## OSI

- OSI stands for Open Systems Interconnection
- Created by International Standards Organization (ISO)
- Was created as a framework and reference model to explain how different networking technologies work together and interact
- It is not a standard that networking protocols must follow
- Each layer has specific functions it is responsible for
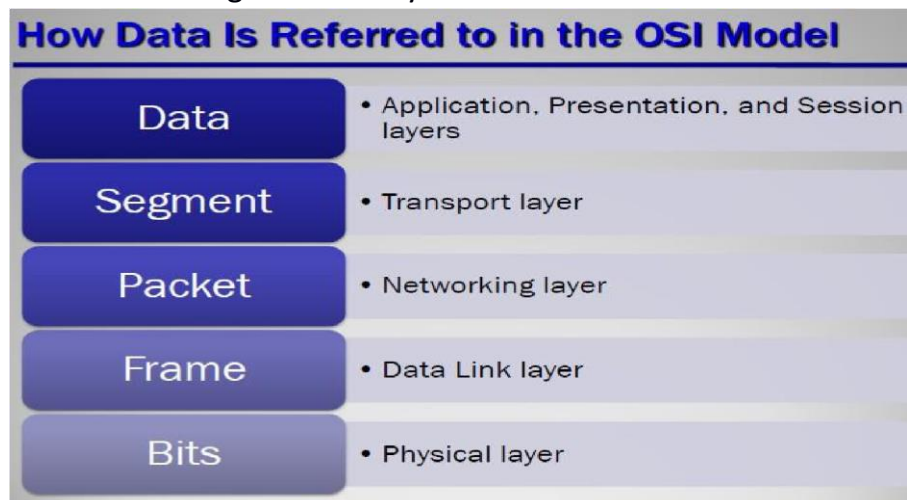- All layers work together in the correct order to move data around a network
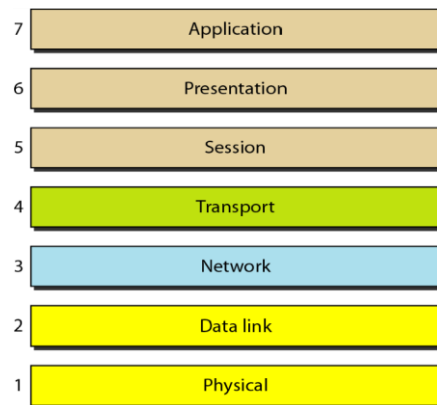
Top to bottom
–All People Seem To Need Data Processing
Bottom to top
–Please Do Not Throw Sausage Pizza Away

Physical Layer

- Deals with all aspects of physically moving data from one computer to the next
- Converts data from the upper layers into 1s and 0s for transmission over media
- Defines how data is encoded onto the media to transmit the data

- Defined on this layer: Cable standards, wireless standards, and fiber optic standards.
  Copper wiring, fiber optic cable, radio frequencies, anything that can be used to transmit data is defined on the Physical layer of the OSI Model
- Device example: Hub
- Used to transmit data
- **Data Link Layer**
- Is responsible for moving frames from node to node or computer to computer
- Can move frames from one adjacent computer to another, cannot move frames across routers
- Encapsulation = frame
- Requires MAC address or *physical address*
- Protocols defined include Ethernet Protocol and Point-to-Point Protocol (PPP) Device example: Switch
- Two sublayers: Logical Link Control (LLC) and the Media Access Control (MAC) o Logical Link Control (LLC)
- –Data Link layer addressing, flow control, address notification, error control
    o   Media Access Control (MAC)
- –Determines which computer has access to the network media at any given time
- –Determines where one frame ends and the next one starts, called frame synchronization
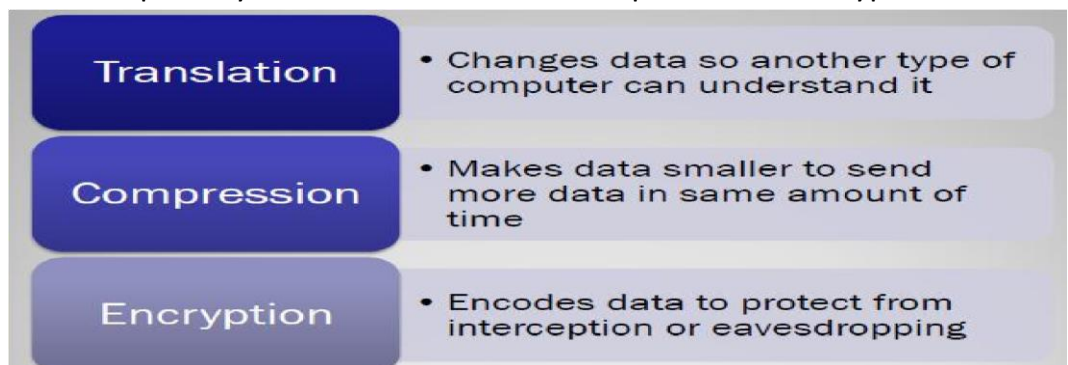- **Network Layer**
- Responsible for moving packets (data) from one end of the network to the other, called *end-to-end communications*
- Requires *logical addresses* such as IP addresses
- Device example: Router
- –Routing is the ability of various network devices and their related software to move data packets from source to destination
- **Transport Layer**
- Takes data from higher levels of OSI Model and breaks it into segments that can be sent to lower-level layers for data transmission
- Conversely, reassembles data segments into data that higher-level protocols and applications can use
- Also puts segments in correct order (called sequencing) so they can be reassembled in correct order at destination
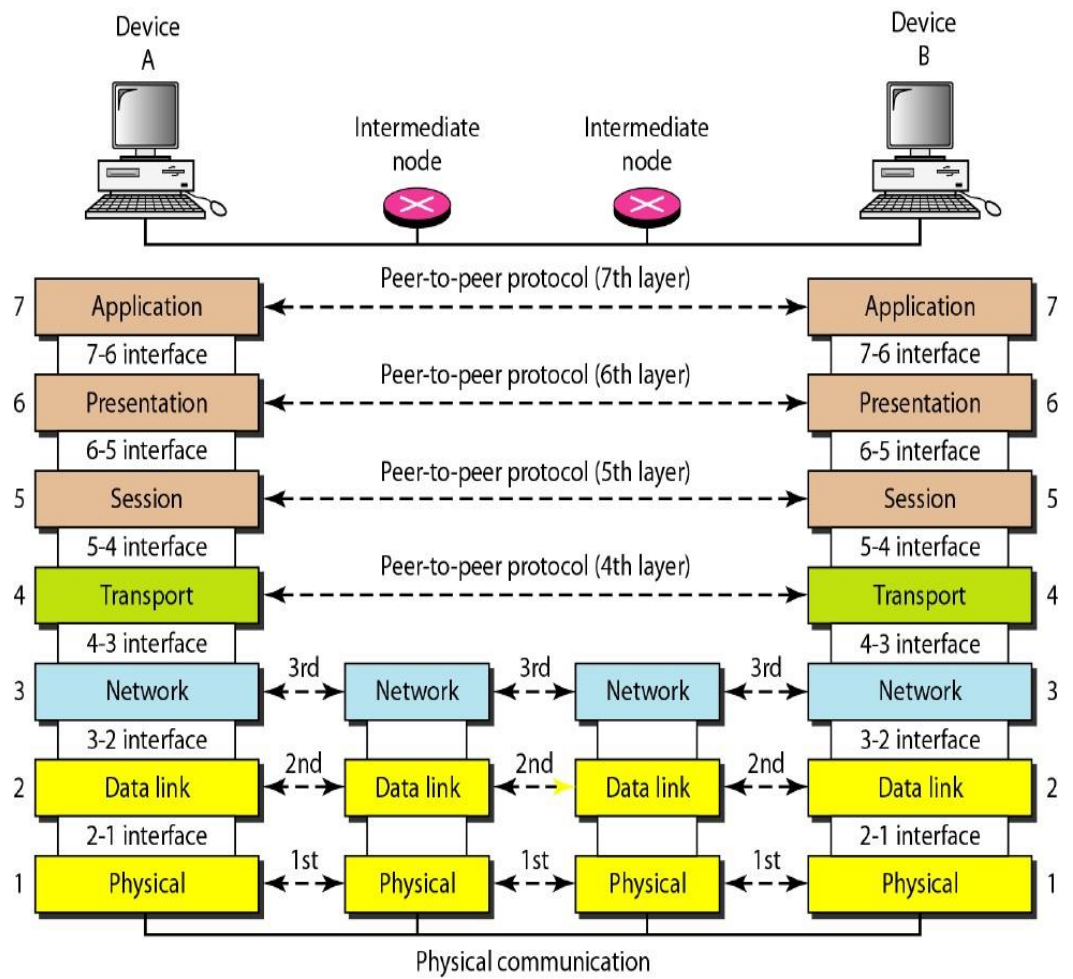- Concerned with the reliability of the transport of sent data

- May use a *connection-oriented protocol* such as TCP to ensure destination received segments
- May use a *connectionless protocol* such as UDP to send segments without assurance of delivery
- Uses port addressing
- **<u>Session Layer</u>**
- Responsible for managing the dialog between networked devices
- Establishes, manages, and terminates connections
- Provides duplex, half-duplex, or simplex communications between devices
- Provides procedures for establishing checkpoints, adjournment, termination, and restart or recovery procedures
- **<u>Presentation Layer</u>**
- Concerned with how data is presented to the network
- Handles three primary tasks: –Translation , –Compression , –Encryption

<u>Application Layer</u>
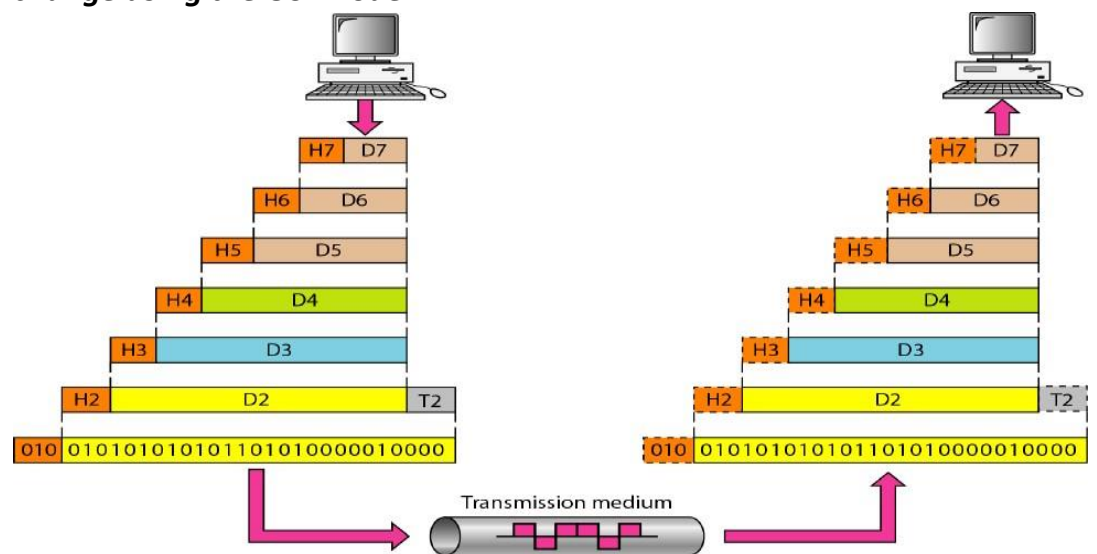- Contains all services or protocols needed by application software or operating system to communicate on the network
- Examples
  - –Firefox web browser uses HTTP (Hyper-Text Transport Protocol)
  - –E-mail program may use POP3 (Post Office Protocol version 3) to read e-mails and SMTP (Simple Mail Transport Protocol) to send e-mails
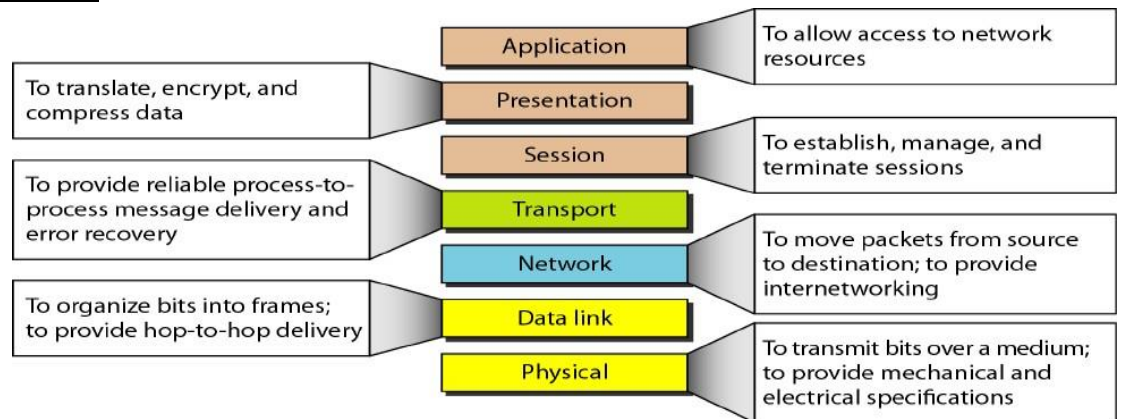
The interaction between layers in the OSI model

Device A

7	Application	7
	7-6 interface	
6	Presentation	6
	6-5 interface	
5	Session	5
	5-4 interface	
4	Transport	4
	4-3 interface	
3	Network	3
	3-2 interface	
2	Data link	2
	2-1 interface	
1	Physical	1

Intermediate node

Intermediate node

Device B

Peer-to-peer protocol (7th layer)
Peer-to-peer protocol (6th layer)
Peer-to-peer protocol (5th layer)
Peer-to-peer protocol (4th layer)

3rd   3rd   3rd

2nd   2nd   2nd

1st   1st   1st

Network   Network

Data link   Data link

Physical   Physical

Physical communication

An exchange using the OSI model

H7 | D7
H6 | D6
H5 | D5
H4 | D4
H3 | D3
H2 | D2 | T2
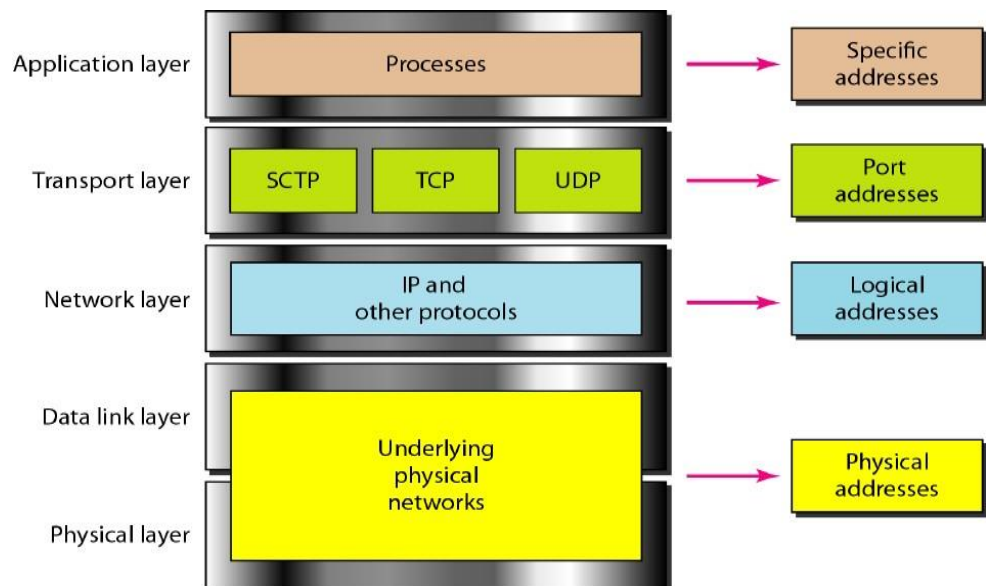010 | 010101010101101010000010000

Transmission medium

SUMMARY:

TCP/IP Model (Transmission Control Protocol/Internet Protocol)
–A *protocol suite* is a large number of related protocols that work together to allow networked computers to communicate

Relationship of layers and addresses in TCP/IP

Application Layer

- Application layer protocols define the rules when implementing specific network applications
- Rely on the underlying layers to provide accurate and efficient data delivery
- Typical protocols:
- o FTP – File Transfer Protocol : For file transfer
- o Telnet – Remote terminal protocol : For remote login on any other computer on the network
  o SMTP – Simple Mail Transfer
  Protocol For mail transfer

- ⬚ HTTP – Hypertext Transfer Protocol : For Web browsing
- Encompasses same functions as these OSI Model layers Application Presentation Session
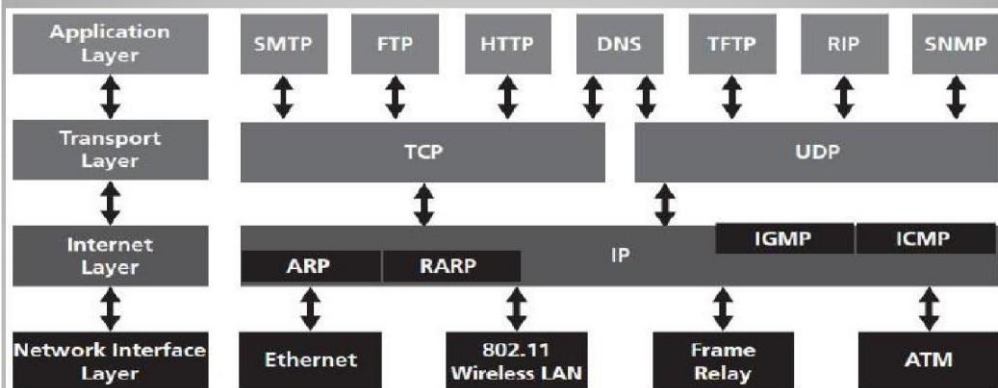
Transport Layer

TCP &UDP

- TCP is a connection-oriented protocol
- o Does not mean it has a physical connection between sender and receiver o TCP provides the function to allow a connection virtually exists – also called virtual circuit

⬚ UDP provides the functions:
- o Dividing a chunk of data into segments o Reassembly segments into the original chunk
- o Provide further the functions such as reordering and data resend
- Offering a reliable byte-stream delivery service
- Functions the same as the Transport layer in OSI
- Synchronize source and destination computers to set up the session between the respective computers
- **Internet Layer**
- The network layer, also called the internet layer, deals with packets and connects independent networks to transport the packets across network boundaries. The network layer protocols are the IP and the Internet Control Message Protocol (ICMP), which is used for error reporting.

Host-to-network layer

The **Host-to-network layer** is the lowest **layer** of the **TCP/IP** reference model. It combines the link **layer** and the physical **layer** of the ISO/OSI model. At this **layer**, data is transferred between adjacent **network** nodes in a WAN or between nodes on the same LAN.

TCP/IP Model and its Relation to Protocols of the TCP/IP Suite

OSI MODEL	TCP/IP MODEL
Contains 7 Layers	Contains 4 Layers
Uses Strict Layering resulting in vertical layers.	Uses Loose Layering resulting in horizontal layers.
Supports both connectionless & connection-oriented communication in the Network layer, but only connection-oriented communication in Transport Layer	Supports only connectionless communication in the Network layer, but both connectionless & connection-oriented communication in Transport Layer
It distinguishes between Service, Interface and Protocol.	Does not clearly distinguish between Service, Interface and Protocol.
Protocols are better hidden and can be replaced relatively easily as technology changes (No transparency)	Protocols are not hidden and thus cannot be replaced easily. (Transparency) Replacing IP by a substantially different protocol would be virtually impossible
OSI reference model was devised before the corresponding protocols were designed.	The protocols came first and the model was a description of the existing protocols

THE INTERNET

The Internet has revolutionized many aspects of our daily lives. It has affected the way we do business as well as the way we spend our leisure time. Count the ways you've used the Internet recently. Perhaps you've sent electronic mail (e-mail) to a business associate, paid a utility bill, read a newspaper from a distant city, or looked up a local movie schedule-all by using the Internet. Or maybe you researched a medical topic, booked a hotel reservation, chatted with a fellow Trekkie, or comparison-shopped

for a car. The Internet is a communication system that has brought a wealth of information to our fingertips and organized it for our use.

A Brief History

A network is a group of connected communicating devices such as computers and printers. An internet (note the lowercase letter i) is two or more networks that can communicate with each other. The most notable internet is called the Internet (uppercase letter I), a collaboration of more than hundreds of thousands of interconnected networks. Private individuals as well as various organizations such as government agencies, schools, research facilities, corporations, and libraries in more than 100 countries use the Internet. Millions of people are users. Yet this extraordinary communication system only came into being in 1969.

In the mid-1960s, mainframe computers in research organizations were standalone devices. Computers from different manufacturers were unable to communicate with one another. The Advanced Research Projects Agency (ARPA) in the Department of Defense (DoD) was interested in finding a way to connect computers so that the researchers they funded could share their findings, thereby reducing costs and eliminating duplication of effort.

In 1967, at an Association for Computing Machinery (ACM) meeting, ARPA presented its ideas for ARPANET, a small network of connected computers. The idea was that each host computer (not necessarily from the same manufacturer) would be attached to a specialized computer, called an *inteiface message processor* (IMP). The IMPs, in tum, would be connected to one another. Each IMP had to be able to communicate with other IMPs as well as with its own attached host. By 1969, ARPANET was a reality. Four nodes, at the University of California at Los Angeles (UCLA), the University of California at Santa Barbara (UCSB), Stanford Research Institute (SRI), and the University of Utah, were connected via the IMPs to form a network. Software called the *Network Control Protocol* (NCP) provided communication between the hosts.

In 1972, Vint Cerf and Bob Kahn, both of whom were part of the core ARPANET group, collaborated on what they called the *Internetting Projec1.* Cerf and Kahn's landmark 1973 paper outlined the protocols to achieve endto-end delivery of packets. This paper on Transmission Control Protocol (TCP) included concepts such as encapsulation, the datagram, and the functions of a gateway. Shortly thereafter, authorities made a decision to split TCP into two protocols: Transmission Control Protocol

(TCP) and Internetworking Protocol (IP). IP would handle datagram routing while TCP would be responsible for higher-level functions such as segmentation, reassembly, and error detection. The internetworking protocol became known as TCPIIP. The Internet Today

The Internet has come a long way since the 1960s. The Internet today is not a simple hierarchical structure. It is made up of many wide- and local-area networks joined by connecting devices and switching stations. It is difficult to give an accurate representation of the Internet because it is continually changing-new networks are being added, existing networks are adding addresses, and networks of defunct companies are being removed. Today most end users who want Internet connection use the services of Internet service providers (ISPs). There are international service providers, national service providers, regional service providers, and local service providers. The Internet today is run by private companies, not the government. Figure 1.13 shows a conceptual (not geographic) view of the Internet.
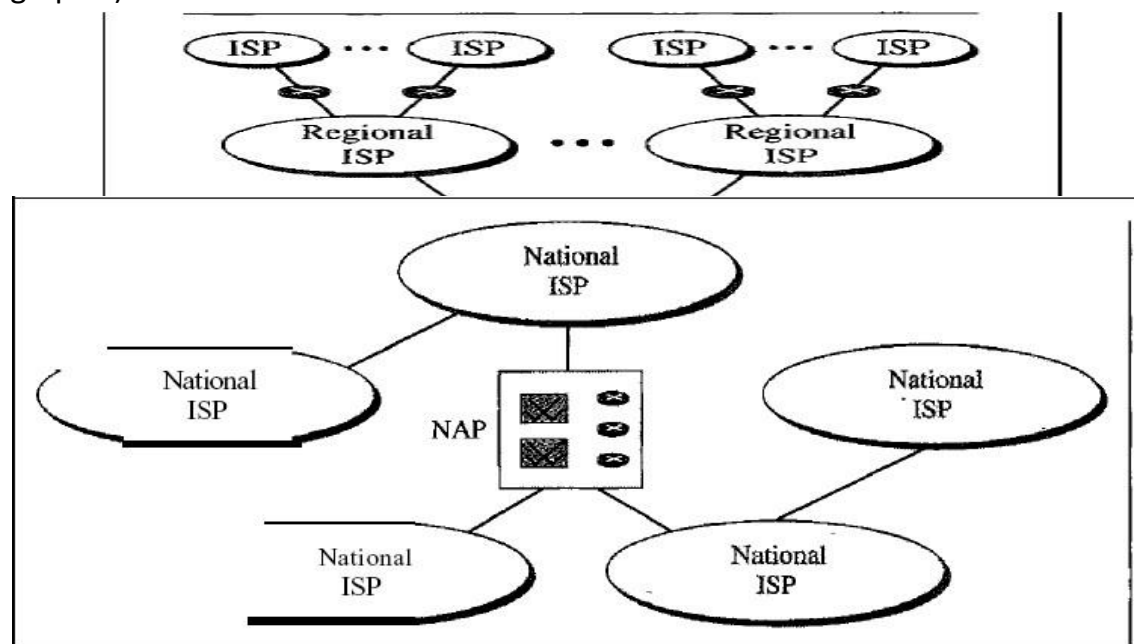
b. Interconnection of national ISPs

International Internet Service Providers:
At the top of the hierarchy are the international service providers that connect nations together.

National Internet Service Providers:
The national Internet service providers are backbone networks created and maintained by specialized companies. There are many national ISPs operating in North America; some of the most well known are SprintLink, PSINet, UUNet Technology, AGIS, and internet Mel. To provide connectivity between the end users, these backbone networks

are connected by complex switching stations (normally run by a third party) called network access points (NAPs). Some national ISP networks are also connected to one another by private switching stations called *peering points.* These normally operate at a high data rate (up to 600 Mbps). ***Regional Internet Service Providers:***

Regional internet service providers or regional ISPs are smaller ISPs that are connected to one or more national ISPs. They are at the third level of the hierarchy with a smaller data rate. ***Local Internet Service Providers*:**

Local Internet service providers provide direct service to the end users. The local ISPs can be connected to regional ISPs or directly to national ISPs. Most end users are connected to the local ISPs. Note that in this sense, a local ISP can be a company that just provides Internet services, a corporation with a network that supplies services to its own employees, or a nonprofit organization, such as a college or a university, that runs its own network. Each of these local ISPs can be connected to a regional or national service provider.

Error Detection

Error

A condition when the receiver's information does not matches with the sender's information. During transmission, digital signals suffer from noise that can introduce errors in the binary bits travelling from sender to receiver. That means a 0 bit may change to 1 or a 1 bit may change to 0.

Error Detecting Codes (Implemented either at Data link layer or Transport Layer of OSI Model)

Whenever a message is transmitted, it may get scrambled by noise or data may get corrupted. To avoid this, we use error-detecting codes which are additional data added to a given digital message to help us detect if any error has occurred during transmission of the message.

Basic approach used for error detection is the use of redundancy bits, where additional bits are added to facilitate detection of errors. Some popular techniques for error detection are:

1. Simple Parity check
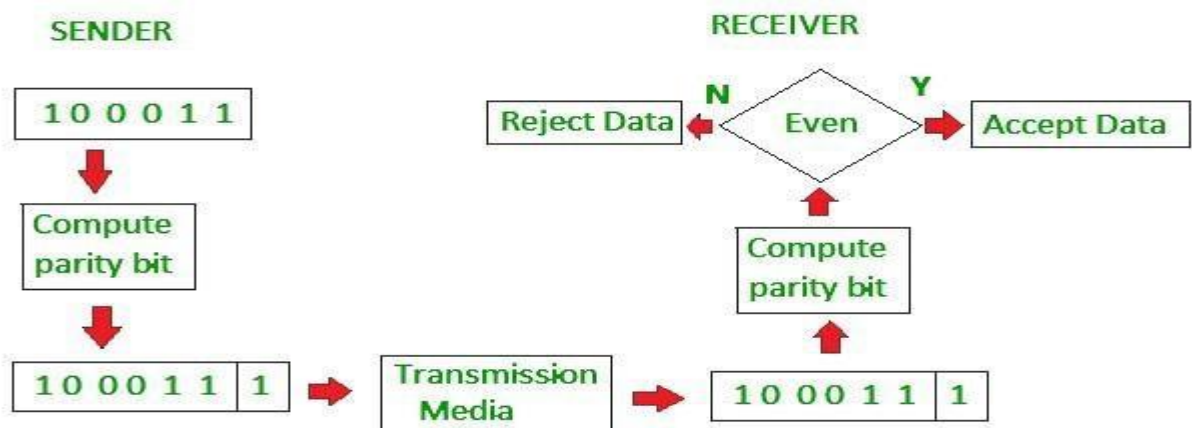
2. Two-dimensional Parity check

3. Checksum

4. Cyclic redundancy check

Simple Parity check
Blocks of data from the source are subjected to a check bit or parity bit generator form, where a parity of :   1 is added to the block if it contains odd number of 1's, and
      0 is added if it contains even number of 1's
This scheme makes the total number of 1's even, that is why it is called even parity checking.

Two-dimensional Parity check
Parity check bits are calculated for each row, which is equivalent to a simple parity check bit. Parity check bits are also calculated for all columns, then both are sent along with the data. At the receiving end these are compared with the parity bits calculated on the received data.

Original Data

10011001	11100010	00100100	10000100

Row parities

1 0 0 1 1 0 0 1	0
1 1 1 0 0 0 1 0	0
0 0 1 0 0 1 0 0	0
1 0 0 0 0 1 0 0	0
1 1 0 1 1 0 1 1	0

Column parities →

100110010	111000100	001001000	100001000	110110110

Data to be sent

Checksum

- In checksum error detection scheme, the data is divided into k segments each of m bits.
- In the sender's end the segments are added using 1's complement arithmetic to get the sum. The sum is complemented to get the checksum.
- The checksum segment is sent along with the data segments.
- At the receiver's end, all received segments are added using 1's complement arithmetic to get the sum. The sum is complemented.
- If the result is zero, the received data is accepted; otherwise discarded.

Original Data

10011001	11100010	00100100	10000100
1	2	3	4

k=4, m=8

Sender

```
1      1 0 0 1 1 0 0 1
2      1 1 1 0 0 0 1 0
     ⓵0 1 1 1 1 0 1 1
                     1
       0 1 1 1 1 1 0 0
3      0 0 1 0 0 1 0 0
       1 0 1 0 0 0 0 0
4      1 0 0 0 0 1 0 0
     ⓵0 0 1 0 0 1 0 0
                     1
Sum:   0 0 1 0 0 1 0 1
CheckSum: 1 1 0 1 1 0 1 0
```

Reciever

```
1      1 0 0 1 1 0 0 1
2      1 1 1 0 0 0 1 0
     ⓵0 1 1 1 1 0 1 1
                     1
       0 1 1 1 1 1 0 0
3      0 0 1 0 0 1 0 0
       1 0 1 0 0 0 0 0
4      1 0 0 0 0 1 0 0
     ⓵0 0 1 0 0 1 0 0
                     1
       0 0 1 0 0 1 0 1
       1 1 0 1 1 0 1 0
Sum:   1 1 1 1 1 1 1 1
Complement:0 0 0 0 0 0 0
```

Conclusion: Accept Data