

Protocol: A set of rules for message exchange between entities.

Protocol Process :

Message format/structure.

Pathway information sharing.

Error/system message handling.

Session setup and termination.

Layering In Networked Computing

- OSI Model (open system interconnection)
- TCP/IP Model

Why a layered model?

1. Simplifies communication into smaller parts.
2. Eases teaching and understanding.
3. Ensures interoperability between hardware and software.
4. Reduces complexity.

The OSI model: is a 7-layer framework for standardizing network communication.

OSI model

Layer	Name	Example protocols
7	Application Layer	HTTP, FTP, DNS, SNMP, Telnet
6	Presentation Layer	SSL, TLS
5	Session Layer	NetBIOS, PPTP
4	Transport Layer	TCP, UDP
3	Network Layer	IP, ARP, ICMP, IPSec
2	Data Link Layer	PPP, ATM, Ethernet
1	Physical Layer	Ethernet, USB, Bluetooth, IEEE802.11

OSI (OPEN SYSTEM INTERCONNECTION)	TCP/IP (TRANSMISSION CONTROL PROTOCOL / INTERNET PROTOCOL)
1. Defines layer functions.	1. Based on protocols, less flexible.
2. Has a presentation layer.	2. No separate presentation layer.
3. General model.	3. Not applicable to other applications.
4. Supports both connection types.	4. Provides connectionless service.
5. Protocols fitting issue.	5. Does not fit any protocol.
6. Protocols easily replaceable.	6. Replacing protocols is difficult.
7. Clear distinction in services.	7. Services, interfaces unclear.
8. 7 layers.	8. 4 layers.

Data Encapsulation

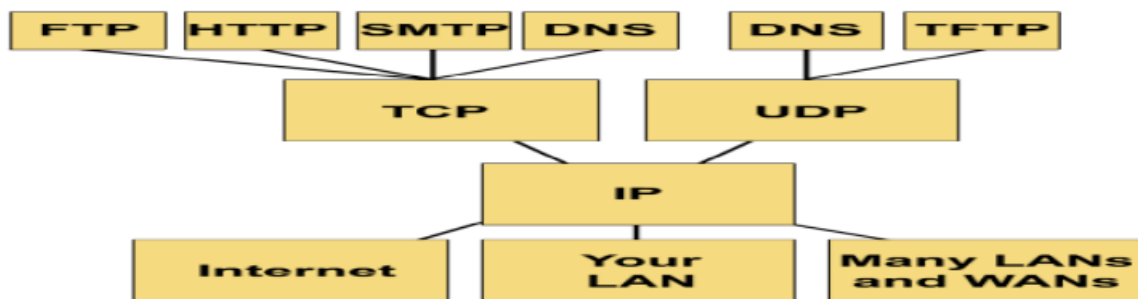
- Each layer contains a **Protocol Data Unit (PDU)**
- PDU's are used for **peer-to-peer contact** between corresponding layers.

The Layer	Shape of data (PDU)
top three layers	Data
Transport layer	Segment
Network layer	packets
Data Link layer	frames
Physical layer	bits

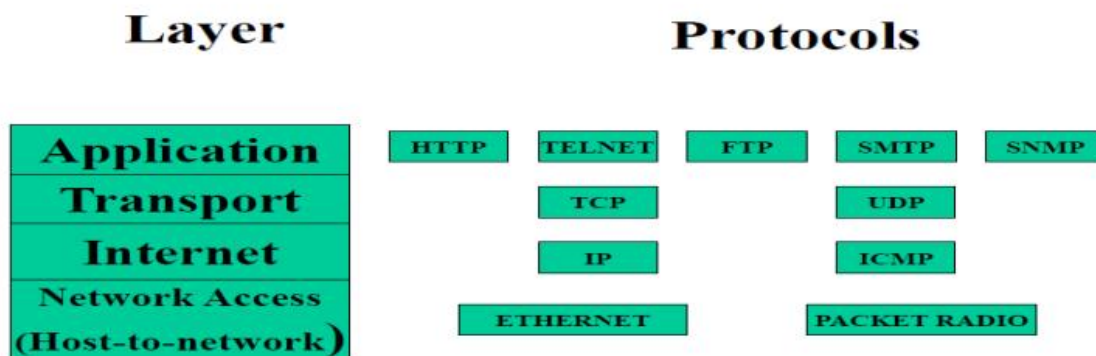
4 layers of the TCP/IP model

- **Layer 4: Application**
- **Layer 3: Transport**
- **Layer 2: Internet**
- **Layer 1: Network access**

TCP/IP protocol stack



TCP/IP Reference Model



Q/Explain the delivery of data in Layered model?

Type of delivery	Layer	Shape of data	Type of addressing
End to End	Transport	Segment	Port (socket)
Source To Destination	Network	Packet	Logical (IP)
Node to Node	Data Link	Frame	Physical(MAC)

SDH/SONET

SDH (SYNCHRONOUS DIGITAL HIERARCHY)	SONET (SYNCHRONOUS OPTICAL NETWORK)
European standard by ITU-T.	American standard by ANSI.
Uses STMs hierarchy.	Uses STSs hierarchy (STS-1 to STS-192).

Bluetooth: is a short-range wireless technology connecting various devices like phones, computers, cameras, and printers.

Architecture of Bluetooth: Bluetooth defines two types of networks: piconet and scatternet

Q/ Datagram or VC network: why?

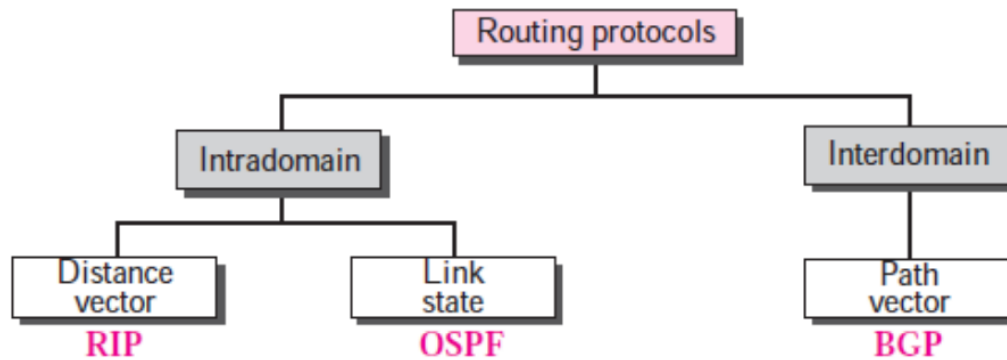
<i>Internet (datagram)</i>	<i>ATM (VC) virtual circuit</i>
• data exchange among computers –“elastic” service, no strict timing req • many link types –different characteristics –uniform service difficult • “smart” end systems (computers) –can adapt, perform control, error recovery –<i>simple inside network, complexity at “edge”</i>	• evolved from telephony • human conversation: –strict timing, reliability requirements –need for guaranteed service • “dumb” end systems –telephones –<i>complexity inside network</i>

Network service model

Q:What service model for “channel” transporting datagrams from sender to receiver?

<i>individual datagrams</i>	<i>flow of datagrams</i>
• guaranteed delivery • guaranteed delivery with less than 40 msec delay	• in-order datagram delivery • guaranteed minimum bandwidth to flow.

Popular routing protocols



BGP route selection

Router may learn about more than 1 route to destination AS, selects route based on:

1. Local preference value attribute: **policy decision**
2. **Shortest AS-PATH**
3. **Closest NEXT-HOP router.**
4. **Additional criteria**

BGP Messages

BGP messages exchanged between peers over TCP connection, **BGP has four types of messages**

- **OPEN:** Establish a connection with a BGP peer
- **UPDATE** -- advertise or withdraw routes to a destination
- **KEEPALIVE:** Inform a peer that the sender is still alive but has no information to send.
- **NOTIFICATION:** Notify that errors are detected, also used to close connection

Example

Now suppose there is a burst error of length 5 that affects 4 bits.

1010111111111001 00011101

When the receiver adds the three sections, it gets

	10101111	
	11111001	
	00011101	
Partial Sum	1 11000101	
Carry		1
Sum	11000110	
Complement	00111001	the pattern is corrupted.

Example

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Carry		1
Sum	11000110	
Complement	00111001	the pattern is corrupted.

Example

Now suppose the receiver receives the pattern sent in Example 7 and there is no error.

10101001 00111001 00011101

When the receiver adds the three sections, it will get all 1s, which, after complementing, is all 0s and shows that there is no error.

	10101001	
	00111001	
	00011101	
Sum	11111111	
Complement	00000000	means that the pattern is OK.

Example

Now suppose there is a burst error of length 5 that affects 4 bits.

10101111 11111001 00011101

When the receiver adds the three sections, it gets

		10101111	
		11111001	
		00011101	
Result	1	11000101	
Carry			1
Sum		11000110	
Complement		00111001	means that the pattern is corrupted.