COMP90007 Internet Technologies Workshop

Week 9 – Application Layer

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When you are trying to browsing a web page

1. IP address of a web page 128.111.24.41

Disadvantages:
But it is hard to remember.
If the company moves the Web Server to a different machine, the IP address will be different

DNS
(Domain Name System)

2. High-level, readable names www.google.com.au

Advantages:
It is easy to remember.
Regardless of its IP address, this web is known as www.google.com.au

Nevertheless, since the network itself understands only numerical addresses(IP address), some mechanism is required to **convert the names to network addresses**.

DNS (Domain Name System)

DNS is the invention of a **hierarchical, domain-based naming scheme**, stored in **a distributed database system** for the implementation.

It is primarily used for mapping host names to IP addresses, but can also be used for other purposes.

DNS (Domain Name System)

The top of the naming hierarchy is managed by an organization called **ICANN** (Internet Corporation for Assigned Names and Numbers)

250 top-level domains

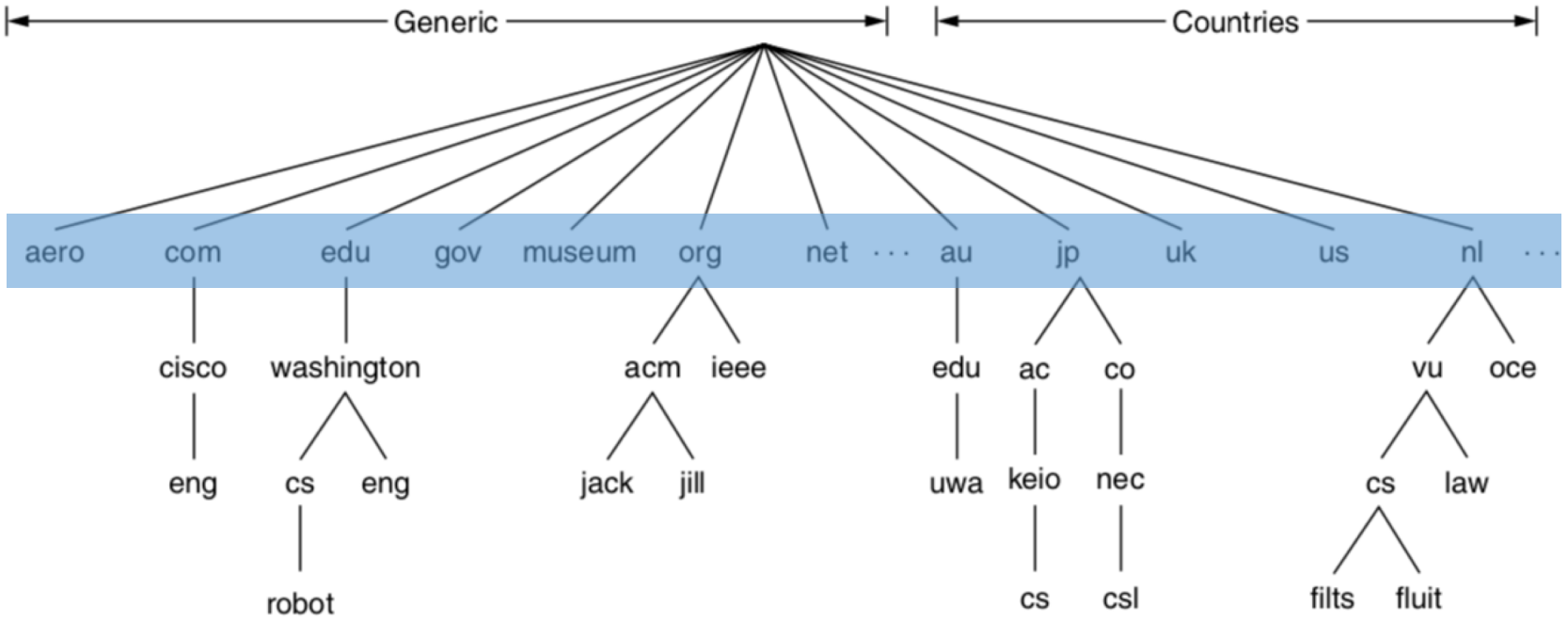


Figure 7-1. A portion of the Internet domain name space.

Domain Resource Records

Every domain, whether it is a single host or a top level domain, can have a set of **resource records** associated with it. These records are the **DNS database**.

The format of a resource record

what kind of record this is

Domain_name	Time_to_live	Class	Type	Value
cs.vu.nl.	86400	IN	SOA	star boss (9527,7200,7200,241920,86400)
cs.vu.nl.	86400	IN	MX	1 zephyr
cs.vu.nl.	86400	IN	MX	2 top
cs.vu.nl.	86400	IN	NS	star

This field can be a number, a domain name, or an ASCII string. The semantics depend on the record type.

how stable the record is

IN: Internet information

Type of a record

Type	Meaning	Value
SOA	Start of authority	Parameters for this zone
A	IPv4 address of a host	32-Bit integer
AAAA	IPv6 address of a host	128-Bit integer
MX	Mail exchange	Priority, domain willing to accept email
NS	Name server	Name of a server for this domain
CNAME	Canonical name	Domain name
PTR	Pointer	Alias for an IP address
SPF	Sender policy framework	Text encoding of mail sending policy
SRV	Service	Host that provides it
TXT	Text	Descriptive ASCII text

Figure 7-3. The principal DNS resource record types.

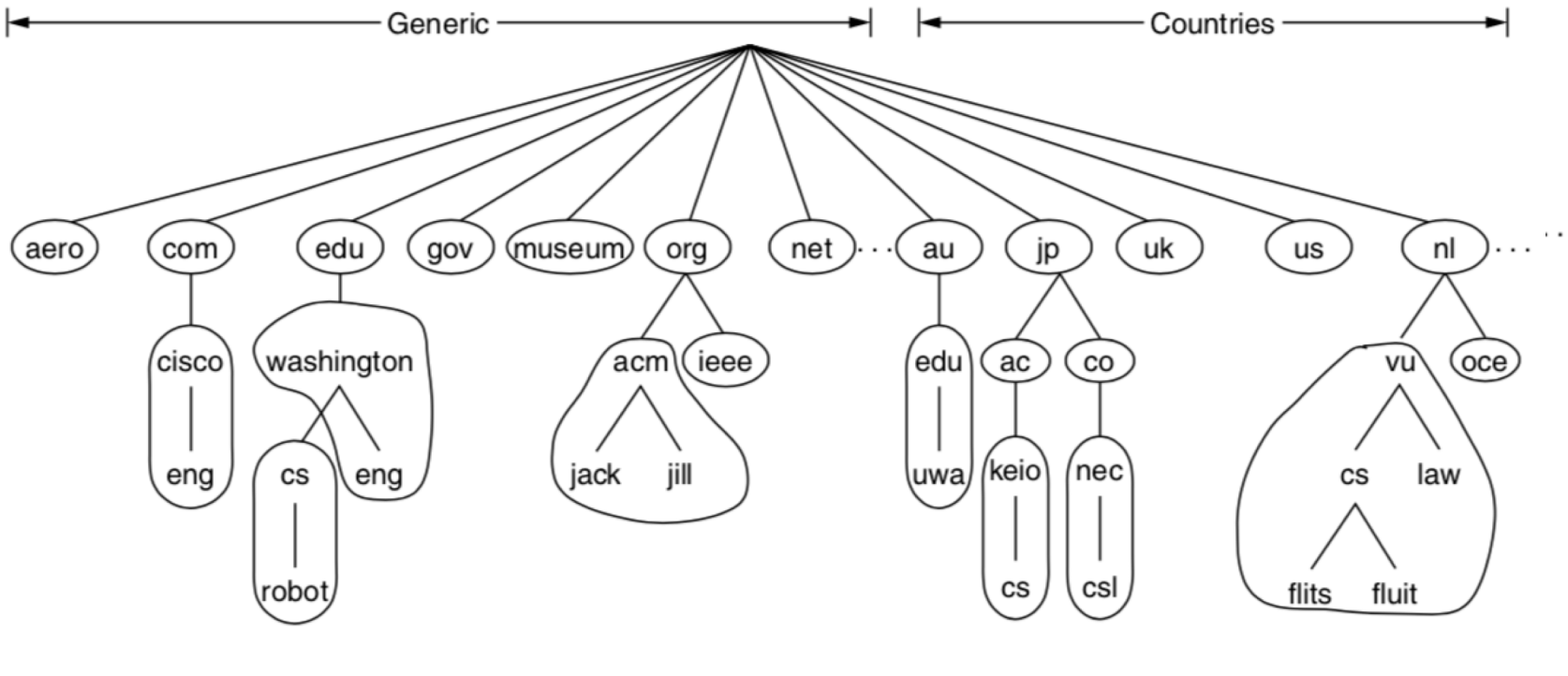


Figure 7-5. Part of the DNS name space divided into zones (which are circled).

A very large, single name server, which contains the entire DNS database

Disadvantages:
In practice, this server would be so **overloaded** as to be useless.
Furthermore, if it ever **went down**, the entire Internet would be crippled.

We should divide the DNS name space into nonoverlapping zones

Name Resolution

The process of looking up a name and finding out an address is called **name resolution.**

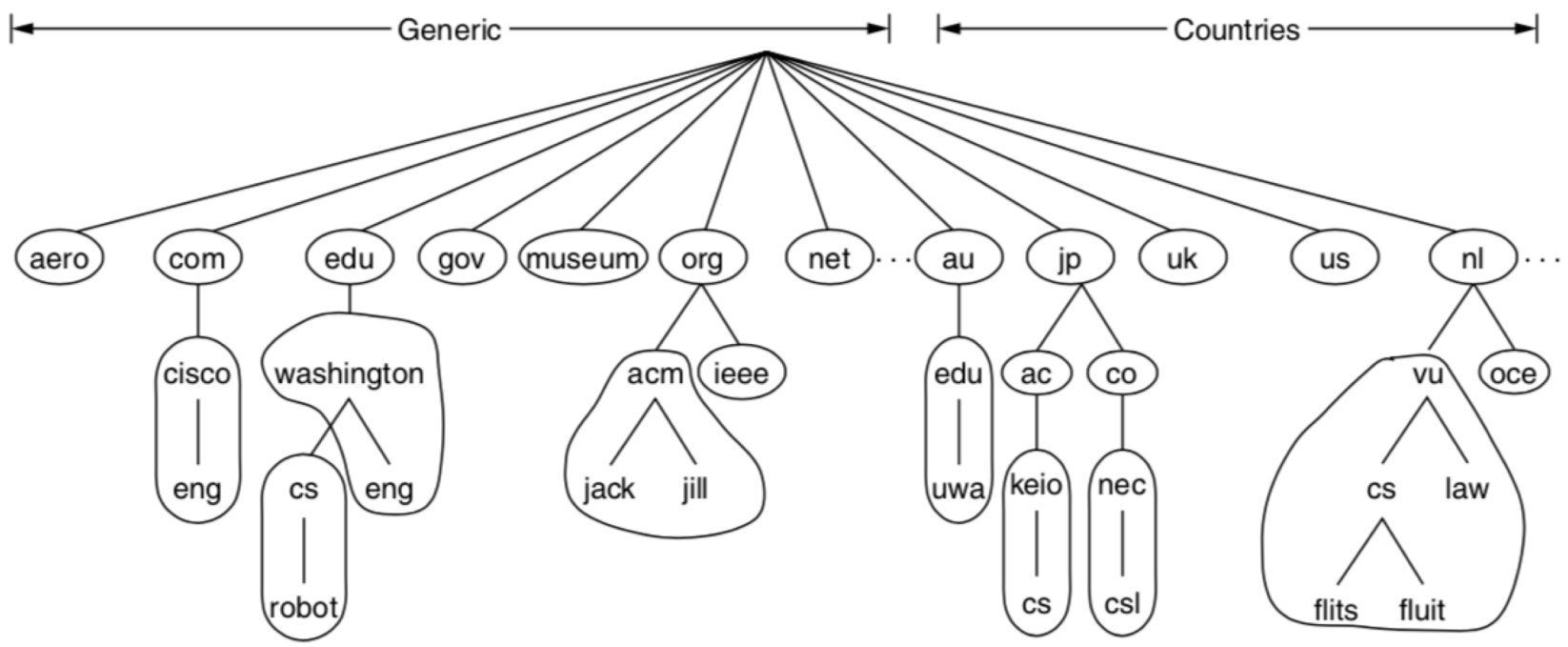


Figure 7-5. Part of the DNS name space divided into zones (which are circled).

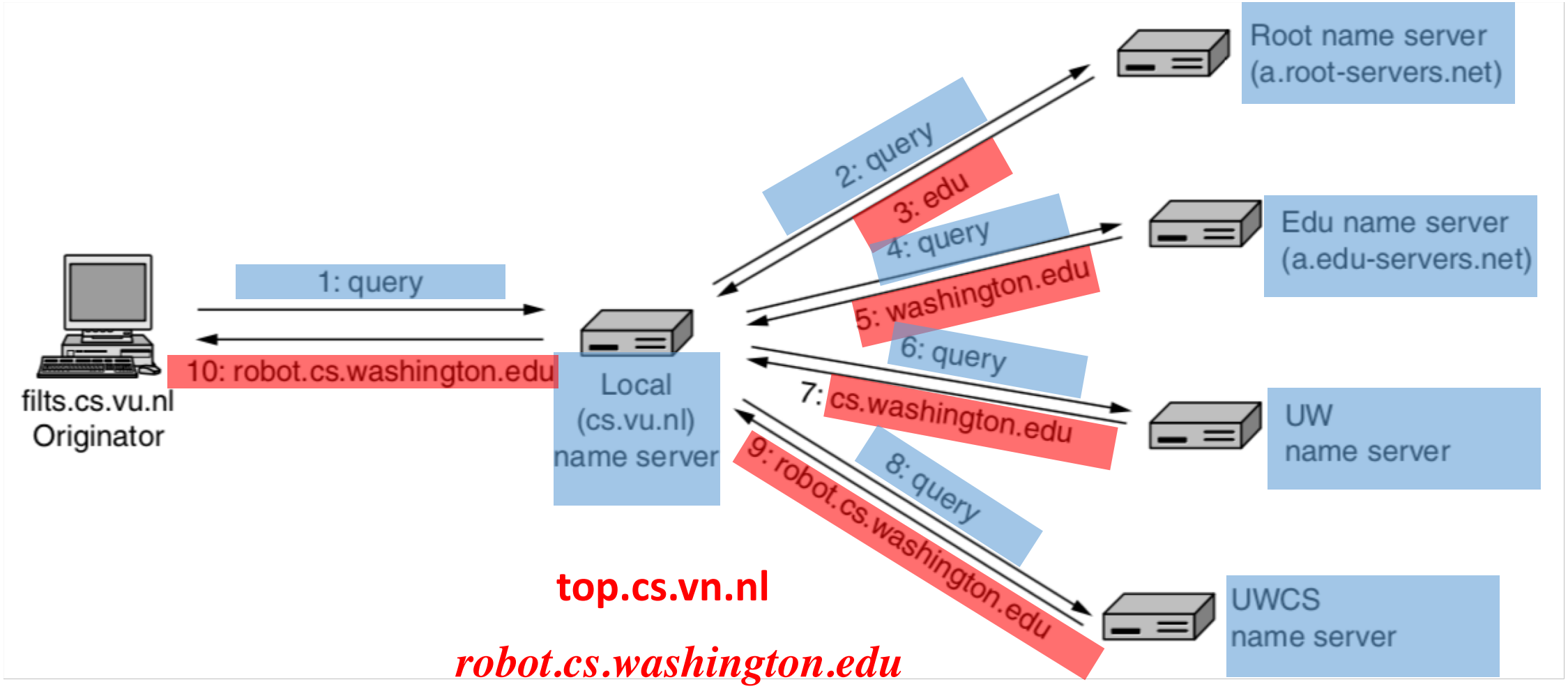
2 types of name servers

Local name server:
The server is located within the zone.

Remote name server:
The server is located outside the zone.

The process of Name Resolution

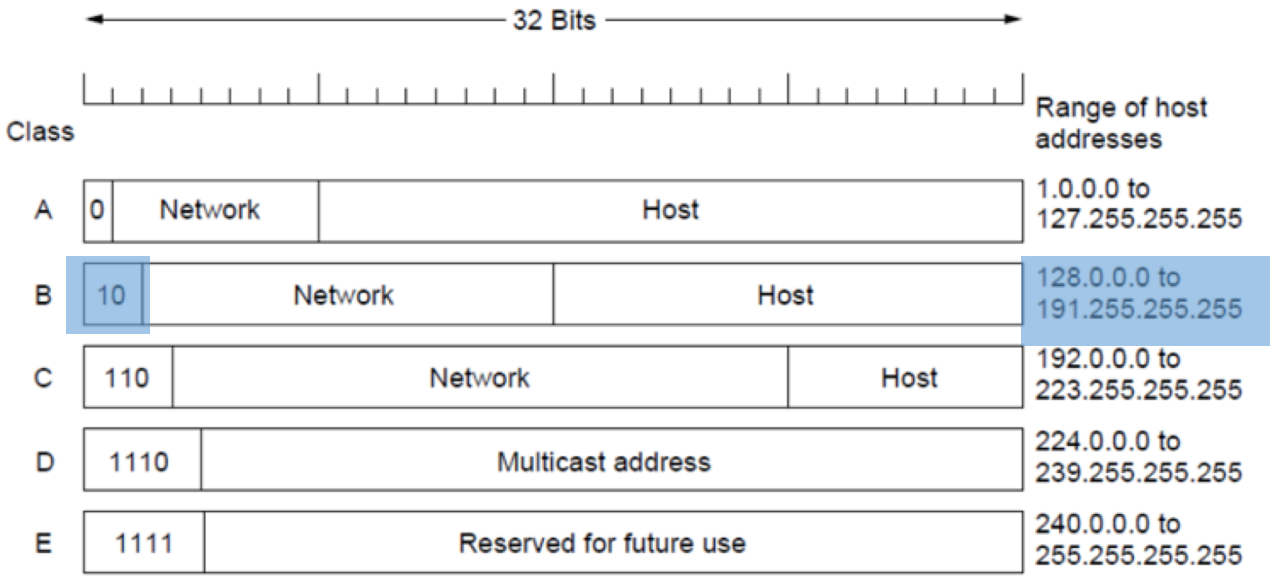
when *flits.cs.vu.nl* wants to find the IP address of *robot.cs.washington.edu*



Question 1

10000000.11111010.00100101.01001110

The IP address of the domain name www.cs.mu.oz.au is 128.250.37.78. Is this address on a Class A, B or C subnetwork?



Answer:
The first byte of the address is 128 (decimal), or **10000000** in binary. An IP address with a leading 10 corresponds to a Class B subnetwork.

Question 2

According to the information given Fig. 7-4 (5th edition), is little-sister.cs.vu.nl on a class A, B or C network?

```
; Authoritative data for cs.vu.nl
cs.vu.nl.     86400     IN     SOA     star boss (9527,7200,7200,241920,86400)
cs.vu.nl.     86400     IN     MX      1 zephyr
cs.vu.nl.     86400     IN     MX      2 top
cs.vu.nl.     86400     IN     NS      star

star          86400     IN     A       130.37.56.205
zephyr        86400     IN     A       130.37.20.10
top           86400     IN     A       130.37.20.11
www           86400     IN     CNAME   star.cs.vu.nl
ftp           86400     IN     CNAME   zephyr.cs.vu.nl

flits         86400     IN     A       130.37.16.112
flits         86400     IN     A       192.31.231.165
flits         86400     IN     MX      1 flits
flits         86400     IN     MX      2 zephyr
flits         86400     IN     MX      3 top

rowboat                 IN     A       130.37.56.201
                        IN     MX      1 rowboat
                        IN     MX      2 zephyr

little-sister           IN     A       130.37.62.23
```

Answer:
It's IP address starts with 130, so it is on a class B network.

Question 3

In Fig. 7-4, there is no period after rowboat? Why not?

```
; Authoritative data for cs.vu.nl
cs.vu.nl.        86400  IN  SOA     star boss (9527,7200,7200,241920,86400)
cs.vu.nl.        86400  IN  MX      1 zephyr
cs.vu.nl.        86400  IN  MX      2 top
cs.vu.nl.        86400  IN  NS      star

star             86400  IN  A       130.37.56.205
zephyr           86400  IN  A       130.37.20.10
top              86400  IN  A       130.37.20.11
www              86400  IN  CNAME   star.cs.vu.nl
ftp              86400  IN  CNAME   zephyr.cs.vu.nl

flits            86400  IN  A       130.37.16.112
flits            86400  IN  A       192.31.231.165
flits            86400  IN  MX      1 flits
flits            86400  IN  MX      2 zephyr
flits            86400  IN  MX      3 top

rowboat                 IN  A       130.37.56.201
                        IN  MX      1 rowboat
                        IN  MX      2 zephyr

little-sister           IN  A       130.37.62.23

laserjet                IN  A       192.31.231.216
```

Figure 7-4. A portion of a possible DNS database for *cs.vu.nl*.

Answer:

It is **not an absolute name**, but relative to .cs.vu.nl.

It is really just shorthand notation for **rowboat.cs.vu.nl**

Question 4

There has been huge growth in the number of websites in the .com domain. This creates an enormous load on the root DNS server for the .com domain. What solutions can you propose to solve this load problem, without requiring changes to names in the .com domain?

Answer:

One option is to route queries to different root servers based on the **first letter of the domain name**, e.g., google.com is mapped to root server G, etc.

Question 5

DNS uses UDP instead of TCP. If a DNS packet is lost, there is no automatic recovery. Does this cause a problem, and if so, how is it resolved?

Emp No	Name	Age	Department	Salary
001	Alex S	26	Store	5000
002	Golith K	32	Marketing	5600
003	Rabin R	31	Marketing	5600
004	Jons	26	Security	5100

Operation:
Delete the row which Emp No is 004

What will happen if I do this operation several times?

We just delete that row once, no matter how many times u do this operation, the result doesn't change.

idempotent

Question 5

DNS uses UDP instead of TCP. If a DNS packet is lost, there is no automatic recovery. Does this cause a problem, and if so, how is it resolved?

Answer:

Just like delete, DNS is **idempotent** (operations can be repeated without changing the final result),

When a process makes a DNS request, it starts a timer. If the timer expires, it just makes the request again. No harm is done.

Question 6

Can a machine with a single DNS name have multiple IP addresses? How could this occur?

Answer:
Yes. In fact, in Fig. 7-4 we see an example of a duplicate IP address.

Remember that an IP address consists of a network part and a host part. If a machine has two Ethernet cards(also now as NIC(Network interface card)), it can be on two separate networks, and if so, it needs two IP addresses.

Question 7

An alternative form for a URL is to use the IP address instead of its DNS name. An example of using an IP address is http://192.31.231.66/index.html.

How does the browser know whether the name following the scheme is a DNS name or an IP address?

Answer:

DNS names may not end with a **digit**, so there is no ambiguity.

The valid characters for use in domains are:

- Any of the letters of the alphabet; example: **abcdefg.com.au**
- Any numbers 0 to 9, example: **369.com.au**
- You may also use a hyphen (-), example: **domain-registration.com.au**
- Domain names cannot begin or end with a hyphen
- You can use a combination of numbers, letters and hyphens, example: **open24-7.com.au**
- You can use multiple instances of hyphens, but not a double hyphen
- Domain names can begin and end in a number, example: **9-5.com.au**
- Other forms of punctuation, symbols or accent characters cannot be used.
- The name's length must be between the range 3 and 63 characters

888888.com

Last week

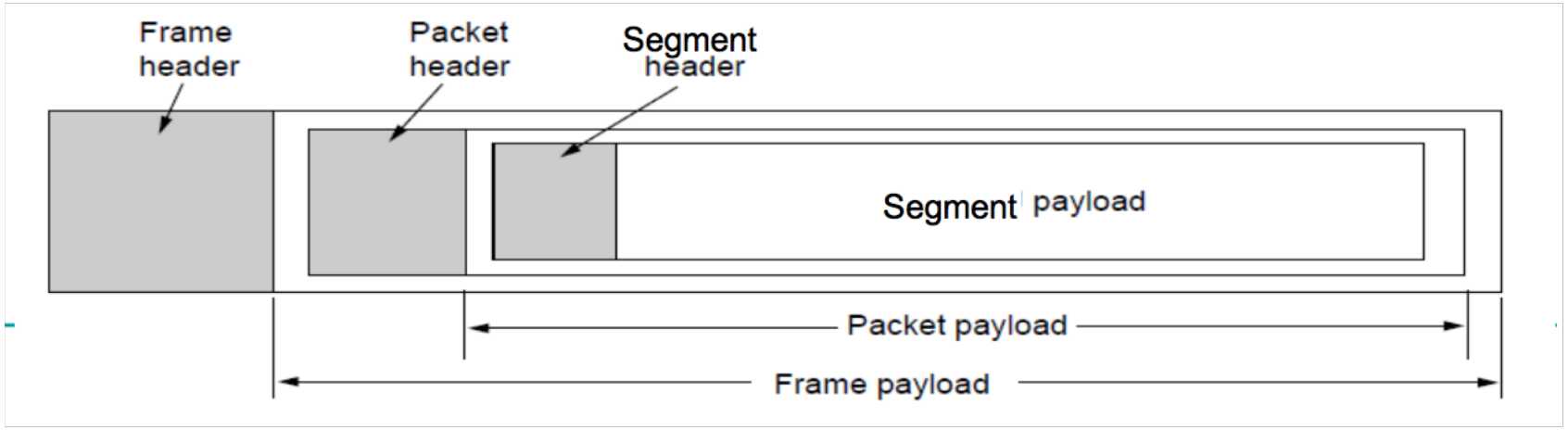
Question 8

The maximum payload of a TCP segment is 65,495 bytes. Why was such a strange number chosen?

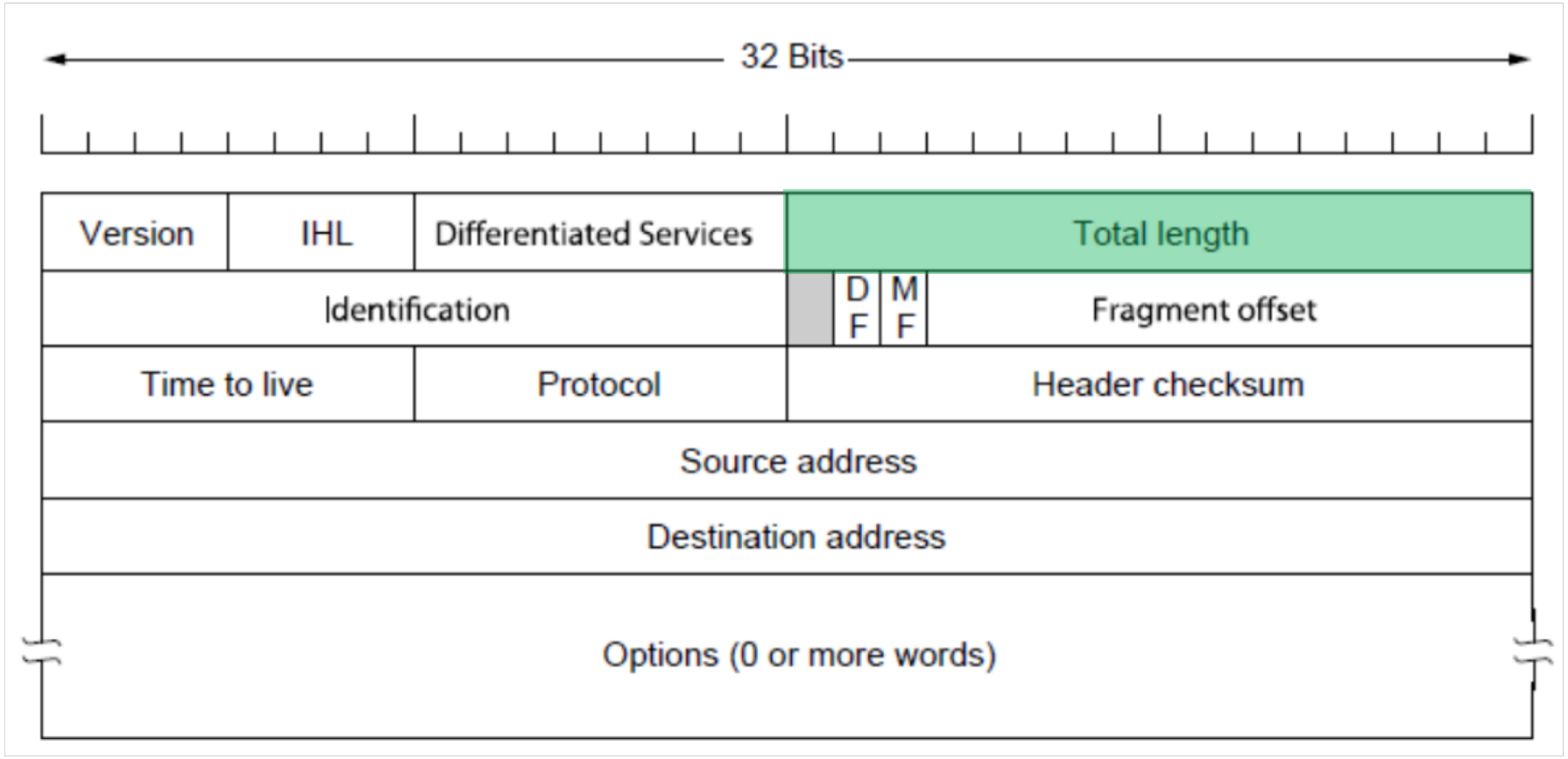
Segment payload = frame payload – packet header – segment header

IP packet length
(includes header and payload)

65535 bytes



IPv4 Frame Structure

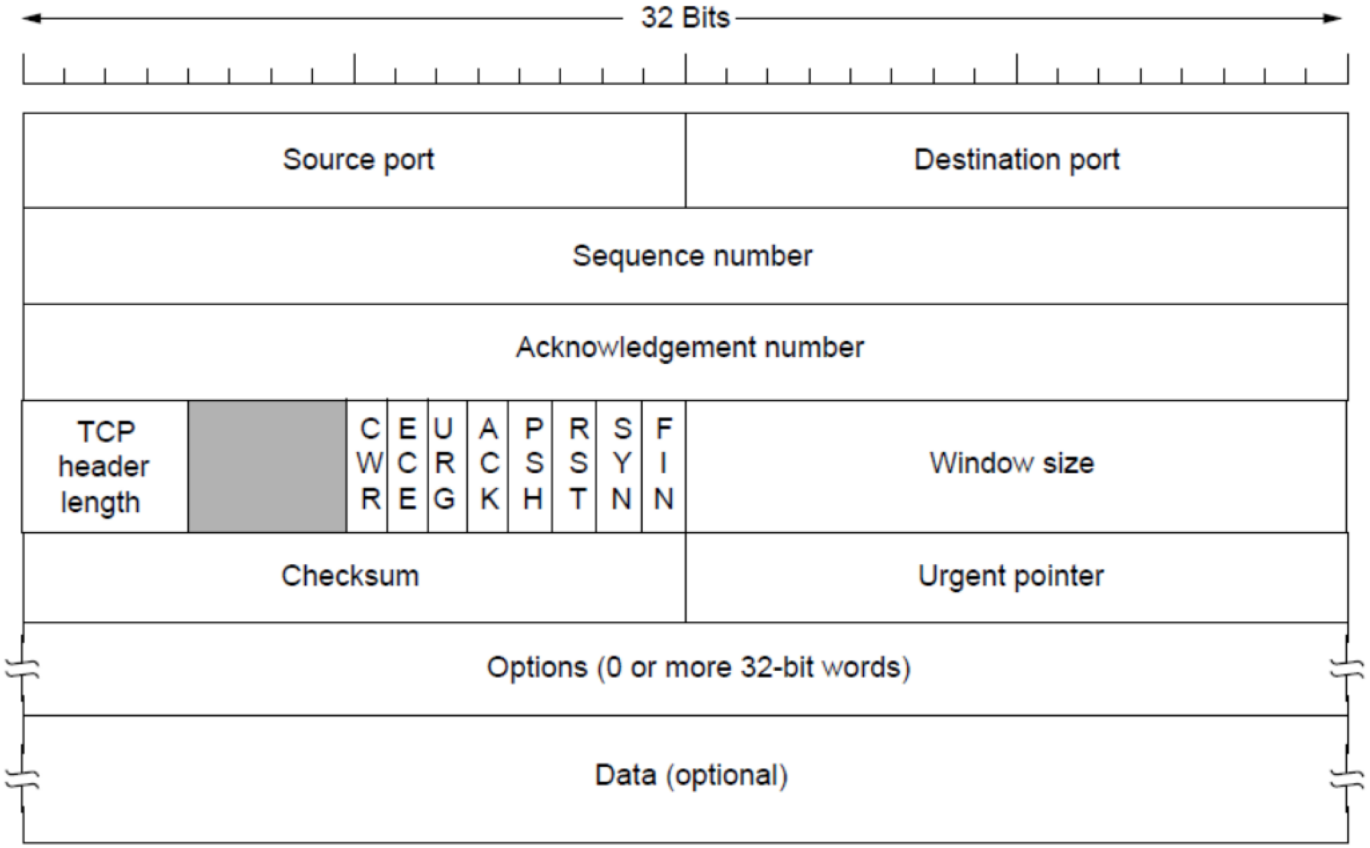


Minimum IP packet header = 5 * 4 = 20bytes

The TCP Segment Header

Minimum TCP segment header = 5 * 4 = 20bytes

- TCP header includes addressing (ports), sliding window (seq. / ack. number), flow control (window), error control (checksum) and more



Question 8

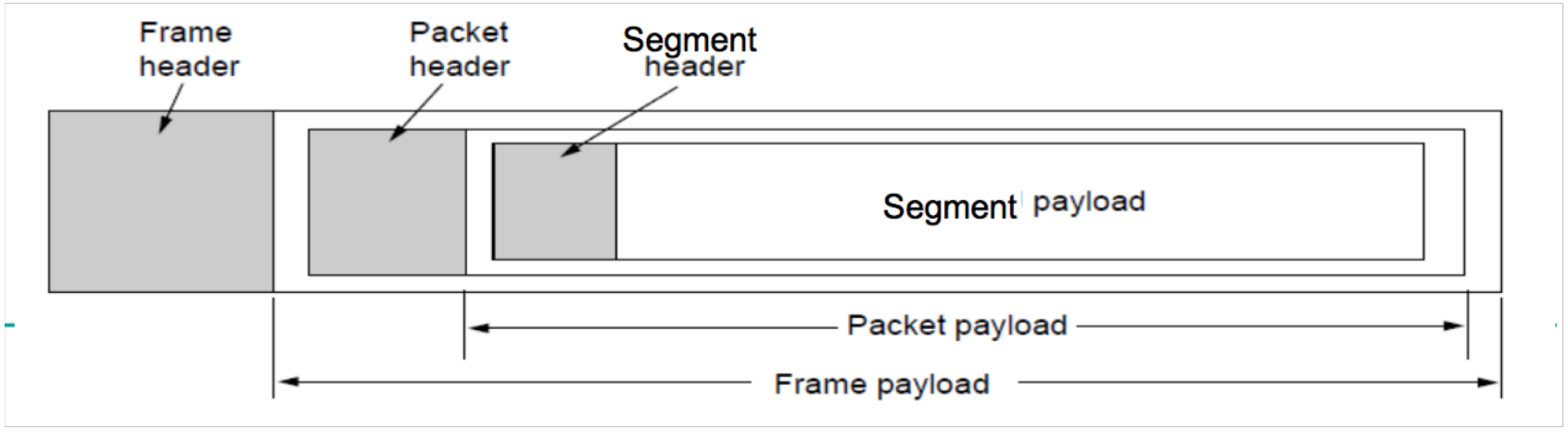
The maximum payload of a TCP segment is 65,495 bytes. Why was such a strange number chosen?

Segment payload = frame payload – packet header – segment header = 65495 bytes

20 bytes **20 bytes**

IP packet length
(includes header and payload)

65535 bytes



Question 9

1 Tbps = 10^{12}bps = $1.25*10^{11}$ bytes/second

To get around the problem of sequence numbers wrapping around while old packets still exist, one could use 64 bit sequence numbers. However, theoretically, an optical fibre can run at 75 Tbps.

What maximum packet lifetime is required to make sure that future 75 Tbps networks do not have wraparound problems even with 64 bit sequence numbers? Assume that each byte has its own sequence number, as TCP does.

Answer:

- The sequence space is 2^{64}. Each byte is assigned a unique sequence number, so the sequence numbers can represent 2^{64} unique bytes.
- A 75 Tbps transmitter can output 9.375×10^{12} bytes/s.
- $t = 2^{64} / 9.375 \times 10^{12} = 1.96 \times 10^{6}$ s = 22.77 days
- It takes 22.77 days, which is over three weeks, to wrap around. A maximum packet lifetime of less than 22.77 days will prevent the problem. In short, going to 64 bits is going to work for quite a while.