KCA 101 : FUNDAMENTAL OF COMPUTERS & EMERGING TECHNOLOGIES
for
Master of Computer Application (MCA)

By
Ramjee Dixit,
Asstt. Professor,

GLBITM, Greater Noida

Unit-III

- **Internet :** Overview, Architecture, Functioning, Basic services like WWW, FTP, Telnet, Gopher etc., Search engines, E-mail, Web Browsers.

- **Internet of Things (IoT):** Definition, Sensors, their types and features, Smart Cities, Industrial Internet of Things.

Internet

- The internet is a network of computers linking many different type of computers all over the world.
- It is a very large wide area network (WAN) connecting computers and networks around the world.
- Internets makes millions users to connect to one another by telephone, cable lines and satellites etc.
- Internet is a world-wide global system of interconnected computer networks.
- Internet uses the standard Internet Protocol (TCP/IP).
- Every computer in internet is identified by a unique IP address.
- IP Address is a unique set of numbers (such as 110.22.33.114) which identifies a computer location.
- A special computer DNS (Domain Name Server) is used to give name to the IP Address so that user can locate a computer by a name.
- For example, a DNS server will resolve a name **http://www.onlinesbi.com** to a particular IP address to uniquely identify the computer on which this website is hosted.

History

- The concept of Internet was originated in 1969 and has undergone several technological & Infrastructural changes as discussed below:

- The origin of Internet devised from the concept of **Advanced Research Project Agency Network (ARPANET).**

- **ARPANET** was developed by United States Department of Defense.

- Basic purpose of ARPANET was to provide communication among the various bodies of government.

- Initially, there were only four nodes, formally called **Hosts.**

- In 1972, the ARPANET spread over the globe with 23 nodes located at different countries and thus became known as Internet.

- By the time, with invention of new technologies such as TCP/IP protocols, DNS, WWW (1990), browsers(1993), scripting languages etc.,

- Internet provided a medium to publish and access information over the web.

Advantages of Internet

- Vast Knowledge Base
- Instant Communication
- Helpful in Navigation
- Online banking
- Job Options
- Allow companies to grow and develop.
- Global workforce accessibility.
- Entertainment and pleasure
- Online marketing
- Internet of things
- Cloud Storage
- Online Education

Disadvantages of Internet

- This can lead to addiction.
- Security Issue.
- Spam and advertizing.
- Cyberbullying and online Harassment
- Health Issue.
- Separated from outside world.
- Time Consuming.
- Bad impact on children

Architecture of Internet

- The architecture of the Internet is ever-changing due to continuous changes in the technologies as well as the nature of the service provided.
- The heterogeneity and vastness of the Internet make it difficult to describe every aspect of its architecture.
- The overall architecture can be described in three levels −
  - ✓ Backbone ISP (Internet Service Provider)
  - ✓ Regional ISPs
 - ✓ Local ISPs
  - ✓ Clients

- Client

  User of computer at home or in LAN.

- Local Internet Service Provider(ISP)
  - ➢ An ISP is an organization that has its own computers connected to the internet and provided facility to individual connect to internet through computers.
  - ➢ Local ISP is a local company located in telephone switching office where telephone of client terminates.
  - ➢ Example :-BSNL, MTNL, Airtel etc.

Architecture of Internet
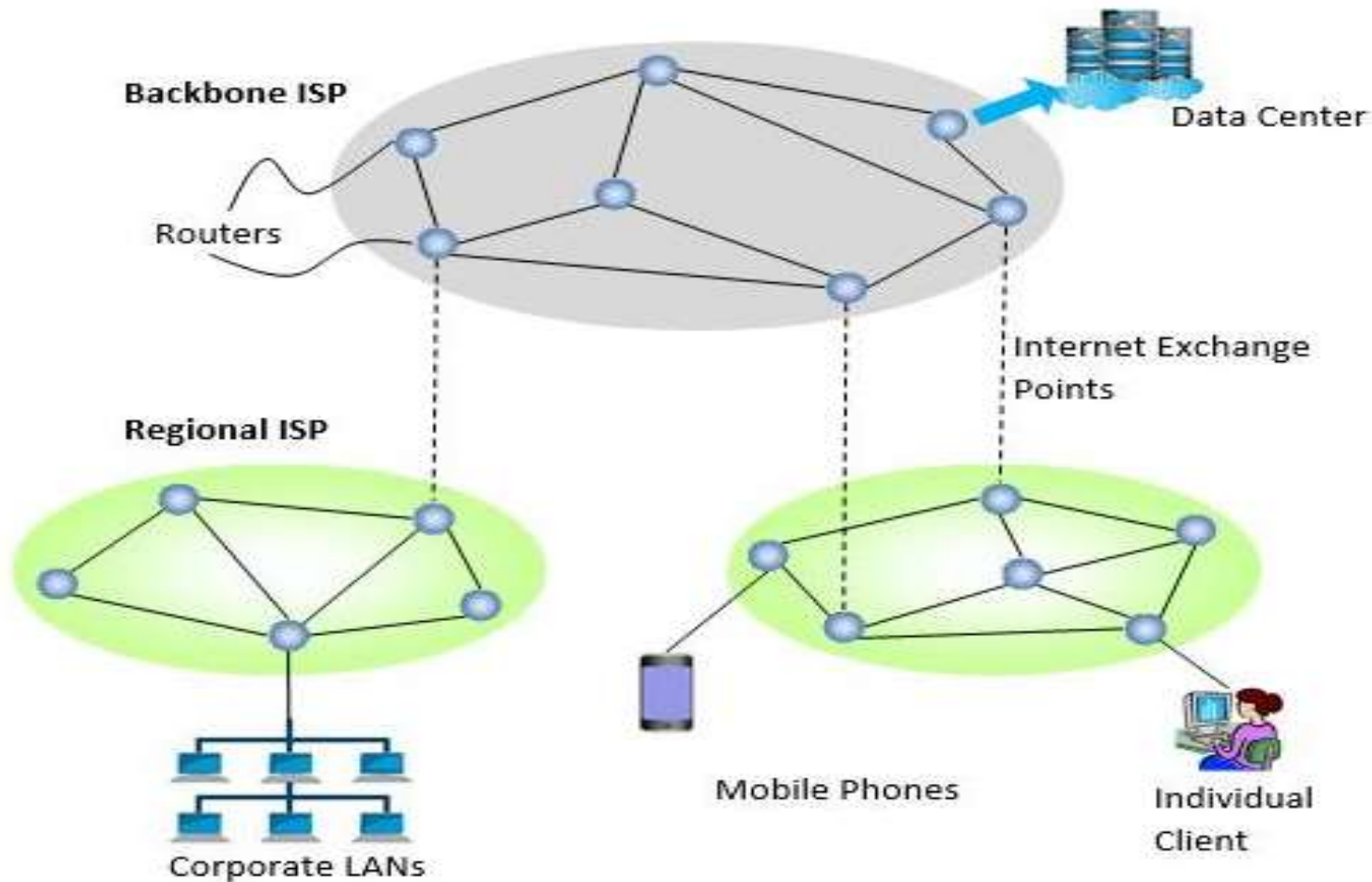
---Continue
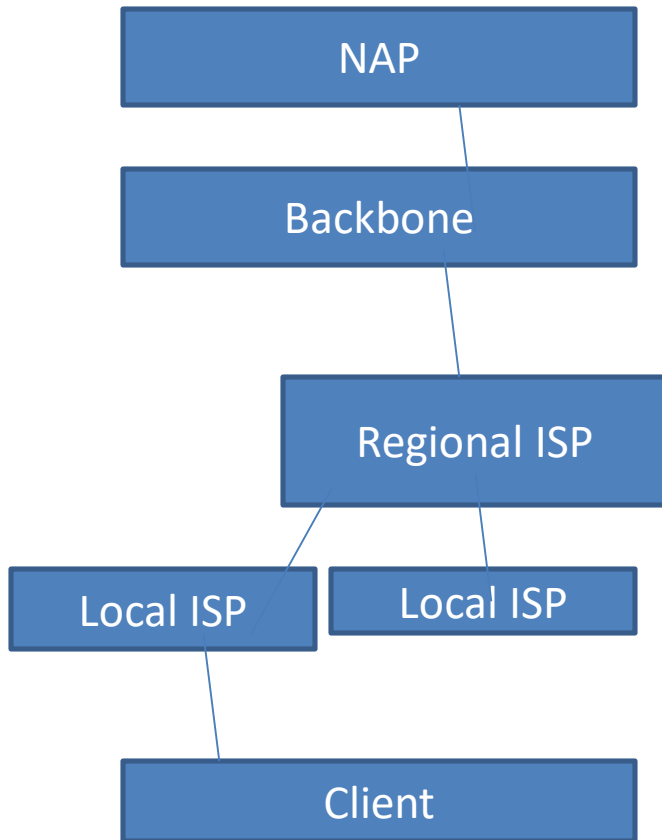
TCP/IP Layers	TCP/IP Prototocols				
Application Layer	HTTP	FTP	Telnet	SMTP	DNS
Transport Layer	TCP			UDP	
Network Layer	IP		ARP	ICMP	IGMP
Network Interface Layer	Ethernet		Token Ring	Other Link-Layer Protocols	

Left diagram: NAP — Backbone — Regional ISP — Local ISP / Local ISP — Client

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- Regional Internet Service Provider(ISP)

  ➢ It is the next level of hierarchy. Local ISPs are connected to regional ISP.

  ➢ A router is a special hardware system consisting of a processor, memory and I/O interface for the purpose of interconnecting networks.

  ➢ Routers can interconnect networks having different technologies, different media and physical addressing scheme or frame formats.

  ➢ If packet received by regional ISP is for client within ISP it is delivered otherwise sent to backbone ISP.

- Backbone Internet Service Provider(ISP)

  ➢ Backbone operators are large corporations AT& T which have their own sexer-farms connected to backbone. There are many backbones existing in the world.

  ➢ Backbones are connected to RISPs with large number of routers through high speed fiber optics.

- Network Access Point

  ➢ Network Access Points Connects Different backbones so the packet can travel across different backbones.

Internet Connection

- **Dial-up Access**
  - ➢ It is method of connecting to internet using existing telephone line.
  - ➢ In dial-up Access you are assigned an account on the server with some storage space on the disk of server.
  - ➢ You are assigned an user_id and password.
  - ➢ You connect to the internet by dial-up one of the computers of ISPs. For this purpose you use telephone number provided by ISP and connect via 56kbps modem.
  - ➢ Computer of dial-up is client and computer of ISP is server.

- **Leased Line**
  - ➢ It is a dedicated phone line that connects special kind modems. At the other end , gateway is connected to a large number of computers, which access the computer via gateway.
  - ➢ The gateway form domain on internet eg. niit.com which is used to provide connection to the other computers on internet to control it.
  - ➢ Leased line provides reliable and high-speed internet access.

- **Integrated Service Digital Network**
  - ISDN is a digital telephone service that can transmit voice, data control information over existing single telephone line.
  - Internet access is faster using ISDN than dial-up access.
  - ISDN is commonly used for business purpose.
  - ISDN services are largely being replaced by high speed broadband connection.

- **Digital Subscriber Line(DSL)**
  - DSL is a broadband connection that allows connecting to internet over the existing telephone line . It does not affect telephone service, DSL uses model provided by ISP.
  - The data transmission speed of DSL ranges from 128 kbps to 8.448 Mbps.

- **Cable-Modem**
  - User can connect to the internet via cable modem trough television.
  - The cable-modem sends and receive data through the coaxial cable modem to cable service provider. Coaxial cable allows transmission of audio, video and text data simultaneously.
  - It also provides high-speed internet connection.

Connecting to Internet

To connect to internet, you require

1) TCP/IP enabled computer

2) Web browser software

3) An account with ISP

4) Telephone line

5) A modem or Network Interface Card(NIC) to connect the line to the computer.

A modem is a device that connects a computer to internet. A NIC is device that is required to connect computer to the internet via LAN or high-speed internet connection line cable-modem or DSL line.

A web browser is a software that allows user to view information on WWW.

WWW is a large-scale repository of information that user search using web browser.

Internet Addresses

- Domain Name System
  - ➢ It is database that stores IP Address and their domain names. When ever Domain Names are used, DNS translated it into corresponding IP Address to access computer on the internet.

Domain Name
  - ➢ It is a text or symbolic name corresponding to numeric IP Address of computer on the internet. A domain name combines group of hosts on the internet. Some domain names are mentioned in table on right side.

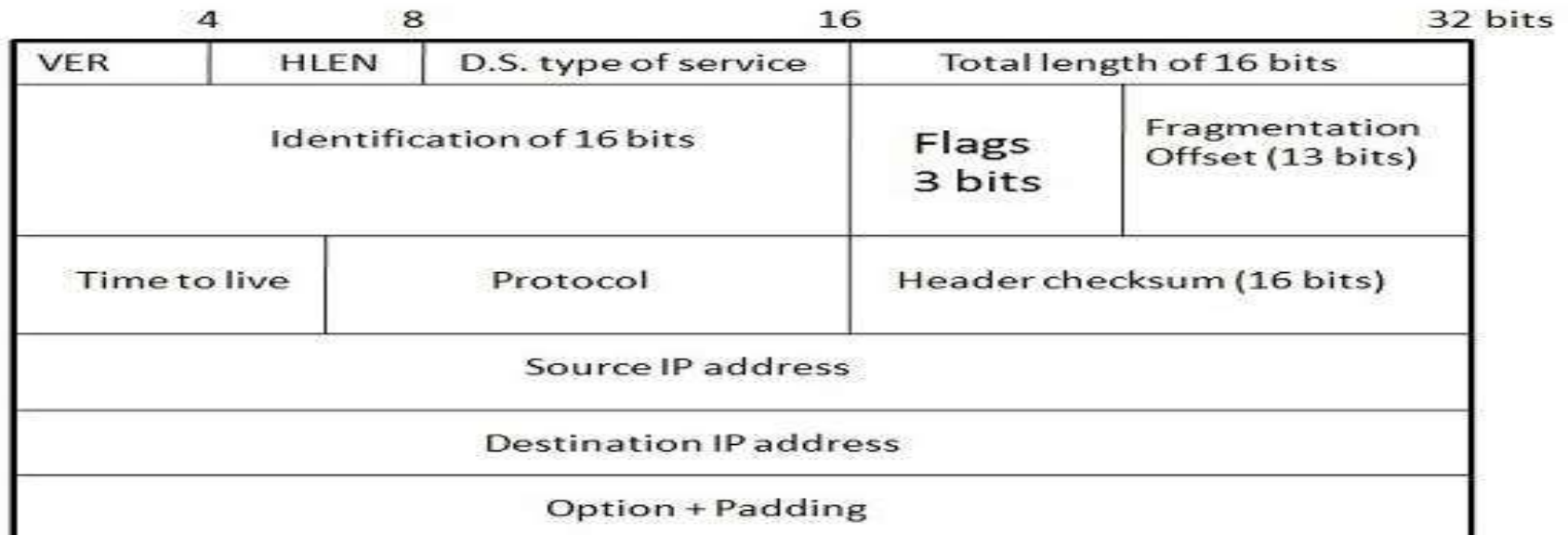| Domain Name	Purpose
.com	commercial
.in	country
.gov	Government
.org	organization
.edu	education

IP Address
- ➢ A computer connecter to internet must have a unique address in order to communicate across the internet. Internet Protocol address is uniquely assigned to each computer connected to internet.
- ➢ IP Address is string of numbers consisting of four parts separated by dot(.). Each part is vary from o to 255. Ex 111.121.1.11.

Functions of Internet

- Helpful in instant Communication
- Provide plate for fore entertainment
- Assists in Map Navigation
- Whether -Forecasting is done using internet
- Sore for online news
- Data Interchange
- Research
- Education
- E-Commerce and E-business facilities are offered with the help of internet.
- Path for IOT(internet-of-things) implementation
- Cloud Service.

Internet Protocol

- Internet Protocol is **connectionless** and **unreliable** protocol. It ensures no guarantee of successfully transmission of data.

- In order to make it reliable, it must be paired with reliable protocol such as TCP at the transport layer.

- Internet protocol transmits the data in form of a datagram as shown in the following diagram:

	4	8	16	32 bits
VER	HLEN	D.S. type of service	Total length of 16 bits	
Identification of 16 bits			Flags 3 bits	Fragmentation Offset (13 bits)
Time to live		Protocol	Header checksum (16 bits)	
Source IP address				
Destination IP address				
Option + Padding				

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- **Version:** The first IP header field is a 4-bit version indicator.

- **Internet Header Length: Header** length, is 4 bits in size. It is also called HELEN (Header Length).

- **Type of Service:** Type of Service is also called Differentiated Services Code Point or DSCP. This field is provided features related to the quality of service for data streaming or VoIP calls.

- **Total length:** The total length is measured in bytes.

- **Identification:** Identification is a packet that is used to identify fragments of an IP datagram uniquely.

- **IP Flags:** Flag is a three-bit field that helps you to control and identify fragments. The following can be their possible configuration:
  - Bit 0: is reserved and has to be set to zero
  - Bit 1: means do not fragment
  - Bit 2: means more fragments.

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- **Fragment Offset:** Fragment Offset represents the number of Data Bytes ahead of the particular fragment in the specific Datagram.

- **Time to live:** It is an 8-bit field that indicates the maximum time the Datagram will be live in the internet system.

- **Protocol:** This IPv4 header is reserved to denote that internet protocol is used in the latter portion of the Datagram.

- **Header Checksum: It** is used to check the header for any errors.

- **Source Address:** The source address is a 32-bit address of the source used for the IPv4 packet.

- **Destination address:** The destination address is also 32 bit in size stores the address of the receiver.

- **IP Options:** It is an optional field of IPv4 header used when the value of IHL (Internet Header Length) is set to greater than 5.

- **Data:** This field stores the data from the protocol layer, which has handed over the data to the IP layer.

IP Routing

- When data is received or sent, such as an email or a webpage, the message is divided into chunks called packets. Each packet contains both the sender's internet address and the receiver's address.

- Any packet is sent first to a gateway computer that understands a small part of the internet.

- The gateway computer reads the destination address and forwards the packet to an adjacent gateway that in turn reads the destination address and so forth until one gateway recognizes the packet as belonging to a computer within its immediate neighborhood or domain.

- That gateway then forwards the packet directly to the computer whose address is specified.

- Because a message is divided into a number of packets, each packet can, if necessary, be sent by a different route across the internet.

- Packets can arrive in a different order than the order they were sent.

- The Internet Protocol just delivers them. It's up to another protocol, the Transmission Control Protocol, to put them back in the right order.

IPv4 and IPv6

IPv4 has a 32-bit address length	IPv6 has a 128-bit address length
It Supports Manual and DHCP address configuration	It supports Auto and renumbering address configuration
In IPv4 end to end, connection integrity is Unachievable	In IPv6 end to end, connection integrity is Achievable
It can generate 4.29×10^9 address space	Address space of IPv6 is quite large it can produce 3.4×10^{38} address space
The Security feature is dependent on application	IPSEC is an inbuilt security feature in the IPv6 protocol
Address representation of IPv4 is in decimal	Address Representation of IPv6 is in hexadecimal
Fragmentation performed by Sender and forwarding routers	In IPv6 fragmentation performed only by the sender
In IPv4 Packet flow identification is not available	In IPv6 packet flow identification are Available and uses the flow label field in the header
Ex. 111.11.121.11	2001:0000:3238:DFE1:0063:0000:0000:FEFB

User Datagram Protocol

- The User Datagram Protocol (UDP) is simplest Transport Layer communication protocol available of the TCP/IP protocol suite.

- It involves minimum amount of communication mechanism.

- UDP is said to be an unreliable transport protocol but it uses IP services which provides best effort delivery mechanism.

- In UDP, the receiver does not generate an acknowledgement of packet received and in turn, the sender does not wait for any acknowledgement of packet sent.

- This shortcoming makes this protocol unreliable as well as easier on processing.

UDP Header
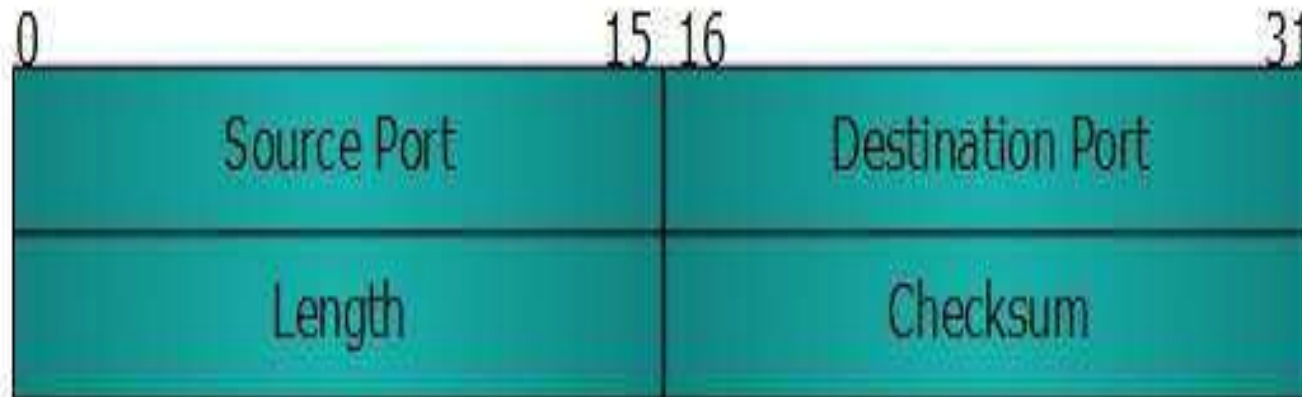
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- **Source Port** -This 16 bits information is used to identify the source port of the packet.
- **Destination Port**-This 16 bits information, is used identify application level service on destination machine.
- **Length** - Length field specifies the entire length of UDP packet (including header). It is 16-bits field and minimum value is 8-byte, i.e. the size of UDP header itself.
- **Checksum**-This field stores the checksum value generated by the sender before sending.

Features of UDP

- UDP is used when acknowledgement of data does not hold any significance.
- UDP is good protocol for data flowing in one direction.
- UDP is simple and suitable for query based communications.
- UDP is not connection oriented.
- UDP does not provide congestion control mechanism.
- UDP does not guarantee ordered delivery of data.
- UDP is suitable protocol for streaming applications such as VoIP, multimedia streaming.

UDP is used to transfer data in DNS, TFTP (Trivial File Transfer Protocol, RIP(Routing information Protocol) etc.

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TCP(Transmission Control Protocol)

- It is a transport layer protocol that facilitates the transmission of packets from source to destination.

- It is a connection-oriented protocol that means it establishes the connection prior to the communication that occurs between the computing devices in a network.

- This protocol is used with an IP protocol, so together, they are referred to as a TCP/IP

- The main functionality of the TCP is to take the data from the application layer. Then it divides the data into a several packets, provides numbering to these packets, and finally transmits these packets to the destination.

- The TCP, on the other side, will reassemble the packets and transmits them to the application layer.

- As we know that TCP is a connection-oriented protocol, so the connection will remain established until the communication is not completed between the sender and the receiver.

TCP Features

- **Reliable**

  TCP is a reliable protocol as it follows the flow and error control mechanism. It also supports the acknowledgment mechanism, which checks the state and sound arrival of the data.

- **Order of the data is maintained**

  This protocol ensures that the data reaches the intended receiver in the same order in which it is sent. It orders and numbers each segment so that the TCP layer on the destination side can reassemble them based on their ordering.

- **Connection-oriented**

  It is a connection-oriented service that means the data exchange occurs only after the connection establishment. When the data transfer is completed, then the connection will get terminated.
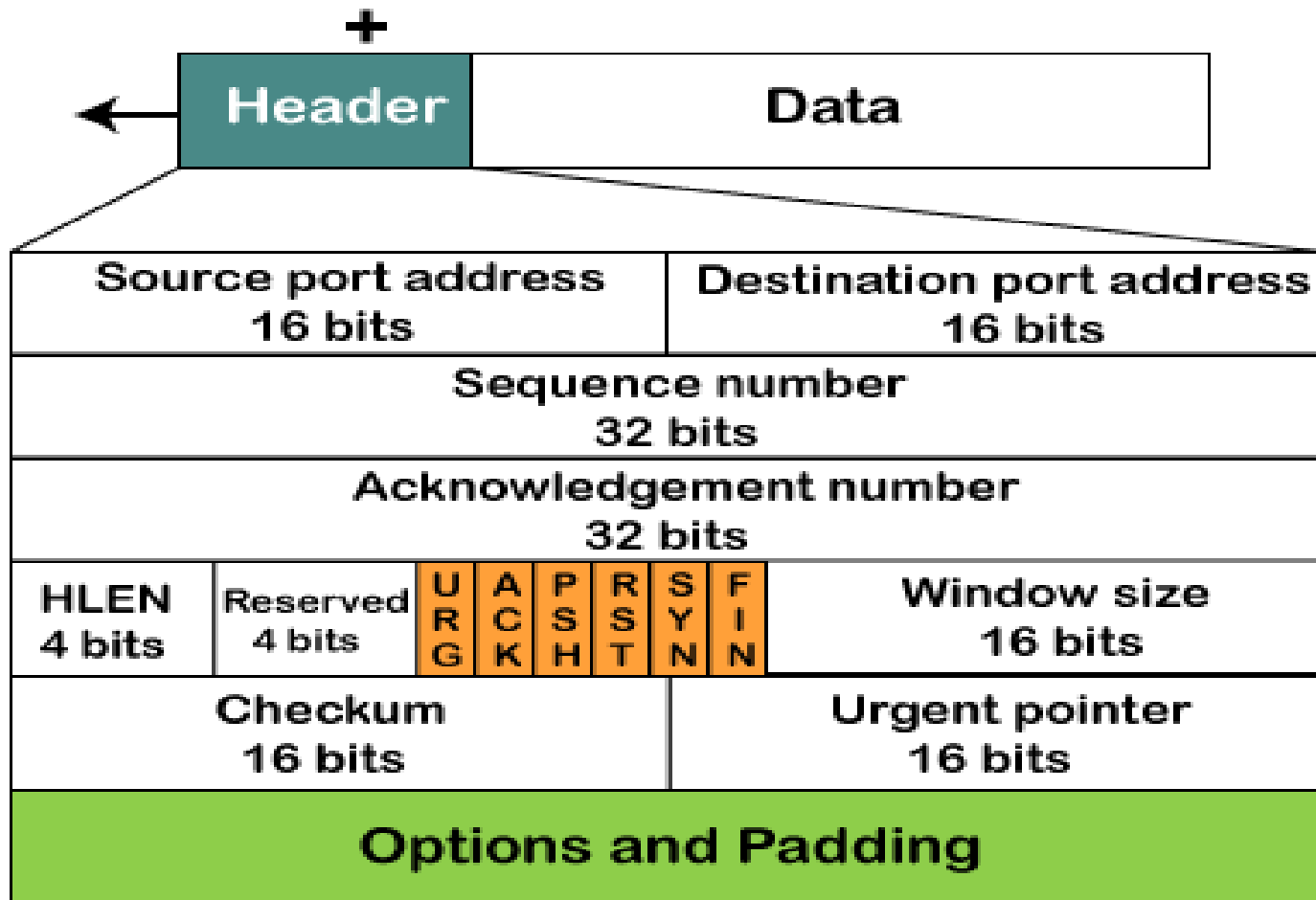
- **Full duplex**

  It is a full-duplex means that the data can transfer in both directions at the same time.

- **Stream-oriented**

  Data are sent and received as stream of bytes

TCP Header

TCP header format

TCP Header Continue

- Source port: Port of the application, which is sending the data.
- Destination port: Port of receiving application.
- Sequence number: This field contains the sequence number of data bytes in a particular session.
- Acknowledgment number: For sending acknowledgement .
- HLEN: It specifies the length of the .
- Reserved: It is a 4-bit field reserved for future use.
- Flags
  There are six control bits or flags:
  - URG: If it is set, then the data is processed urgently.
  - ACK: For acknowledgement.
  - PSH: If this field is set, the receiving application process without buffering it.
  - RST: If it is set, then it requests to restart a connection.
  - SYN: It is used to establish a connection between the hosts.
  - FIN: Release connection.

TCP Header Continue

- **Window size**
  It is a 16-bit field. It contains the size of data that the receiver can accept. This field is used for the flow control between the sender and receiver and also determines the amount of buffer allocated by the receiver for a segment.

- **Checksum**
  It is a 16-bit field. This field is optional in UDP, but in the case of TCP/IP, this field is mandatory.

- **Urgent pointer**
  It is a pointer that points to the urgent data byte if the URG flag is set to 1

- **Options**
  It provides additional options. The optional field is represented in 32-bits. If this field contains the data less than 32-bit, then padding is required to obtain the remaining bits.

TCP Connection Management

Working of the TCP protocol