Introduction to the DNS

Track E0

AfNOG workshop

April 23-27 2007

Abuja, Nigeria

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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?

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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)

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What is DNS ?

- System to convert names to IP addresses:

```
www.afnog.org  ->  196.216.2.34
```

- ... and back:

```
196.216.2.34  ->  www.afnog.org
```

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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 www.afnog.org

www.afnog.org is an alias for afnog.org.
afnog.org has address 196.216.2.34

# host 196.216.2.34

34.2.216.196.in-addr.arpa domain name
pointer www.afnog.org.
```

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
```

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

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

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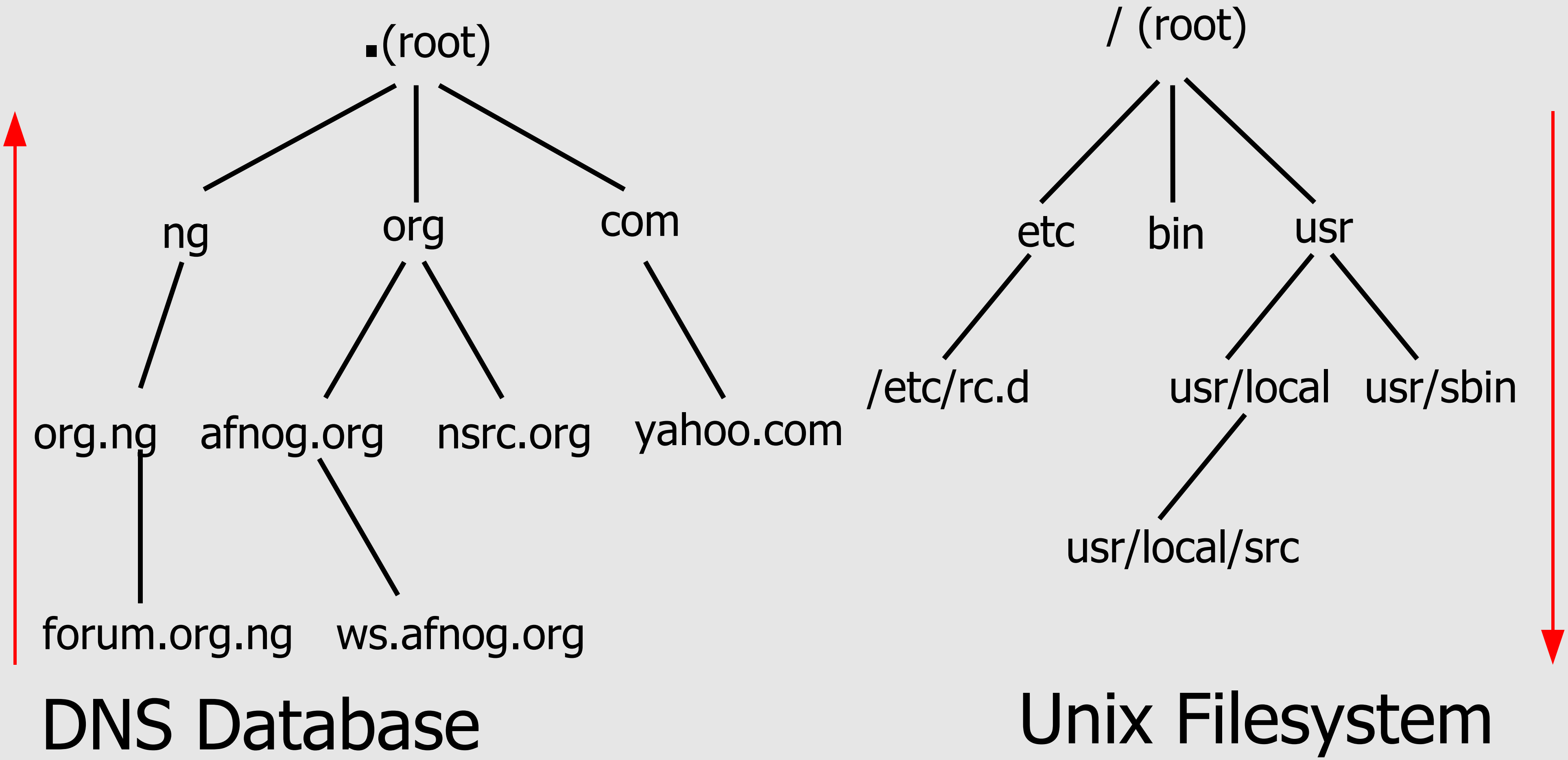
How is DNS built ?



... 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' *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.

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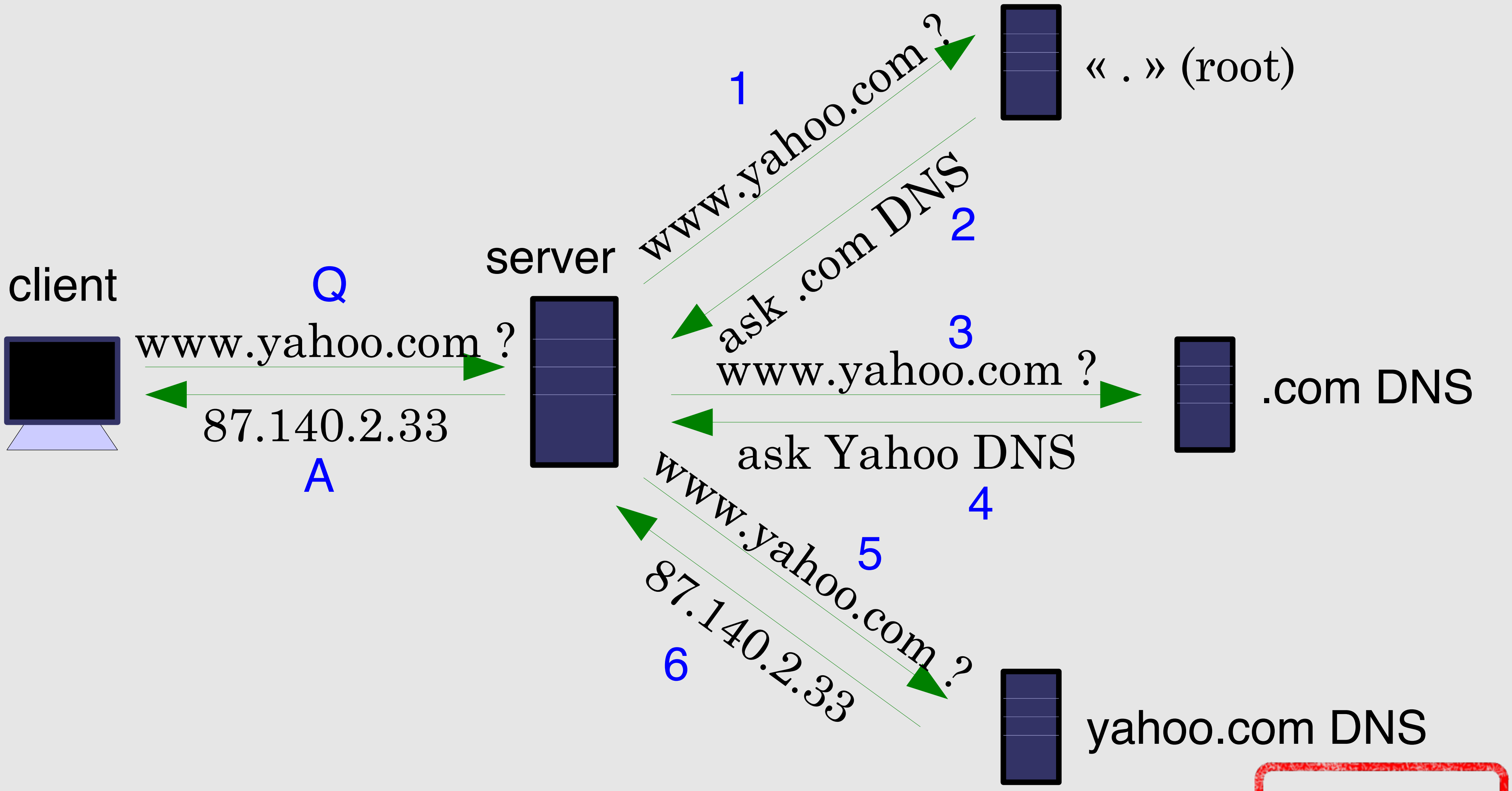
A DNS query



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Query detail with tcpdump

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

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

Query detail - output

- 1: 18:40:38.62 IP 196.200.216.219.57811 > 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 > 196.200.216.219.57811: 29030- 0/13/16 (540)

- 3: 18:40:39.24 IP 196.200.216.219.57811 > 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 > 196.200.216.219.57811: 7286 FormErr- [0q] 0/0/0 (12)

- 5: 18:40:39.93 IP 196.200.216.219.57811 > 192.43.172.30.53: 50994 A? h1-web.hosting.catpipe.net. (44)
- 6: 18:40:40.60 IP 192.43.172.30.53 > 196.200.216.219.57811: 50994- 0/3/3 (152)

- 7: 18:40:40.60 IP 196.200.216.219.57811 > 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 > 196.200.216.219.57811: 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...

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 namerserver has a list of the root nameservers (A – M.ROOT-SERVERS.NET) and their IP address
- In BIND, `named.conf`

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.afnog.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       196.216.2.4

;; AUTHORITY SECTION:
afnog.org.              14400   IN      NS      rip.psg.com.
afnog.org.              14400   IN      NS      austin.gh.com.
afnog.org.              14400   IN      NS      ns-ext.isc.org.
afnog.org.              14400   IN      NS      ns-sec.ripe.net.

;; ADDITIONAL SECTION:
rip.psg.com.            77044   IN      A       147.28.0.39
austin.gh.com.          14400   IN      A       196.3.64.1

;; 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: 182
```

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' 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 a permanent copy, 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.

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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 ?

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SOA

- Let's query the SOA for a domain:

```
# dig SOA <domain>
...
;; AUTHORITY SECTION:
<domain>. 86400 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 ?

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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
  - cd to /etc/namedb and run

    ```
    sh make-localhost
    ```
  - start named:

    ```
    /etc/rc.d/named start
    ```
- What is a good test to verify that named is running ?

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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

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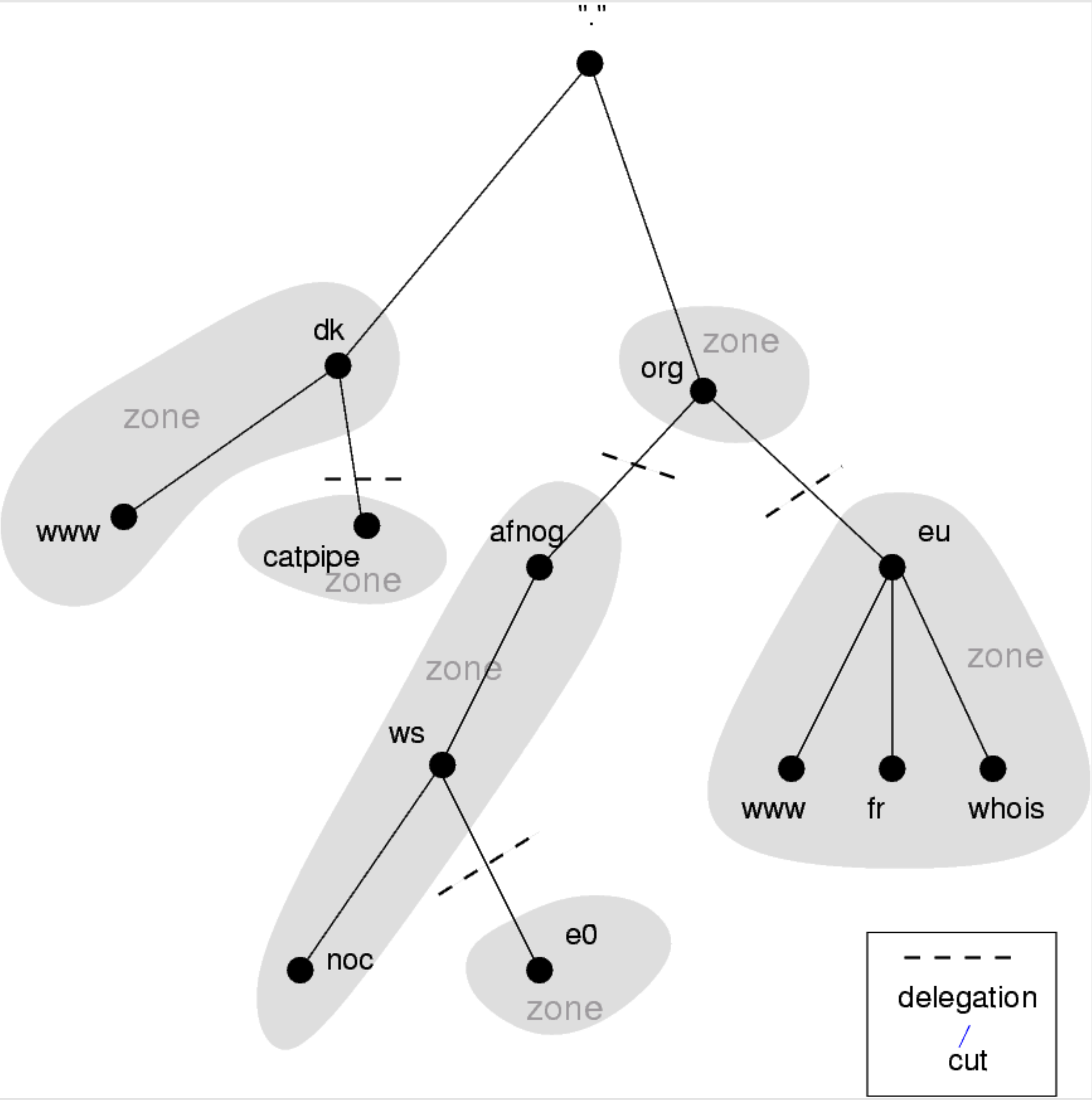
Delegation


"."
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*

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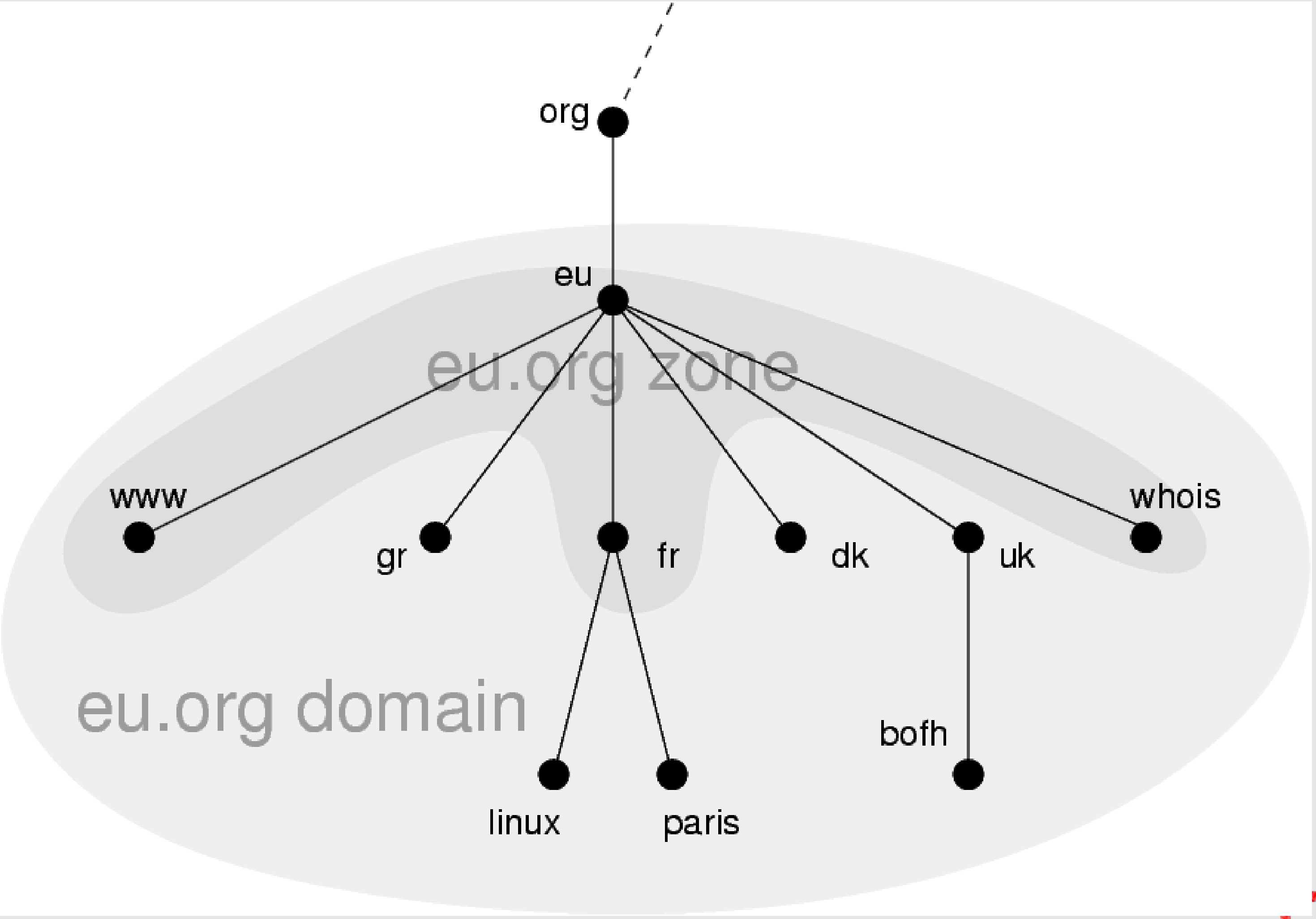
Delegation: Domains vs Zones



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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...

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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...

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Questions ?

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