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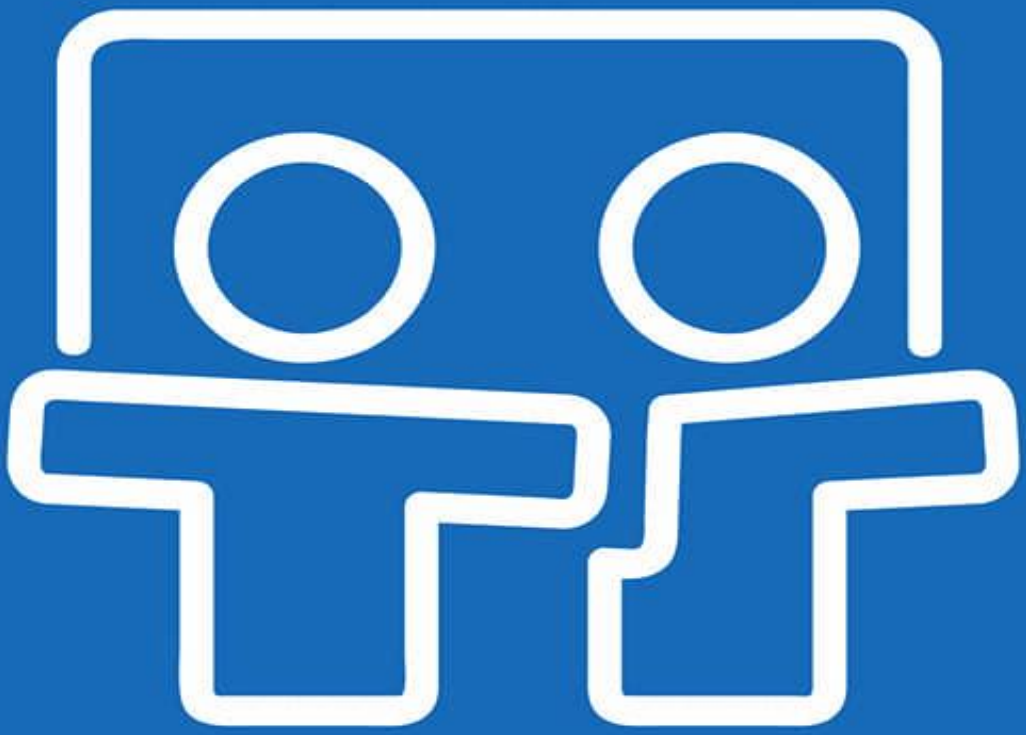
NETWORKING FUNDAMENTALS



Complete Course book

Course Objective –

The core objective of this e-book is to learn about Networking concept and how network works. This course e-book is for students, professional or any individual who is willing to learn concept of networking and how computer talk to each other via guided or wireless media. Here we learn about networking, topologies rules of communication, network port and transmission media and much more.

Preface –

This is the first edition of book in your hands. This book provides an introduction about Network and Networking Fundamentals and its various topology and transmission medium to start your professional career or can learn these concepts to work within a computer network. As with rapidly changing and updating world we were trying to describe every detail topic in this e-book. We have tries or best to make this e-book a complete product and it's gratifying to know that a lot of people agree with our approach. *Dear reader, thank you very much for your love and faith. Your association makes us feel proud.*

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Before You Start –

In this course of Networking Fundamental, we assume you are newbie and don't have any prior knowledge about network, don't worry we start from fundamentals and level up effort with every new section. This course is to learn networking concept to communicate with other computer in a network with more ease. We designed this course for student and learner or any individual who willing to learn Networking concept for career enhancement.

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INTRODUCTION

Before we start learning about Networking, first read this example its helps you lot to understand the topic we are going to discuss in this course.

You all have a Computer system in your home and for printing purpose you all have a printer through which you get print out of your important documents.

Similarly, In Banks or in Office there is lot many Computer systems for working purpose. So if we buy separate printer or scanner for each system its make the working setup highly cost effective.

So it is a good idea to connect all computers to the network so that they can share resources (printer in this case.) which is not cost effective.

Because only one printer is need to get a print out from any of the system connected to network. So this is what a network does.
Now back to topic. This one printer can be shared among a number of computers if they are inter-connected. Inter-connected computer forms the Computer Network.

You can share hardware, software and even a data among a computer which are interlinked in a network. Networking in generals refers to the creation of network.

What is networking?

Networking in generals refers to the creation of network.

So what is Network?

Network is the group of devices which all are linked or connected with one another. So basically, networking makes sharing of resources or data easily. A computer connected to the network, known as the Work-station or Node or Host. A computer which is not connected to the network is known as Stand Alone Computer.

NEED OF NETWORKING

Networking makes the sharing of information much easier, it breaks the barrier of time, distance and cost. Now any from anywhere can communicate to anyone who is not physically present near him or her.

Also communication via computer network is much cost effective can be done to any device present anywhere in the world with a very sort interval of time. Also any kind of data can be transmitted through it.

Example - text, audio, images, videos, graphics etc. These all are some major needs of networking which are summarized above.

COMPONENT OF NETWORK

Before learning about Component of computer first read this example and try to understand, you and your friend talk to each other. You explain him something about the Computer Fundamental. Here you both communicate to each other.

Here You (sender of information) is a one component, your friend (receiver of information) is the second component and the communication channel or medium through which you both are able to speak and listen respectively is a third component which is air in this case. Similarly in a computer network when two computers are interlinked in order to share data or information there are several component that helps in communicating in network. These are -

1. Sender
2. Communication channel
3. Receiver

Sender is one who sends the information.

Communication Channel is a medium through which data travel and reach to Receiver computer.

Receiver Computer is one who receives the data send by the sender.

So mainly Computer Network have a three Component of networking.

Here Communication channel meant that, Connection cables which help to connect devices together for data or information transmission.

HOW DATA IS MOVING?

Till now you learn so much about Computer Networking, have you think about how data is moving in a Network. If not yet, then think about it for minute, and then we going to answer you this curious question.

How data is moving in a Network?

Data in network moving with the help of several things like Data encapsulation which helps in communicating the message. The process of segmenting benefits because different conversation can be interleaved and also it increase the reliability of network communication.

But apart from benefits it also have some disadvantage like it increased the level of complexity. In simple language, we can describe it that first when the data is send by the source side it fragments into small pieces known as segment and each segment is get a label which is providing for ordering and assembling the piece's whey they arrives at the receiving side.

This process of segmenting and labeling is done every time when data packets are moves in a network. At the receiver end all segment are reassembled and message is appearing as it was in beginning.

Types of Network

Computer Network defines as the group of computer system which hare linked with one another in order to share data, information or resources etc. with one another. So this group of Computer System may be small or may be large enough, also the method of inter-connection (connection between nodes or host) may be different as per condition, because computer network is vary with respect to size, geographical area and complexity.

So on the basic of geographical region, Network are classified as

1. Local Area Network (LAN)
2. Metropolitan Area Network (MAN)
3. Wide Area Network (WAN)

Let discuss one by one,

Local Area Network-

Local Area Network or LAN are those network who covers the small geographical region like home, office, group of building etc. It connects the computer, printer, workstation etc. within a network and also has a low speed of communication lines for connection like twisted pair, co-axial cable or fiber optics. Cost of transmitting data (sending and receiving data) is negligible.

Metropolitan Area Network-

Metropolitan Area Network is bigger than Local Area Network because it covers the larger geographical area such as town or city. It also has a high speed of connection microwaves links or co-axial cable. Best example of MAN is Cable television network in many cities. MAN is formed by connecting several LANs which may belong to various organizations.

Wide Area Network-

Wide Area Network (WAN) is a computer network covering very large geographical area, like a country or a continent. WAN is a very high speed communication link like satellite communication, telephones line or Microwaves links.

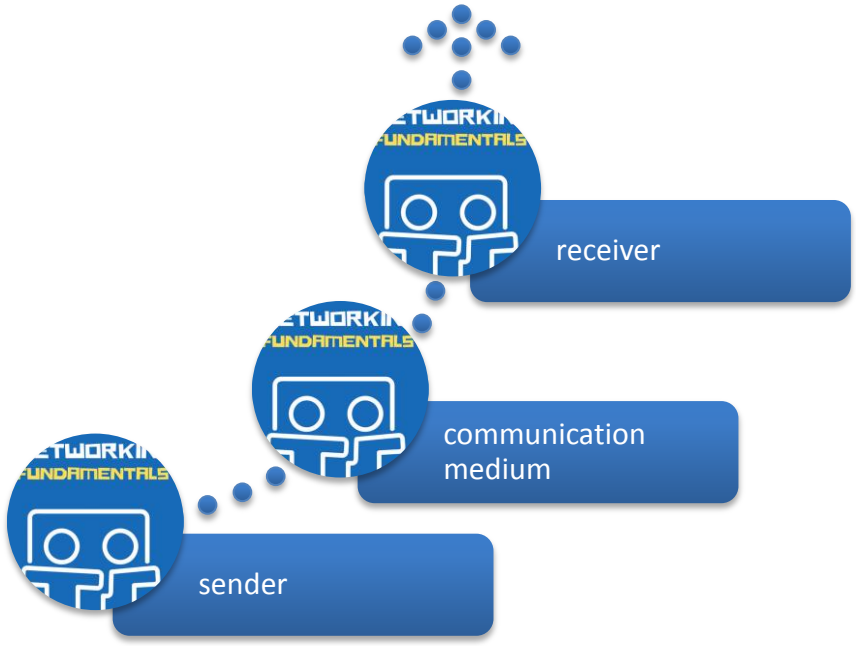
The cost of sending data from sender to receiver in a WAN is higher than MAN and LAN because of the use of the public communication system such as satellite or telephones lines.

RULES OF COMMUNICATION

There is always some rules and regulation you have to follow everywhere. So like everywhere here in computer networking you also have to take care about some rules while communicating with any other workstation.

First we talk about Human Communication So let suppose have to tell something to his friends. So what is the minimum required thing they need?

1. First a sender (Pappu)
2. Communication Medium (Air)
3. A receiver (Arvind)



Because of a communication channel or medium one can transmit his or her message. Communication channel sometimes as simple as air and sometimes is full of many complications like in modem. Let take above example again, If Pappu send a message to Arvind via Computer network which is connected with a modem at the both end, so what the process is going on in communication channel.

After sending message from Pappu computer first conversion takes place at sender side. (Modem convert digital signal to analog signal) so that telephone lines can transmit the data signal to other side. Then secondly data signal transmits and as soon as they reach at receiver end again analog signal are

converted into digital signal so that computer can read the message. So here, in transmission channel is not simple as we seen in first case where Pappu simply tells a message to Arvind.

Now imagine, if there is more modem is present in a midway of data transmission so it's make a transfer of data more complexity. Let suppose there is 10 modem present in between so apart from sender and receiver end 10 times more the conversion of signal to digital to analog and vice-versa take place.

Establishing the Rules

For establishing a network between two nodes there is some parameter which are essential to follow to make a secure and better network. These rules are mentioned below

1. An Identifier Sender and Receiver.
2. Both should be agreeing upon a method of communication.
3. Common language and grammar.
4. Speed and timing of delivery.
5. Confirmation of acknowledgement.

These rules also applicable in human communication, read them and think about it.

NETWORK TOPOLOGIES

Topology in network refers to the way in which the nodes in network are connected to one another. It determines the various available paths between any pair of nodes in network. Choice of network topology depends upon the various factors:

1. Desired performance of the system.
2. Reliability of the system.
3. Size of the system (Number of host or nodes and their geographical region)
4. Cost of components and services requires to implement network
5. Availability of communication lines.

There are several types of network topologies some of which are define below:

1. Star topology

In star topology multiple nodes are connected to a host node. Two nodes can communicate in star topology via host nodes because nodes in a network are linked with each other through host node. Basically, host node perform the routing function that controls the communication between two nodes by establishing the logical path between them.

Advantage

Each topology has some advantage and disadvantage. Here we mentioned some advantage of using a star topology.

1. This topology is very low cost effective. Because only lines are required to connect nodes.
2. Transmission delay between two nodes is not increased by adding new node in network, because any two nodes are connected via two links only.
3. If any of the nodes in network fail except host nodes, other nodes are remaining unaffected.

Disadvantage

Apart from advantage star topology also have some disadvantage. The only disadvantage with this topology is that if host nodes are fail under any circumstance entire network is fails.

2. RING TOPOLOGY

Ring topology is another kind of topology in which each nodes has two communicating subordinate (every nodes is connected to its two adjacent nodes), so there is no need of host node or master node for controlling the network.

Every node receives data from any of its two adjacent nodes. The only decision a node has to take is whether the data is for his own use or not. If its addressed to it, utilize it unless it merely passed it to the next node.

Advantage

1. There is no central host node for making routing decision.
2. It more reliable than a star topology because communication is not depend on the single central node. If the link of any two nodes fail, or if any node fail alternate routing is possible.

Disadvantage

1. Communication will delay if numbers of nodes are more or increased in a network.
2. It requires more complicated control than star topology.

3. COMPLETELY CONNECTED NETWORK

This a more reliable than above two topologies because there is separate physical link for connecting each node to any other node. Each Node has a direct link to other nodes in a network, known as point-to-point link. The control is distributed with each node deciding it's communicating priorities.

Advantage

1. Most reliable because failure in any link will affect only direct communication between nodes connected by that link.
2. Each node of network need not have individual routing capability.
3. Communication is very fast between any two nodes.

Disadvantage

1. It's a most expensive network from the point of view of link cost.
2. If there are nodes in a network, links are required.

4. BUS TOPOLOGY

Bus topology is option for you to reduce the number of physical link because in this network topology all nodes in a network are connected with the single transmission medium.
When a node wants to send a message to another node, it depends on destination address to the message and check whether communication line is free or not.

If it busy then as soon as line become free, it broadcast the message on the line and when message is travelling in a line each node check whether the message addressed to it.

Finally message is picked up by the addressed node and then acknowledgement message is sent to sender node and free the line.

Advantage

1. It helps in reducing the number of physical lines.
2. Failure of one node does affect the other nodes working on a network.
3. Addition of a new node is easy.

Disadvantage

1. If the shared transmission line is fails, entire network is fail.

5. Hybrid Topology

Hybrid topology is a collection network of different topology used in a big network.

NETWORK TRANSMISSION MEDIA

When we talk about transmission media or medium its meant that we talk about connecting cable which are used to connect two or more work-station. Many different types of networking media are used in a LAN (Local Area Network) like copper conductor in the form of twisted pair. Recently we use optical cable as a networking medium.

There are some other medium also which help in transmission of data such as microwave transmission, infrared, telephone line etc. So because of this wide variety of networking medium we classified them in two categories, named as -

1. Guided media
2. Unguided media

Guided media includes the wire and cables for transmission of data while unguided media is free from cable its uses the waves, air, vacuum for their transmission.

GUIDED MEDIA

Guided media is also known as Wired Media or Bound Media because the data signals are transmitting along a specific path which are bounded or guided by cable system. There are three basic types of guided media -

1. Twisted Pair
2. Co-axial Pair
3. Optical Fiber

Twisted Pair

It a most common form of transmission medium where two or more work station are connected with each other with the help of twisted pair. In twisted pair cable, wire is twisted together in pairs.

Co-axial Cable

In co-axial cable there is several layer coiled over the conductor. Solid wire core is surrounded by one or more wire shield; each one is separated by plastic insulator. Signals are carried by inner core and shield provides its ground. Because of high electric properties its gives a high speed transfer of data signal and leads a high speed communication between nodes or host.

That a reason they are widely used in television, network and communication sector.

Optical Fiber

Optical fiber consists of thin glass fibers that can carry information at frequencies in the visible light spectrum. It consists of a very narrow strand of glass called a core. Which is surrounded by concentric layer of glass called cladding. Cladding is also having a protective coating called Jacket or Sheath which is of plastic coated.

What is Modem?

Modem is a device which attached to computer and convert digital signal to analog signal or vice versa. Digital signal is a group of discrete electronic unit that are transmitted in rapid succession while Analog signal consist of continues electrical waves.

Actually Modem is a short name for Modulator-Demodulator where Modulator can convert digital signal to analog signal and Demodulator does the opposite.

What's the need of conversion of Analog to Digital or vice versa?

Let suppose you want to send data from your computer to someone else computer. Computer is an electronic machine works on digital signal so data is transmitting from your computer in a form of digital signal and also at the receiver end its receives data in digital form but telephones lines which act as a connection channel or network medium are works on analog signal. Since to make data transmittable by telephones lines you have to convert in a signal that they can carry so here we need a modem to convert the digital signal to analog signal or vice versa.

Speed of Modem –

Modems transmitted data in a different speed, measured by the number of bits of data they send in per second (bps). Example – 256 Kbps, 512 Kbps, 1 Mbps, 4Mbps etc.

MODE OF DATA TRANSMISSION

There are several mode through which a data is transmitted at sender and receiver end. Here you going to learn about the mode of data transmission.

1. Simplex Mode - In a simplex mode communication system data can be transmitted only in one direction. Devices connected to such as circuit either can only send data (keyboard) or can only receive data (printer).

2. Half Duplex - In a Half Duplex mode of communication system, you can have transmitted data in both directions but in only one direction at one time. Here, it can alternately send and receive data. It requires two wires hence it is most suitable for telephone communication in which only one person can speak at a time.

3. Full Duplex - This mode of data transmission requires four wires that allow data to flow in both directions a same time or simultaneously. Modern computer and internet are most popular example of this mode. It's improves efficiency because it eliminates the direction switching delay of half duplex.

Wireless or Unguided Media

In wireless media data signal are free to move means they are not guided or bounded by cable and also they are not a path specific that why also known as unguided or unbounded Media. There are two types of wireless media listed and describe below -

Long Distance Wireless Media +

Long distance wireless media is a category of those medium which work on a large distance which they can communicate between the thousands of kilometers. This includes -

1. Microwave:

   Like radio and television signal microwave signal are also transmitted data without the cabling system but with a different frequencies range. Here data signals are transmitted in straight path free of material obstacles that why also known as line-of-straight transmission.

2. Radio wave:

   When transmission is made via radio frequencies the transmission is known as radio-wave transmission.

3. Satellite:

   In satellite communication the earth station consists of satellite dish. Satellite dish functions as an antenna and communication equipment to transmit the signal which are later receive data from satellite passing overhead.

Communication satellites are owned by government or Private Organizations which are placed in stationary orbit about 22,300 miles above earth surface.

These satellite works as a relay station for data signals. Satellite accept data, amplify it, and retransmitted them to another earth station. This is a setup used to transmitted data to the other side of earth.

Short Distance Wireless Media +

Short distance wireless medium supports the data transmission in as short range without any guidance or cable system.

1. Infrared:

   Infrared transmission used infrared light to transmit data. You used this types of transmission in everyday life TV remote, automotive garage door, wireless speaker etc. Transmission of data is through the air and can propagate throughout a room, but can penetrate the wall.

2. Laser:

   Laser transmissions is a direct line of straight but work on single direction like microwaves but have a much higher speed than microwave. It requires a laser transmitter and a photo sensitive receiver at the both end. It is a point to point transmission.

3. Bluetooth:

   Bluetooth is a medium of connection through which cellular phones, computer and PDAs (Personal Digital Assistance) are connected with each other in order to share information without the cables and any others guided media. This technology required the low cost transceiver chip on each device. The transceiver transmitted and receives data in a frequency of about 2.45 Ghz with some variation.

Its help to synchronized data and information between mobile phone and computer devices.

4. Wi-Fi:

   Wi-Fi refers to the Wireless Fidelity, which help you to connect with the internet without a direct line from your PC to your ISP (Internet Service Provider). For a Wi-Fi connection you need:

- A broadband internet connection.
- A wireless router, which relays your internet connection from walls to the PC.
- A laptop or a Desktop with a wireless internet card or external wireless adapter.

Data transmission without the cable between computers makes your data susceptible to Hacker, who can steal your data by intercept your network. So be sure to use secure Wi-Fi connection.

DATA ENCODING

Now in a network message is always travel in a transmission medium, every node send data to one another node. So if there is no proper method in a network to protect the message so it can be read by any one in a network. So thus to prevent this and to make network secure, the message is encoded or encrypted so no one other than an addressed receiver can read that message.

Here, the path of data signal is something like -

1. Message send by - Sender end
2. Go through Encoder - to encode our data, then its goes to,
3. Transmitter - to transmit our data, and for transmission they need.
4. Transmission medium - which helps data in moving, then its reaches to Receiver end.
5. Decode - Here, data will be decode back to original form

And thus message reached to address node.

Formatting and Encapsulation of Data –

There is a format of everything, like when we write a letter to anyone then there is a proper format of writing letter (like content of letter, ending indication of letter and a signature of sender etc.) and then on an envelope we write our address (sender address) and a destination addressed (receiver addressed). So it goes to a right place. Similarly while sending message to anyone in a network there is a format like,

- Sender location
- Receiver location
- Message content
- Source identifier
- Acknowledgement of receiving message

DATA SIZE

Size of Data

When you send the message to any node (host) on a network, the data is break in small pieces known as segment. Then every piece of data is

encapsulated in a separate frame. At the receiver end data is de-capsulated and put back together so that receiver can read it.

Delivery of Data

1. In a network message can be send in three ways, Unicast, Multicast or Broadcast.
2. Unicast Message is deliver from sender to receiver (one to one).
3. Multicast Message is send from sender to more than one receiver (one to many).
4. Broadcast Message is send from sender to all the nodes present in a network (one to all).

NETWORKING PROTOCOL

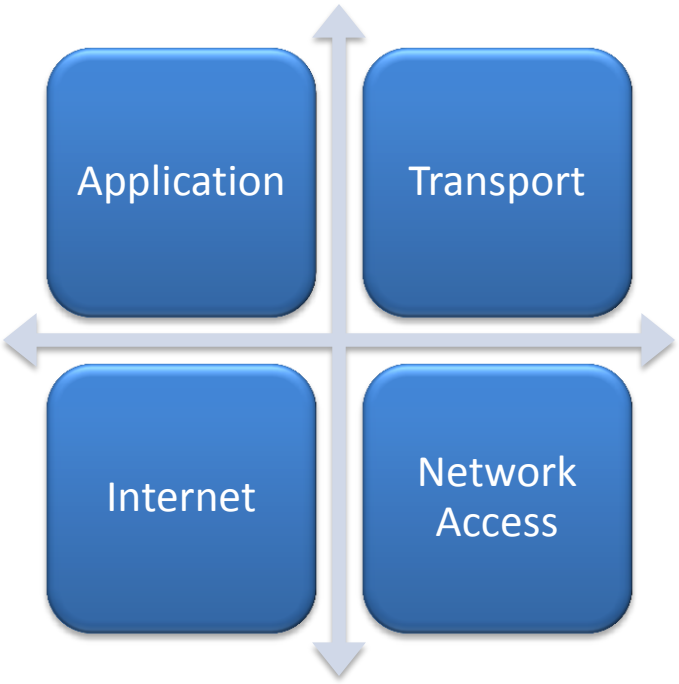
Network Protocol are a set of rules which govern the communication, like what a structure of message, the process by which networking devices share their information about their identity or pathway with other network, termination and setup of data transfer session.

While data is been transfer from source (sender) to destination (receiver) it interact with many network protocol such as

1. Application Protocol : Hyper-text Transfer Protocol (HTTP)
2. Transport Protocol : Transmission Control Protocol (TCP)
3. Internet Protocol : Internet Protocol (IP)
4. Network Access Protocol : Data Link Layer and Physical Layer

Now, it a time to learn about above mentioned protocol in a brief, there is something known as networking model which define the representation of network operation. The networking model is not the actual network. It just gives us an idea that how the entire operation is takes place.

There is two types of networking model OSI reference model and TCP/IP reference model. Well TCP/IP is more reliable and briefly discussed below. These all protocol layer are constituent of TCP/IP reference model.



Application Protocol

This protocol leads the representation of data to user, and also deals with the encoding and decoding of data.

Transport Protocol

This protocol supports the connection between two diverse devices across diverse network.

Internet Protocol

This protocol helps to determine the best path through a network.

Network Access Protocol

This protocol deals with the connection of all essential hardware devices used to build and to connect to the network.

PDU - Protocol Data Unit

When data is moving in a network at every layer its structured is change because some additional information is added with the original data which moves along with it. This additional information is added to guide the data towards its right direction unless data cannot reach to its destination and moves in network for ever and create an unnecessary traffic.

PDU refer the data unit in each Protocol layer which is as follow :

1. Data
2. Segment
3. Packet
4. Frame
5. Bits

Let's make it simple –

You know there is several layer which all constituent the network model. As soon as you sent an email (a data) to your friend, network layer start their working to transfer data to its destination.

Now look how this happen –

First Application layer (http protocol) starts its work i.e. it's encapsulate data and send it to the next layer. Now next layer is of Transport layer (TCP) which fragments the data into small pieces and label each segment with its header known as Transport header. And send it to next layer.

Now next, when data reaches to Internet layer (IP) a new header is added to the existing data known as Network layer, and now the segment is named as Packets.

On moving towards the next layer, packet is called as frames because at this layer a new header known as Frame header is added to original data and helps it to goes to the right destination.

Now till this point data from Application Layer reaches to Data link or Physical Layer and now frames are travel in network in the form of Bits.

As soon as the data is reached to the addressed destination it first convert into frame from Bits, then on moving forwards its get converted in to packet then into segments and then into data at and at finally when its reached to Application layer of receiver its de-capsulate and shows the notification on your friend screen about new e-mail.

I thought this explanation helps you a lot that how data is moving in a network but if you want more to learn about this then you should learn the OSI model and TCP/IP model first so it's become more easier to you to understand this.

Also to understand how email which you send to your friends is goes to here so read about SMTP (Simple Mail Transfer Protocol) along with SMTP there is lot more many Protocol which you should read and learn for advance knowledge.

Here we complete this course Networking Fundamental, with all essential concept of networking. Now you have an idea about how computer talk or communicate with other computer connected to a network, also you know able to connect your computer or device with any network via method we discussed above. We hope you don't stop your learning here and dive deep with networking concept. Don't stop learning, don't stop growing.