

Distributed Systems

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Distributed Systems

Naming

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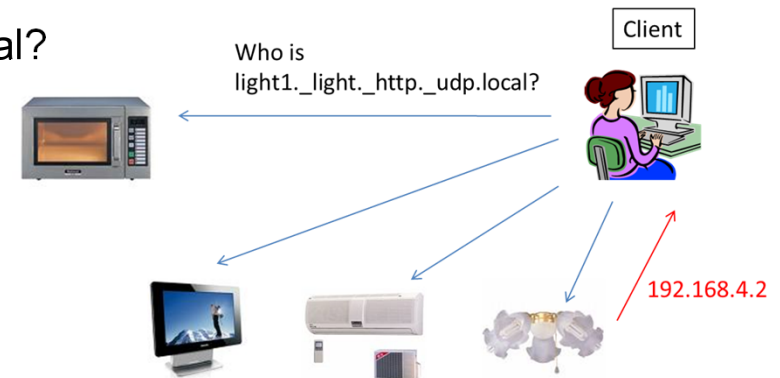
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Naming

- Naming in distributed systems
 - Refer to locations: 兩節點間要通訊，必須能(透過網路)找到對方
 - Identify entities: 兩節點間要通訊，必須能識別雙方
- Naming structures
 - Flat-naming
 - The name is just a universal identifier
 - 名字未表現出結構，例如: 網路卡卡號
 - Structural-naming
 - 名字隱含一定結構，例如: URI: <https://www.nccu.edu.tw>

通訊節點如何找到對方？

- 去中心化的尋找機制：廣播或群播
 - 對位於同一區域網路的端點發出詢問封包 (XXX在那裡?)
 - 例如
 - ARP (Address Resolution Protocol)
 - 在區域網路中，網路交換器(switch)會以廣播方式，詢問誰持有特定IP
 - » 問: 誰有這個IP: 192.168.4.1
 - » 答: 回傳網路卡號: 00-B0-D0-63-C2-26
 - mDNS (multi-cast DNS) : used in LAN
 - 在區域網路中，節點以群播方式，發出A查詢，詢問持有特定name的IP
 - » 問: 誰是light1._light._http._udp.local?
 - » 答: 192.168.4.2



通訊節點如何找到對方？

- 集中式尋找機制

- 尋問某一台 伺服器 上的服務

- 例如:

- DNS

- device1.local開機後，向Name Server註冊其資訊

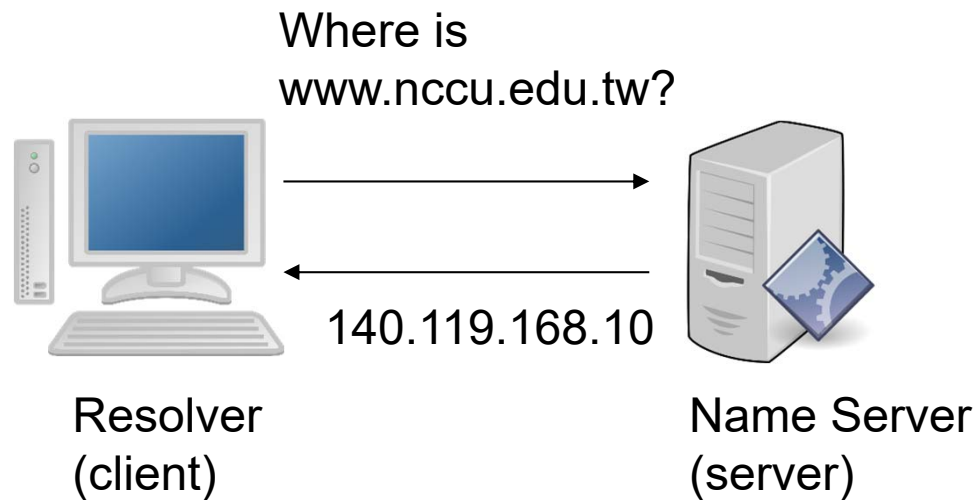
- Client問Name Server: 誰是device1.local?

- Name Server答: 192.168.4.3

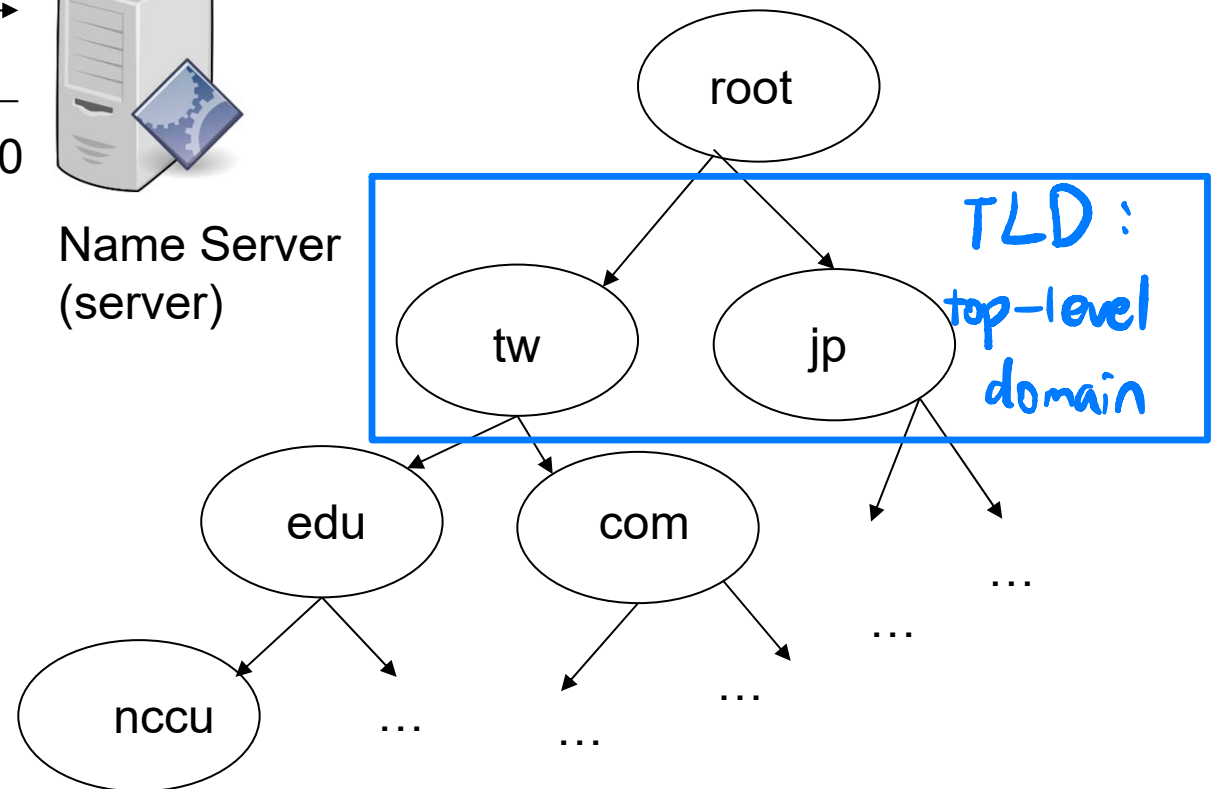


translates domain names to IP addresses

Domain Name System (DNS)



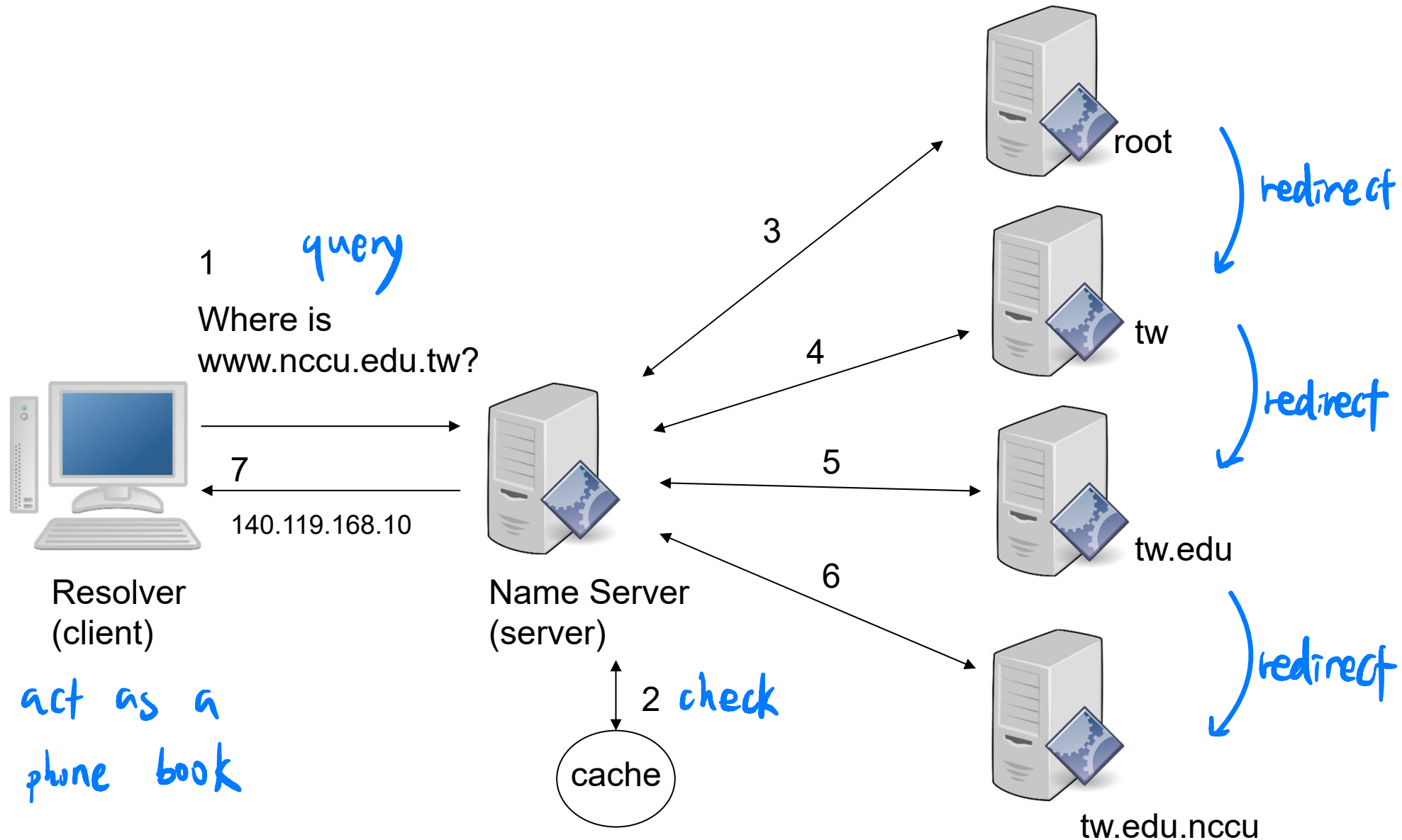
DNS hierarchy



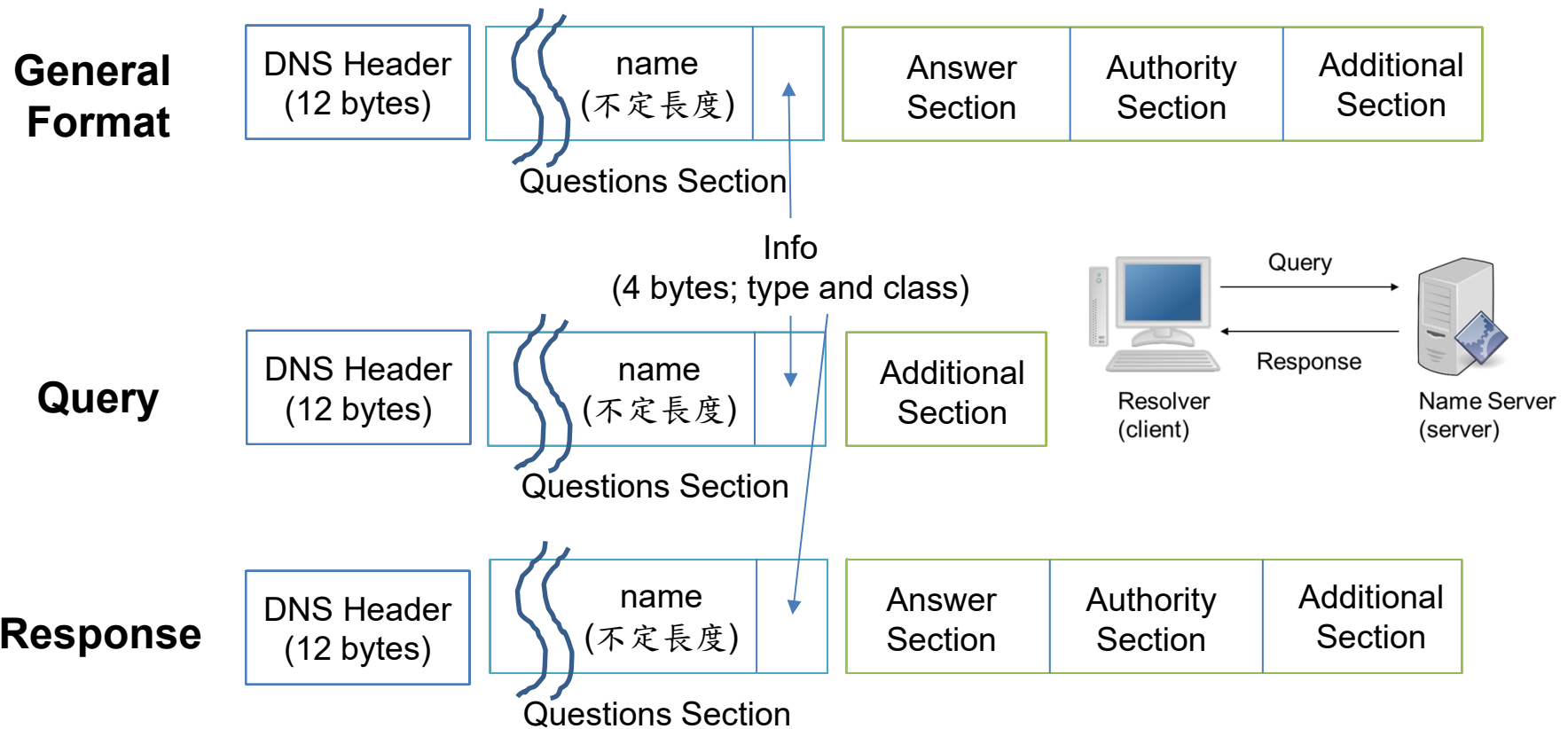
TLD:
top-level
domain

root server
top-level domain server
authoritative DNS Server

DNS Lookup: the Full Path



DNS Packet Format



1.DNS Header: This is always present and is 12 bytes in size. The header contains several fields that dictate the behavior of the DNS query and response, including transaction IDs, flags, and counters for the questions and answers.

2.Questions Section: This contains the actual query with the domain name being requested. It also includes the query type (A, MX, TXT, etc.) and class (usually IN for internet).

3.Answer Section: Present in a response packet, this part contains the records being returned by the DNS server, such as IP addresses for A records.

4.Authority Section: Also in the response packet, this contains records of the authoritative name servers for the queried domain.

5.Additional Section: It often contains additional records related to the query, such as the canonical name for CNAME records or name server records for NS records.

DNS Packet Contents

1	0.000000	192.168.1.165	192.168.1.1	DNS	84 Standard query 0x0001 PTR 1.1.168.192...
2	0.001987	192.168.1.1	192.168.1.165	DNS	84 Standard query response 0x0001 No suc...
3	0.004385	192.168.1.165	192.168.1.1	DNS	75 Standard query 0x0002 A www.nccu.edu...
4	0.007337	192.168.1.1	192.168.1.165	DNS	91 Standard query response 0x0002 A www...
5	0.009575	192.168.1.165	192.168.1.1	DNS	75 Standard query 0x0003 AAAA www.nccu.e...
6	0.011839	192.168.1.1	192.168.1.165	DNS	103 Standard query response 0x0003 AAAA w...

> Internet Protocol Version 4, Src: 192.168.1.165, Dst: 192.168.1.1

> User Datagram Protocol, Src Port: 51801, Dst Port: 53

▼ Domain Name System (query)

Transaction ID: 0x0002

> Flags: 0x0100 Standard query

Questions: 1

Answer RRs: 0

Authority RRs: 0

Additional RRs: 0

▼ Queries

> www.nccu.edu.tw: type A, class IN

[\[Response In: 4\]](#)

DNS Header (12 bytes)

name (不定長度)

Info (type and class)

Questions Section

```

0000 74 f6 1c 00 1d 03 6c 6a 77 e7 ef 91 08 00 45 00
0010 00 3d 81 33 00 00 80 11 00 00 c0 a8 01 a5 c0 a8
0020 01 01 ca 59 00 35 00 29 84 31 00 02 01 00 00 01
0030 00 00 00 00 00 00 03 77 77 77 04 6e 63 63 75 03
0040 65 64 75 02 74 77 00 00 01 00 01
    
```

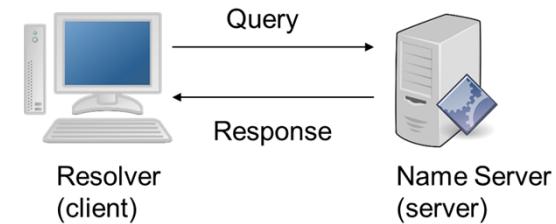
Query

Response

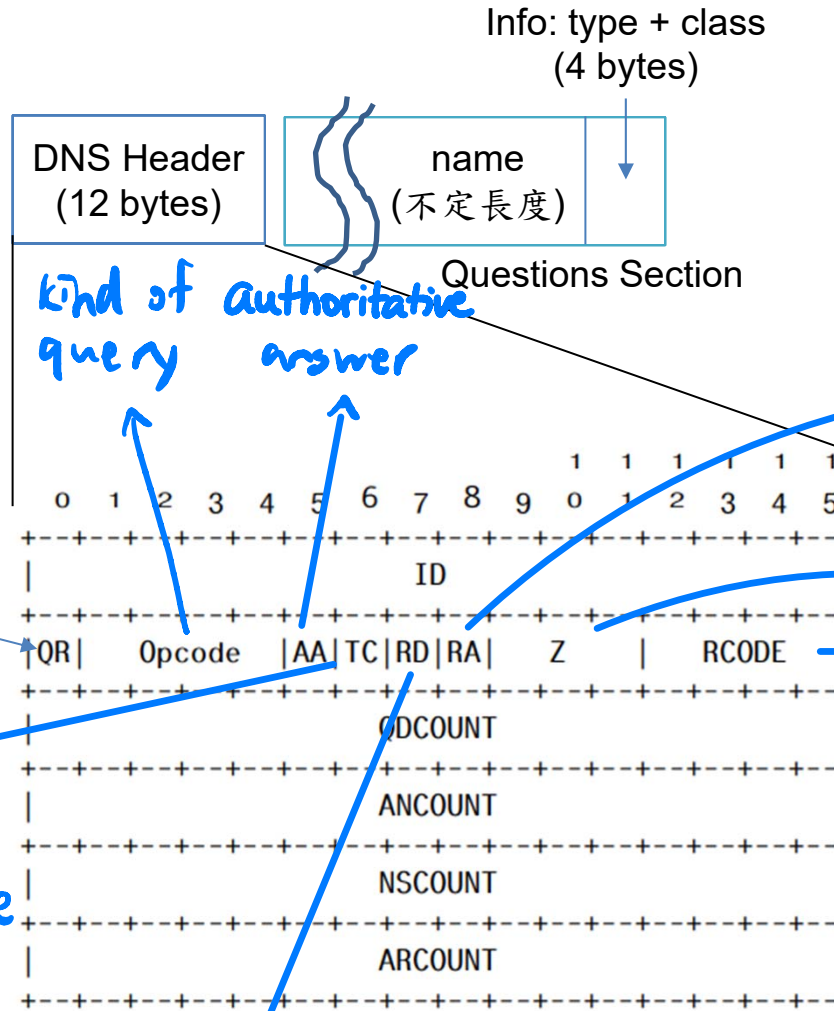
Resolver (client)

Name Server (server)

DNS Header



Query



recursion available (the server can query other servers)

1行 = 2 bytes

reserved for future use

response code (status of the query response)

記錄 Question、Answer、Authority、Additional Section 各有幾個?

RR=Resource Record

query response

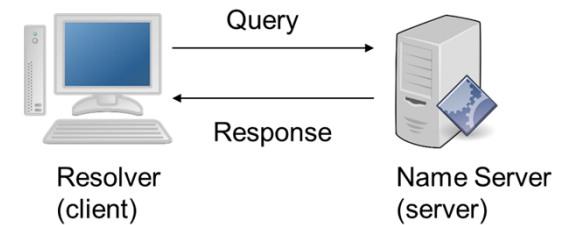
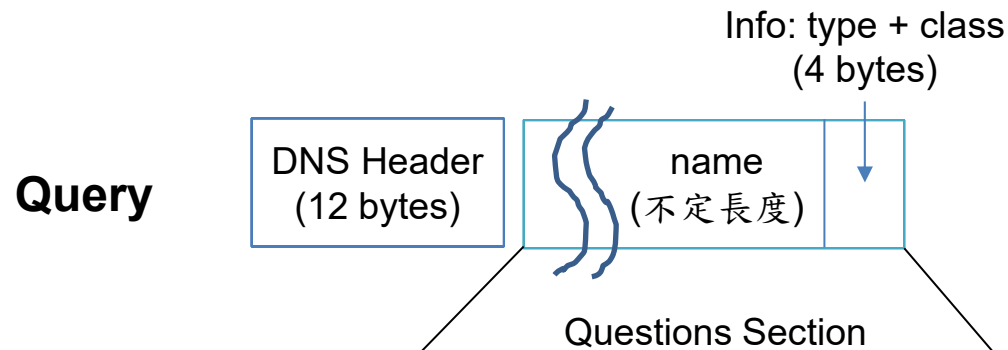
Q:0
R:1

truncated response (indicates the response was > 1 packet)

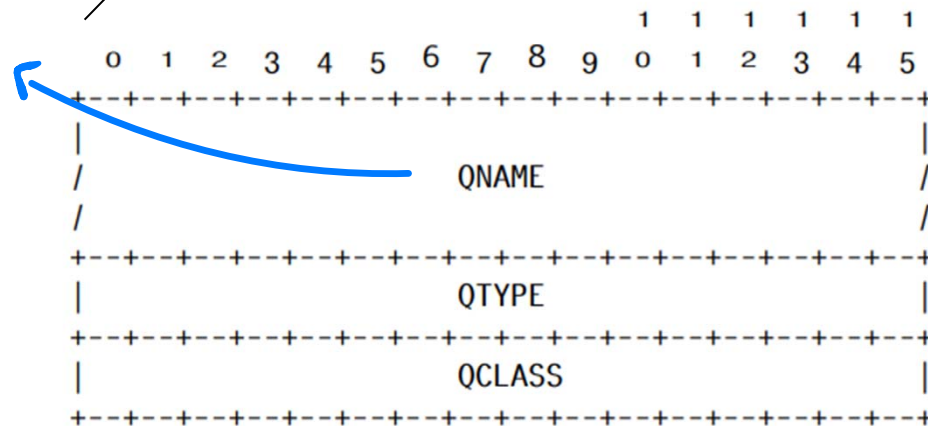
recursion desired (asks the server to query other servers if it does not have the answer)

Where actual requests are specified

DNS Question Section



domain name
being queried



不定長度

Query Type (2 bytes) e.g. A, MX, NS

Query Class (2 bytes)
永遠是1 (IN)

↘ internet

Query Type

used for service discovery
on local networks
↗

○ DNS ^{IPv6}

- A/AAAA
^{IPv4}
 - Domain name to IP
- PTR
 - IP to domain name
- CNAME ^{Canonical Name}
 - Domain name to domain name ^(aliases)
- MX ^{Mail Exchanger}
 - Domain name of Mail server ^(used for emails)

○ mDNS/DNS-SD

- PTR
 - Service type to instance
- SRV
 - Instance to port
- A/AAAA
 - Instance to IP
- TXT
 - 補充資訊

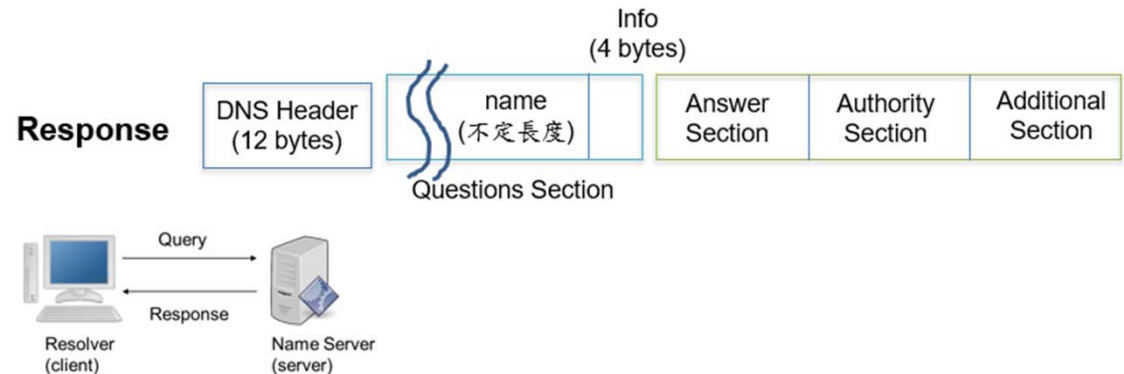
Bonjour / Zeroconf

mDNS / DNS-SD

DNS Response Section

```

> User Datagram Protocol, Src Port: 53, Dst Port: 53
✓ Domain Name System (response)
  Transaction ID: 0x0002
  > Flags: 0x8180 Standard query response, No error
  Questions: 1
  Answer RRs: 1
  Authority RRs: 0
  Additional RRs: 0
  ✓ Queries
    ✓ www.nccu.edu.tw: type A, class IN
      Name: www.nccu.edu.tw
      [Name Length: 15]
      [Label Count: 4]
      Type: A (Host Address) (1)
      Class: IN (0x0001)
  ✓ Answers
    ✓ www.nccu.edu.tw: type A, class IN, addr 140.119.168.10
      Name: www.nccu.edu.tw
      Type: A (Host Address) (1)
      Class: IN (0x0001)
      Time to live: 5732 (1 hour, 35 minutes, 32 seconds)
      Data length: 4
      Address: 140.119.168.10
  [Request In: 3]
  [Time: 0.002057000 seconds]
  
```



Question Section

Answer Section

Answer Section

Response

DNS Header
(12 bytes)

Answer
Section

Authority
Section

Additional
Section

▼ Answers

▼ www.nccu.edu.tw: type A, class IN, addr 140.119.168.10
Name: www.nccu.edu.tw
Type: A (Host Address) (1)
Class: IN (0x0001)
Time to live: 5732 (1 hour, 35 minutes, 32 seconds)
Data length: 4
Address: 140.119.168.10

usually IN ←

RDATA依type有所不同

0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5
NAME															
TYPE															
CLASS															
TTL															
RDLENGTH															
RDATA															

the domain name the
query was about

type of DNS record e.g.

A, MX,
CNAME, etc

length

RDATA格式

○ A/AAAA

- <NAME> <TTL> IN A <IP>

- www.nccu.edu.tw. 5732 IN A 140.119.168.10

○ CNAME

- <NAME> <TTL> IN CNAME <NAME>

- nccu.edu.tw. 5732 IN CNAME www.nccu.edu.tw.

○ MX

- <NAME> <TTL> IN MX <MAIL_SVR_NAME>

○ SRV

- <NAME> <TTL> IN SRV <PRIORITY> <WEIGHT> <PORT> <INSTANCE>

○ PTR : used for reverse DNS lookups, mapping IP addresses back to domain names

- <REVERSE_IP> <TTL> IN PTR <NAME>

- 10.168.119.140.in-addr.arpa. 5732 IN PTR www.nccu.edu.tw.

○ DNS

- A/AAAA

- Domain name to IP

- PTR

- IP to domain name

- CNAME

- Domain name to domain name

- MX

- Domain name of Mail server

工具demo

- nslookup

- nslookup <host-name>
- Ex: nslookup www.nccu.edu.tw

- dig

- Windows系統需要另行安裝
- Dig @<dns server> -p <dns server port>
 <QType> <QName>

Ex: dig @localhost -p 1053 TXT www.foo.example

Resource Discovery

- Naming的進階應用

- 不只能依名稱查詢，還能依照「特性」查詢
 - Ex: 問: 請告訴我「地點最近」、「14吋以上」的投影裝置IP?
- 又稱為Service discovery或Resource discovery
- 例如

- 中心化的resource discovery

- LDAP (Lightweight Directory Access Protocol)
- RMI Registry *RMI: Remote Method Invocation, used in Java*
- Netflix Eureka

- 去中心化的resource discovery

- UPnP *Universal Plug & Play*
- mDNS/DNS-SD *SD: Service Discovery*
- SLP (Service Location Protocol)