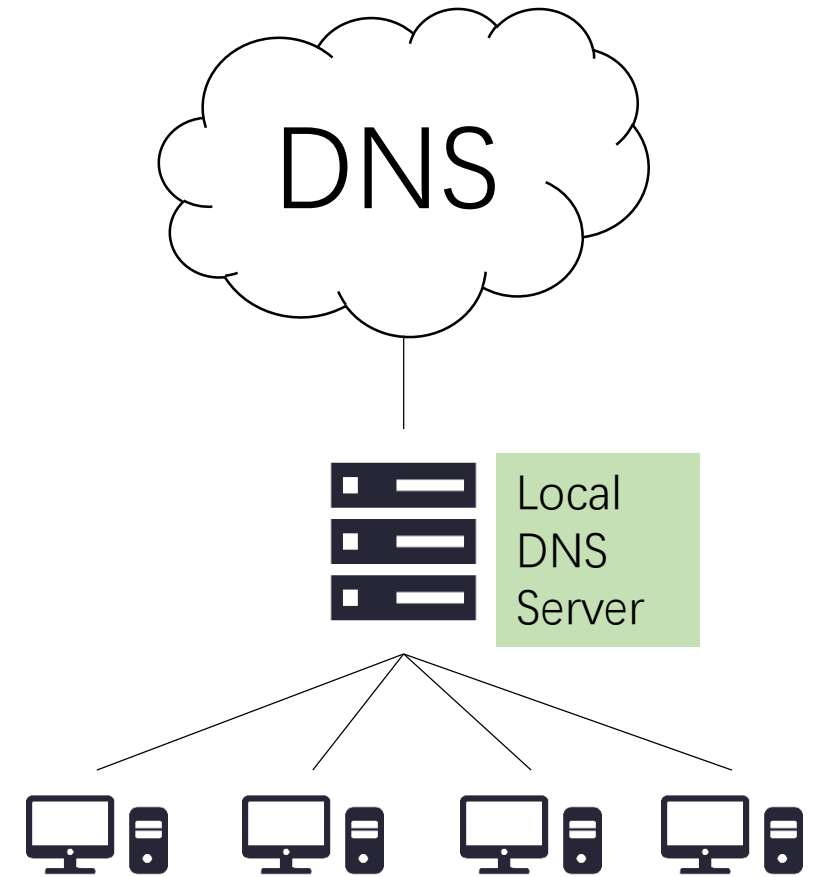
- These servers are responsible for top-level domains such as **com**, **org**, **net**, **edu**, and **gov**, and all of the country top-level domains such as **uk**, **fr**, **ca**, and **jp**.
- The company Verisign Global Registry Services maintains the TLD servers for the **com** top-level domain.
- The company Educause maintains the TLD servers for the **edu** top-level domain.

Authoritative DNS servers

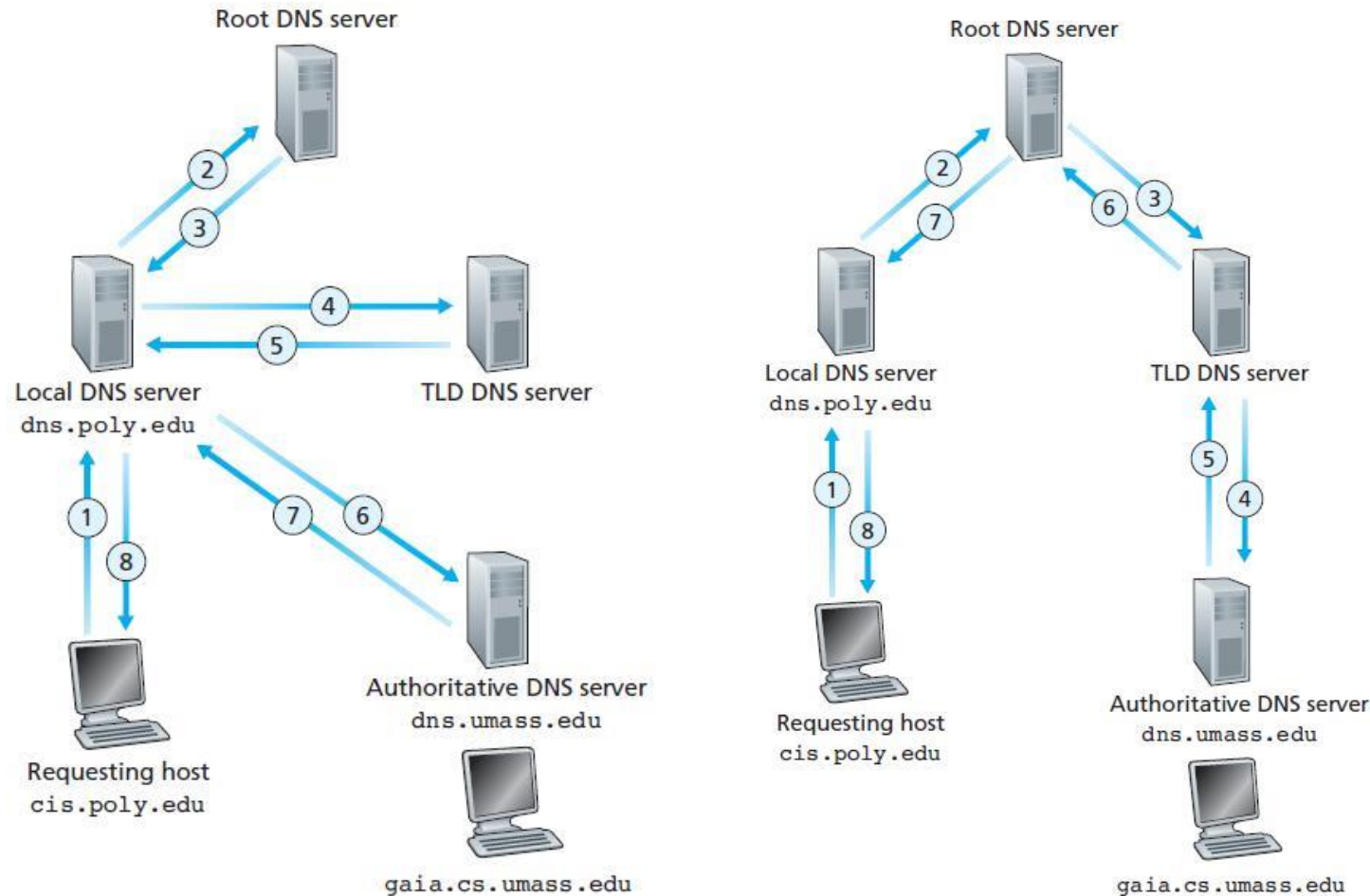
- Every organization with publicly accessible hosts (such as Web servers and mail servers) on the Internet must provide publicly accessible DNS records that map the names of those hosts to IP addresses.
 - Self-implemented or by DNS service provider.

The local DNS server

- A local DNS server does not strictly belong to the hierarchy of servers but is nevertheless central to the DNS architecture.
 - Provided by your ISP.
- What is Default DNS Server?



Interaction of the various DNS servers



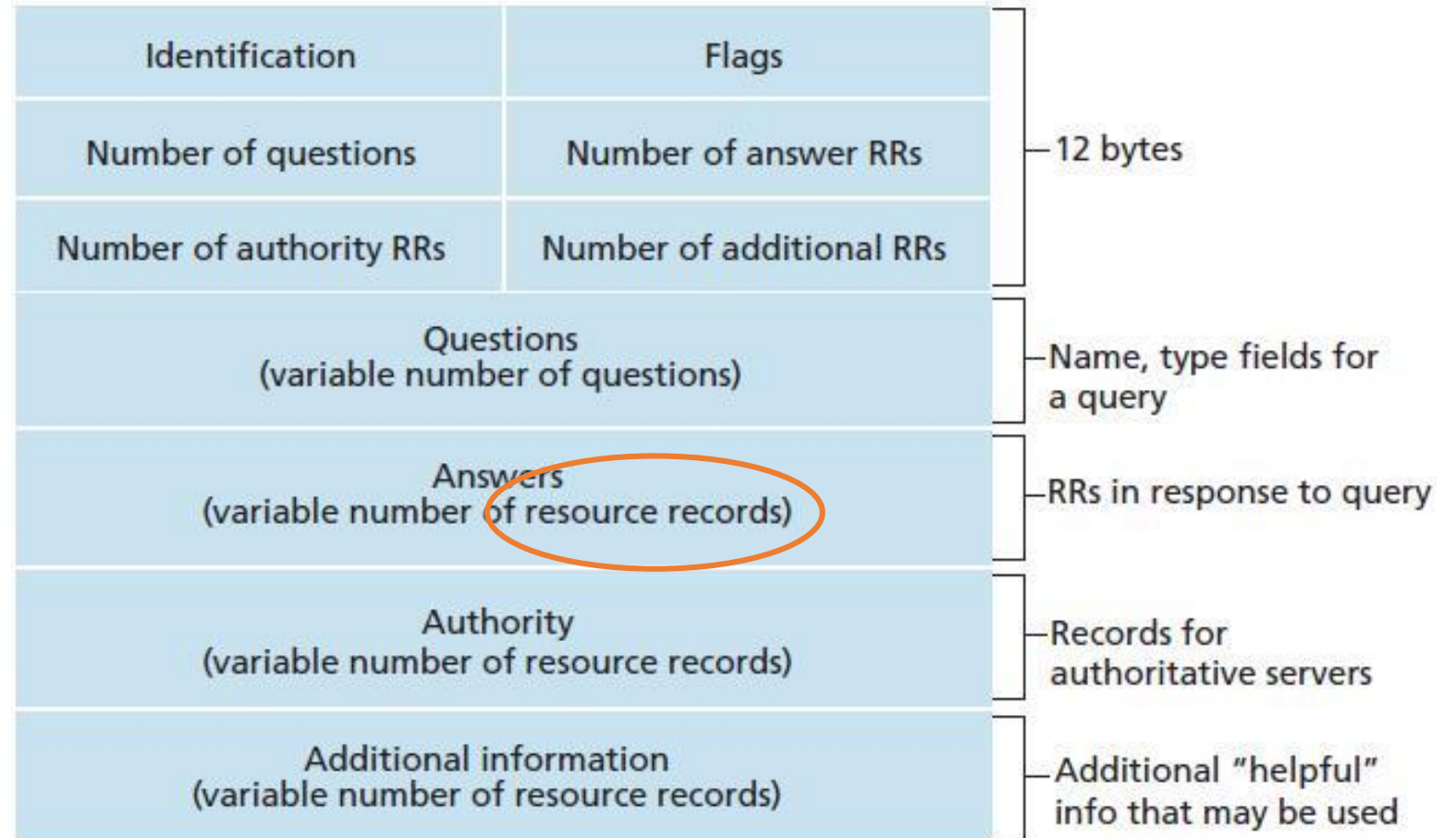
DNS Caching

At every layer

Recursive queries and Iterative queries

The DNS Protocol

- Message types:
 - Query and Response
- Message Syntax:
 - Header section
 - Question section
 - Answer section
 - *authority section*
 - *additional section*
- **Resource Records**



DNS message: the header section

- A 16-bit number that identifies the query
- 16 bits for flags
 - A 1-bit query/reply flag indicates whether the message is a query (0) or a reply (1).
 - A 1-bit authoritative flag is set in a reply message when a DNS server is an authoritative server for a queried name.
 -

Identification	Flags
Number of questions	Number of answer RRs
Number of authority RRs	Number of additional RRs
Questions (variable number of questions)	
Answers (variable number of resource records)	
Authority (variable number of resource records)	
Additional information (variable number of resource records)	

DNS message: the question section

- Contains information about the query that is being made.
- A name field that contains the name that is being queried,
 - e.g. www.baidu.com
- A type field that indicates the type of question being asked about the name.
 - e.g. cname

Identification	Flags
Number of questions	Number of answer RRs
Number of authority RRs	Number of additional RRs
Questions (variable number of questions)	
Answers (variable number of resource records)	
Authority (variable number of resource records)	
Additional information (variable number of resource records)	

DNS message: the answer section

- Contains the resource records for the name that was originally queried.
- A reply can return multiple RRs in the answer, since a hostname can have multiple IP addresses.

Identification	Flags
Number of questions	Number of answer RRs
Number of authority RRs	Number of additional RRs
Questions (variable number of questions)	
Answers (variable number of resource records)	
Authority (variable number of resource records)	
Additional information (variable number of resource records)	

DNS Records and Messages

- The DNS servers that together implement the DNS distributed database store **resource records (RRs)**, including RRs that provide hostname-to-IP address mappings.
- Each DNS reply message carries one or more resource records.
- A resource record is a four-tuple that contains the following fields: (Name, Value, Type, TTL)
 - TTL: time to live

DNS Records and Messages

- If **Type=A**, then **Name** is a hostname and Value is the IP address for the hostname. Thus, a Type A record provides the standard hostname-to-IP address mapping.
 - (www.a.shifen.com, 103.235.46.39, A, ttl)
- If Type=NS, then Name is a domain (such as foo.com) and Value is the hostname of an authoritative DNS server that knows how to obtain the IP addresses for hosts in the domain.
 - (www.a.shifen.com, ns1.a.shifen.com, NS, ttl)

DNS Records and Messages

- If Type=CNAME, then Value is a canonical hostname for the alias hostname Name.
 - (www.baidu.com, www.a.shifen.com, CNAME, ttl)
- If Type=MX, then Value is the canonical name of a mail server that has an alias hostname Name.
 - (scut.edu.cn, postmaster.scutsv33.scut.edu.cn, MX, ttl)

Inserting Records into the DNS Database

- Network Utopia: domain name 'networkutopia.com'
- DNS registration service by **registrar**
 - Many registrars, managed by ICANN
- Insert two resource records into the DNS system:
 - (networkutopia.com, dns1.networkutopia.com, NS)
 - (dns1.networkutopia.com, 212.212.212.1, A)
- (networkutopia.com, 212.212.71.4, A), for web server