TCS 332 Fundamental of Information Security and Blockchain

B. Tech CSE III Semester

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19-1 IPv4 ADDRESSES

An IPv4 address is a 32-bit address that uniquely and universally defines the connection of a device (for example, a computer or a router) to the Internet.

Note

An IPv4 address is 32 bits long.

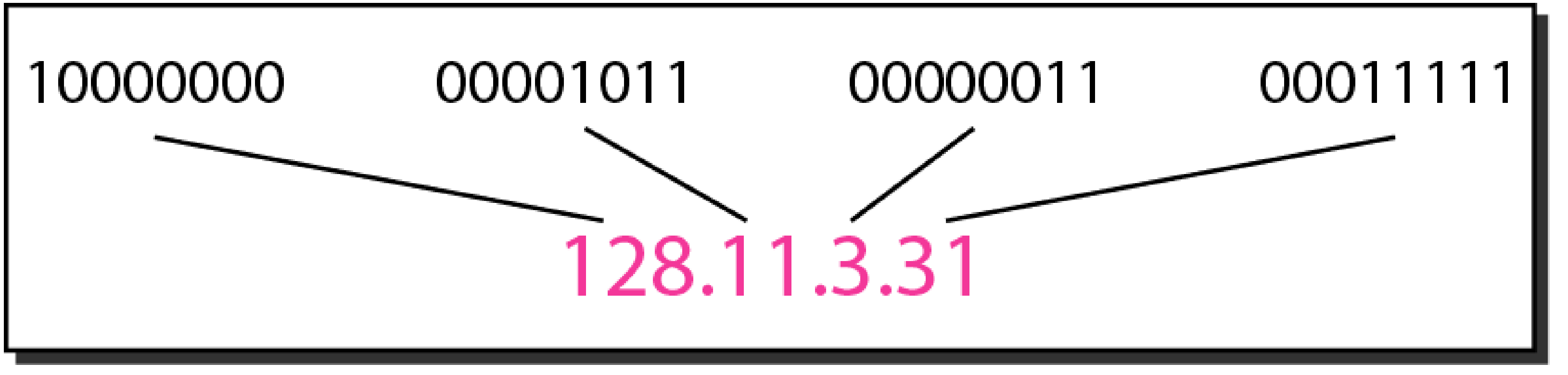
Note

The IPv4 addresses are unique and universal.

Note

The address space of IPv4 is 2^{32} or 4,294,967,296.

Figure 19.1 *Dotted-decimal notation and binary notation for an IPv4 address*



Example 19.1

Change the following IPv4 addresses from binary notation to dotted-decimal notation.

a. 10000001 00001011 00001011 11101111

b. 11000001 10000011 00011011 11111111

Solution

We replace each group of 8 bits with its equivalent decimal number (see Appendix B) and add dots for separation.

a. 129.11.11.239

b. 193.131.27.255

Explanation:

10000001 = $(1 \times 2^7) + (0 \times 2^6) + (0 \times 2^5) + (0 \times 2^4) + (0 \times 2^3) + (0 \times 2^2) + (0 \times 2^1) + (1 \times 2^0) = 129$

Example 19.2

Change the following IPv4 addresses from dotted-decimal notation to binary notation.

a. 111.56.45.78

b. 221.34.7.82

Solution

We replace each decimal number with its binary equivalent (see Appendix B).

a. 01101111 00111000 00101101 01001110

b. 11011101 00100010 00000111 01010010

Example 19.3

Find the error, if any, in the following IPv4 addresses.

a. 111.56.045.78

b. 221.34.7.8.20

c. 75.45.301.14

d. 11100010.23.14.67

Example 19.3

Find the error, if any, in the following IPv4 addresses.

a. 111.56.045.78

b. 221.34.7.8.20

c. 75.45.301.14

d. 11100010.23.14.67

Solution

a. There must be no leading zero (045).

b. There can be no more than four numbers.

c. Each number needs to be less than or equal to 255.

d. A mixture of binary notation and dotted-decimal notation is not allowed.

Note

In classful addressing, the address space is divided into five classes: A, B, C, D, and E.

Figure 19.2 *Finding the classes in binary and dotted-decimal notation*

Class	Theoretical Address Range	Binary Start	Used for
A	0.0.0.0 to 127.255.255.255	0	Very large networks
B	128.0.0.0 to 191.255.255.255	10	Medium networks
C	192.0.0.0 to 223.255.255.255	110	Small networks
D	224.0.0.0 to 239.255.255.255	1110	Multicast
E	240.0.0.0 to 247.255.255.255	1111	Experimental

Example 19.4

Find the class of each address.

a. <u>**14**</u>.23.120.8

b. <u>**242**</u>.5.15.111

Solution

*a. **The first byte is 14; the class is A.***

*b. **The first byte is 242; the class is E.***

Note

In IPv4 addressing, a block of addresses can be defined as

x.y.z.t /*n*

in which x.y.z.t defines one of the addresses and the /*n* defines the mask.

Note

The first address in the block can be found by setting the rightmost $32 - n$ bits to 0s.

Example

A block of addresses is granted to a small organization. We know that one of the addresses is 205.16.37.39/28. What is the first address in the block?

Solution

The binary representation of the given address is

11001101   00010000   00100101   00100111

If we set 32−28 rightmost bits to 0, we get

11001101   00010000   00100101   0010000

or

205.16.37.32.

This will be the first address

Note

The last address in the block can be found by setting the rightmost $32 - n$ bits to 1s.

Example

Find the last address for the block

Solution

The binary representation of the given address is

11001101 00010000 00100101 00100111

If we set 32 − 28 rightmost bits to 1, we get

11001101 00010000 00100101 00101111

or

205.16.37.47

This will be the last address

Note

The number of addresses in the block can be found by using the formula 2^{32-n}.

Example 19.8

Find the number of addresses in Example

Solution

The value of n is 28, which means that number of addresses is 2 $^{32-28}$ ***or 16.***

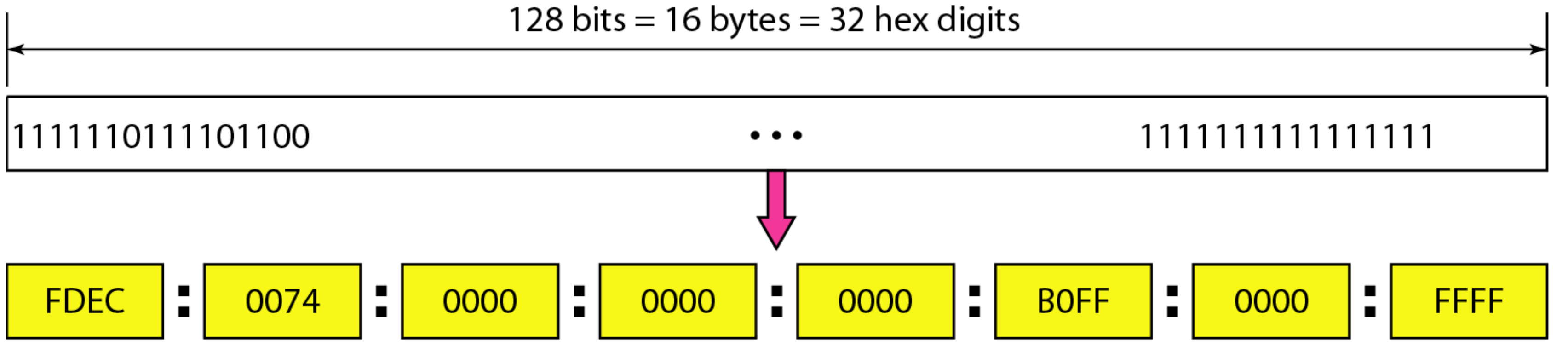
19-2 IPv6 ADDRESSES

Despite all short-term solutions, address depletion is still a long-term problem for the Internet. This and other problems in the IP protocol itself have been the motivation for IPv6.

Note

An IPv6 address is 128 bits long.

Figure 19.14 *IPv6 address in binary and hexadecimal colon notation*



Example 19.11

Expand the address 0:15::1:12:1213 to its original.

Solution

We first need to align the left side of the double colon to the left of the original pattern and the right side of the double colon to the right of the original pattern to find how many 0s we need to replace the double colon.

```
xxxx:xxxx:xxxx:xxxx:xxxx:xxxx:xxxx:xxxx
   0:  15:                :    1:  12:1213
```

This means that the original address is.

```
0000:0015:0000:0000:0000:0001:0012:1213
```

Classes of IPV4 address along with their subnet mask

CLASS	IP ADDRESS	DEFAULT SUBNET MASK
Class A	0 – 126	255.0.0.0
Class B	128 – 191	255.255.0.0
Class C	192 – 223	255.255.255.0
Class D	224 – 239	N/A
Class E	240 - 255	N/A

DNS (domain name server)

- DNS is a application layer protocol.
- It provides a host name to IP address translation service.
- There is a IP address corresponding to each website name.
- It is very difficult to remember that IP address.
- Therefore, domain name to IP address translation mechanism helps us.
- DNS is a distributed database implemented in a hierarchy of name servers.
- It is used for message exchange between clients (i.e., web client) and servers (i.e., web server).

Requirement of DNS

- Every host on the Internet is identified by the IP address but remembering numbers is very difficult for the people and also the IP addresses are not static therefore a mapping is required to change the domain name to IP address.
- So DNS is used to convert the domain name of the websites to their numerical IP address.

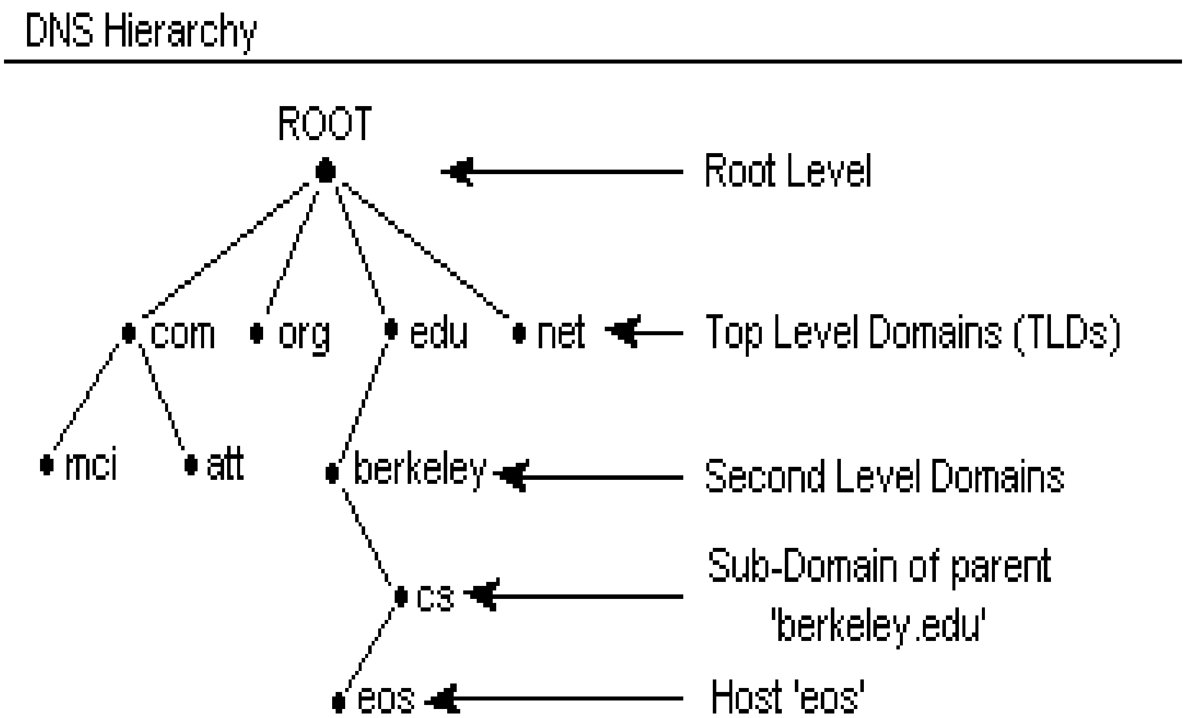
DNS Hierarchy

- Domain Names are hierarchical and each part of a domain name is referred to as either the root, top level, second level or as a sub-domain.
- To allow computers to properly recognize a fully qualified domain name, dots are placed between each part of the name.
- All resolvers treat dots as separators between the parts of the domain name.
- The fully qualified domain name is split into pieces at the dots and the tree is searched starting from the root of the hierarchical tree structure.
- All resolvers start their lookups at the root, therefore the root is represented by a dot and is often assumed to be there, even when not shown.
- The resolver navigates it's way down the tree until it gets to the last, left-most part of the domain name and then looks within that location for the information it needs.

DNS Hierarchy

Example:

https://cs.berkeley.edu/



References

- “Computer Networks” textbook by Andrew S. Tanenbaum
- “Data Communications and Networking” textbook by Behrouz A. Forouzan