

Networking Concepts

- How does computer systems works over the network
 - What are protocols why do we need to use them?
 - Application Protocols
 - Transport Protocols [OSI Model Layer - Highlevel]
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Basics of Networking

Every computer in order to communicate with other computer over the network it requires an Network Adapter called NIC Card "Network Interface Card". NIC Cards are plugged into the Motherboard of the Computer and these cards are Plugged in with RJ45 Socket Network Cables connecting computers.

A Computer can have multiple NIC Cards Plugged-In in order to inter-connect with multiple computers.

How does a computer can communicate with another computer after inter-connecting them? Every computer in order identify itself on the network it requires an unique address called "ip address". Ip address is a logical network address that is available for every computer on a network. The ip address is unique within the network, so that a computer can communicate to another computer using the ip address of the others.

What is mac address?

"ip address" is a logical address that is generated whenever a computer is brought on to the network. Whereas the Network Interface Card has another address seeded inside it by the manufacturer that uniquely identifies your computer within others which is "Mac Address" or "Physical Address" of the computer.

Then why dont we use mac address for communicating?
These are not user friendly and cannot be memorized.

Who communicates over the network in a computer?

No computers will communicate with each other in exchanging the data over the network. Programs running in the computers wants to exchange data with another program running on another computer, so programs wants to communicate over the network.

Here "ip address" allows you to identify Computer, but we need to pass the data to a specific program running inside the other computer. So a program by itself has to register with operating system wishing asking operating system to pass the data that it received over the network. So operating system allots one numeric number to the program called "port no" to identify itself in that computer.

The program looking for receiving data over the network only has to register a portNo with operating system, every program will not have portno in a computer.

In order to send the data across the network to another program we need to use ipaddress and port no also.

portNo is required only for the program which wants to receive the data from the network.

How does the data transfer takes place over the network connection?

Network/Physical hardware devices are not capable of trasmitting the data in symbolic represenation format. They are capable of only sending singals either as off or on. If some how some way if we can express the data interms of singals off/on then the information can be transferred over the n/w from one device to the another one.

How to represent information interms of singals as off/on?

We can express the data interms of 0's and 1's indicates 0 as off and 1 as on in a binary format. in order to transform the data into binary or 0/1 format we need to use character set encoding standards.

The charset encoding standards helps us in expressing the characters/symbols in a nuemric represenation so that it can converted into binary format and can transfered over the network. There are many charset encoding standards are available.

1. ASCII
2. utf-8
3. UNICODE
4. ISO-9001
5. utf-32

Both the senders and the receiver should use the same charset standard in exchaning the data to understand.

OSI Model Layer = Open System Inter-Connection standard protocol that is used for enabling computer programs across the network to communicate and exchange the data.
Any 2 programs running on any platform can still communicate with each other by using OSI Layer protocol.

OSI Layer protocol comprises both application/transport protocols within it. It is divided into 7 layers

1. Application layer
2. Presentation layer
3. Session layer
4. Transport layer
5. Network layer
6. Datalink layer
7. Physical layer

1. Application layer

Any 2 applications who wishes to exchange the data over the network in an understandable manner, 1st of all the application need to define set of rules in exchanging the data and operation. unless otherwise both parties cannot communicate. Here we require the following.

- 1.1 away to differentiate data and operation (requested)
- 1.2 data format in which it should exchanged by both application.

These are some of the rules application by themselves should define to exchange the data, which is called application layer protocols.

protocol is a set of rules and guidelines that should be followed by computers and applications running in them to effectively communicate over the network.

few of responsibilities/duties of protocols

- ensure the data is received by the intended receiver
- guaranteed delivery of the data
- data arrives intact at the receiver side.

In this way many responsibilities/duties are carried by the protocol.

osi model layer is a standard network protocol used for exchanging the data over the computer networks.

osi = open system inter-connection standard.

It has of 7 layers

1. Application Layer
2. Presentation Layer
3. Session Layer
4. Transport Layer
5. Network Layer
6. Datalink Layer
7. Physical Layer

The order of the layers cannot be changed and the data flows from top to the bottom at the sender side and flows from bottom to the top at receiver side in order to have the data transmission.

#1. Application Layer

Application Layer = comprises of several different protocols used by different type of applications defining their own data standards and rules in exchanging the data between network applications.

1. application layer
 2. presentation layer
 3. session layer
 4. transport layer
 5. network layer
 6. datalink layer
 7. physical layer
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1. application layer = how can 2 different network applications can exchange the data in an understandable format. Here applications by themselves define set of rules over the data should be exchanged between them.

2. presentation layer = it takes care of presenting the data to the network in a transferable format it does 3 responsibilities.

2.1 data conversion = converting the application layer representation data into bits format so that it can be sent over the network as signals

2.2 data compression = reduces the number of bits so that it can be quickly transferred over the network with less bandwidth

2.3 encryption = encrypts the data so that it cannot be stolen by others/intruders

OSI Model Layer

1. Application Layer
 2. Presentation Layer
 3. Session Layer
 4. Transport Layer
 5. Network Layer
 6. Datalink Layer
 7. Physical Layer
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1. Application Layer

defines set of rules between any 2 n/w applications in order to exchange the data in understandable manner.

There are lot of standard applications that has come-up with their own set of protocols over which the data/information exchange will happen like.

Web Server / Web Clients = Http

Email Server / Email Clients = SMTP

File Server / File Clients = FTP

2. Presentation Layer

There are 3 responsibilities being handled by Presentation Layer

2.1 Data Conversion = Takes the data from Application Layer and converts the stream of characters into binary representation so that those can be transmitted as signals over the network.

2.2 Compression/De-Compression = More bits takes more band-width and transmission time so that presentation layer uses compression technics in reducing the no of bits to be transferred so that data transfer takes place very fast.

2.3 Encryption/DeCrypton = The sensitive data is prone to be stolen over the network in order to protected the data from stealing presentation layer using encryption technics

3. Session Layer

End to End application communication will be managed by session layer

1. Authentication / Authorization = session layer helps the application in authenticating/authorizing the client applications with server and keeps track of which applications are authenticated and not by storing them in session.

2. Session Management

all the data from server to client will be transferred by breaking them into smaller packets, at the client the side the information should be reconstructed by identifying which packet belongs to what data, this can be done by taking the help of session layer.

The above three layers are related to application implementation these are not about data transfer over the network.

Transport Layer

There are 3 responsibilities of the Transport layer

1. Segmentation = breaks the data into small parts called segments and populate sequence no to reconstruct the message at the receiver side. and populate port no to identify this segment should be received by which application of the destination computer.

2. Flow Control = It slows down the sender indicating the receiver is not capable of receiving the data at higher transmission rates so that flow control can be achieved.

3. Error Control = Identify the lost segments and corrupted segments and re-instructing the

sender to re-transmit them will be done by Transport Layer

Network Layer [ip addressing] [Routers are devices works at Network Layer]

It is responsible for transferring the data from computer of one network to another computer of another network.

There are 3 responsibilities Network Layer does

1. Logical addressing
2. Routing
3. Path Determination

Transport layer

There are 3 responsibilities Transport layer does

1. segmentation = breaks the data into smaller packets and attaches the below.

1.1 sequence no = to re-assemble the message at the destination side

1.2 port no = to determine this packet has to be sent to which application on the destination computer.

So that the segments can be sent over the network easily

2. flow control = it instructs the sender in slowing down the transfer rate when the receiver is a slow receiver so that loss of data transmission will not happen.

3. error control = lost and corrupted data segments will be identified and request the sender to re-transmit

Network layer

Transmission of data from one computer to another computer on another network.

There are 3 responsibilities network layer does

1. Logical addressing = attach to the data segment the source ip address and the receiver ip address and the resulted segment is called "ip packet" or "data packet" the process of binding ip address to the data segment of transport layer is called logical addressing.

2. Routing = determine the network address from the receiver ip address and route the packet to the correct network of the destination computer is called "Routing"

3. Path Determination = There are multiple intermediaries through which the data packet has to be routed to receive by the destination network computer. The network layer computes the shortest path of travel to reach to the destination and this process is called Path Determination.

6. Datalink Layer

Datalink is a software that is embedded as part of the Network Adapter (Hardware Unit) responsible for transmitting the data.

Physical addressing

Media Access control

Error control

5. Network Layer

Transfer data from a computer to another computer on another network.

There are 3 responsibilities are they

1. Logical addressing = adding sender/receiver ip address to the segment of the transport layer (data packet / ip packet)

2. Routing = determine the network address from the receiver ip address of data packet and route the data packet to the correct destination computer network.

3. Path determination = There are many ways/hops between sender and receiver in transferring the data, Network Layer determines the shortest-path/optimistic path in sending the data.

6. Datalink layer

Datalink layer is a software that is embedded as part of Network Interface Card (or) Network Adapter.

There are 2 types of addresses are there for a computer on a network

1. Logical Addressing = ip address that is generated/assigned to a computer when it is connected to the network is called "Logical", it is called logical because it is not permanent.

2. Physical Addressing = mac address (which is 12 digit hexa-decimal number) of the network interface card, and it comes as part of the hardware of the NIC card and written by manufacturer looks like unique and permanent.

It takes the data packet/ip packet from Network Layer and adds mac address of sender/receiver to the data packet which is called "Data Frame"

There are 2 responsibilities of Datalink layer

1. Media Access Control = The datalink layer is responsible making the higher level layers accessible to the media of transmission, for eg. if the physical channel is a wired communication then datalink layer receives the ip packet from network layer and adds head/tail bits to the ip packet forming data frame in such a way it can be transitted over the wire.

Datalink layer is responsible for reading/writing the data in a format of the transferable media.

2. Error Control

There are 2 types of error control will be done.

2.1 collision detection = Datalink will inspect the media and instructs the Network Adapter about the traffic over the physical media.

2.2 due to hardware limitations sometimes the dataframes are received in corrupted state, so the datalink layer while transmitting at the source it adds some random bits to the dataframe before transmitting and verify at the receiver side the dataframe has been received intact or not by checking the random bits.

7. Physical Layer

It is responsible for converting the bits of data into transmittable format over the physical channel for e.g.. if it is wired communication converts bits into signals and transfer over the physical channel.

