DNS refresher

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Overview

- Goal of this session
- What is DNS ?
- How is DNS built and how does it work?
- How does a query work ?
- Record types
- Caching and Authoritative
- Delegation: domains vs zones
- Finding the error: where is it broken?

Goal of this session

- We will review the basics of DNS, including query mechanisms, delegation, and caching.

- The aim is to be able to understand enough of DNS to be able to configure a caching DNS server, and troubleshoot common DNS problems, both local and remote (on the Internet)

What is DNS ?

- System to convert names to IP addresses:

  www.ws.afnog.org → 196.200.223.1
  www.afrinic.net → 2001:42d0::200:80:1

- ... and back:

  196.200.223.1 → noc.ws.afnog.org
  1.0.0.0.0.8.0.0.0.0.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.d.2.4.1.0.0.2.ip6.arpa. → www.afrinic.net.

What is DNS ?

- Other information can be found in DNS:
  - where to send mail for a domain
  - who is responsible for this system
  - geographical information
  - etc...
- How do we look this information up ?

Basic DNS tools

- Using the host command:

```
# host noc.ws.afnog.org.

noc.ws.afnog.org has address 196.200.223.1

# host 196.200.223.1

1.223.200.196.in-addr.arpa domain name
pointer noc.ws.afnog.org.
```

Basic DNS tools

- Host with IPv6:

```
# host www.afrinic.net

www.afrinic.net has IPv6 address
2001:42d0::200:80:1

# host 2001:42d0::200:80:1

1.0.0.0.0.8.0.0.0.0.2.0.0.0.0.0.0.0.0.0.0.
0.0.0.0.d.2.4.1.0.0.2.ip6.arpa domain name
pointer www.afrinic.net.
```

Basic DNS tools

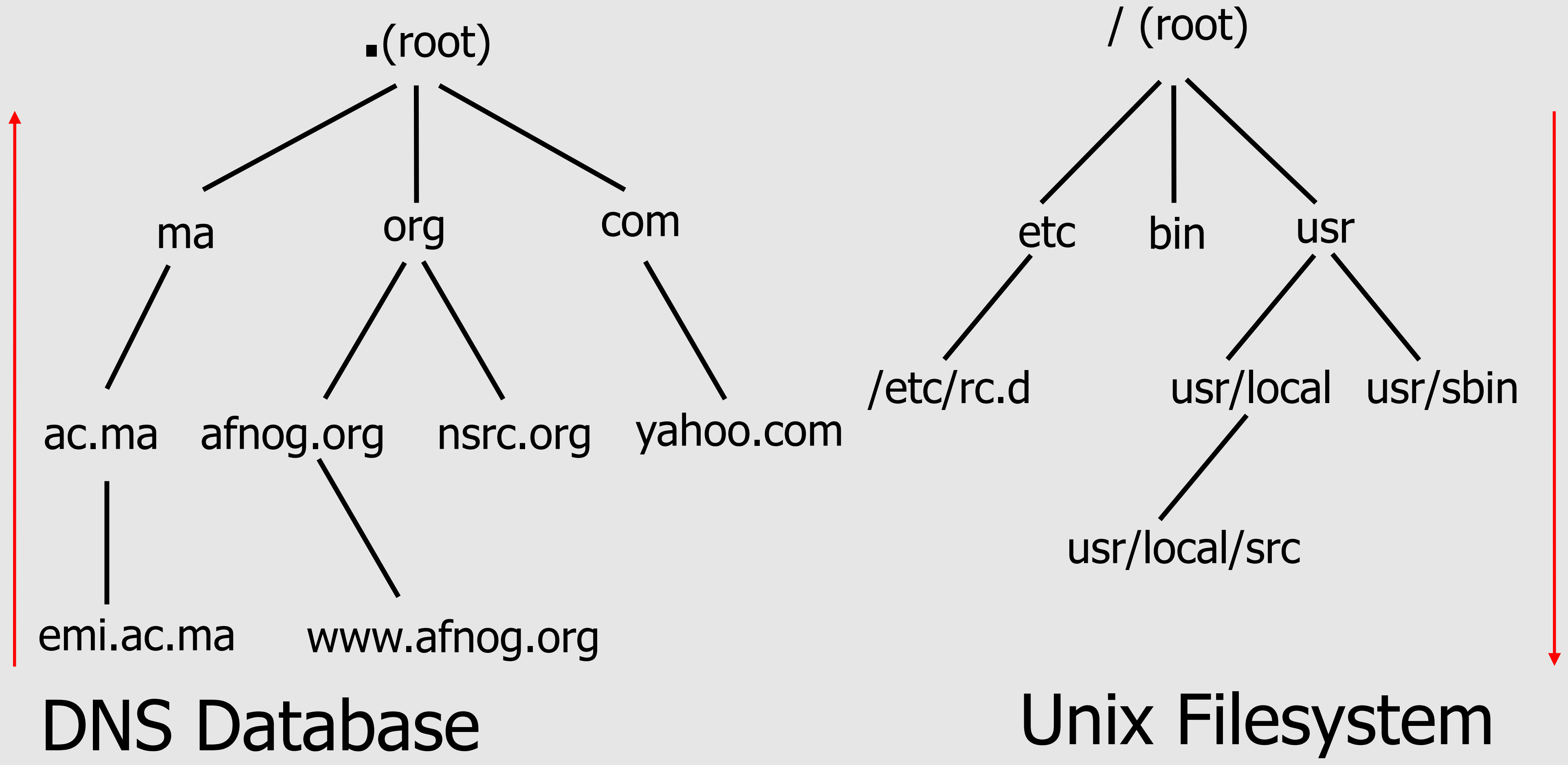
- Try this yourself with other names – first lookup the names below, then do the same for the IP address returned:

```
www.yahoo.com
www.nsrc.org
ipv6.google.com
```

- Does the lookup of the IP match the name ? Why ?

- Where did the 'host' command find the information ?

How is DNS built ?



... forms a tree structure

How is DNS built ?

- DNS is hierarchical
- DNS administration is shared – no single central entity administrates all DNS data
- This distribution of the administration is called *delegation*

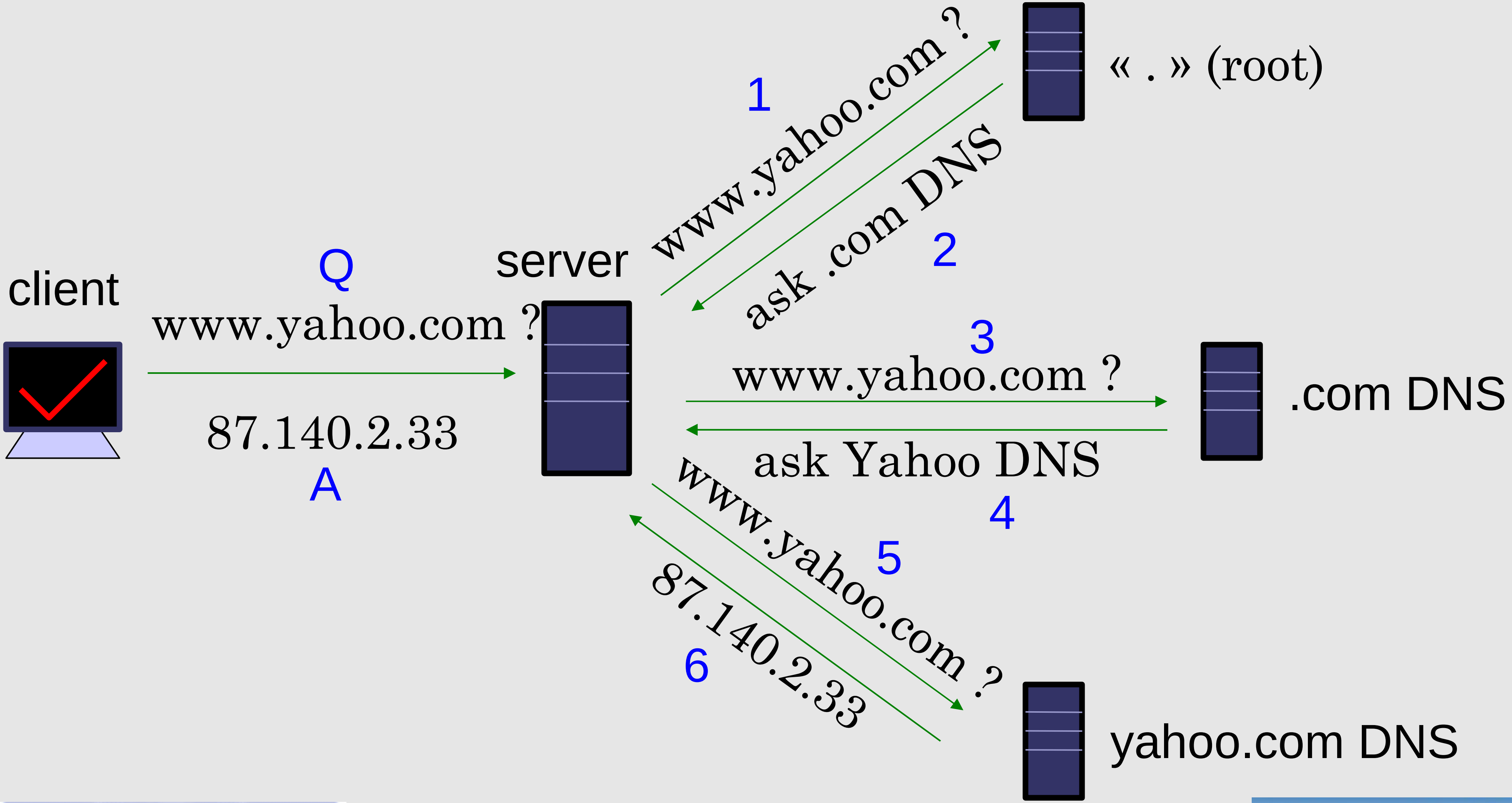
How does DNS work ?

- **Clients** use a mechanism called a **resolver** and ask **servers** – this is called a **query**
- The server being queried will try to find the answer on behalf of the client
- The server functions recursively, from top (the root) to bottom, until it finds the answer, asking other servers along the way - the server is referred to other servers

How does DNS work ?

- The client (web browser, mail program, ...) use the OS’s resolver to find the IP address.
- For example, if we go to the webpage www.yahoo.com:
  - the web browser asks the OS « I need the IP for www.yahoo.com »
  - the OS looks in the resolver configuration which server to ask, and sends the query
- On UNIX, /etc/resolv.conf is where the resolver is configured.

A DNS query



client

server

Q

www.yahoo.com ?

87.140.2.33

A

1

www.yahoo.com ?

« . » (root)

2

ask .com DNS

3

www.yahoo.com ?

.com DNS

ask Yahoo DNS

4

5

www.yahoo.com ?

yahoo.com DNS

6

87.140.2.33

Query detail with tcpdump

- Let's lookup 'h1-web.hosting.catpipe.net'
- On the server, we do:

```
# tcpdump -n udp and port 53
```

- In another window/screen do:

```
# host <something>
```

Query detail - output

```
• 1: 18:40:38.62 IP 192.168.1.1.57811 > 192.112.36.4.53:
  29030 [1au] A? h1-web.hosting.catpipe.net. (55)
• 2: 18:40:39.24 IP 192.112.36.4.53 > 192.168.1.1.57811:
  29030- 0/13/16 (540)

• 3: 18:40:39.24 IP 192.168.1.1.57811 > 192.43.172.30.53:
  7286 [1au] A? h1-web.hosting.catpipe.net. (55)
• 4: 18:40:39.93 IP 192.43.172.30.53 > 192.168.1.1.57811:
  7286 FormErr- [0q] 0/0/0 (12)

• 5: 18:40:39.93 IP 192.168.1.1.57811 > 192.43.172.30.53:
  50994 A? h1-web.hosting.catpipe.net. (44)
• 6: 18:40:40.60 IP 192.43.172.30.53 > 192.168.1.1.57811:
  50994- 0/3/3 (152)

• 7: 18:40:40.60 IP 192.168.1.1.57811 > 83.221.131.7.53:
  58265 [1au] A? h1-web.hosting.catpipe.net. (55)
• 8: 18:40:41.26 IP 83.221.131.7.53 > 192.168.1.1.57811:
  58265* 1/2/3 A 83.221.131.6 (139)
```

Query detail - analysis

- We use a packet analyzer (wireshark / ethereal) to view the contents of the query...

Resolver configuration

- So how does your computer know which server to ask to get answers to DNS queries ?
- On UNIX, look in /etc/resolv.conf
- Look now in the file, and verify that you have a 'nameserver' statement of the form:

```
  nameserver a.b.c.d
```

or

```
  nameserver ip:v6:ad:dr:es:ss
```

... where a.b.c.d is the IP/IPv6 of a functioning DNS server (it should)

Finding the root...

- The first query is directed to:

  192.112.36.4 (G.ROOT-SERVERS.NET.)

- How does the server know where to reach the root servers ?
- Chicken-and-egg problem
- Each nameserver has a list of the root nameservers (A – M.ROOT-SERVERS.NET) and their IP address
- In BIND, named.root

Using 'dig' to get more details

- the 'host' command is limited in its output – good for lookups, but not enough for debugging.
- we use the 'dig' command to obtain more details
- dig shows a lot of interesting stuff...

Using 'dig' to get more details

```
ns# dig @147.28.0.39 www.nsrc.org. a

; <<>> DiG 9.3.2 <<>> @147.28.0.39 www.afnog.org
; (1 server found)
;; global options:  printcmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 4620
;; flags: qr aa rd; QUERY: 1, ANSWER: 1, AUTHORITY: 4,
ADDITIONAL: 2

;; QUESTION SECTION:
;www.afnog.org.                  IN      A

;; ANSWER SECTION:
www.afnog.org.          14400    IN      A       128.223.162.29

;; AUTHORITY SECTION:
afnog.org.              14400    IN      NS      rip.psg.com.
afnog.org.              14400    IN      NS      arizona.edu.

;; ADDITIONAL SECTION:
rip.psg.com.            77044    IN      A       147.28.0.39
arizona.edu.             2301    IN      A       128.196.128.233

;; Query time: 708 msec
;; SERVER: 147.28.0.39#53(147.28.0.39)
;; WHEN: Wed May 10 15:05:55 2007
;; MSG SIZE  rcvd: 128
```

```
noc# dig www.afrinic.net any

; <<>> DiG 9.4.2 <<>> any www.afrinic.net
;; global options:  printcmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 36019
;; flags: qr rd ra; QUERY: 1, ANSWER: 2, AUTHORITY: 6, ADDITIONAL: 10
```

```
;; QUESTION SECTION:
;www.afrinic.net.        IN   ANY

;; ANSWER SECTION:
www.afrinic.net. 477     IN   AAAA    2001:42d0::200:80:1
www.afrinic.net. 65423   IN   A       196.216.2.1

;; AUTHORITY SECTION:
afrinic.net.     65324   IN   NS      sec1.apnic.net.
afrinic.net.     65324   IN   NS      sec3.apnic.net.
afrinic.net.     65324   IN   NS      ns1.afrinic.net.
afrinic.net.     65324   IN   NS      tinnie.arin.net.
afrinic.net.     65324   IN   NS      ns.lacnic.net.
afrinic.net.     65324   IN   NS      ns-sec.ripe.net.

;; ADDITIONAL SECTION:
ns.lacnic.net.   151715  IN   A       200.160.0.7
ns.lacnic.net.   65315   IN   AAAA    2001:12ff::7
ns-sec.ripe.net. 136865  IN   A       193.0.0.196
ns-sec.ripe.net. 136865  IN   AAAA    2001:610:240:0:53::4
ns1.afrinic.net. 65315   IN   A       196.216.2.1
tinnie.arin.net. 151715  IN   A       168.143.101.18
sec1.apnic.net.  151715  IN   A       202.12.29.59
sec1.apnic.net.  151715  IN   AAAA    2001:dc0:2001:a:4608::59
sec3.apnic.net.  151715  IN   A       202.12.28.140
sec3.apnic.net.  151715  IN   AAAA    2001:dc0:1:0:4777::140

;; Query time: 1 msec
;; SERVER: 196.200.218.1#53(196.200.218.1)
;; WHEN: Tue May 27 08:48:13 2008
;; MSG SIZE  rcvd: 423
```

dig output

- Some interesting fields:
  - flags section: qr aa rd
  - status
  - answer section
  - authority section
  - TTL (numbers in the left column)
  - query time
  - server
- Notice the 'A' and 'AAAA' record type in the output.

Record types

- Basic record types:

A, AAAA:	IPv4, IPv6 address
NS:	NameServer
MX:	Mail eXchanger
CNAME:	Canonical name (alias)
PTR:	Reverse information

Caching vs Authoritative

- In the dig output, and in subsequent outputs, we noticed a decrease in query time if we repeated the query.
- Answers are being **cached** by the querying nameserver, to speed up requests and save network ressources
- The TTL value controls the time an answer can be cached
- DNS servers can be put in two categories: **caching** and **authoritative**.

Caching vs Authoritative: authoritative

- Authoritative servers typically only answer queries for data over which they have authority, i.e.: data of which they have an external copy, i.e. from disk (file or database)
- If they do not know the answer, they will point to a source of authority, but will not process the query recursively.

Caching vs Authoritative: caching

- Caching nameservers act as query forwarders on behalf of clients, and cache answers for later.
- Can be the same software (often is), but mixing functionality (recursive/caching and authoritative) is discouraged (security risks + confusing)
- The TTL of the answer is used to determine how long it may be cached without re-querying.

TTL values

- TTL values decrement and expire
- Try repeatedly asking for the A record for www.yahoo.com:

```
# dig www.yahoo.com
```

- What do you observe about the query time and the TTL ?

SOA

- Let's query the SOA for a domain:

```
# dig SOA <domain>
...
;; AUTHORITY SECTION:
<domain>. 860 IN SOA ns.<domain>. root.<domain>.
                       200702270 ; serial
                       28800       ; refresh
                       14400       ; retry
                       3600000   ; expire
                       86400       ; neg ttl
...
```

SOA

- The first two fields highlighted are:
  - the SOA (Start Of Authority), which the administrator sets to the name of the « source » server for the domain data (this is not always the case)
  - the RP (Responsible Person), which is the email address (with the first @replaced by a '.') to contact in case of technical problems.

SOA

- The other fields are:
  - serial: the serial number of the zone: this is used for replication between two nameservers
  - refresh: how often a replica server should check the master to see if there is new data
  - retry: how often to retry if the master server fails to answer after refresh.
  - expire: when the master server has failed to answer for too long, stop answering clients about this data.
- Why is expire necessary ?

Running a caching nameserver

- Running a caching nameserver locally can be very useful
- Easy to setup, for example on FreeBSD:
  - add `named_enable="YES"` to /etc/rc.conf
  - start named:

    ```
    /etc/rc.d/named start
    ```

- **What is a good test to verify that named is running ?**

Running a caching nameserver

- When you are confident that your caching nameserver is working, enable it in your local resolver configuration (`/etc/resolv.conf`):

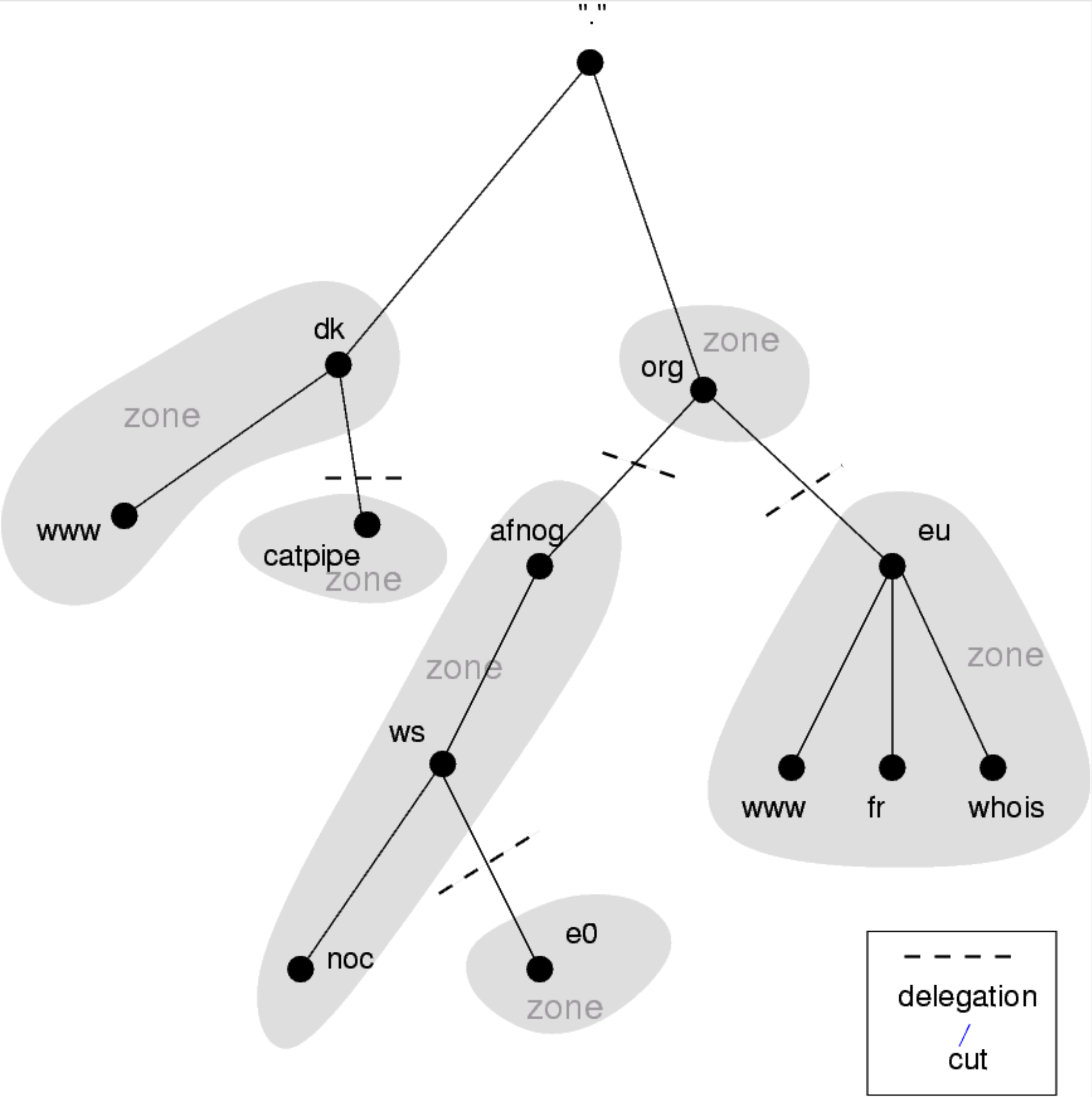
```
nameserver 127.0.0.1
```

Delegation

- We mentioned that one of the advantages of DNS was that of distribution through shared administration. This is called delegation.

- We delegate when there is an administrative boundary and we want to turn over control of a subdomain to:
  - a department of a larger organization
  - an organization in a country
  - an entity representing a country's domain

Delegation

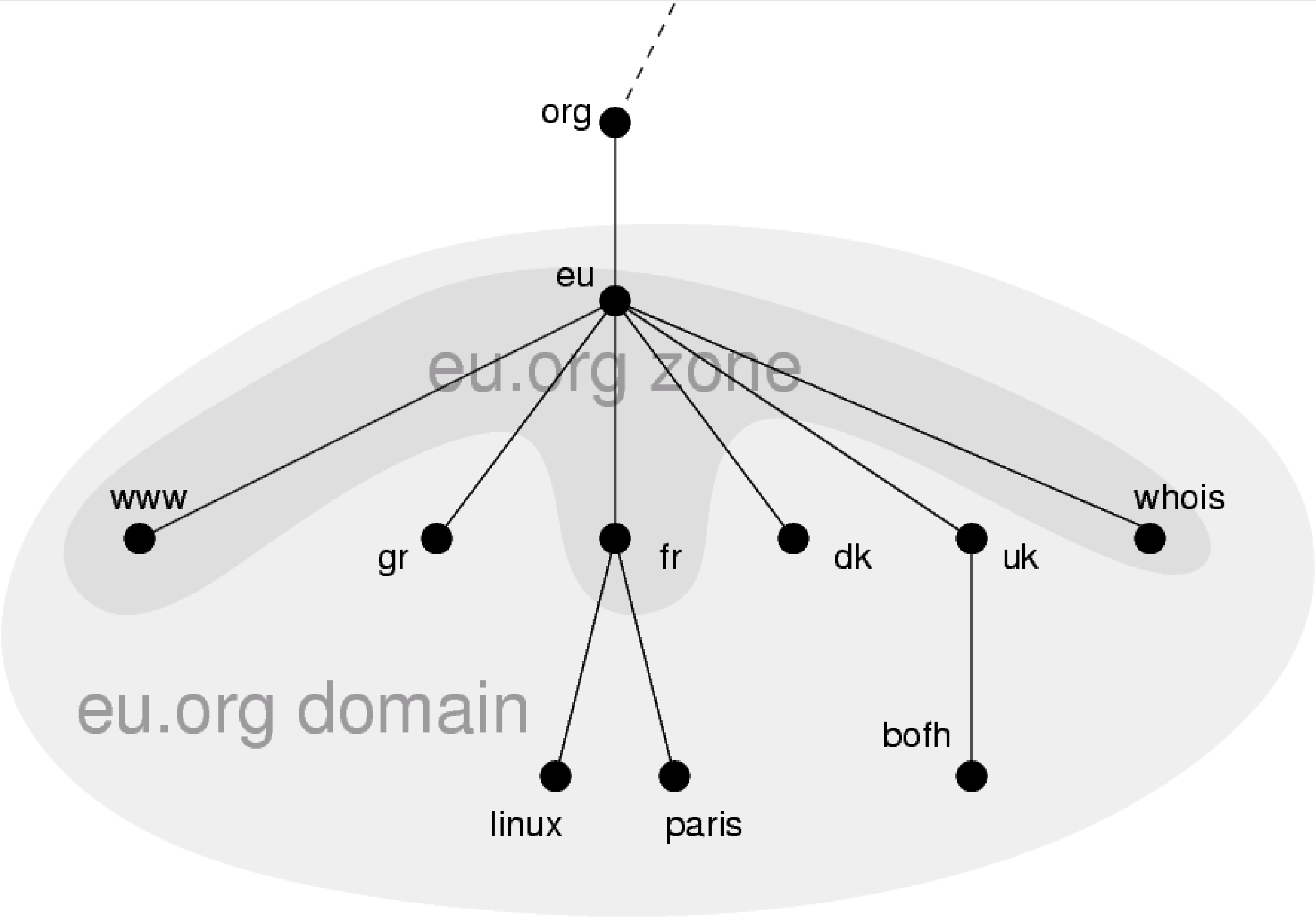

"."
dk
zone
www
catpipe
zone
org
zone
afnog
zone
ws
noc
e0
zone
eu
zone
www
fr
whois
delegation
/
cut

Delegation: Domains vs Zones

- When we talk about the entire subtree, we talk about *domains*

- When we talk about part of a domain that is administered by an entity, we talk about *zones*

Delegation: Domains vs Zones



Finding the error: using doc

- When you encounter problems with your network, web service or email, you don't always suspect DNS.
- When you do, it's not always obvious what the problem is – DNS is tricky.
- A great tool for quickly spotting configuration problems is 'doc'
- /usr/ports/dns/doc – install it now!
- Let's do a few tests on screen with doc...

Conclusion

- DNS is a vast subject
- It takes a lot of practice to pinpoint problems accurately the first time – caching and recursion are especially confusing
- Remember that there are several servers for the same data, and you don't always talk to the same one
- Practice, practice, practice!
- Don't be afraid to ask questions...

Questions ?

?