

Data Communication

data references to information in format agreed upon by parties creating and using data.

Effectiveness depends on

- i) delivery - delivered to intended person
- ii) accuracy - accurate data delivery
- iii) timeliness - should be fast
- iv) jitter - variation in packet delivery time

Components

- i) Message
- ii) Sender
- iii) Receiver
- iv) Medium
- v) Protocol

Data representation

Text - Unicode 32 bits for a symbol, bit patterns

Numbers - bit patterns, converted to binary

Images - represented by bit patterns, matrix of pixels.

black and white - 1 bit pattern

B&W and grayscale - 2 bit

RGB

Audio - continuous data form

video - can be continuous or discrete.

* Data Flow

i) Simplex

uni directional

ex. Keyboard, monitor

ii) Half duplex

Both can send and receive but not simultaneously
entire capacity is used

iii) Full duplex

both can send and receive simultaneously
capacity divided between the two

* Network

distributed processing - Task divided among several computers.

network criteria - performance reliability security

i) Performance - can be measured in transit time and response time.

Transit time - time from source to destination

response time - time taken for response

It depends on

a) no. of users

b) Medium

c) efficiency of software

Usually performance measured in throughput and delay
they are contradictory

More throughput less delay - Best

Reliability

Measured by frequency of failure, time taken to recover and robustness of network

Security

Protecting data from unauthorized access

Physical Structure

Type of connection

- i) Point to point - Link between two devices.
- ii) Multipoint - Multiple share the same link

Physical Topology

- i) Mesh - We need $\frac{n(n-1)}{2}$ physical links, duplex
- ii) Star Topology - central controller hub.
- iii) Bus Topology - link is backbone which connects all. Limit to number of taps
- iv) Ring Topology - Each device is a repeater
- v) Hybrid Topology - Hub as star connected to many bus topology

Network Models

(categories)

LAN - privately owned by org in single office, building or campus. Used for sharing resources like printer

VAN - Long distance transmission of data

i) switched - between two enclaves

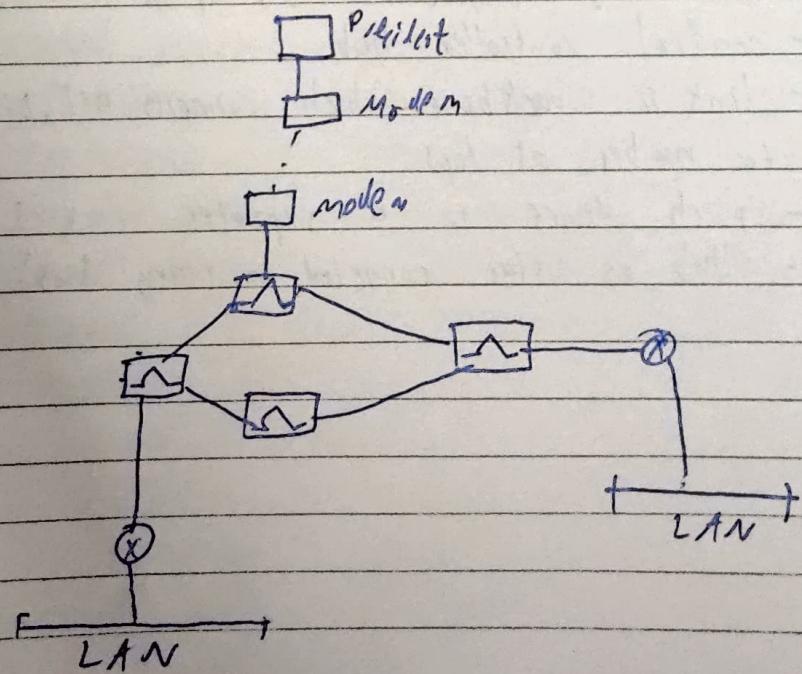
ii) point - point - internet

MAN - Metropolitan Area Network - between LAN and

VAN - covers cities. Cable TV network as example.

Internetwork

when two or more network are connected it is called internetwork.



The Internet

Internet is collaboration of more than hundreds of thousands of interconnected networks

Came into being 1969

In mid -1960s computer unable to communicate

Advanced Research Projects Agency (ARPA) in DOD was finding a way

In 1967 Association for computing machinery meeting ARPA presented ARPANET.

The idea was each host would be attached to a specialised computer called interface message processor. The IMPs in turn would be connected to one another.

In 1969 it became reality at UCLA and UC at Santa Barbara, Stanford and University of Utah were connected. Software- Network control Protocol

In 1972 - Vint Cerf and Bob Kahn ARPANET worked on Internetworking project.

In 1973 - TCP included concept such as encapsulation, datagram and functions of gateway

TCP was split into two Transmission control protocol and Internetworking protocol.

IP - would handle data gram routing

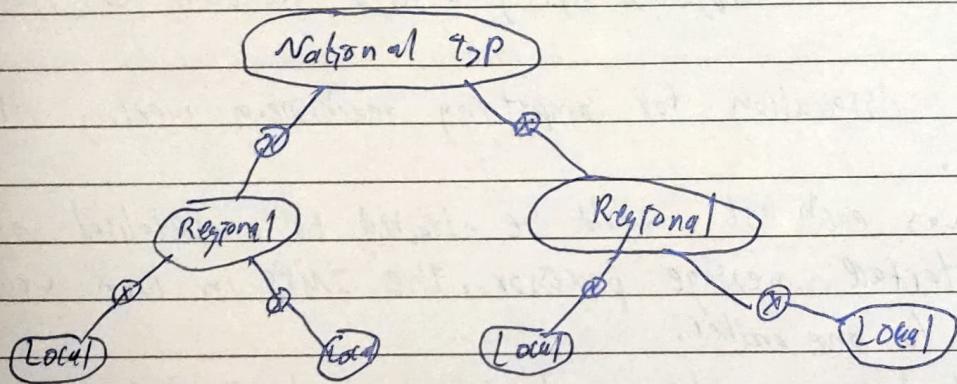
TCP - segmentation, reassembly and error detection

Internet Today

Not hierarchical structure.

Made up of many WAN and LAN joined by connecting device and switching station

Users take service from ISP - Internet service provider.



International ISP - connects national ISPs together

National backbone networks connecting Regional ISPs

Regional ISP - regional ISP are smaller connected to one or more national ISPs

Local ISP - provide direct service to end user.

Protocols and standards

Protocol - rule

Standards - agreed upon rule

Protocol

Syntax - structure or format of data, meaning order of presentation

Semantics - Refers to the meaning of each section of bits

Timing - when data should be sent and how fast.

Standards

Essential in creating an open market to guarantee interoperability of data and telecommunication technology or process

- de facto - Not approved but so widespread widespread
- de jure - legislated by officially recognised body

Standard creation committee

ISO - International organization for standards

ITU-T - International Telecommunication Union - Telecommunication standards

American National Standards Institute - ANSI

IEEE - Institute of Electrical and Electronics Engineers

EIA - Electronic Industry Association

Forum - as standard committee are slow forums are formed to test, evaluate and standardize new tech

Regulatory Agencies - Federal communication commissions (FCC)

Internet standard - An internet draft is a working document with 6 month lifetime
on recommendation it goes through various levels of maturity The RFC goes
there is also categorized according to requirement level

Network Models

LAYERED TASK

Example

At sender side

Higher Layer - writes letter, inserts in envelope, writes sender and receiver addresses, drop in mailbox

Middle Layer - picked up by mail carrier

Lower Layer - Letter sorted at post office

At Receive

Layer Lower - Carrier transports letter to post office

Middle - sorted and delivered to mailbox

Higher - receiver gets the letter opens and reads it

Services

Each layer uses the services below it

OSI Model

In 1970,

It is not a protocol but a model for making understanding and designing network architecture that is flexible robust and interoperable

Application

Presentation

Session

Transport

Network

Physical Data Link

Physical

Peer to peer processes

Each layer in sending device adds its own information to message it receives from layer above and passes package to layer below it. At receiver end the message is then unwrapped layer by layer.

Interface

lower layer provides services to higher layer using interface

Organization

physical, data link, network - network support layers - deals with physical moving
Transport - ensures what lower levels have sent is usable by higher levels
session, presentation, application - user support layers
mostly implemented in software
header and trailer is added at each layer while sending and are removed while receiving

Encapsulation

A packet at N^{th} is encapsulated at level k and so on.
The whole packet is considered an integral unit.

LAYER in MODEL

- a) Physical - coordinates the functions required to carry bit stream over physical medium
concerned with:
 - i) Characteristics of medium
 - ii) Representation of bits
 - iii) Data Rate
 - iv) Synchronization of bits
 - v) Line configuration
 - vi) Physical topology
 - vii) Transmission mode

b) Data Link

Makes physical layer appear error free to upper layer
responsibility

Framing - Divides streams of bits received from network layer into manageable frames

Physical addressing

Flow control

Error control

Access control

Network Layer

Responsible for source to delivery

Responsibilities

Logical addressing

Routing

Transport Layer

Process to process delivery

Service-point

Segmentation and reassembly

(connection control)

Flow control

Error control

Session Layer

It is the network dialog controller. It establishes, maintains and synchronizes the interactions among communicating systems.

Responsibility

Dialog

Synchronization

Presentation Layer

Translation

Encryption

Compression

Application Layer

Network virtual terminal

File transfer, access and management

Mail services

Directory services

TCP/IP protocol

three protocols

TCP - Transmission control protocol

UDP - User Datagram Protocol

SCTP - Stream control transmission

Physical and Data Link Layer

No specific protocol. It supports all standard and proprietary network can be LAN and WAN

Network

Supports IP - { ARP, RARP, ICMP, Icmpv3 }

IP -

Unreliable and connection-less best effort delivery

transport in datagram

keeps no tract

no reordering datagram

Address resolution protocol

Associate logical address with physical

Reverse ARP

allows to know Internet address when it knows only physical address

Internet Control Message Protocol

Mechanism to send notification of datagram problems

Internet group message Protocol

Facilitate simultaneous transmission to a group

Transport Layers

UDP - process to proxy protocol that adds only port address, checksum error control and length of info

TCP - reliable stream transport protocol, connection oriented divides into smaller unit called segments.

Each segment includes sequence number together with acknowledgement number for segment received

Stream control protocol

Application Layer

Many layer protocols are defined at this layer

Addressing

Any communication that involves two parties needs to be addressed

Except for physical, every layer does addressing

packets	layer	address
message	Application	Name
segment	Transport	port No.
Datagram	Network	logical address
Frame	Data link	Link layer address