# DNS Session 1: Fundamentals

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# Computers use IP addresses. Why do we need names?

- ➤ Easier for people to remember
- ➤ Computers may be moved between networks, in which case their IP address will change

# Old solution: hosts.txt

- ➤ A centrally-maintained file, distributed to all hosts on the Internet

```
SPARKY                    128.4.13.9
UCB-MAILGATE              4.98.133.7
FTPHOST                   200.10.194.33

... etc
```

This feature still exists:
/etc/hosts [Unix]
c:\windows\hosts [Windows]

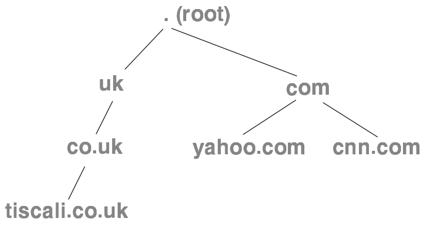
# hosts.txt doesn't scale

- ✘ Huge file
- ✘ Needs frequent copying to ALL hosts
- ✘ Consistency
- ✘ Always out-of-date
- ✘ Name uniqueness
- ✘ Single point of administration

# The Domain Name System was born

- ➤ DNS is a Distributed Database for holding name to IP address (and other) information
- ➤ Distributed:
  - → Shares the administration
  - → Shares the load
- ➤ Robustness and performance through:
  - → Replication
  - → Caching
- ➤ A *critical* piece of Internet infrastructure

# DNS is Hierarchical



Forms a tree structure

## DNS is Hierarchical (2)

- Gives globally unique names
- Administered in zones (parts of the tree)
- You can give away ("delegate") control of part of the tree underneath you
- Example:
  - isoc.org on one set of nameservers
  - isocws.isoc.org on a different set
  - t1.isocws.isoc.org on another set

## Domain Names are (almost) unlimited

- Max 255 characters total length
- Max 63 characters in each part
  - RFC 1034, RFC 1035
- If a domain name is being used as a host name, you should abide by some restrictions
  - RFC 952 (old!)
  - a-z 0-9 and minus (-) only
  - No underscores ( _ )

## Using the DNS

- A Domain Name (like www.tiscali.co.uk) is the KEY to look up information
- The result is one or more RESOURCE RECORDS (RRs)
- There are different RRs for different types of information
- You can ask for the specific type you want, or ask for "any" RRs associated with the domain name

## Commonly seen RRs

- A (address): map hostname to IP address
- PTR (pointer): map IP address to name
- MX (mail exchanger): where to deliver mail for user@domain
- CNAME (canonical name): map alternative hostname to real hostname
- TXT (text): any descriptive text
- NS (name server), SOA (start of authority): used for delegation and management of the DNS itself

## Simple example

- Query: www.tiscali.co.uk
- Query type: A
- Result:

```
www.tiscali.co.uk.  IN   A   212.74.101.10
```

In this case just a single RR is found,
but in general, multiple RRs may be returned

(IN is the "class" for INTERNET use of the DNS)

## Possible results

- Positive (one or more RRs found)
- Negative (definitely no RRs match the query)
- Server fail (cannot find the answer)

## How do you use an IP address as the key for a DNS query?

- ➤ Convert the IP address to dotted-quad
- ➤ Reverse the four parts
- ➤ Add ".in-addr.arpa." to the end; special domain reserved for this purpose

```
e.g. to find name for 212.74.101.10

10.101.74.212.in-addr.arpa.
          ➔ PTR www.tiscali.co.uk.
```

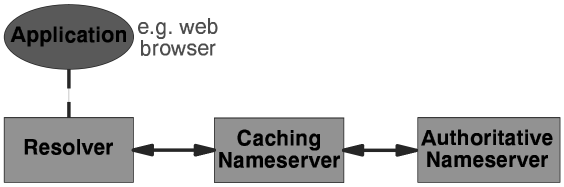
Known as a "reverse DNS lookup"
(because we are looking up the name for an IP address,
rather than the IP address for a name)

?

## DNS is a Client-Server application

- ➤ (Of course - it runs across a network)
- ➤ Requests and responses are normally sent in UDP packets, port 53
- ➤ Occasionally uses TCP, port 53
  - → for very large requests, e.g. zone transfer from master to slave

## There are three roles involved in DNS



Application

e.g. web browser

Resolver

Caching Nameserver

Authoritative Nameserver

## Three roles in DNS

- ➤ RESOLVER
  - → Takes request from application, formats it into UDP packet, sends to cache
- ➤ CACHING NAMESERVER
  - → Returns the answer if already known
  - → Otherwise searches for an authoritative server which has the information
  - → Caches the result for future queries
  - → Also known as RECURSIVE nameserver
- ➤ AUTHORITATIVE NAMESERVER
  - → Contains the actual information put into the DNS by the domain owner

## Three roles in DNS

- ➤ The SAME protocol is used for resolver→cache and cache→auth NS communication
- ➤ It is possible to configure a single name server as both caching and authoritative
- ➤ But it still performs only one role for each incoming query
- ➤ Common but NOT RECOMMENDED to configure in this way (see later)

## ROLE 1: THE RESOLVER

- A piece of software which formats a DNS request into a UDP packet, sends it to a cache, and decodes the answer
- Usually a shared library (e.g. libresolv.so under Unix) because so many applications need it
- EVERY host needs a resolver - e.g. every Windows workstation has one

## How does the resolver find a caching nameserver?

- It has to be explicitly configured (statically, or via DHCP etc)
- Must be configured with the IP ADDRESS of a cache (why not name?)
- Good idea to configure more than one cache, in case the first one fails

## How do you choose which cache(s) to configure?

- Must have PERMISSION to use it
  - e.g. cache at your ISP, or your own
- Prefer a nearby cache
  - Minimises round-trip time and packet loss
  - Can reduce traffic on your external link, since often the cache can answer without contacting other servers
- Prefer a reliable cache
  - Perhaps your own?

## Resolver can be configured with default domain(s)

- If "foo.bar" fails, then retry query as "foo.bar.mydomain.com"
- Can save typing but adds confusion
- May generate extra unnecessary traffic
- Usually best avoided

## Example: Unix resolver configuration

## /etc/resolv.conf

```
search tiscali.co.uk
nameserver 212.74.112.66
nameserver 212.74.112.67
```

That's all you need to configure a resolver

## Testing DNS

- Just put "www.yahoo.com" in a web browser?
- Why is this not a good test?

## Testing DNS with "dig"

- "dig" is a program which just makes DNS queries and displays the results
- Better than "nslookup", "host" because it shows the raw information in full

```
dig tiscali.co.uk.
  -- defaults to query type "A"

dig tiscali.co.uk. mx
  -- specified query type

dig @212.74.112.66 tiscali.co.uk. mx
  -- send to particular cache (overrides
     /etc/resolv.conf)
```

## The trailing dot

```
dig tiscali.co.uk.
```

- Prevents any default domain being appended
- Get into the habit of using it always when testing DNS
  - only on domain names, not IP addresses

```
# dig @81.199.110.100 www.gouv.bj. a
; <<>> DiG 8.3 <<>> @81.199.110.100 www.gouv.bj a
; (1 server found)
;; res options: init recurs defnam dnsrch
;; got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 4
;; flags: qr aa rd ra; QUERY: 1, ANSWER: 2, AUTHORITY: 4, ADD’L: 3
;; QUERY SECTION:
;;      www.gouv.bj, type = A, class = IN

;; ANSWER SECTION:
www.gouv.bj.            1D IN CNAME     waib.gouv.bj.
waib.gouv.bj.           1D IN A         208.164.179.196

;; AUTHORITY SECTION:
gouv.bj.                1D IN NS        rip.psg.com.
gouv.bj.                1D IN NS        ben02.gouv.bj.
gouv.bj.                1D IN NS        nakayo.leland.bj.
gouv.bj.                1D IN NS        ns1.intnet.bj.

;; ADDITIONAL SECTION:
ben02.gouv.bj.          1D IN A         208.164.179.193
nakayo.leland.bj.       1d23h59m59s IN A  208.164.176.1
ns1.intnet.bj.          1d23h59m59s IN A  81.91.225.18

;; Total query time: 2084 msec
;; FROM: ns.t1.ws.afnog.org to SERVER: 81.199.110.100
;; WHEN: Sun Jun  8 21:18:18 2003
;; MSG SIZE  sent: 29  rcvd: 221
```

## Interpreting the results: header

- STATUS
  - NOERROR: 0 or more RRs returned
  - NXDOMAIN: non-existent domain
  - SERVFAIL: cache could not locate answer
- FLAGS
  - AA: Authoritative answer (not from cache)
  - You can ignore the others
    - QR: Query/Response (1 = Response)
    - RD: Recursion Desired
    - RA: Recursion Available

## Interpreting the results

- Answer section (RRs requested)
  - Each record has a Time To Live (TTL)
  - Says how long the cache will keep it
- Authority section
  - Which nameservers are authoritative for this domain
- Additional section
  - More RRs (typically IP addresses for the authoritative nameservers)
- Total query time
- Check which server gave the response!
  - If you make a typing error, the query may go to a default server

## Practical Exercise

- Configure Unix resolver
- Issue DNS queries using 'dig'
- Use tcpdump to show queries being sent to cache