Basic Networking Concepts

1. Introduction
2. Protocols
3. Protocol Layers
4. Network Interconnection/Internet

1. Introduction

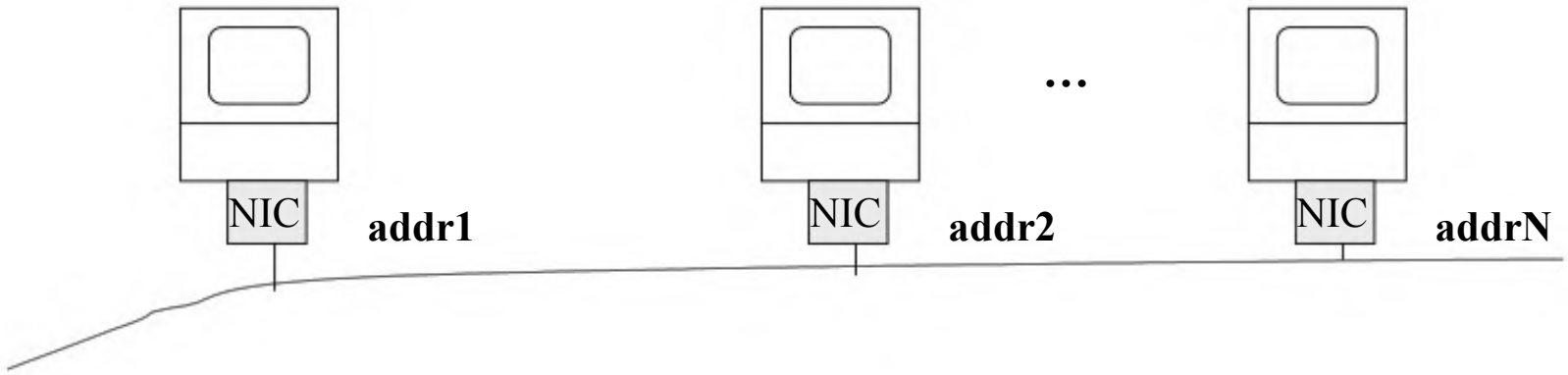
-A network can be defined as a group of computers and other devices connected in some ways so as to be able to exchange data.

-Each of the devices on the network can be thought of as a node; each node has a unique address.

-Addresses are numeric quantities that are easy for computers to work with, but not for humans to remember.

Example: 204.160.241.98

-Some networks also provide names that humans can more easily.



Addressing

Internet address

Consists of 4 bytes separated by periods

Example: 136.102.233.49

-The R first bytes (R= 1,2,3) correspond to the network address;

-The remaining H bytes (H = 3,2,1) are used for the host machine.

Domain Name System (DNS)

-DNS servers are responsible for translating mnemonic textual Internet addresses into hard numeric Internet addresses.

Ports

-An IP address identifies a host machine on the Internet.

-An IP port will identify a specific application running on an Internet host machine.

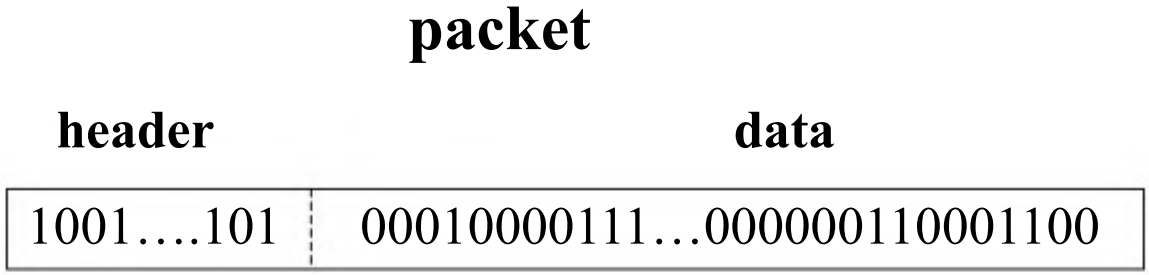
-A port is identified by a number, the *port number*.

-There are some port numbers which are dedicated for specific applications.

Applications	**Port numbers**
HTTP	80
FTP	20 and 21
Gopher	70
SMTP (e-mail)	25
POP3 (e-mail)	110
Telnet	23
Finger	79

Data Transmission

-In modern networks, data are transferred using *packet switching*.
-Messages are broken into units called *packets*, and sent from one computer to the other.
-At the destination, data are extracted from one or more packets and used to reconstruct the original message.
-Each packet has a maximum size, and consists of a header and a data area.
-The header contains the addresses of the source and destination computers and sequencing information necessary to reassemble the message at the destination.



Types of Networks

There are two principle kinds of networks: Wide Area Networks (WANs) and Local Area Networks (LANs).

WANs

-Cover cities, countries, and continents.

-Based on *packet switching* technology

-Examples of WAN technology: Asynchronous Transfer Mode (ATM), Integrated Services Digital Network (ISDN)

LANs

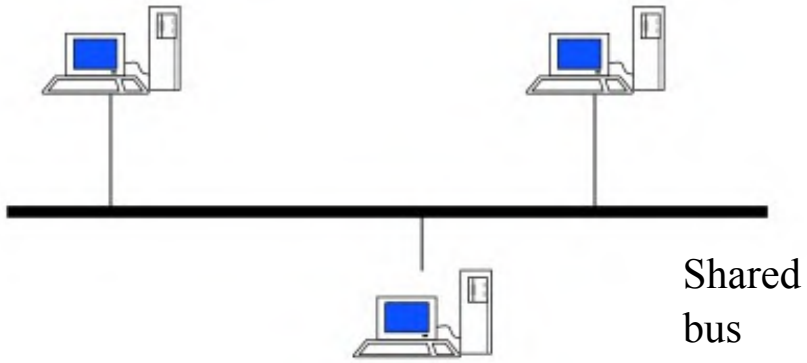
-Cover buildings or a set of closely related buildings.

-Examples of LAN technology: Ethernet, Token Ring, and Fibber Distributed Data Interconnect (FDDI).

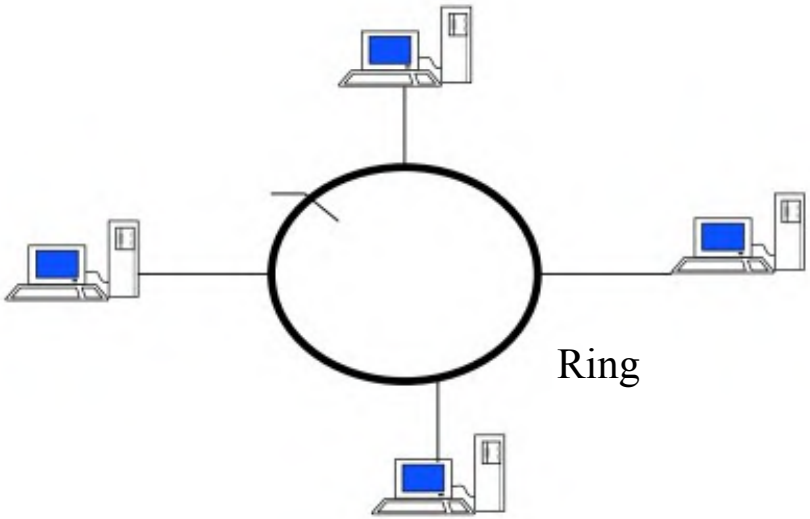
Ethernet LANs: based on a bus topology and broadcast communication

Token ring LANs: based on ring topology

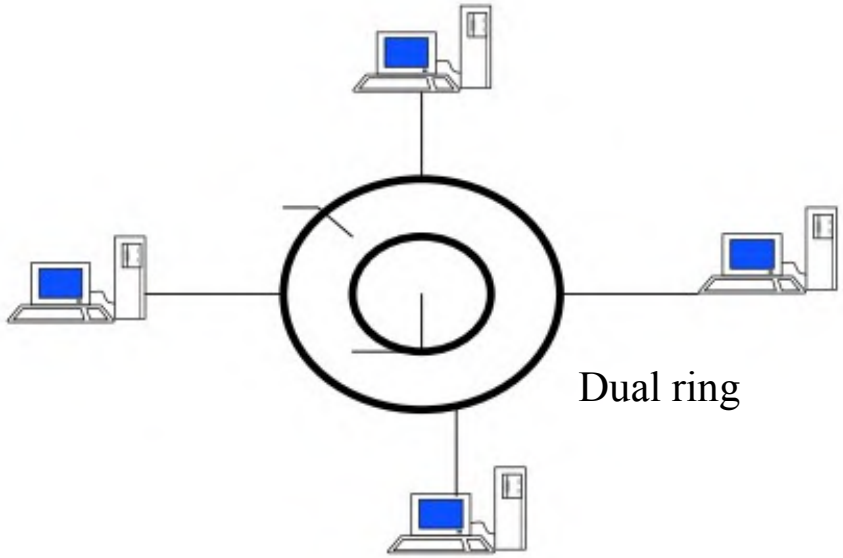
FDDI LANs: use optical fibbers and an improved token ring mechanism based on two rings flowing in opposite directions.



(a) Ethernet LAN



(b) Token Ring LAN



(c) FDDI LAN

Interconnection

-Networks of low capacity may be connected together via a *backbone* network which is a network of high capacity such as a FDDI network, a WAN network etc.

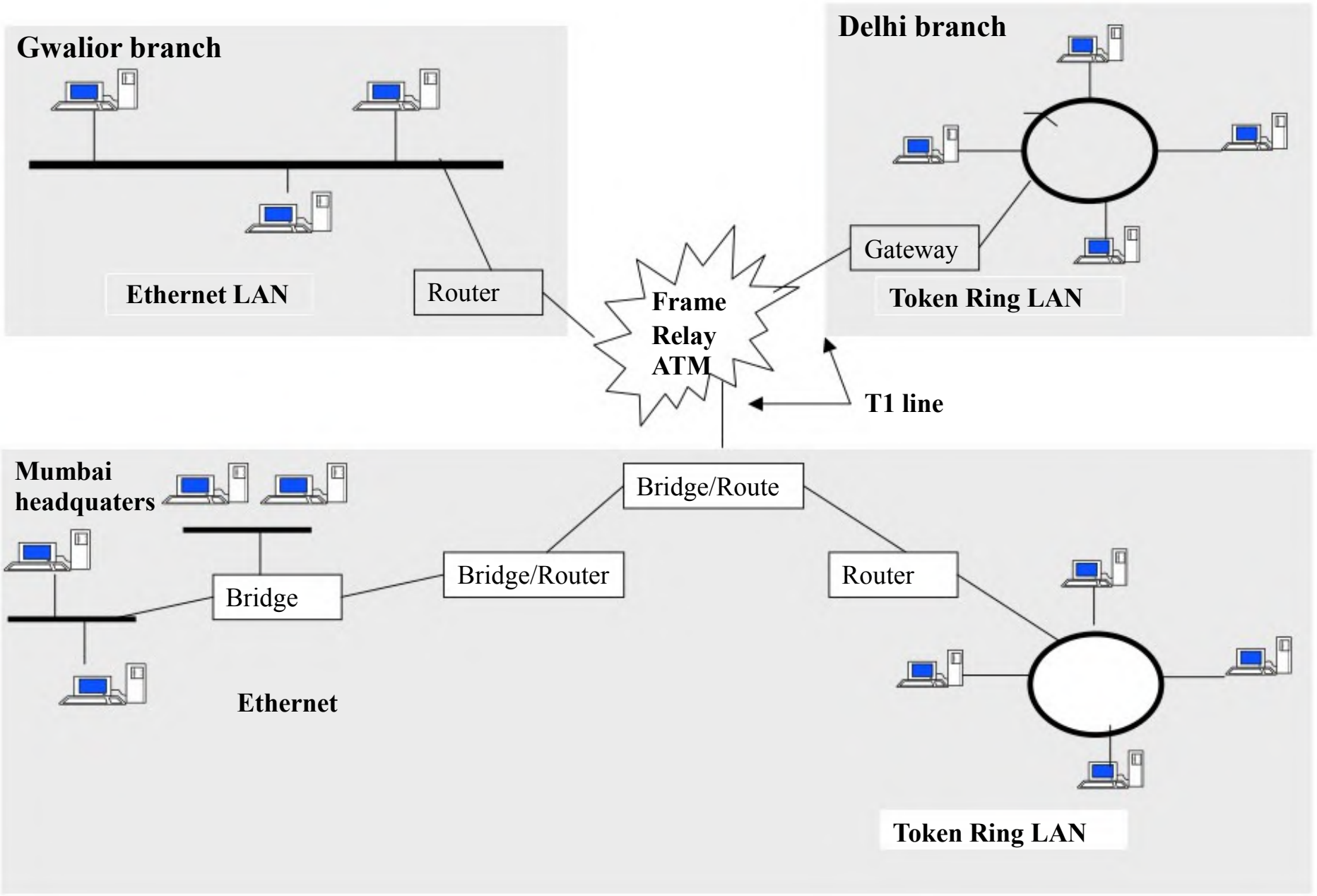
-Networks interconnection is achieved using one or several of the following devices:

→*Bridge:* a computer or device that links two similar LANs based on the same protocol.

→ *Router:* a communication computer that connects different types of networks using different protocols.

→ *B-router or Bridge/Router:* a single device that combines both the functions of bridge and router.

→ *Gateway:* a network device that connects two different systems, using direct and systematic translation between protocols.


Gwalior branch
Ethernet LAN
Router
Delhi branch
Gateway
Token Ring LAN
Frame
Relay
ATM
T1 line
Mumbai
headquaters
Bridge
Bridge/Router
Bridge/Route
Router
Ethernet
Token Ring LAN

Network Topology Diagram

The network topology diagram requires the following description about the network :

-Geographical locations of the different components or subnets involved in the network.

-Description of the LAN topology

-Description of the WAN topology

-Description of the network connectors such as routers, bridges, repeaters, and gateways.

2. Protocols

-Define the rules that govern the communications between two computers connected to the network.

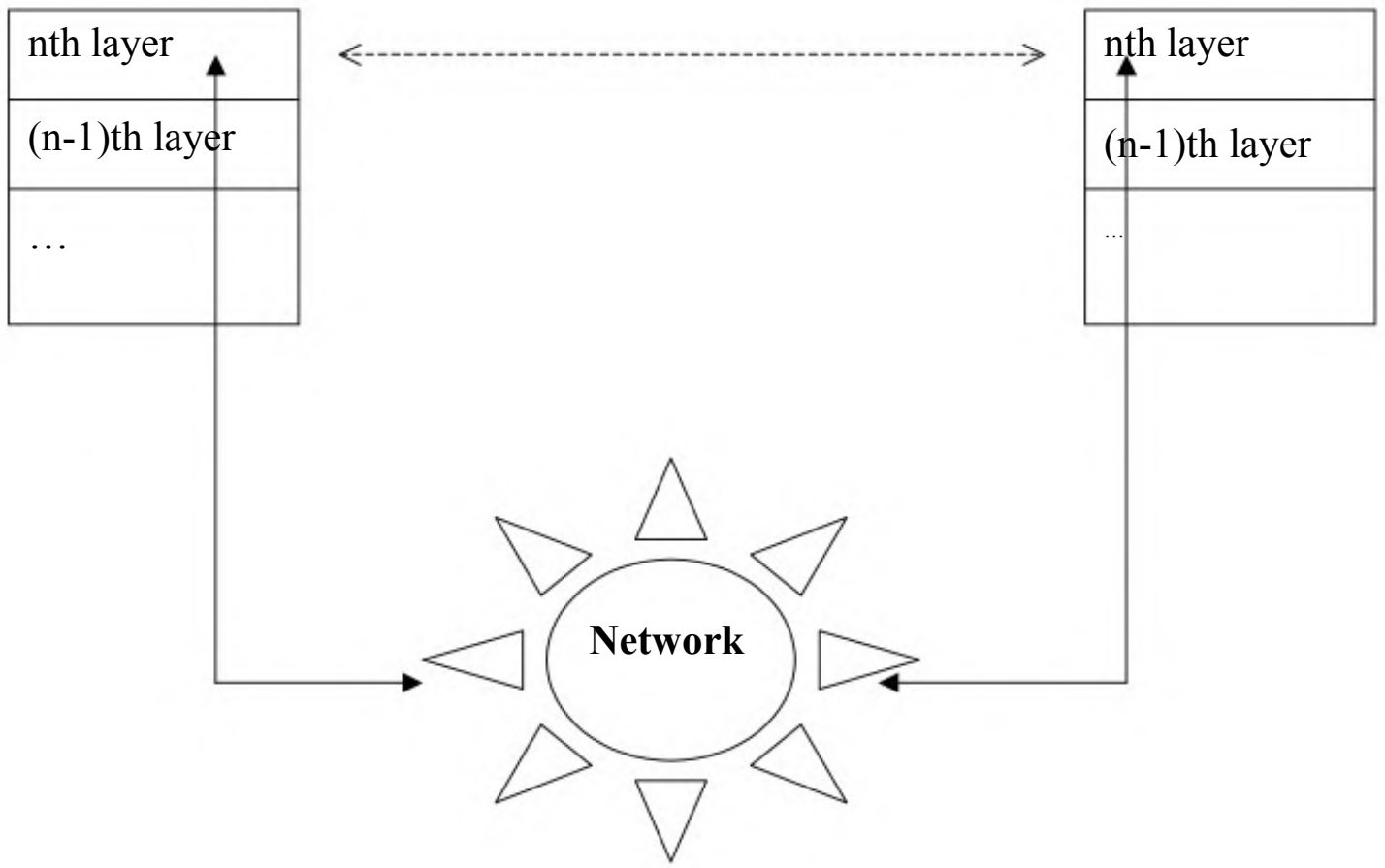
-Roles: addressing and routing of messages, error detection and recovery, sequence and flow controls etc.

-A protocol consists of the *syntax*, which defines the kinds and formats of the messages exchanged, and the *semantic*, which specifies the action taken by each entity when specific events occur.

Example: HTTP protocol for communication between web browsers and servers.

-Protocols are designed based on a layered architecture such as the OSI reference model.

-Each entity at a layer *n* communicates only with entities at layer *n-1*.



3. Protocol Layers

The OSI (Open Systems Interconnection) Data Model

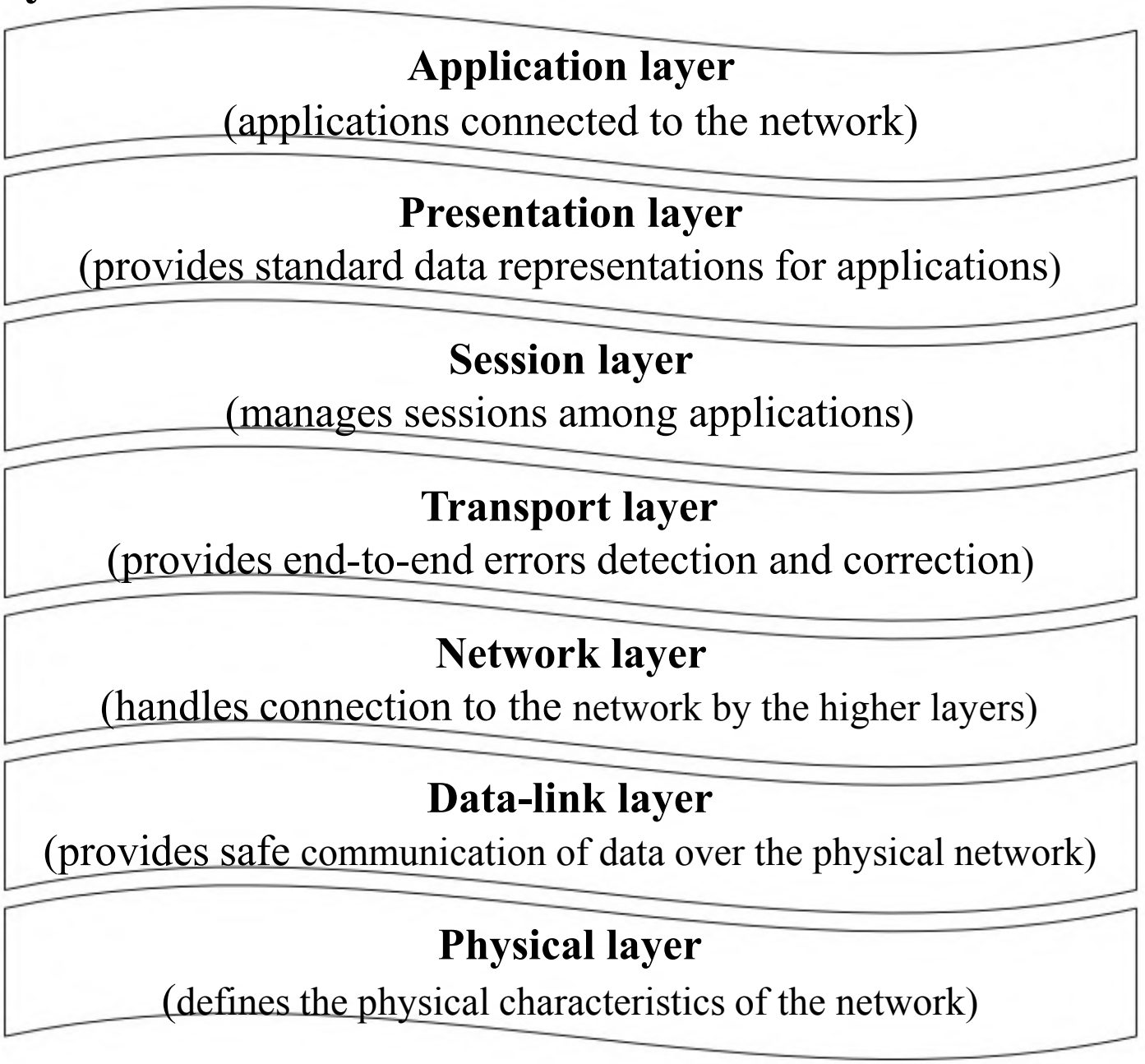
-ISO standard for computer networks design and functioning.

-Involves at least 7 layers, each playing a specific role when applications are communicating over the net.

-During the sending process, each layer (from top to down) will add a specific header to the raw data.

-At the reception, headers are eliminated conversely until the data arrived to the receiving application.

OSI Layers


Application layer
(applications connected to the network)
Presentation layer
(provides standard data representations for applications)
Session layer
(manages sessions among applications)
Transport layer
(provides end-to-end errors detection and correction)
Network layer
(handles connection to the network by the higher layers)
Data-link layer
(provides safe communication of data over the physical network)
Physical layer
(defines the physical characteristics of the network)

Physical layer: ensures a safe and efficient travel of data; consists of electronic circuits for data transmission etc.

Data link layer: in charge of data encapsulation under the form of packets and their interpretation at the physical layer.

Network layer: in charge of packets transmission from a source A to a destination B.

Transport layer: in charge of the delivery of packets from a source A to a destination B

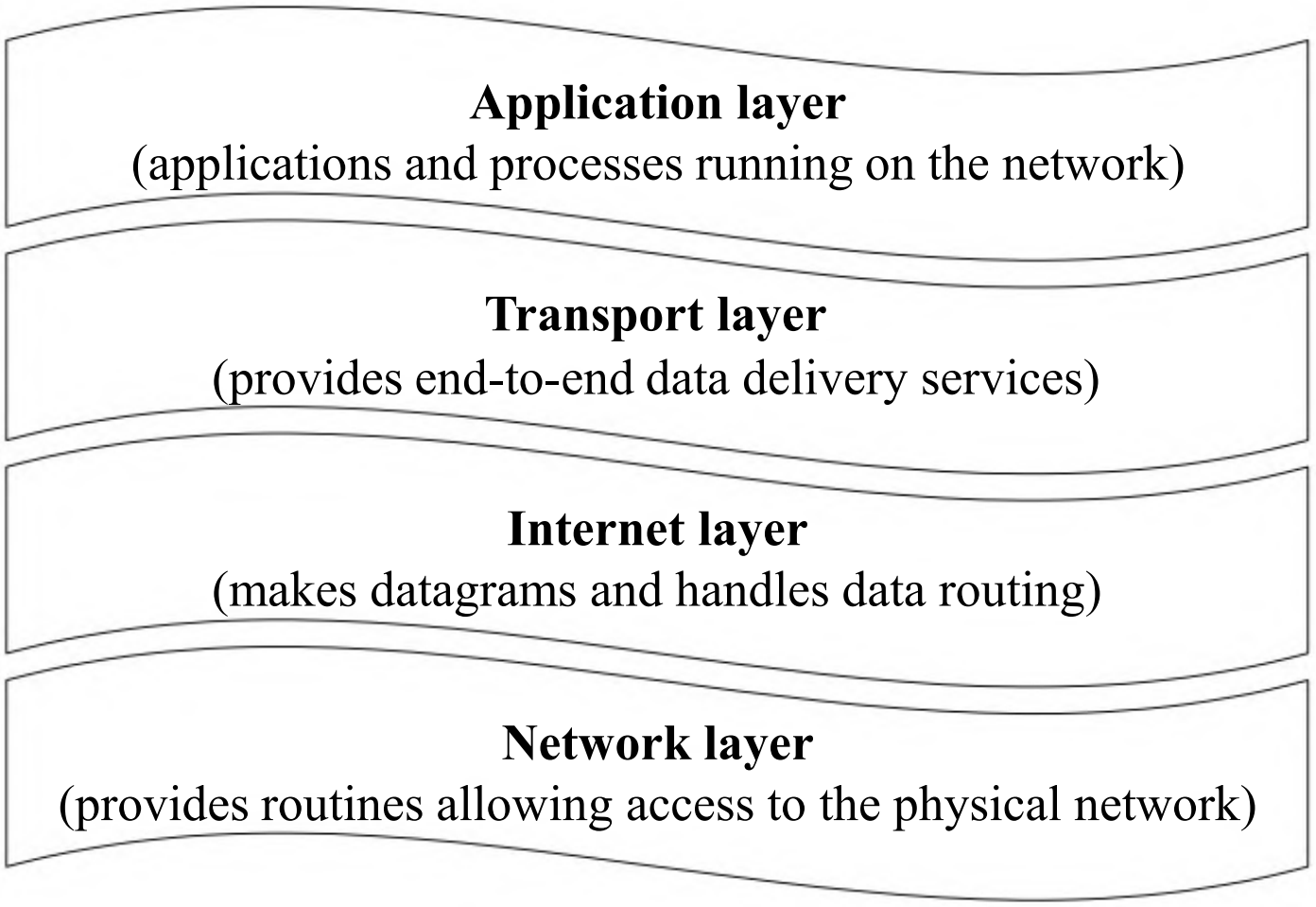
Session layer: in charge of the management of network access.
Presentation layer: determines the format of the data transmitted to applications, data compressing/decompressing, encrypting etc.

Application layer: contains the applications which are used by the end-user, such as Java, Word etc.

The TCP/IP Model

-Consists of only 4 layers: application, transport, internet and network.

Layers



Network layer

-Provides the same functionality as the physical, the data link and network layers in the OSI model.

-Mapping between IP addresses and network physical addresses.

-Encapsulation of IP datagrams, e.g packets, in format understandable by the network.

Internet layer

-Lies at the heart of TCP/IP.

-Based on the Internet Protocol (IP), which provides the frame for transmitting data from place *A* to place *B*.

Transport layer

-Based on two main protocols: TCP (Transmission Control Protocol) and UDP (User Datagram protocol)

Application layer

-Combines the functions of the OSI application, presentation, and session layers.

-Protocols involved in this layer: HTTP, FTP, SMTP etc.

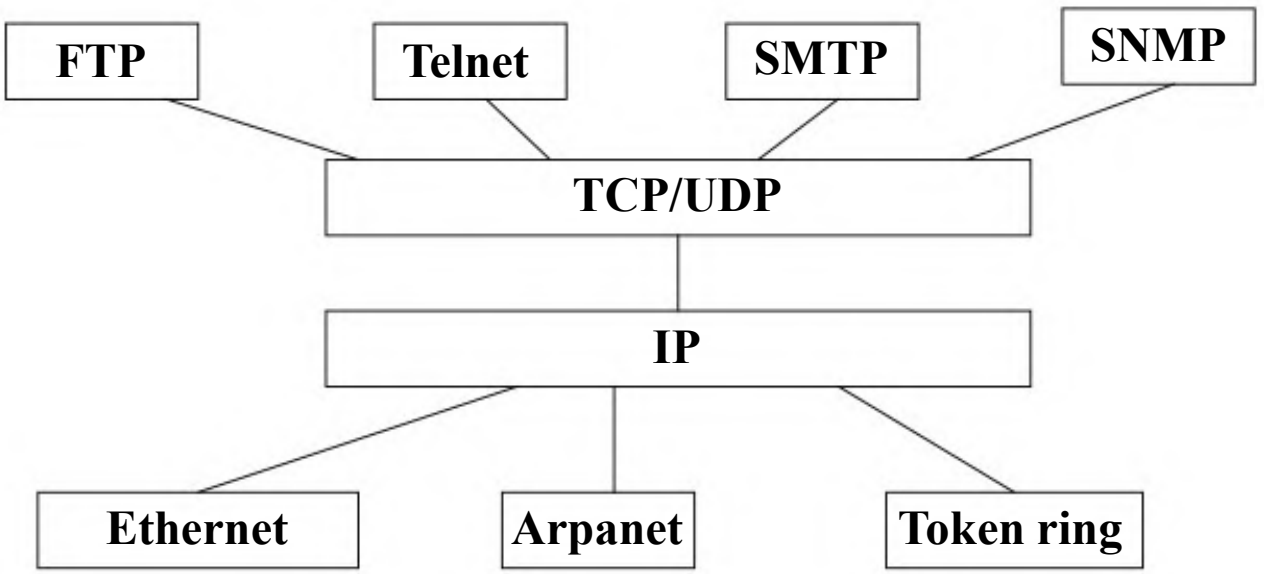
4. Networks Interconnection/Internet

Concept of Network Interconnection

-Consists of connecting several computer networks based on different protocols

-Requires the definition of a common interconnection protocol on top the local protocols.

-The *Internet Protocol (IP)* plays this role, by defining unique addresses for a network and a host machine.



Internet Protocol (IP)

Overview

-The IP protocol provides two main functionality:

→Decomposition of the initial information flow into packets of standardized size, and reassembling at the destination.

→Routing of a packet through successive networks, from the source machine to the destination identified by its IP address.

-Transmitted packets are not guaranteed to be delivered (*datagram protocol).*

-The IP protocol does not request for connection (*connectionless*) before sending data and does not make any error detection.

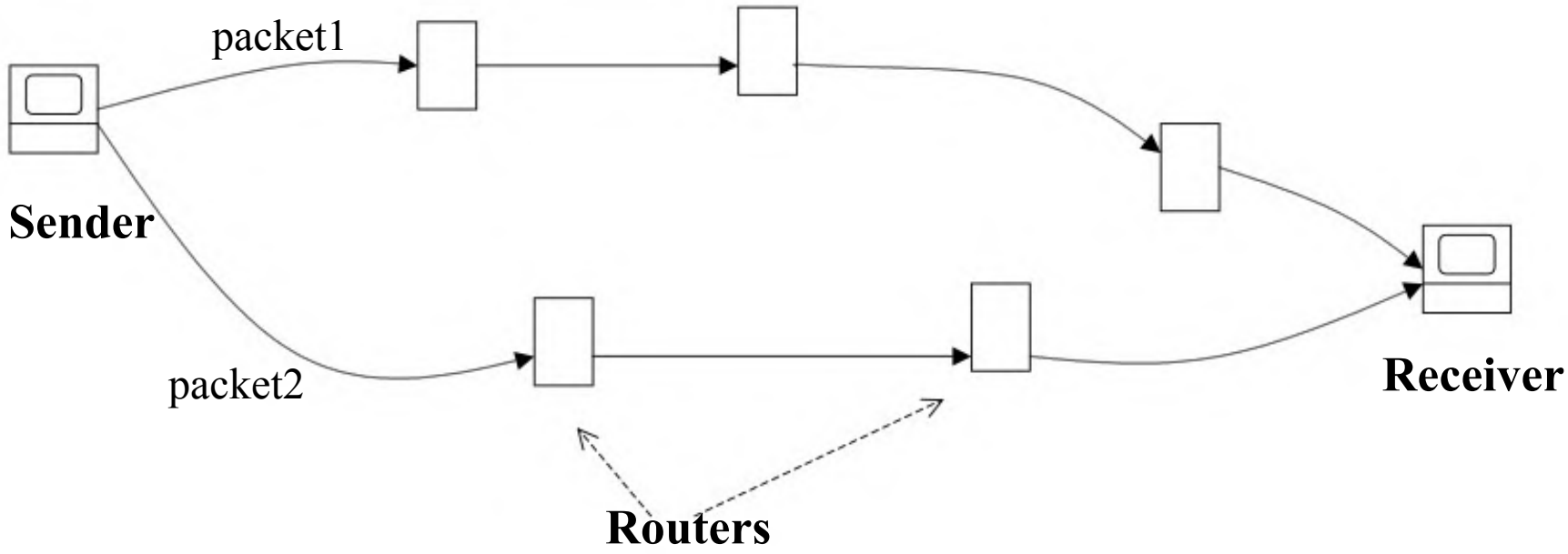
Functions

-Decompose the initial data (to be sent) into datagrams.

-Each datagram will have a header including, the IP address and the port number of the destination.

-Datagrams are then sent to selected gateways, e.g IP routers, connected at the same time to the local network and to an IP service provider network.

-Datagrams are transferred from gateways to gateways until they arrived at their final destination.



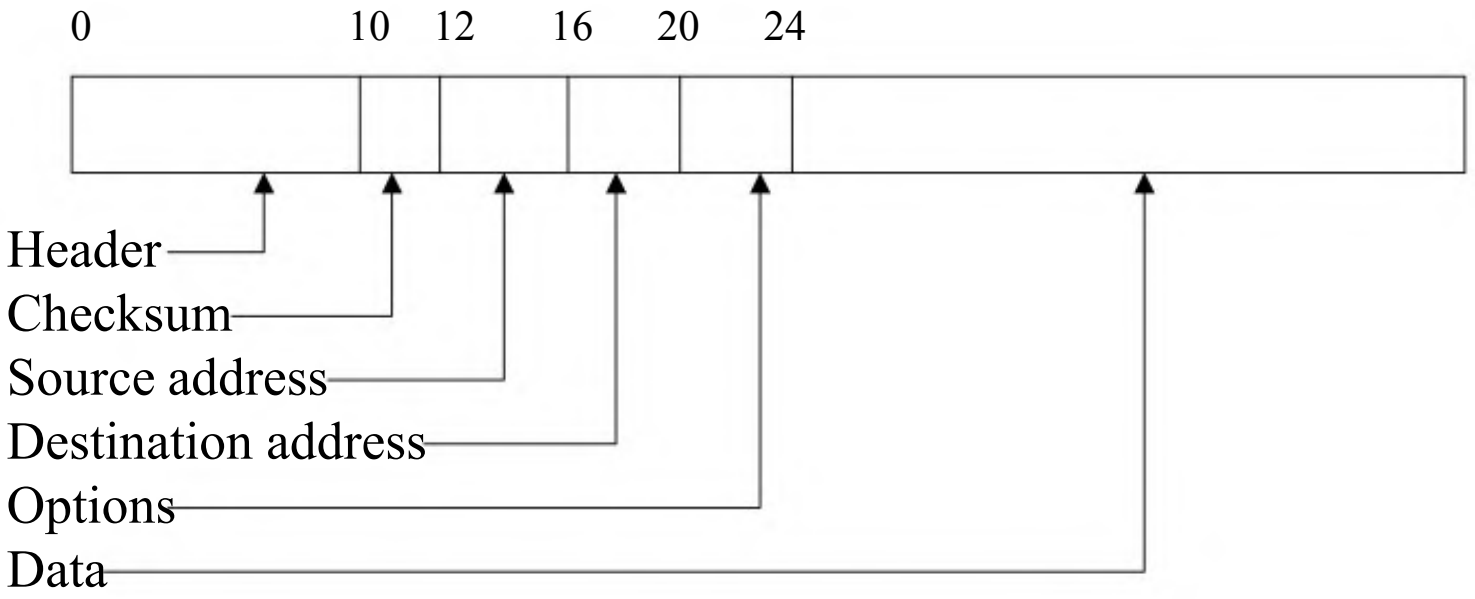
Structure of an IP packet

-The fields at the beginning of the packet, called the frame header, define the IP protocol's functionality and limitations.

-32 bits are allocated for encoding source and destination addresses

-The remainder of the header (16 bits) encodes various information such as the total packet length in bytes.

-Hence an IP packet can be a maximum of 64Kb long.



Transmission Control Protocol (TCP)

Overview

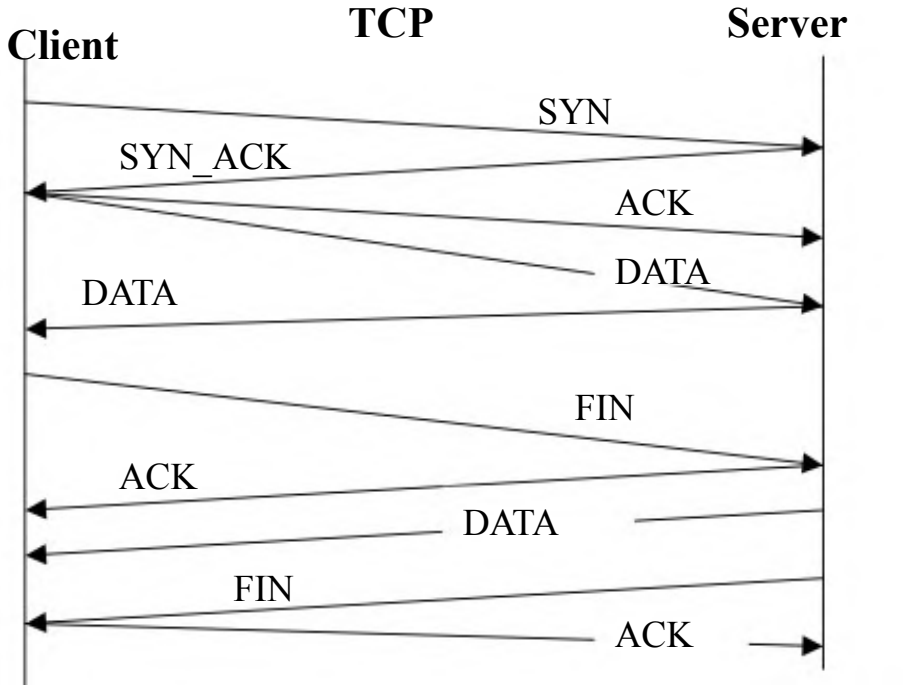
-TCP provides by using IP packets a basic service that does guarantee safe delivery:

→error detection

→safe data transmission

→assurance that data are received in the correct order

-Before sending data, TCP requires that the computers communicating establish a connection (*connection-oriented protocol*).

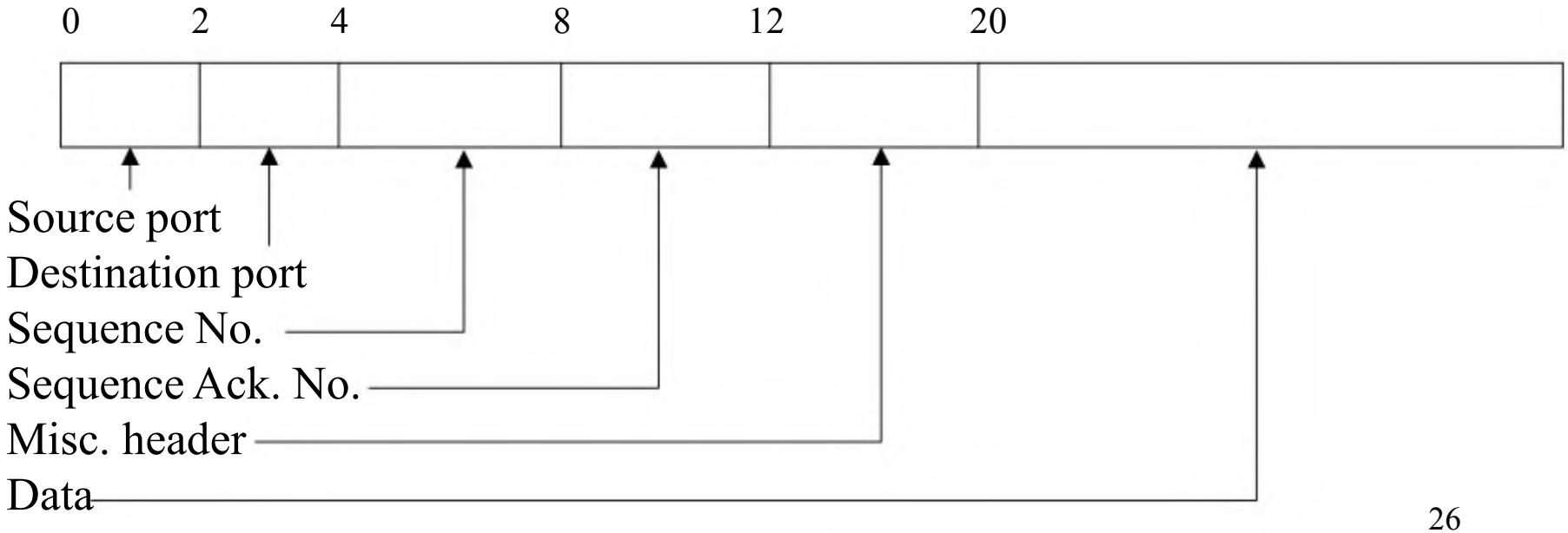


-TCP provides support for sending and receiving arbitrary amounts of data as one big stream of byte data (IP is limited to 64Kb).

-Packets are numbered, and reassembled on arrival, using sequence and sequence acknowledge numbers.

-TCP also improves the capability of IP by specifying port numbers.

Structure of a TCP packet



User Datagram Protocol (UDP)

Overview

-Datagram protocol also built on top of IP.

-Has the same packet-size limit (64Kb) as IP, but allows for port number specification.

-Provides also 65,536 different ports.

-Hence, every machine has two sets of 65,536 ports: one for TCP and the other for UDP.

-Connectionless protocol, without any error detection facility.

-Provides only support for data transmission from one end to the other, without any further verification.

-The main interest of UDP is that since it does not make further verification, it is very fast.

-Useful for sending small size data in a repetitive way such as time information.