The Domain Name System

Lecture given by Emmanuel Lochin

ISAE-SUPAERO

Original slides from A. Carzaniga (Univ. Lugano)
Extended/modified by E. Lochin (ISAE-SUPAERO) with author permission

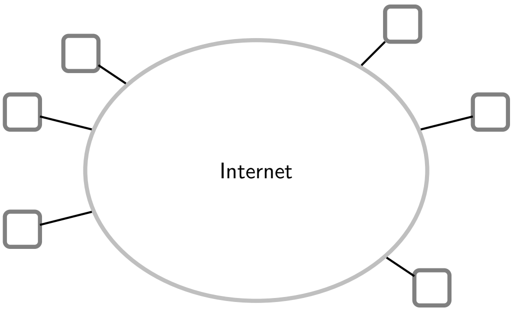
Textbook Chap. #2 Section 2.5

Outline

- IP addresses and host names
- DNS architecture
- DNS process
- DNS requests/replies

End Systems

Internet applications involve **end system communication**



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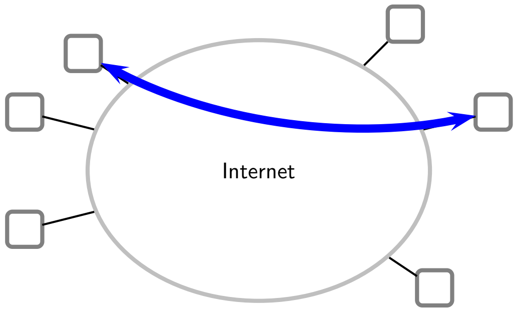

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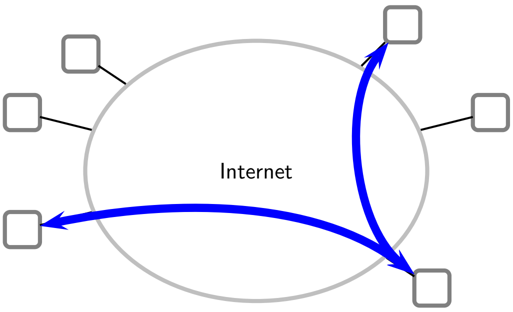

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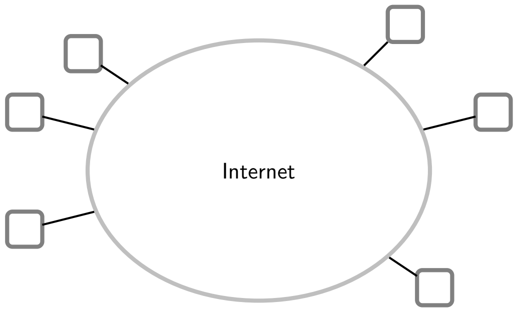


How does one end system **address** another end system ?

IP Addresses

- An end system is identified and addressed by its **IP address**
  - 32 bits (4 bytes) in IPv4
  - e.g., 192.93.254.254
  - 128 bits (16 bytes) in IPv6
  - e.g., fe80 : :211 :43ff :fecd :30f5/64
- **Advantages**
  - computers (e.g., routers) are good at processing bits
  - especially in small packs of a size that is a power of two
- **Disadvantages**
  - not practical for use by **people**
  - i.e., not mnemonic
  - e.g., "look it up on 64.233.183.104 !"

Host Names

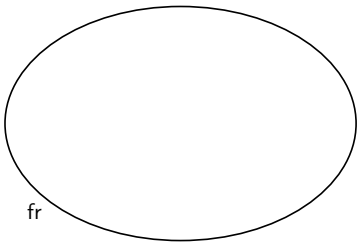
- Goal : help the human users of the Internet
  - human-readable, mnemonic addresses, aliases
- Solution : **domain name system (DNS)**
  - host names
  - e.g., www.google.com
- Primary function of the domain name system

  name $\rightarrow$ *IP address*

  maps a name to an IP address

Host Names

- E.g., `www.disc.isae.fr`
- Hierarchical name space
- Top-level domain



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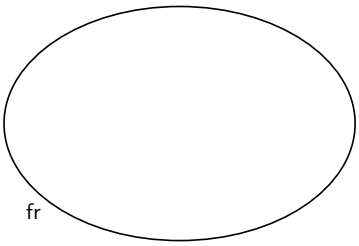

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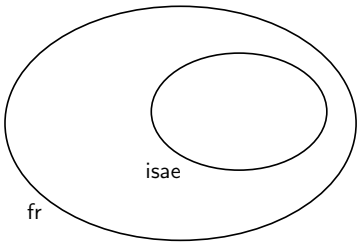

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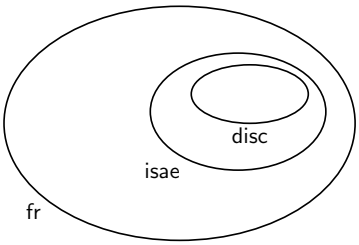

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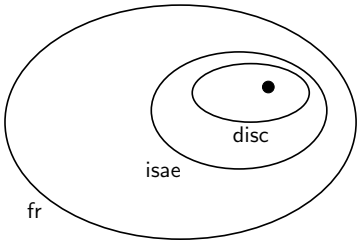
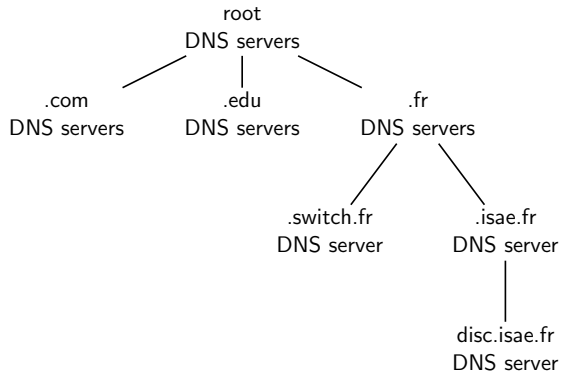


Architecture of DNS

- Hierarchical architecture that mirrors the hierarchical structure of the namespace

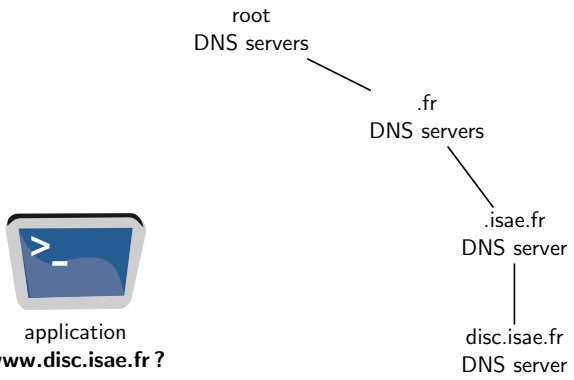


DNS Architecture

- Root servers : 13 "root" DNS servers know where the top-level servers are (labeled A through M)
  - see http ://www.root-servers.org
- Top-level domain servers : each one is associated with a top-level domain (e.g., .com, .edu, .fr, .org, .tv)
- Authoritative servers : for each domain, there is an authoritative DNS server that holds the map of publicly-accessible hosts within that domain
- Most root "servers" as well as servers at lower levels are themselves implemented by a distributed set of machines

How DNS Works

- Hierarchical architecture that mirrors the hierarchical structure of the namespace



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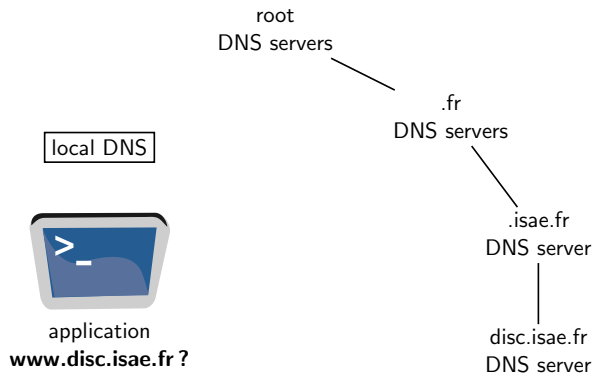

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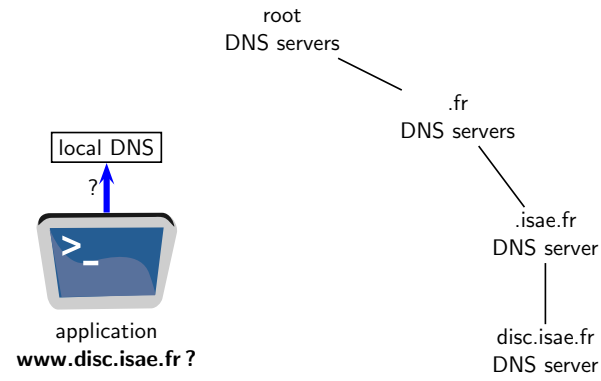

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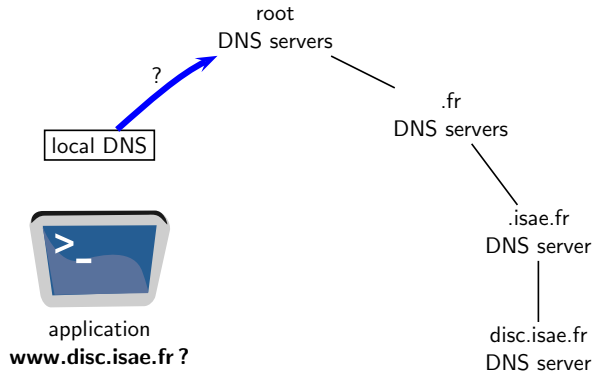

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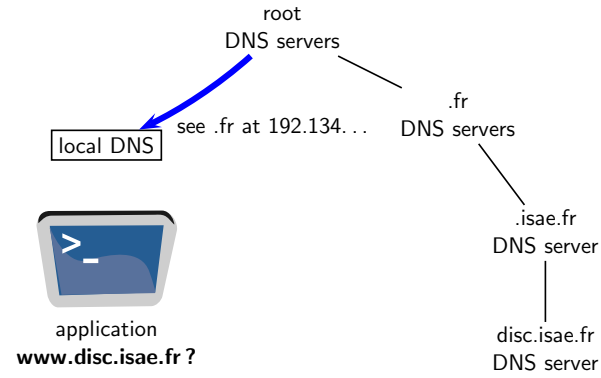

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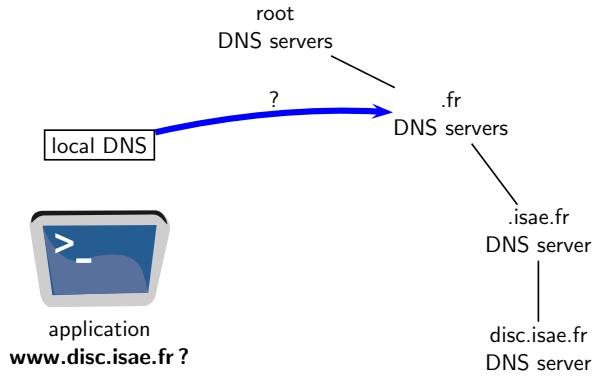

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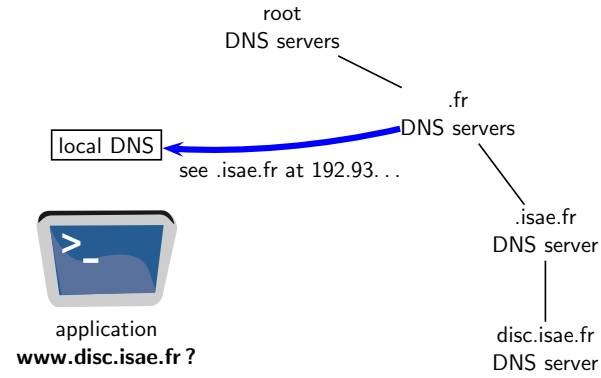

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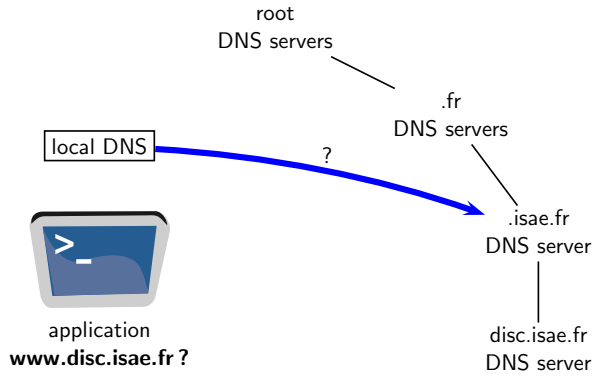

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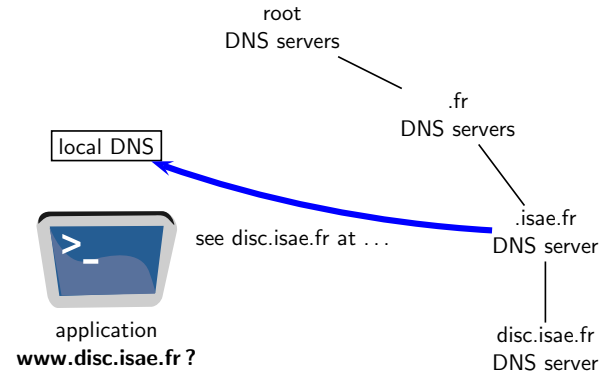

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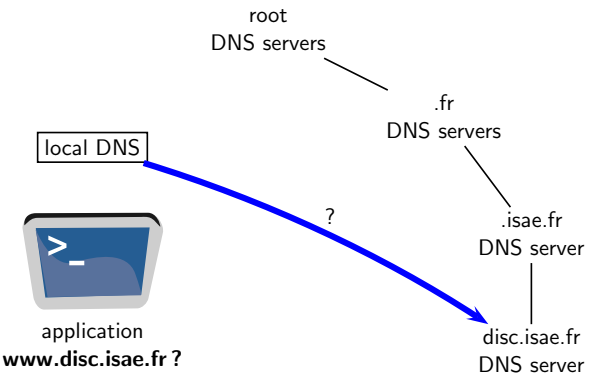

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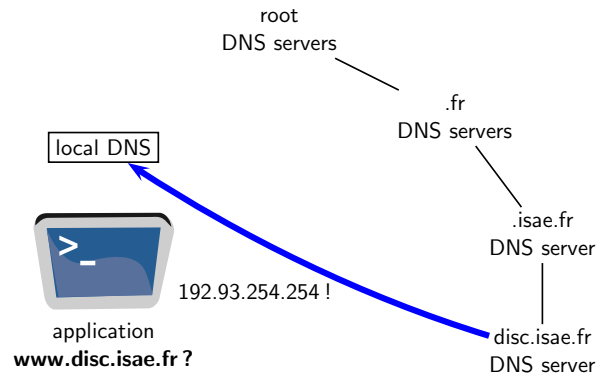

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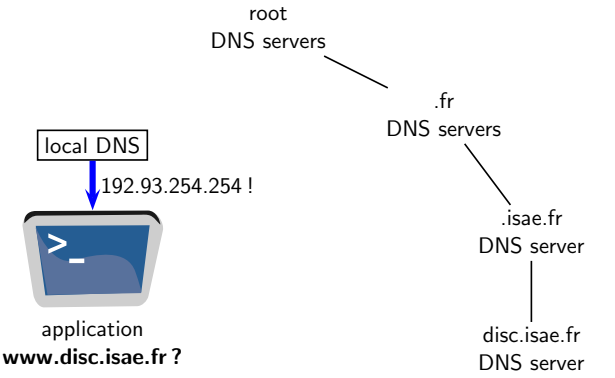

Recursive Queries

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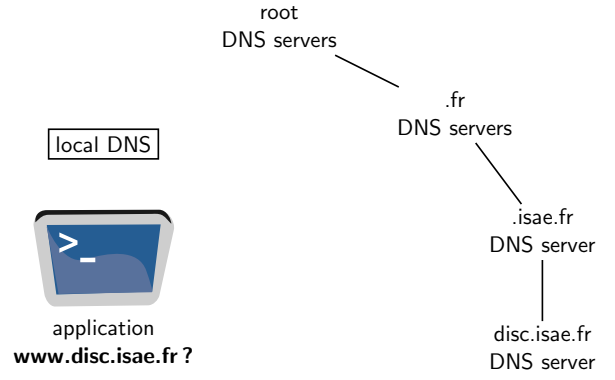

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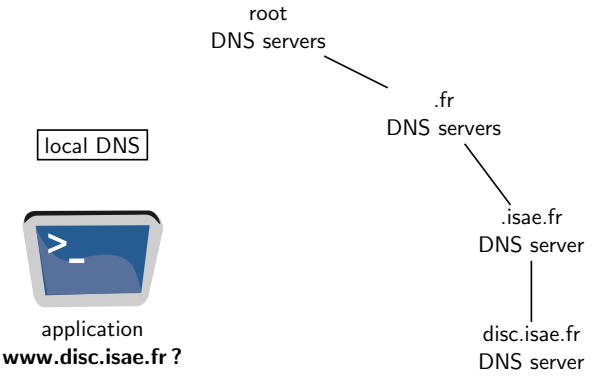

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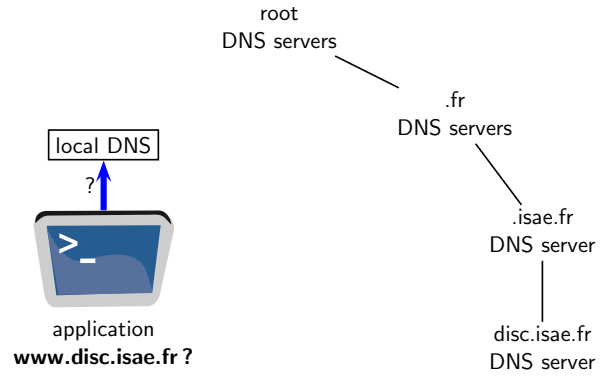

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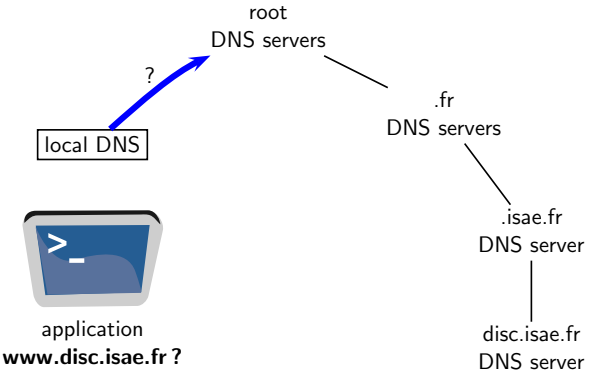

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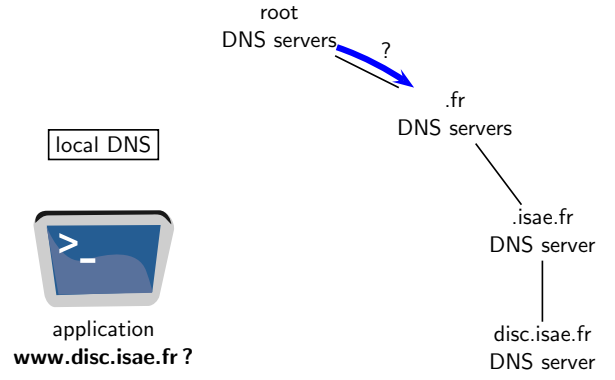

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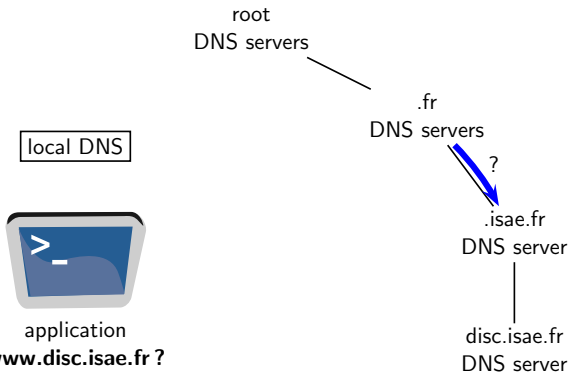

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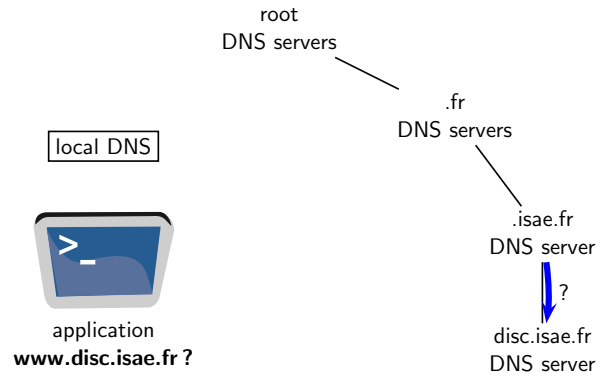

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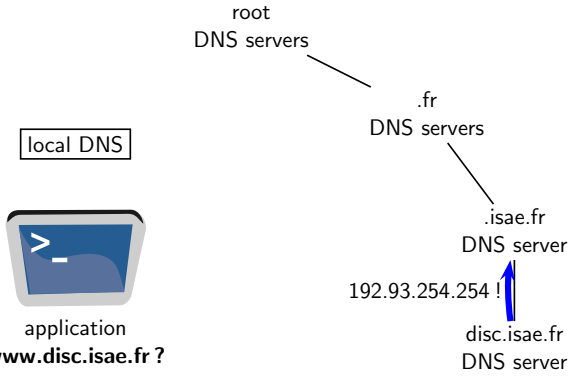

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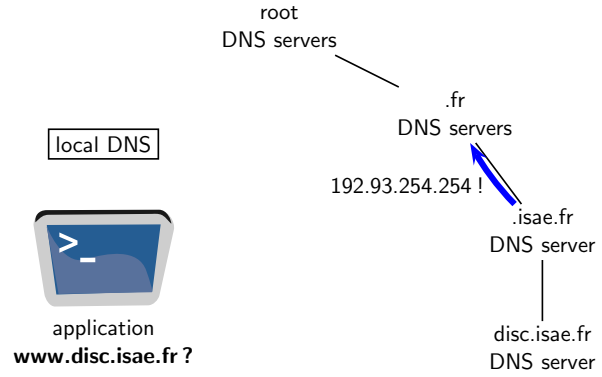

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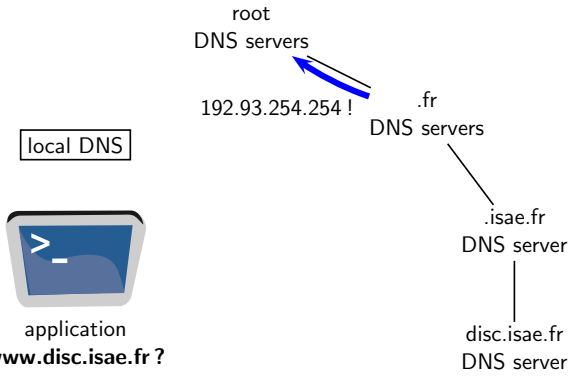

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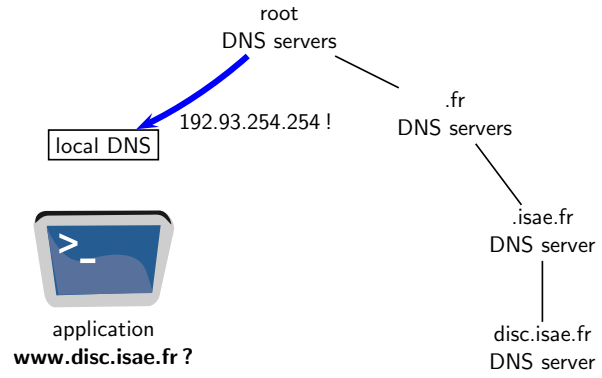

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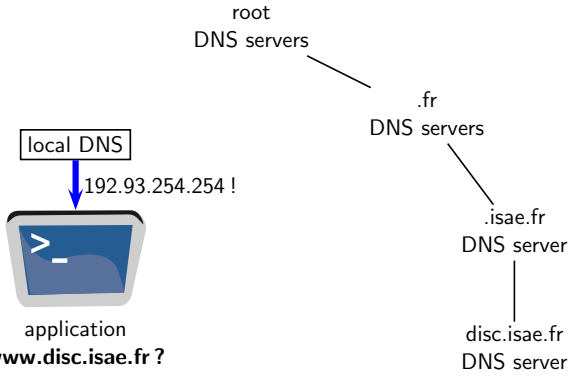

Observations on DNS

- A lot of messages just to figure out where to connect to !
  - DNS can indeed be a major bottleneck for some applications (typically, the Web)
  - it is also to a large extent a critical point of failure

DNS Caching

- Caching is clearly very important, as it can dramatically
  - improve the performance of DNS
  - reduce the load on the DNS infrastructure
- How does caching work in DNS ?
- Same as always
  - a DNS server may cache a reply (i.e., the mapping) for a name *n*
  - if the server receives a subsequent request for *n*, it may respond directly with the cached address, even though the server is not the authoritative server for that domain

DNS Features

- DNS is essentially a "directory service" database
- The database contains resource records (RRs)

name	value	type	ttl
www.disc.isae.fr	192.93.254.254	A	...
research.disc.isae.fr	192.93.254.253	A	...
...	...	...	...

- **Name** and **value** have the intuitive meaning
- What about **type** ?

DNS Query Types

A this is the main mapping *host_name* → *address*, so **name** is a host name and **value** is its (IP) address

NS this is a query for a name server, so **name** is a domain name and **value** is the authoritative name server for that domain. For example,

name	value	type	ttl
isae.fr	ns.isae.fr	NS	...

CNAME this is a query for a canonical name. The canonical name is the "primary" name of a host. A host may have one or more mnemonic **aliases**. For example,

name	value	type	ttl
www.google.com	www.l.google.com	CNAME	...

DNS Query Types (2)

MX this is a query for the mail exchange server for a given domain, so **name** is a host or domain name and **value** is the name of the mail server that handles (incoming) mail for that host or domain. For example,

name	value	type	ttl
mail.isae.fr	spamfilter.renater.fr	MX	...

... several other types

DNS Protocol

- DNS is a connectionless protocol
- Runs on top of UDP (port 53)
- DNS has query and reply messages
  - since DNS is connectionless, queries and replies are linked by an identifier
- Both queries and replies have the same format
  - **a DNS message can carry queries and answers**

DNS Message Format