APNIC

DNS Concepts

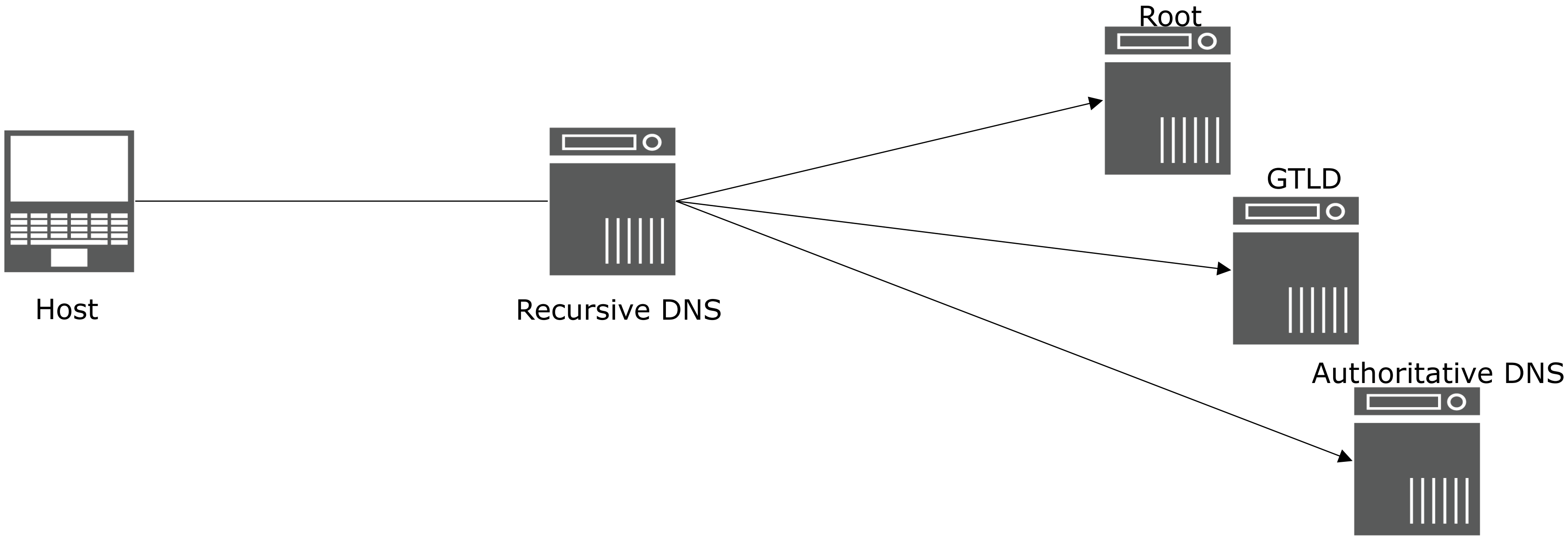
WEBINAR COURSE

Overview

- What is DNS?
- DNS Features
- Domains and Namespaces
- Zones and Delegation
- Nameservers
- DNS Resource Records
- DNS Query

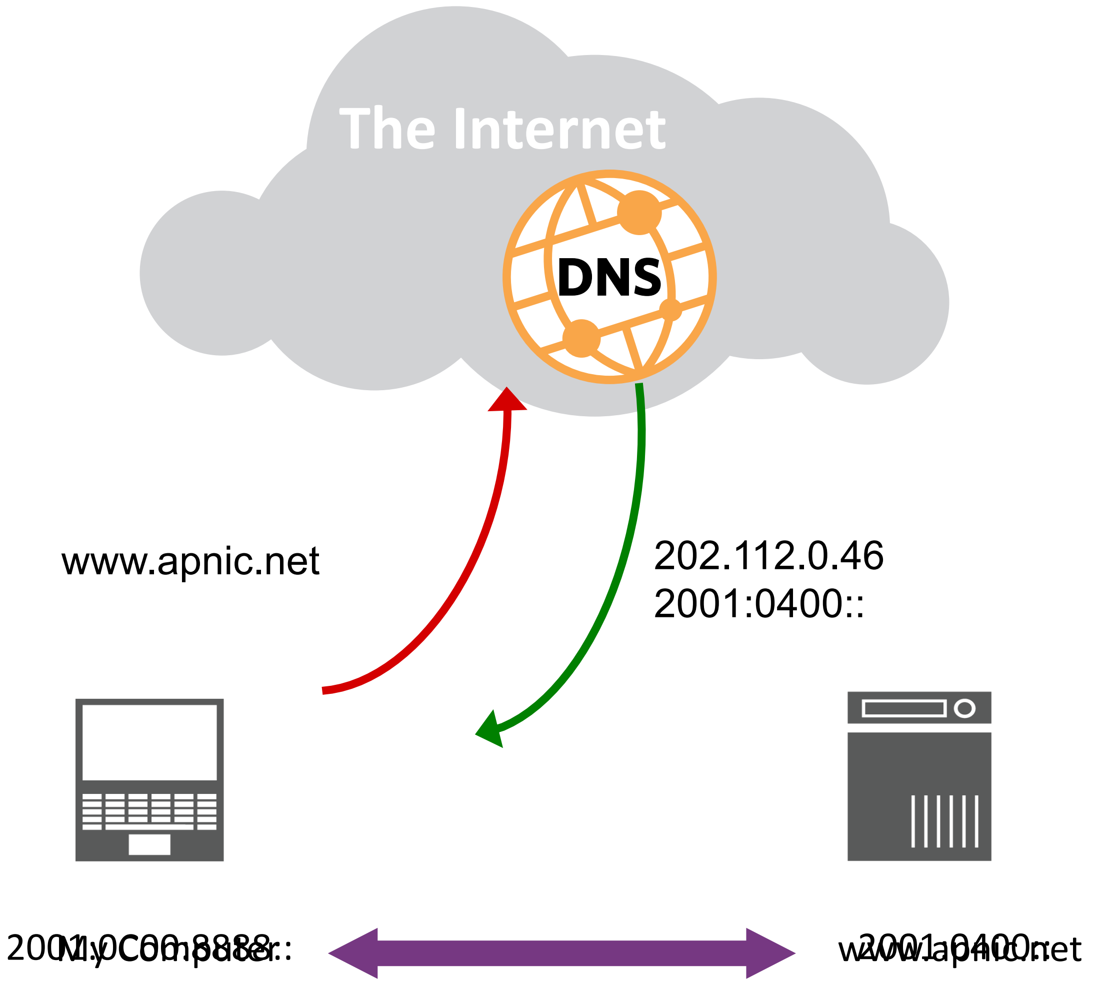
DNS Overview

DNS is a distributed, hierarchical system for translating objects

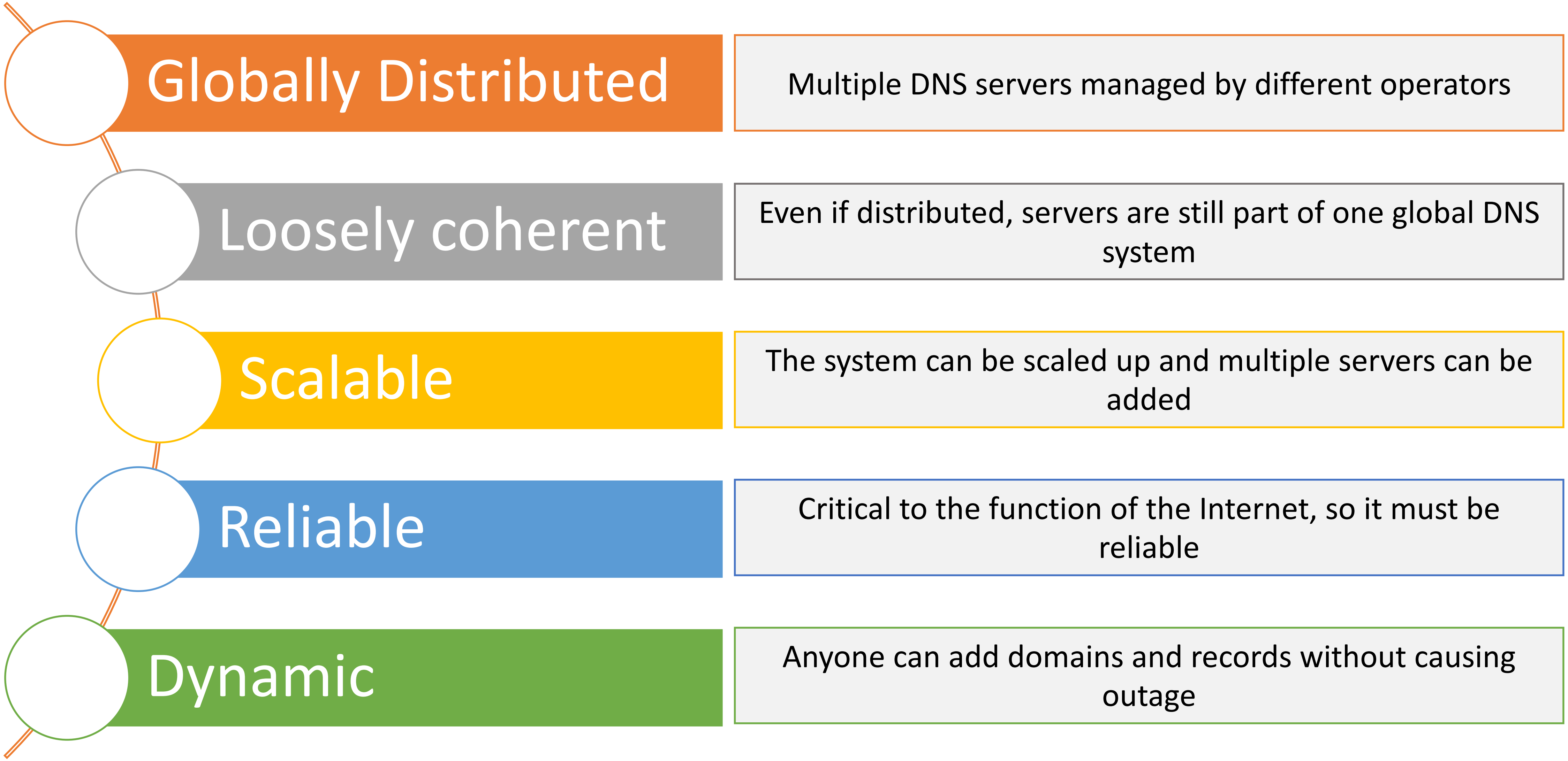


DNS is a critical piece of the Internet infrastructure

IP Addresses vs Domain Names



DNS Features



Globally Distributed	Multiple DNS servers managed by different operators
Loosely coherent	Even if distributed, servers are still part of one global DNS system
Scalable	The system can be scaled up and multiple servers can be added
Reliable	Critical to the function of the Internet, so it must be reliable
Dynamic	Anyone can add domains and records without causing outage

More about DNS

- DNS is a client-server application
  - Client (resolvers) must request, and DNS server responds with information about the record

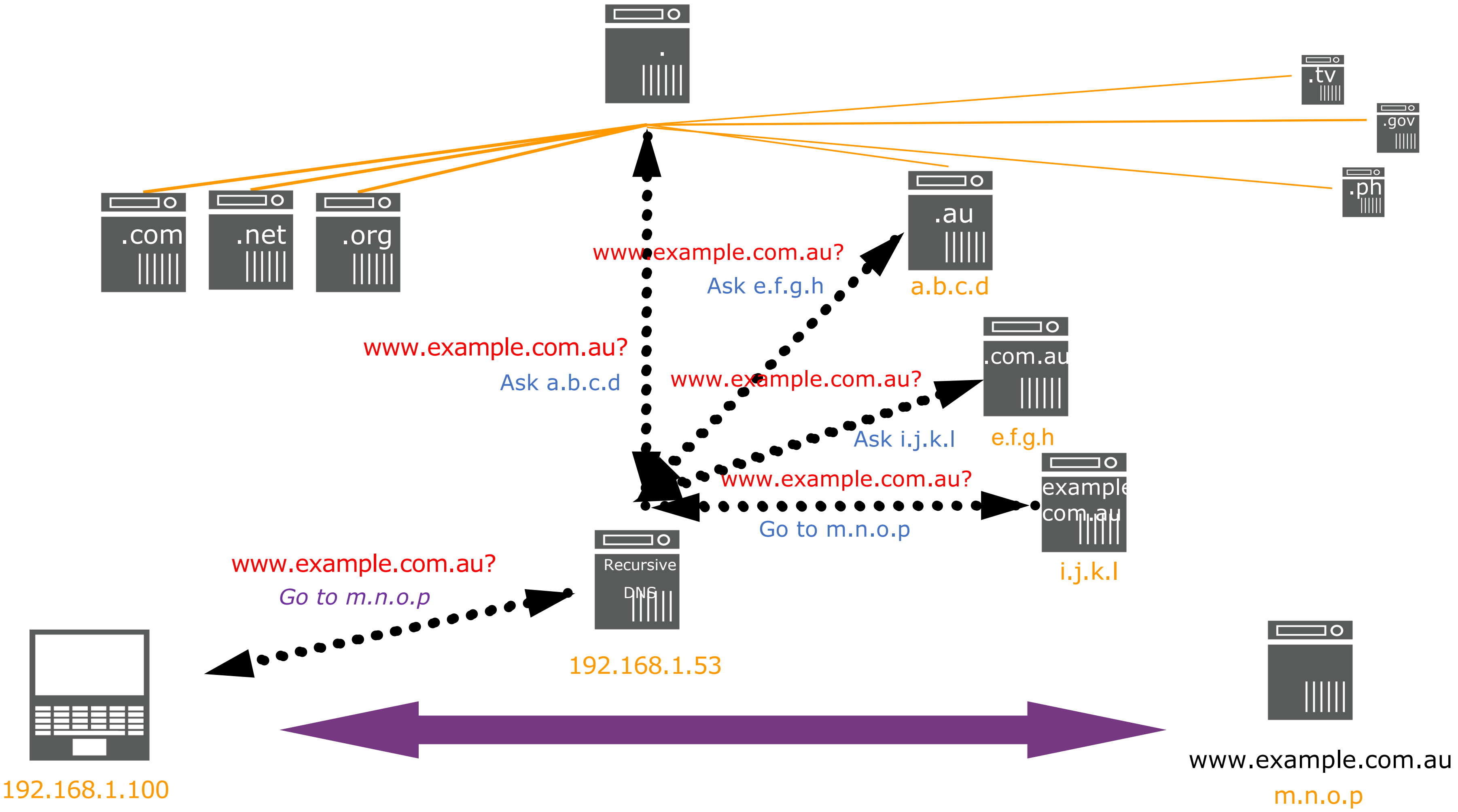
- Requests and responses are normally sent via UDP port 53

- Occasionally uses TCP port 53 for large requests
  - Ex: Zone transfers

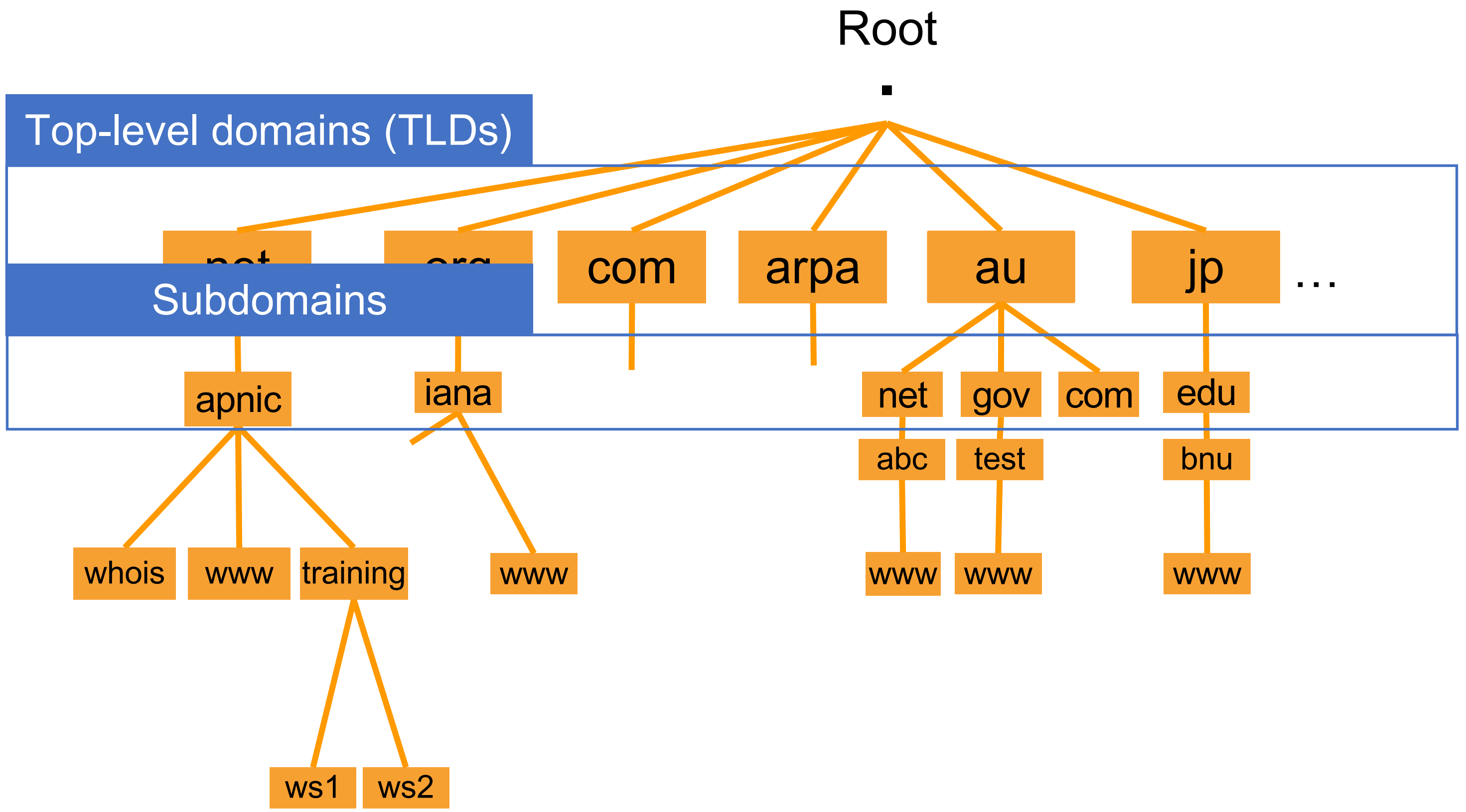
RFC 1032

RFC 1034

What is DNS?


.
.tv
.gov
.ph
.com
.net
.org
.au
a.b.c.d
www.example.com.au?
Ask e.f.g.h
www.example.com.au?
Ask a.b.c.d
.com.au
www.example.com.au?
Ask i.j.k.l
e.f.g.h
example
com.au
www.example.com.au?
Go to m.n.o.p
i.j.k.l
www.example.com.au?
Go to m.n.o.p
Recursive
DNS
192.168.1.53
192.168.1.100
www.example.com.au
m.n.o.p

DNS Hierarchy Tree



Country-code TLDs (ccTLDs)

Generic TLDs (gTLDs)

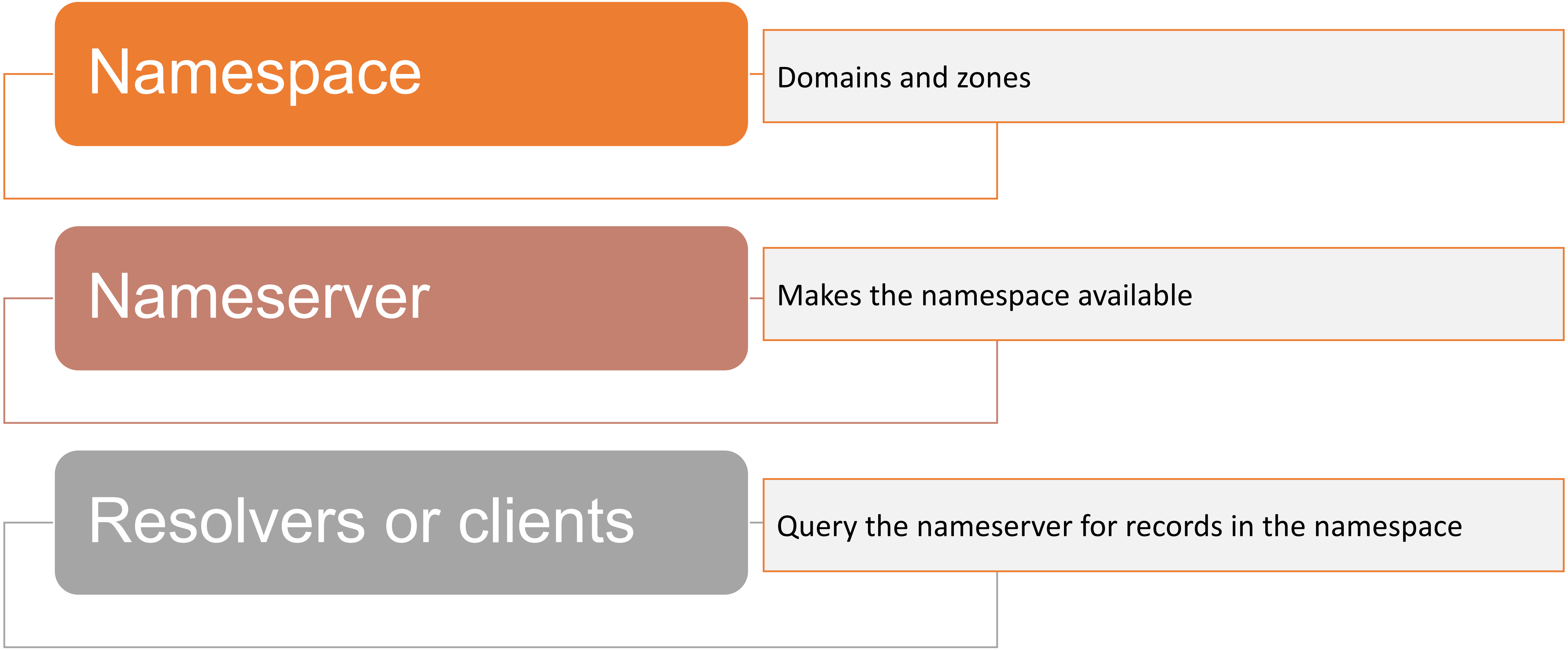
Infrastructure TLD

Internationalized TLDs (IDN)

FQDN: ws1.training.apnic.net.

FQDN = **F**ully **Q**ualified **D**omain **N**ame

DNS Components



Namespace

Domains and zones

Nameserver

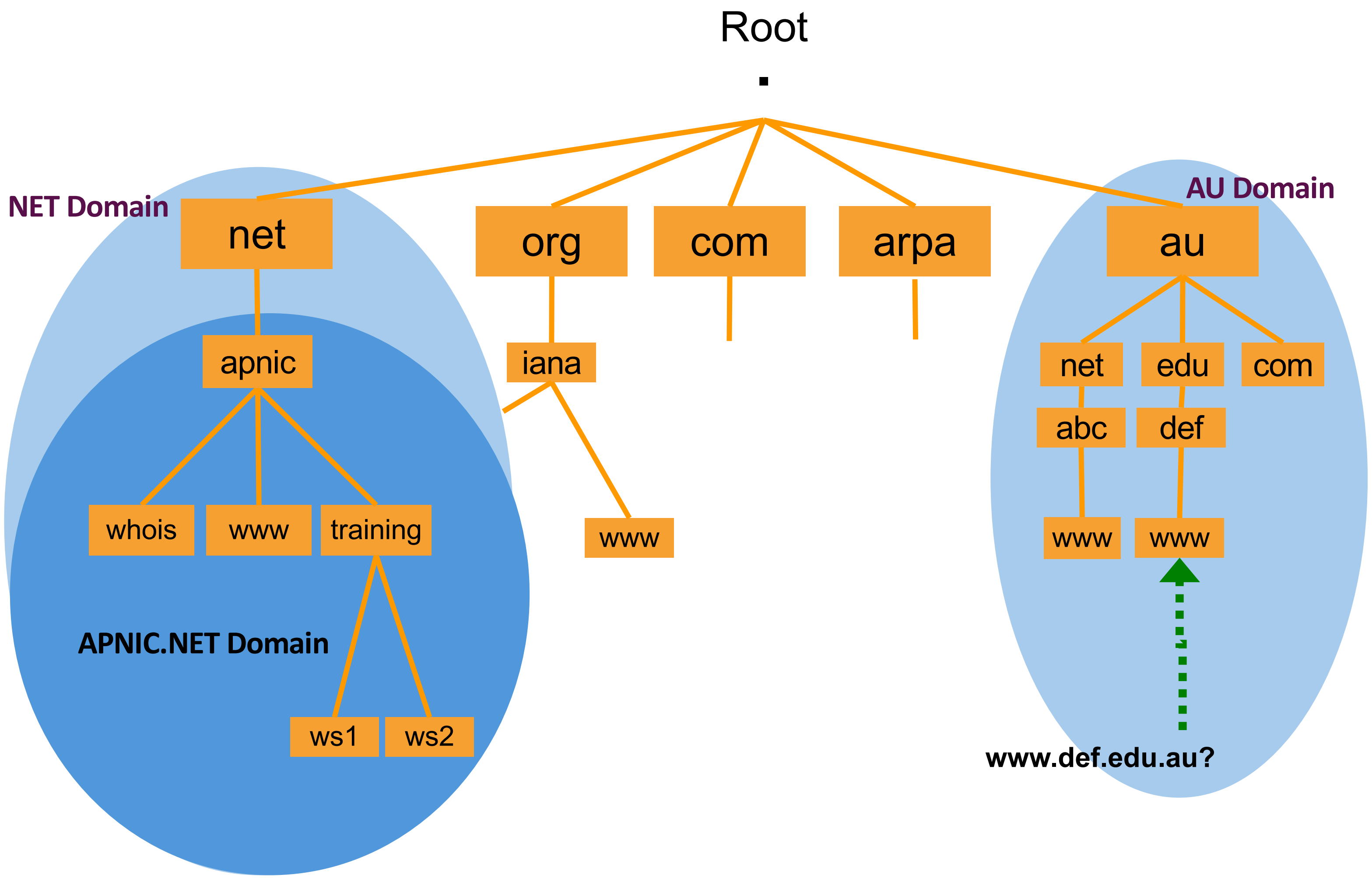
Makes the namespace available

Resolvers or clients

Query the nameserver for records in the namespace

Domains

Domains are “namespaces”



Delegation

Administrators can create subdomains to group hosts

Administrators can delegate responsibility for managing a subdomain to someone else

The parent domain retains links to the delegated subdomain

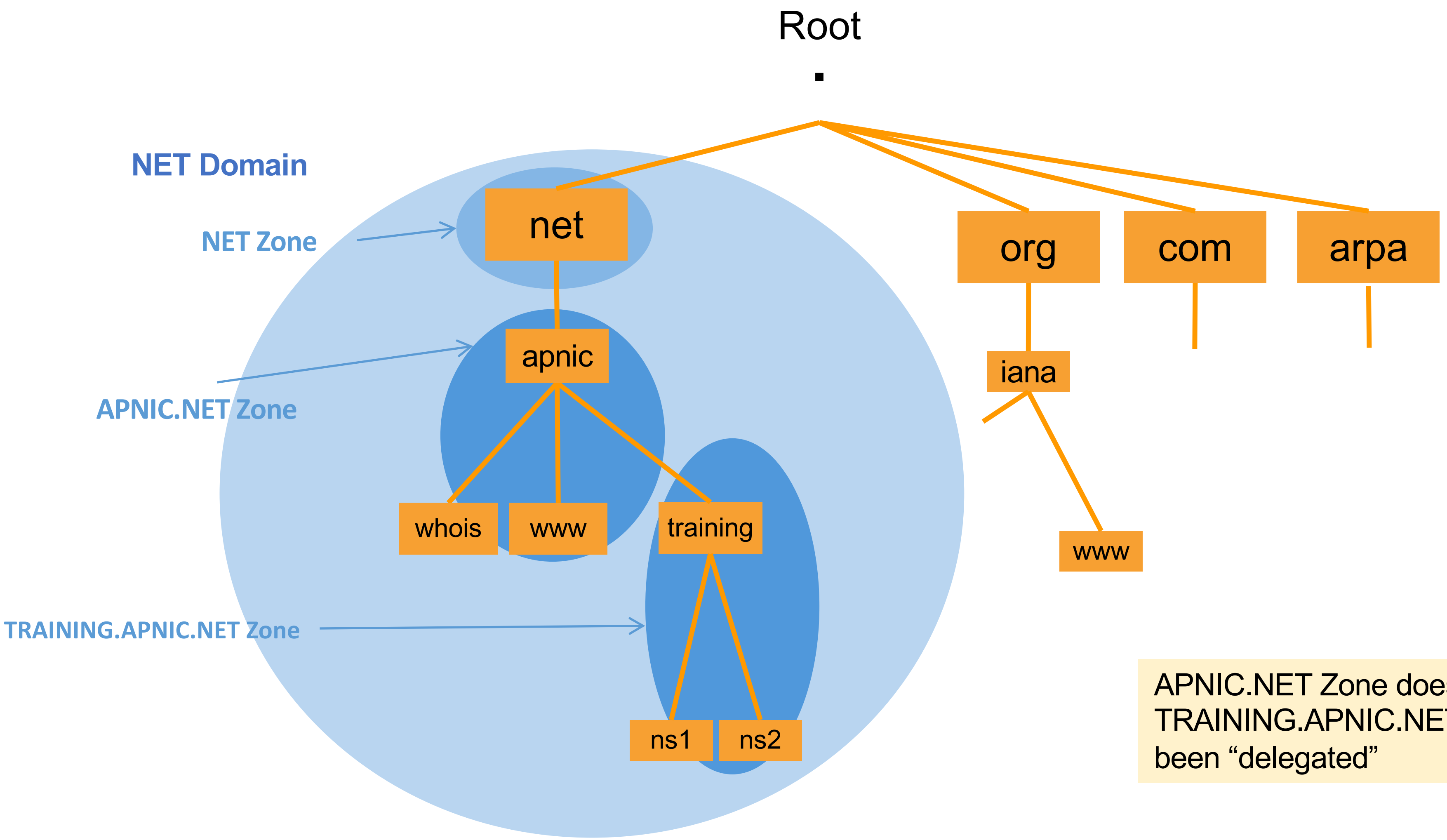
Zones

Zones are “administrative spaces”

Zone administrators are responsible for a portion of a domain’s name space

Authority is delegated from parent to child

Zones



APNIC.NET Zone doesn’t include TRAINING.APNIC.NET since it has been “delegated”

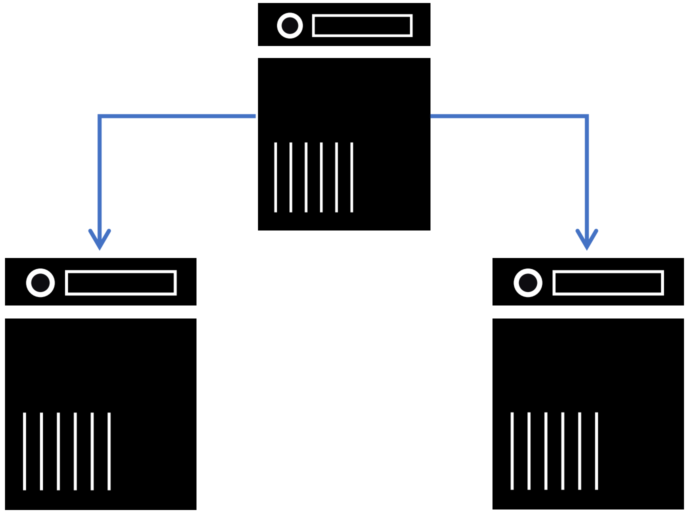
Name Servers

- Name servers answer DNS questions

- Several types of name servers
  - Authoritative servers
    - Primary
    - Secondary
  - Recursive servers
    - also caching forwarders

- Mixture of functions

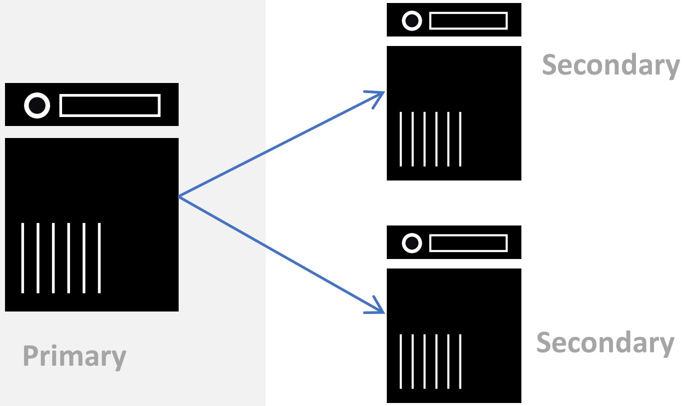
Primary DNS



Secondary DNS servers

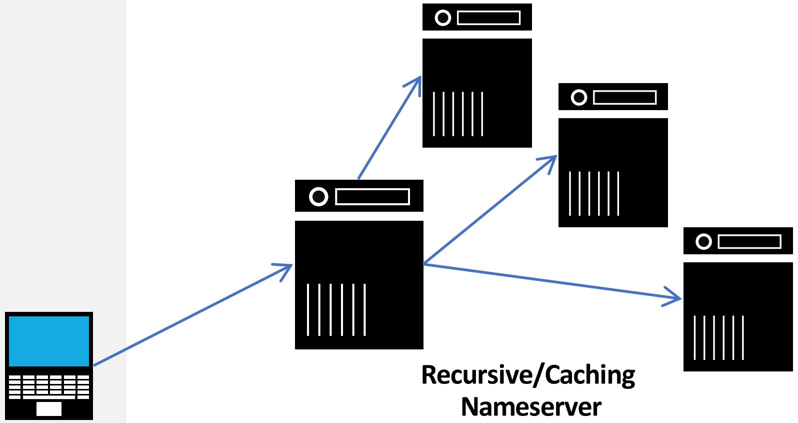
Authoritative Nameserver

- A nameserver that is authorised to provide an answer for a particular domain
  - Can be more than one auth nameserver
- Two types based on management method:
  - Primary (Master) and Secondary (Slave)
- Only one primary nameserver
  - All changes to the zone are done in the primary
- Secondary nameserver/s will retrieve the zonefile from the primary server
  - Secondary polls the primary periodically
- Primary server can “notify” the secondary servers



Recursive Nameserver

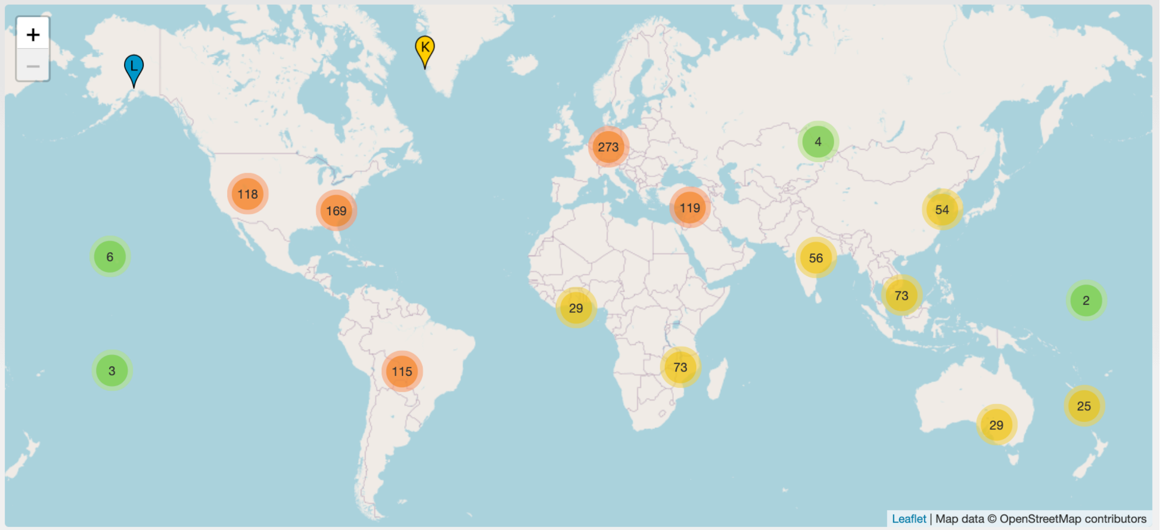
- The job of the recursive nameserver is to locate the authoritative nameserver and get back the answer
- This process is iterative – starts at the root
- Recursive servers are also usually caching servers
- Prefer a nearby cache
  - Minimizes latency issues
  - Also reduces traffic on your external links



Root Servers

- The top of the DNS hierarchy
- There are 13 root name servers operated around the world

  `[a-m].root-servers.net`
- There are more than 13 physical root name servers
  - Each rootserver has an instance deployed via anycast

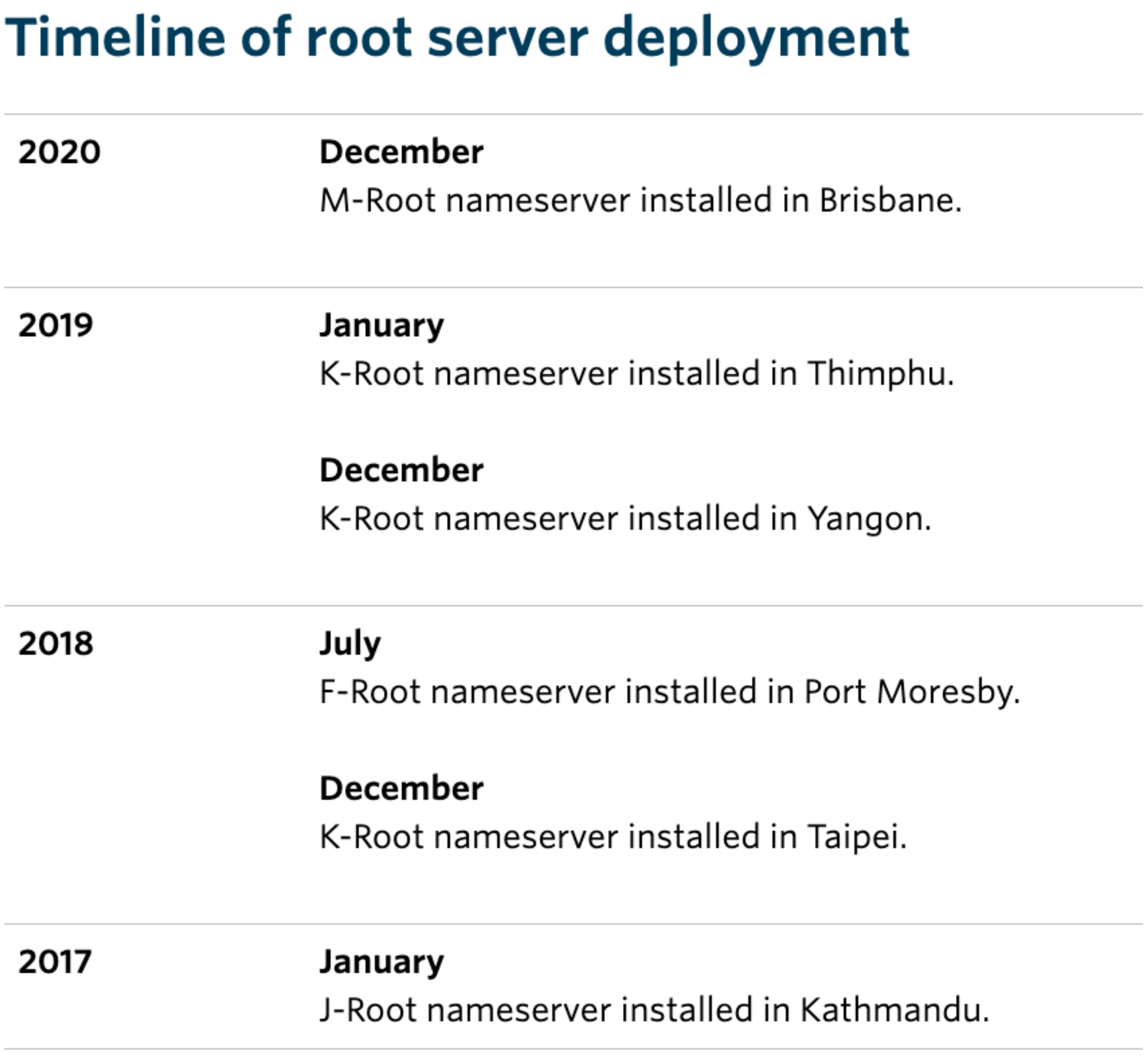


As of 01/20/2021 1:39 a.m., the root server system consists of 1368 instances operated by the 12 independent root server operators.

Src: https://root-servers.org/

Root Server Deployment at APNIC

- Started in 2002, APNIC is committed to establish new root server sites in the AP region
- The aim is to strengthen DNS by deploying additional resources to handle growing Internet traffic.



Timeline of root server deployment

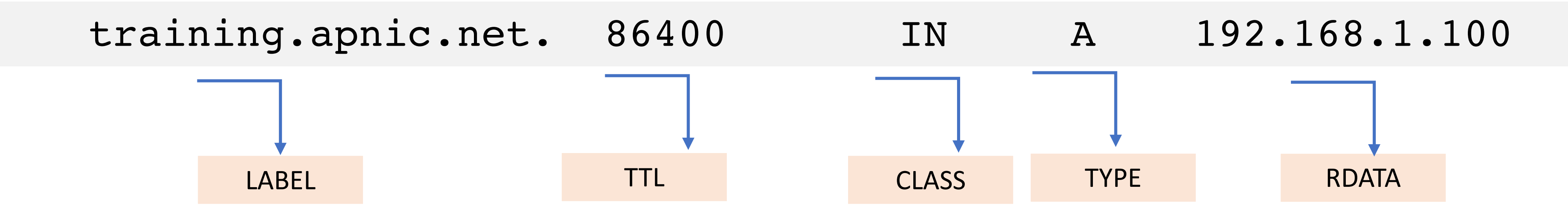
2020	**December** M-Root nameserver installed in Brisbane.
2019	**January** K-Root nameserver installed in Thimphu. **December** K-Root nameserver installed in Yangon.
2018	**July** F-Root nameserver installed in Port Moresby. **December** K-Root nameserver installed in Taipei.
2017	**January** J-Root nameserver installed in Kathmandu.

Ref: https://www.apnic.net/community/support/root-servers/

Resource Records

Entries in the DNS zone file

Resource Record	Function
Label	Name substitution for FQDN
TTL	Timing parameter, an expiration limit
Class	IN for Internet, CH for Chaos
Type	RR Type (A, AAAA, MX, PTR) for different purposes
RDATA	Anything after the Type identifier; Additional data



```
training.apnic.net.  86400      IN   A   192.168.1.100
```

LABEL

TTL

CLASS

TYPE

RDATA

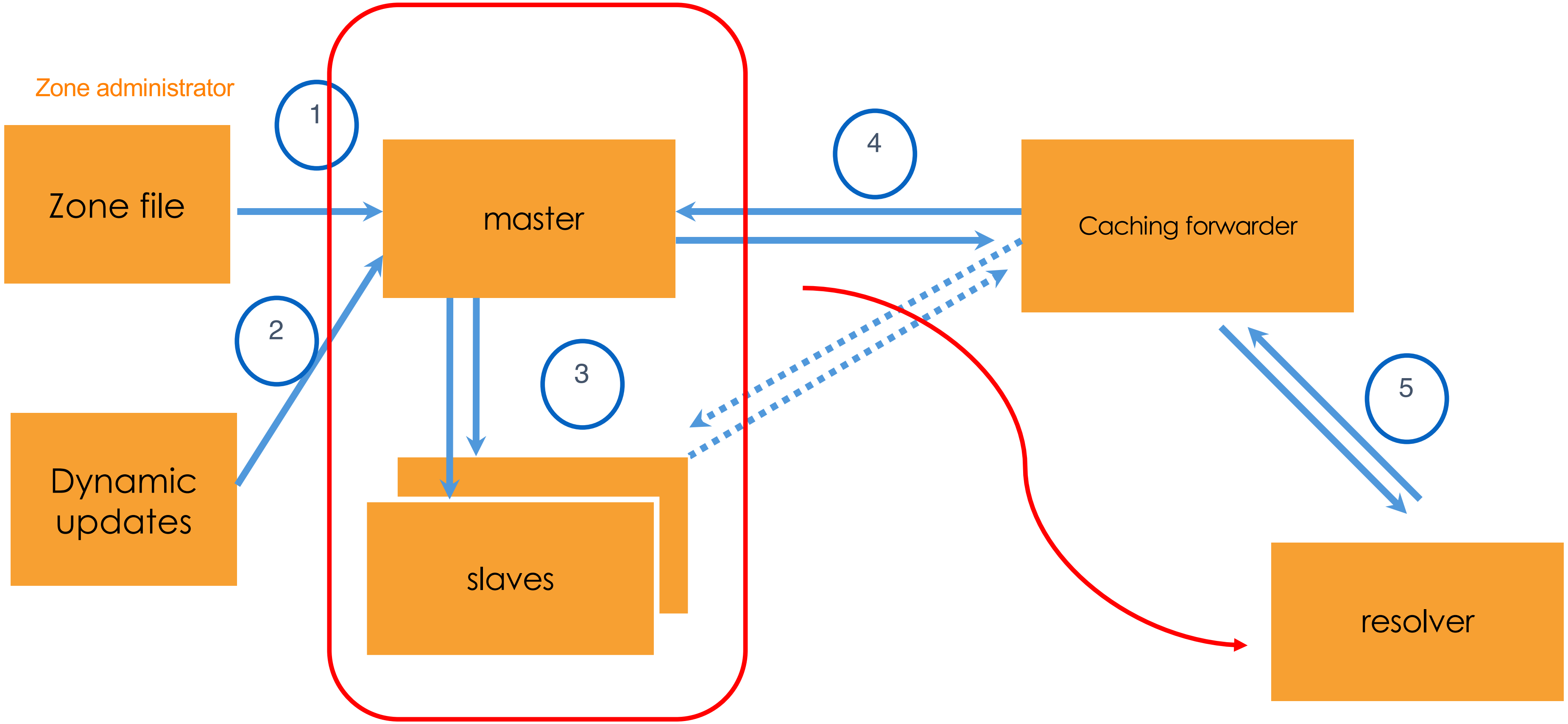
Common Resource Record Types

RR Type	Name	Functions
A	Address record	Maps the domain name to IP address www.example.com. IN A 192.168.1.1
AAAA	IPv6 address record	Maps the domain name to an IPv6 address www.example.com. IN AAAA 2001:db8::1
NS	Name server record	Used for delegating zone to a nameserver example.com. IN NS ns1.example.com.
PTR	Pointer record	Maps an IP address to a domain name 1.1.168.192.in-addr.arpa. IN PTR www.example.com.
CNAME	Canonical name	Maps an alias to a hostname web IN CNAME www.example.com.
MX	Mail Exchanger	Defines where to deliver mail for user @ domain example.com. IN MX 10 mail01.example.com. IN MX 20 mail02.example.com.

Example: RRs in a Zone File

```
apnic.net.     7200        IN   SOA     ns.apnic.net. admin.apnic.net. (
                           2020072001    ; Serial
                           12h           ; Refresh 12 hours
                           4h            ; Retry 4 hours
                           4d            ; Expire 4 days
                           2h )          ; Negative cache 2 hours

apnic.net.     7200        IN    NS               ns.apnic.net.
apnic.net.     7200        IN    NS               ns.ripe.net.

www.apnic.net. 3600        IN   A                 192.168.0.2
www.apnic.net   3600       IN   AAAA     2001:DB8::2
```

DNS Data Flow



Delegating a Zone

Delegation is done by adding NS records.

RFC 1912

In this example, **apnic.net** zone is delegating the subdomain **academy.apnic.net** to these 2 nameservers.

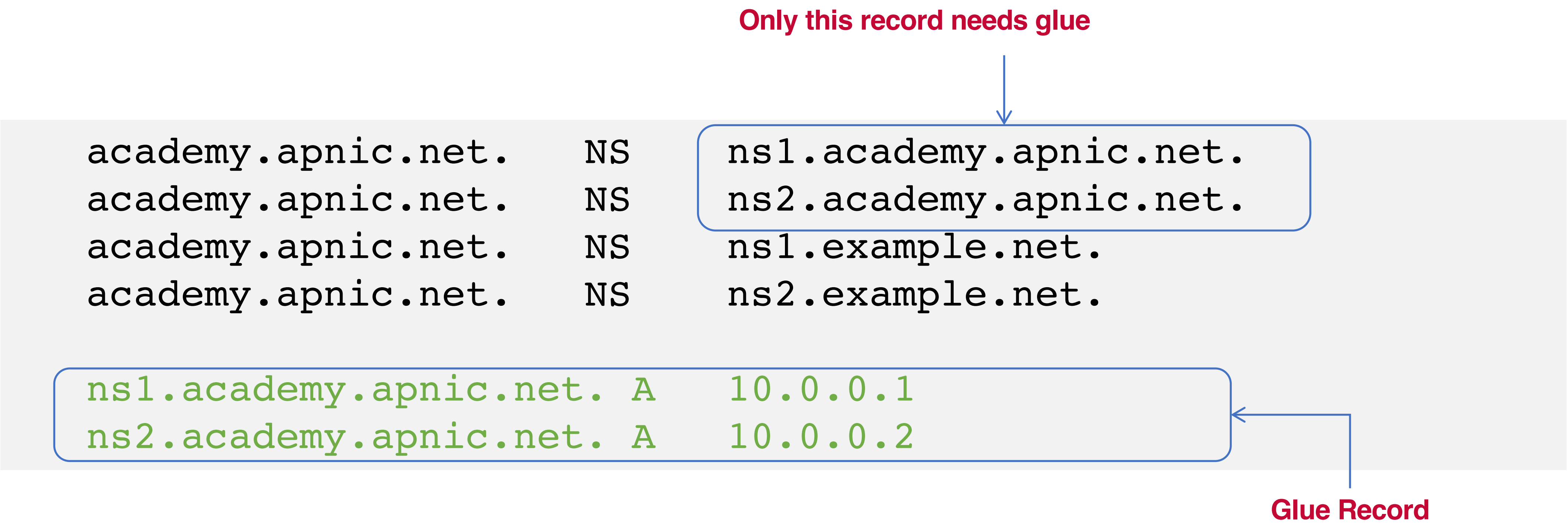
```
;From apnic.net zone, add these records:

academy.apnic.net.   NS    ns1.academy.apnic.net.
academy.apnic.net.   NS    ns2.academy.apnic.net.
```

A client must then go to ns1.academy.apnic.net (or ns2) to query for any of its subdomain.

Now how can we reach ns1 and ns2? We must add a **Glue Record.**

Glue Record

A **glue record** is a non-authoritative data. It is an A record that maps the address of the sub-domain’s nameserver.



Only this record needs glue

```
academy.apnic.net.    NS    ns1.academy.apnic.net.
academy.apnic.net.    NS    ns2.academy.apnic.net.
academy.apnic.net.    NS    ns1.example.net.
academy.apnic.net.    NS    ns2.example.net.

ns1.academy.apnic.net. A    10.0.0.1
ns2.academy.apnic.net. A    10.0.0.2
```

Glue Record

Delegation Example

ns.apnic.net

1. Add NS records and glue
2. Make sure there is no other data from the academy.apnic.net. zone in the zone file

ns.academy.apnic.net

1. Setup minimum two servers
2. Create zone file with NS records
3. Add all academy.apnic.net data in its own zonefile.

Resolvers

A piece of software (usually in the operating system) which formats the DNS request into UDP packets

A stub resolver is a minimal resolver that forwards all requests to a local recursive nameserver

Every host needs a resolver

- In Linux, this is in /etc/resolv.conf
- Configure to use more than one DNS server

DNS Query – dig

What is the IP address of academy.apnic.net?

```
dig academy.apnic.net

; <<>> DiG 9.14.10 <<>> academy.apnic.net
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 60912
;; flags: qr rd ra ad; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;academy.apnic.net.               IN       A

;; ANSWER SECTION:
academy.apnic.net.        86400   IN       A        203.119.101.88

;; Query time: 17 msec
;; SERVER: 202.12.29.236#53(202.12.29.236)
;; WHEN: Wed Jan 20 10:58:42 AEST 2021
;; MSG SIZE  rcvd: 62
```

DNS Query – drill

```
drill academy.apnic.net

;; ->>HEADER<<- opcode: QUERY, rcode: NOERROR, id: 62275
;; flags: qr rd ra ; QUERY: 1, ANSWER: 1, AUTHORITY: 4, ADDITIONAL: 6
;; QUESTION SECTION:
;; academy.apnic.net.        IN       A

;; ANSWER SECTION:
academy.apnic.net. 86400     IN       A         203.119.101.88

;; AUTHORITY SECTION:
apnic.net.         3600      IN       NS        ns4.apnic.net.
apnic.net.         3600      IN       NS        netnod.apnic.net.
apnic.net.         3600      IN       NS        ns2.apnic.net.
apnic.net.         3600      IN       NS        apnic.authdns.ripe.net.

;; ADDITIONAL SECTION:
ns2.apnic.net.     2547      IN       A         203.119.95.53
ns4.apnic.net.     2547      IN       A         202.12.31.53
netnod.apnic.net.  2575      IN       A         194.146.106.106
ns2.apnic.net.     2547      IN       AAAA      2001:ddd::53
ns4.apnic.net.     2547      IN       AAAA      2001:dd8:12::53
netnod.apnic.net.  2575      IN       AAAA      2001:67c:1010:27::53

;; Query time: 107 msec
;; SERVER: 203.119.110.16
;; WHEN: Mon Jan 25 15:34:07 2021
;; MSG SIZE  rcvd: 273
```

Remember …

Deploy multiple authoritative servers to distribute load and risk

Use cache to reduce load to authoritative servers and response times

SOA timers and TTL need to be tuned to the needs of the zone

Thank You!