

# **C** LEARNING OBJECTIVES

- To understand the need of Domain Name System for proper functioning of Internet
- To know the importance of IP addresses
- To know the parts of URL and its types
- To know the components of Domain name system and its functions
- To know how the DNS is working

# 12.1 Introduction

In earlier days, websites were accessed through their IP addresses. It was difficult for an individual to remember all the IP address to access the websites. So, the domain names were created and mapped with IP addresses. Like phone book, where all the contact numbers are stored under respective names and are accessed by the contact names. Domain Name System (DNS) maintains all the directory of domain names/host names and help us to access the websites using the domain/ host names.

# 12.2 Overview of DNS

For the communication to takes place, the information should pass through

seven layers. Application layer is one among the seven layers. There are several applications in the application layer and DNS (Domain Name System) is one among them. Internet is based on IP addresses, not domain names. But it is easy to use domain names to refer them rather than the long numbers (IP address). To enable the use of domain names in a network, the Domain Name System (DNS) is used. Domain names to IP address mapping must be consistent across the network to ensure interoperability. DNS provides the domain name to IP address mapping through Name servers. To know more about DNS working we must first know about IP address, URL and DNS components. So, let us see about each in detail. Refer Figure 12.1

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Figure 12.1 Domain Name System

While typing a web address, e.g., www.tnschools.gov.in, DNS translates it into a machine friendly IP address (for example 35.173.69.207 is the IP for www.tnschools.in) and directs your Internet connection to the correct website.

**MU** American computer scientist KNUWO Paul V. Mockapetris together with Jon Postel, invented the Internet Domain Name System (DNS) Jon Postel was an administrator of the Internet Assigned Numbers Authority (IANA) until his death and he was known as "God of the Internet".





Paul V. Mockapetris

#### 12.3 IP Address

Internet Protocol (IP) address is simply the logical address in the network layer. Like how the door number/flat number

is used to differentiate individual house from others in the same apartment, IP address is also used to find the



host system in the whole network. Due to increase in the number of system in a network there is a need of more addresses which lead to two addressing methods i.e., IPv4 and IPv6.

#### 12.3.1 IPv4 Address

IPv4 address is a 32-bit unique address given to a computer system. No two systems can have same IP address. If the network has p connections then 'p' addresses should be there. An address space is the total number of addresses that can be made by that protocol. It is determined by the number of bits that the protocol use. If the protocol uses 'n' bits then the address space of that protocol would be '2n' addresses. So, the number of addresses that can be formed in IPv4 is  $2^{32}$ . There are two ways to represent the IP address

- **Binary** notation
- Dotted-decimal notation

In binary notation the address is expressed as 32-bit binary values.

For E.g. 00111001 10001001 00111000 00000111

In dotted-decimal notation the address is written in decimal format separated by dots(.). Refer Figure 12.2

For e.g. 128.143.137.144

Chapter 12 DNS (Domain Name System)

163

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# 12.3.2 IPv6 Address

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IPv6 address is a 128-bit unique address given to a computer system. The number of addresses that can be formed in IPv6 is 2<sup>128</sup>. In IPv6 address, the 128 bits are divided into eight 16-bits blocks. Each block is then changed into 4-digit Hexadecimal numbers separated by colon symbols. E.g. 2001:0000:32313:DFE1:0063:0000:0000:FEFB. Refer Figure 12.3

128	Bits	
Network prefix (64 bits) Host number (64 bits)		
XXXX XXXX XXXX XXXX	XXXX XXXX XXXX XXXX	
X - Hexadecimal number (0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F XXXX - 0000 to FFFF		

#### Figure 12.3 IPv6 Address

# 12.4 Uniform Resource Locator (URL)

URL (Uniform Resource Locator) is the address of a document on the Internet. URL is made up four parts-protocols, hostname, folder name and file name. Each part has its own specific functions. Depending on the applications, additional information can be added to the URL but the common and fundamental URL consists of these four parts. Refer Figure 12.4





164 Chapter 12 DNS (Domain Name System)

Figure 12.4 shows the basic URL where http is a protocol, www.cms.tn.gov.in is a hostname / domain name, sites/ default/files/press\_release are the folders and pr070119a.jpg is the file name. These are all the basic information which can be obtained from a URL.

## URL Type

Depending on the location of the document the URL is divided into 2 types

- Absolute URL
- Relative URL

#### 12.4.1 Absolute URL

Absolute URL is the complete address of a document on the Internet. Absolute URL contains all the information that are required to find the files on the Internet. These are similar to postal address if any of the information is missing then the post will not be delivered to the right person. Similarly, if any of the four parts is missing then the browser would not able to link to the specific file. So, all the four parts is very important in absolute URL.

#### 12.4.2 Relative URL

Relative URL is the partial address of a document on the Internet. Relative URL contains only file name or file name with folder name. We can use this type of URL when the file is on the same server related to original document.

## 12.5 DNS Components

There are three important components in the Domain Name System. They are

- Namespace
- Name server
- Zone

#### 12.5.1 Name Space

The domain names must be very unique and appropriate. The names should be selected from a names pace. The name space can be organized in two ways

- Flat name space
- Hierarchical name space

Flat name space is where the name is assigned to the IP address. They do not have any specific structure. In this flat name space, some meaningful names are given to IP address for accessing. The major disadvantage of flat name space is that they cannot be used in large system. Because they need to be accessed and controlled centrally to avoid ambiguity and redundancy. But it is difficult in flat name system. To avoid this major disadvantage hierarchical name space is used in large.

Hierarchical name space is where the name is made up of several parts. The first part may represent the nature of organization, the second part may represent the name of organization, and third part may represent the department of the organization and so on. In this way the power to control the name space can be decentralized.

#### **Domain Name Space**

Domain name space was designed to achieve hierarchical name space. In this, the names are represented as a tree like structure with root element on the top and this tree can have a maximum of 128 levels starting from root element taking the level 0 to level 127.



Figure 12.5 Domain Name Space

Figure 12.5 represent the domain name space where the root element is present at the top most level i.e., level 0. The root element always represents the NULL string (empty string). The next level to the root element is node (children of root element). Each node in the tree has a **label** and a **domain name**.

#### Label

It is a string which can have maximum of 63 characters. Each node in that level should have different labels thereby assuring the individuality of the domain name.

In other words, Labels are the names given to domains. **Domain** is a sub tree in domain name space tree structure. The domain can be further divided into sub domains.



Figure 12.6 Domain Name and Label

166 Chapter 12 DNS (Domain Name System)

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Figure 12.6 explain the domain name and label clearly. challenger.atc. fhda.edu. is the domain name which is obtained by reading the labels from bottom to top, separating each label by dot (.) Refer Figure 12.7

#### Domain name

It is the sequence of labels. In domain name the sequence of labels are separated by dot (.). The domain name is always read from the lower level to higher level i.e., from the leaf node to root node. Since the root node always represent NULL string, all the domain name end with dot.

#### **Basic rules of Domain names**

- Domain can consists of Alphabets a through z, and the digits 0 through 9.
- Hyphens are allowed, but hyphens can not be used as first character of a domain name.
- Spaces are not allowed
- Special symbols (such as !, \$, &, \_ and so on) are not permitted.

- Domain names have the minimum length of 2, and the maximum length of 63 characters. The entire name may be at most 253 characters long.
- Domain names are not case-sensitive. (It may be upper, lower or mixing of both case letters)

#### Generic Top-Level Domain names:

Top level domain is the last part of a domain name. Generic top level domains are used for generic purpose and maintained by IANA. Refer Table 12.1

Table 12.1 Generic Domain Names		
Domain Name	Meaning	
com	Commercial Organisation	
edu	Educational Institutions	
gov	Government (US)	
mil	Military groups	
org	Non profit Organization	
net	Networking organization	
info	Information service providers	





Chapter 12 DNS (Domain Name System)

#### Country top-level domain names

Country domain uses 2-character country abbreviation according to country. For e.g., google.in – for INDIA, google.us for US. Refer Table 12.2

Table 12.2    Country domain names		
Domain Name	Meaning	
in	India	
us	United States	
fr	France	
uk	United Kingdom	
ca	Canada	
au	Australia	
lk	Srilanka	
bd	Bangladesh	
cn	China	
pk	Pakistan	
јр	Japan	
sg	Singapore	

Domain names may also be used in other than English languages in UNICODE format. Tamil language is also used in three country Top Level Domain names which are. இந்தியா,.சிங்கப்பூர் and .இலங்கை

Domain Name	Meaning
இந்தியா	India
சிங்கப்பூர்	Singapore
இலங்கை	Srilanka

#### 12.5.2 Name Server

The information which needs to be stored in Domain name space is quite large. Single system would be inefficient and insufficient to store such a huge amount as responding to requests from all over the world. It also becomes unreliable because in case of any failure the data becomes inaccessible.

The solution to this problem is to distribute the information among many computers. The best way to do that is to divide the entire space into many domains and sub domains. DNS also allows domains to be further divided into sub domains. By this, the solution to the problem is obtained and hierarchy of servers is also maintained. Name servers store the data and provide it to clients when queried by them. Name Servers are programs that run on a physical system and store all the zone data.

VOU Inverse domain performs the opposite task of normal DNS query. It converts the IP address to domain name.

Name Server is a main part in the Domain Name System (DNS). It translate the domain names to IP addresses. Name server contains the DNS database which consists of domain names and their corresponding IP addresses. There is a need to store large number of domain names for the world wide usage, so plenty of servers are used in the hierarchical manner. Name servers do the important task of searching the domain names. While you searching a website, Local Name server (provided by ISP) ask the different name servers until one of them find out your answer. At last it returns IP address for that domain name. Your computer can now connect to the requested webpage stored on the webserver. Refer Figure 12.8



Figure 12.8 working structure of Name server

#### **Types of Name Servers**

There are three types of Name Servers which control the entire Domain Name System:

- 1. Root Name Server top level server which contains entire DNS tree, maintained by ICANN. There are 13 servers.
- Primary/Master Name Servercontains a zone resource records. These records are updatable by domain name holders such as organizations.
- Secondary/Slave Name Server contains a copy of primary server files. This server has no authority to update, but reduce the workload of master server by sharing the queries.



#### 12.5.3 Zone

The entire name space is divided into many different zones. It is the area up to which the server has access. Zone is defined as a group of contiguous domains and sub domains. If the zone has a single domain, then zone and domain are the same.

Every zone has the server which contains a database called zone file. Using the zone file, the DNS server replies to the queries about hosts in its zone. There are two copies of zone files available, Master file and slave file. Refer Figure 12.9



• A domain is a single node of the Domain Namespace.

• A zone is a subset of the Domain namespace generally stored in a file.

- Domain Name space is an entire collection Domains, Sub domains and Zones
- Name server manages the database of domain names and corresponding IP addresses.
- A server can contain more than one zone files (Zones). A zone can contain more than one sub domains

Chapter 12 DNS (Domain Name System)



Figure 12.9 Zone and Domains

#### 12.5.4 Resolver

Domain Name System is a client/ server application. A host system need to map domain name to IP address or vice versa according to the call and that work is done by resolver. Resolver either asks server to provide information about IP address. If it doesn't find any information, then it sends the request to other servers and so on. Once the resolver receives the mapping, it checks whether it is an error or resolution (mapping) and provides result according to that. The resolver is a program which is responsible for initiating the translation of a domain name into an IP address. Since a resolver is stored in the host, There is no need of any protocol to form a connection between the resolver and the user program.

#### 12.5.5 How DNS works?

When the user enters the URL (consists of protocol, domain name, folder name, file name) in the browser, the system first checks its DNS cache for the corresponding IP address. If the IP address is found in the cache then the information is retrieved from cache. If not, then the system needs to perform DNS query i.e., the system needs to query the resolver about the IP address from Internet Service Provider (ISP). Each resolver has its own cache and if it is found in that then that information is retrieved. If not, then the query is passed to next domain



Figure 12.10 workflow of basic DNS

170 Chapter 12 DNS (Domain Name System)



Web Server

Web server is a program running on dedicated machine which handle the queries of www enduser. Server is used to host the websites and to deliver the contents of websites using HTTP. While typing the URL in browser, the browser send the URL to DNS. After getting an IP address from DNS, It sends the request to the web server with IP address. Now the content of websites appear on browser.

server i.e., TLD (Top Level Domain) which reviews the request and direct the query to name servers associated with that specific domain. Until the query is solved it is passed to next level domains. At last the mapping and the record are returned to the resolver who checks whether the returned value is a record or an error. Then the resolver returns the record back to the computer browser which is then viewed by the user. Refer Figure 12.10

IANA is an affiliated authority of ICANN. IANA does the overall management of the DNS Root, IP addressing, and other Internet protocol resource handling. IANA takes care of a number of key aspects of the DNS, including the root zone, and the domains .int and .arpa.



**ICANN WHOIS** 

LCANN.

https://www.iana.org/

The WHOIS is a service of ICANN. It is a free, publicly available directory containing the details of registered domain names and their owners (registrants). https://whois.icann.org/en

## POINTS TO REMEMBER

- Domain Name System (DNS) maintains all the directory of domain names and help us to access the websites using the domain names. It translates the domain name into IP address.
- IP address is a logical address used to uniquely identify a computer over the network. There are two types: IPv4 and IPv6.
- IPv4 address is a 32 bit unique address given to a computer or a device. There are two ways to represent the IP address: Binary notation, Dotted-decimal notation.

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• IPv6 address is a 128 bit unique address given to a computer or a device. It follows Hexadecimal number notation.

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- URL (Uniform Resource Locator) is the address of a document on the Internet. URL is divided into two types: Absolute URL and Relative URL
- URL is made up of four parts- protocols, hostname, folder name and file name. Absolute URL contains all the four necessary and fundamental parts of URL.
- Relative URL contains only folder name and the file name or just the file name.
- There are 3 important components in the Domain Name System. They are Namespace, Name server and Zone.
- Label is a string which can have maximum of 63 characters. Each node in that level should have unique label.
- Domain name space is a tree like structure with root element on the top. It can have a maximum of 128 levels starting from root element taking the level 0 to level 127.
- Domain name is the sequence of labels separated by dot (.). The domain name is always read from the leaf node to root node. The root node always represent NULL string. So All the domain name ends with dot.
- In the domain name space (DNS) tree structure **domain** is a sub structure tree. The domain can be further divided into sub domains.
- Name Servers are programs that run on a physical system and store all the zone data. It provides to clients when queried by them.
- Zone is the contiguous part up to which the server has access. The domain assigned for the server does not divide into further sub domains then zone is same as domain.
- Resolver, a client/ server application, initiates the process of resolving the domain names.

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DNS	Domain Name System an Internet service that translates domain name into IP address.
IP address	used to uniquely identify a computer over the network.
URL	Uniform Resource Locator, the address of a specific web page or file on the Internet.
Domain Name space	A naming system on which domain names are in a hierarchical and logical tree structure.
Domain Name	a symbolic name associated with an IP address
Name server	Contains the DNS database which consists of domain names and their corresponding IP addresses.
ICANN	Internet Corporation for Assigned Name and Numbers, Non-profit organization which regulates an Internet.
IANA	Internet Assigned Numbers Authority (IANA) is an affiliated authority of ICANN.
Zone	A group of contiguous domains and sub domains in the Domain Name Space.
The resolver	a program which is responsible for initiating the translation of a domain name into an IP address
TLD	Top Level Domain, domains below the root domain
IPv4 /IPv6	Internet Protocol version 4/6

en? **EVALUATION** 

# Part - I Choose the correct answer

- 1. Which of the following is used to maintain all the directory of domain names?
  - a) Domain name system b) Domain name space
  - c) Name space d) IP address
- 2. Which of the following notation is used to denote IPv4 addresses?
  - a) Binary b) Dotted-decimal
  - c) Hexadecimal d) a and b



173

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- **3.** How many bits are used in the IPv6 addresses?
  - a) 32
  - b) 64
  - c) 128
  - d) 16
- 4. Expansion of URL is
  - a) Uniform Resource Location
  - b) Universal Resource Location
  - c) Uniform Resource Locator
  - d) Universal Resource Locator
- 5. How many types are available in Relative URL?
  - a) 2 b) 3 c) 4
- 6. Maximum characters used in the label of a node?

d) 5

- a) 255 b) 128 c) 63 d) 32
- 7. In domain name, sequence of labels are separated by
  - a);
  - b) .(dot)
  - c) :
  - d) NULL
- 8. Pick the odd one out from the following.
  - a) node b) label
  - c) domain d) server
- **9.** Which of the following initiates the mapping of domain name to IP address?
  - a) Zone
  - b) Domain
  - c) Resolver
  - d) Name servers

Chapter 12 DNS (Domain Name System)

**10.** Which is the contiguous area up to which the server has access?

- a) Zone
- b) Domain
- c)Resolver
- d) Name servers
- 11. ISP stands for
  - a) International Service provider
  - b) Internet Service Provider
  - c) Internet service Protocol
  - d) Index service provider
- 12. TLD stands for
  - a) Top Level Data
  - b) Top Logical Domain
  - c) Term Level Data
  - d) Top Level Domain
- **13.** Which of the following statements are true?
- i) Domains name is a part of URL.
- ii) URL made up of four parts
- iii) The relative URL is a part of Absolute URL
- iv) URL doesn't contain any protocol
  - a) i & ii b) ii c) i, ii & iii d) i, ii & iv
- 14.

Assertion (A) : The number of addresses used in IPv6 addressing method is 128.

Reason (R) : IPv6 address is a 128 bit unique address.

- a) A is true and R is false.
- b) A is false and R is true.
- c) Both A and R are correct and R is the correct explanation of A.
- d) Both A and R are correct and R is not the correct explanation of A.

174

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- **15.** Match the following
- a. domain 1. progress that initiates translation
- b. zone 2. contains database of domain names
- c. name server 3. single node
- d. resolver 4. contiguous nodes
  a. 1432
  b.3421
  c. 3214
  d. 3412

# Part - II

# Short Answers

- **1.** List any four domain names.
- 2. What is an IP address?
- 3. What are the types of IP address?
- **4.** What is an URL?
- 5. List out four URLs you know.
- 6. What are the types of URL?
- 7. What is a domain?
- 8. What is a zone?
- 9. What is a resolver?

- **10.** What are the categories available in domain name space?
- **11.** Write any four generic Top Level Domain.

## Part - III

#### **Explain in Brief Answer**

- **1.** Write a note on DNS.
- 2. Differentiate IPv4 and IPv6.
- 3. Differentiate Domain name and URL
- **4.** What are the differences between Absolute URL and Relative URL?
- 5. Write a note on domain name.
- 6. Differentiate web address and URL

#### Part - IV

#### **Explain in detail**

- **1.** Explain briefly the components of DNS.
- **2.** Classify and Explain the IP address.
- **3.** Explain about the name server?
- **4.** What is domain name space? Explain.
- 5. Explain how the DNS is working.

# STUDENT ACTIVITIES

## 1. Find out IP address of your system

- i. Click start menu and type command or cmd to open command prompt
- ii. A command prompt window will be displayed. Type ipconfig and press enter.
- iii. The IP number is listed under IPv4 Address and IPv6 Address.
- iv. Find out the MAC address of the network card in the list.
- v. Find out and analyze what the other information displayed on the screen.

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- 2. Find out IP address for the websites using command prompt
  - i. Click start menu and type command or cmd to open command prompt.
  - ii. A command prompt window will be displayed. Type tracert and press enter.
  - iii. From the displayed window, You'll see the IPv4 and IPv6 address.
  - iv. Find out IP address for another website.
- 3. List out websites to find out IP address of other websites

#### For example:

https://ipinfo.info/html/ip\_checker.php

- 4. Use nslookup in command line and analyse what purpose it is used.
- 5. Buy your own domain name or create free sub-domain and connect free hosting servers.

#### For example:

www.goDaddy.com, www.webs.com

176

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