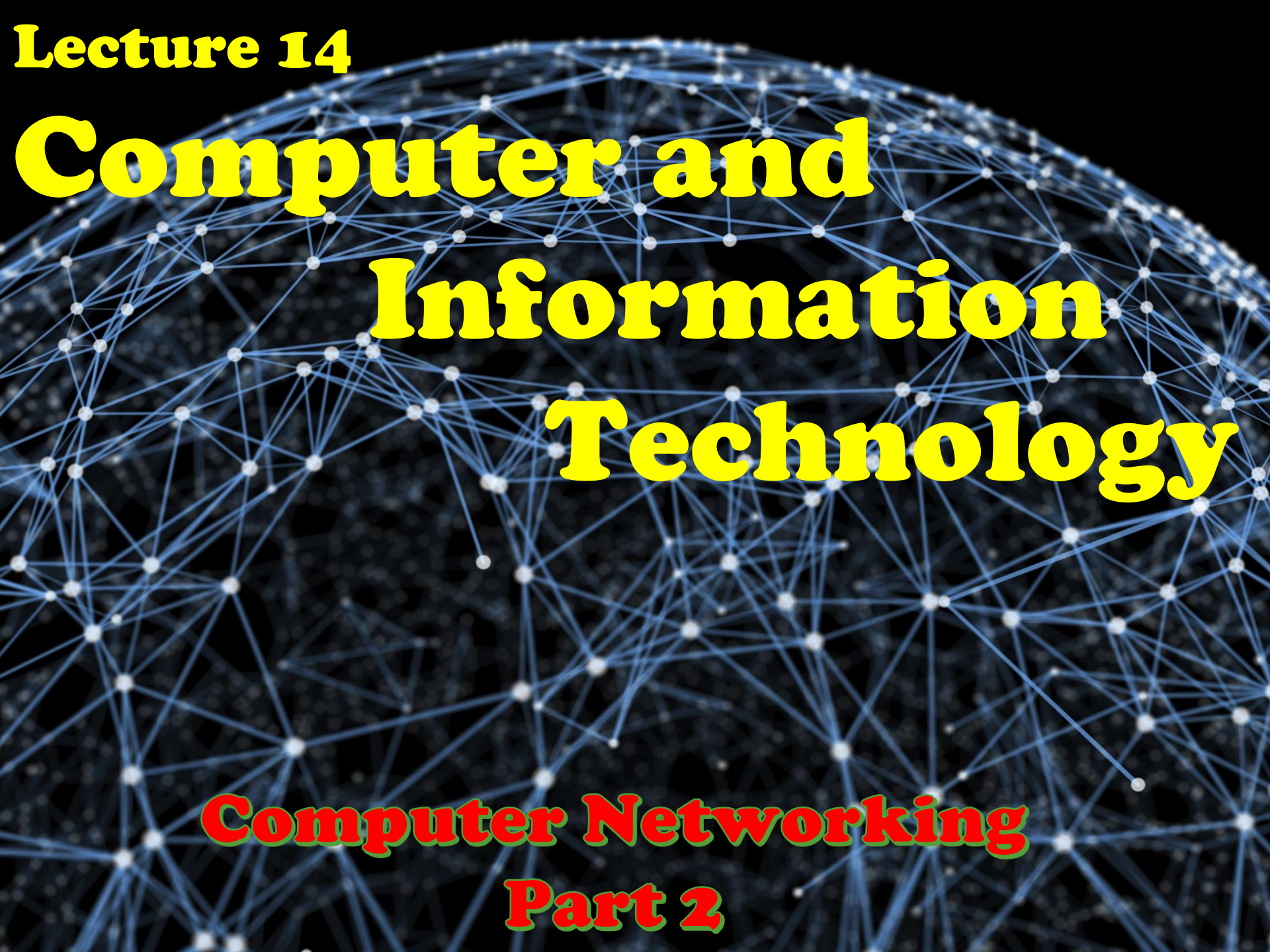

Lecture 14
Computer and Information Technology
Computer Networking
Part 2

Computer Network Protocol

Or,

Data Communication Protocol

A protocol is an agreed-upon set of rules, which describe actions or sequences of actions that initiate and control the transmission of data along the physical connections. A protocol is designed in layer upon layer design where each layer provides a richer functionality than the layer below it. Every layer implements its own functionality on the basis and services of the lower layer's functionality.

How

What

When

ISO/OSI Protocol Model

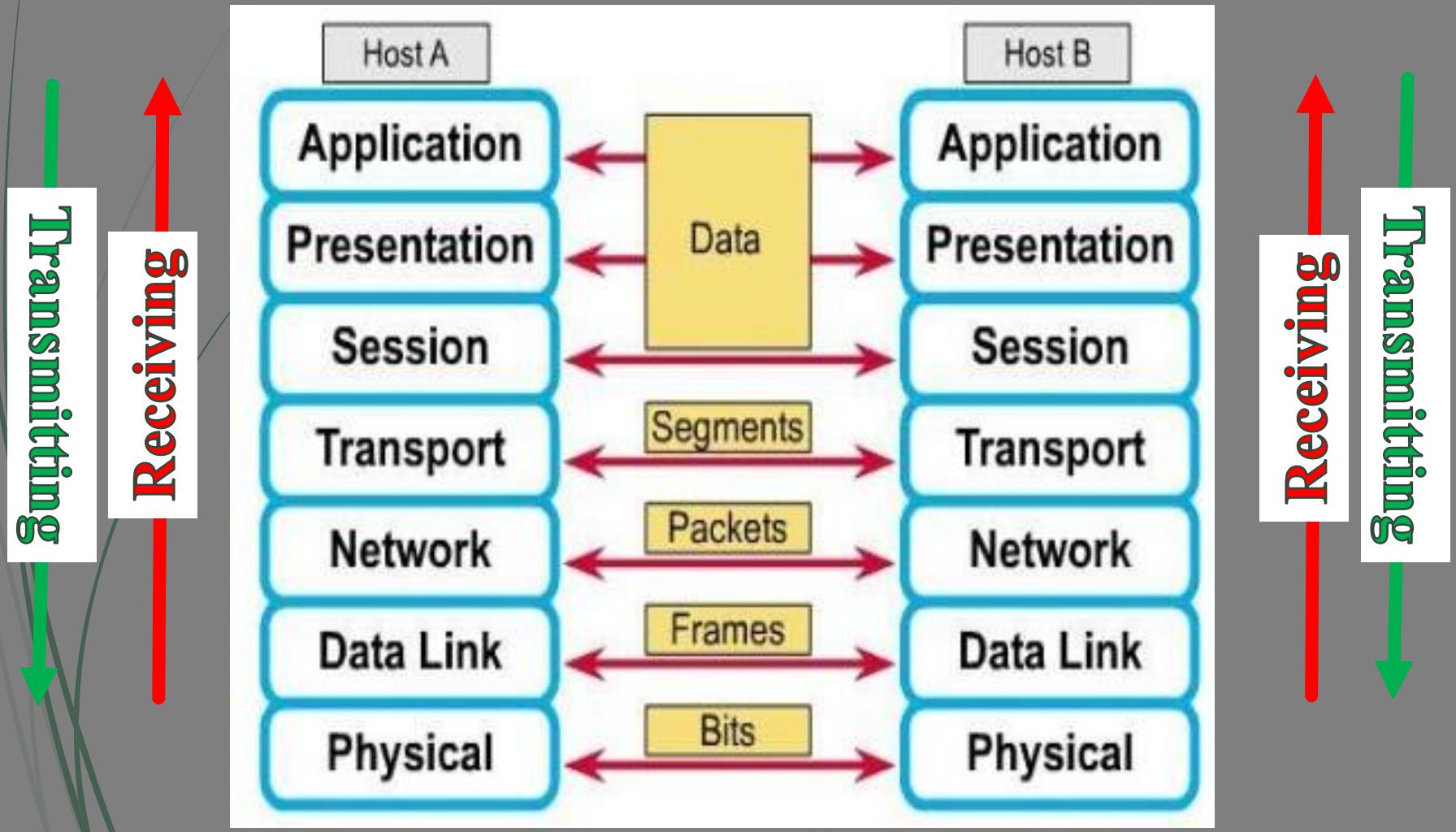
OSI stands for **Open System for Interconnection**. It is a conceptual model finalized by ISO or International Standardization Organization.

This model provided a framework for the overall communication processes and was originally intended for to the development of any communication standard.

OSI model partitions a communication system into seven abstraction layers without regard to its underlying internal structure and technology. A layer serves the layer above it and is served by the layer below it. The layers are named as:

►Application, ►Presentation, ►Session, ►Transport, ►Network, ►Data link & ►Physical

ISO/OSI Protocol Model



ISO/OSI Protocol Model

Application Layer (7th Layer)

The application layer is the top most layer and directly in touch with the end user and the software application which requires the data communication.

Applications like web browser, messenger and file download manager produce data which has to be transferred over the network. This layer serves as a window for these data transmission and allows applications to access the network and for displaying the received information to the user.

ISO/OSI Protocol Model

Presentation Layer (6th Layer)

Presentation layer is also called the 'Translation layer'. The data from the application layer is extracted here and manipulated as per the required format to transmit over the network.

The functions of the presentation layer are :

►**Translation :** For example, ASCII to EBCDIC.

►**Encryption/ Decryption :** Data encryption translates the data into another form or code. The encrypted data is known as the cipher text and the decrypted data is known as plain text. A key value is used for encrypting as well as decrypting data.

►**Compression:** Reduces the number of bits that need to be transmitted on the network.

ISO/OSI Protocol Model

Session Layer (5th Layer)

This layer is responsible for establishment of connection, maintenance of sessions, authentication and also ensures security.

The functions of the session layer are :

Session establishment, maintenance and termination: The layer allows the two processes to establish, use and terminate a connection.

Synchronization : This layer allows a process to add checkpoints which are considered as synchronization points into the data. These synchronization point help to identify the error so that the data is re-synchronized properly, and ends of the messages are not cut prematurely and data loss is avoided.

Dialog Controller : The session layer allows two systems to start communication with each other in half-duplex or full-duplex.

ISO/OSI Protocol Model

Transport Layer (4th Layer)

Transport layer receives the formatted data from the upper layers, performs **Segmentation** and also implements **Flow & Error control** to ensure proper data transmission. It also adds source and destination port number in its header and forwards the segmented data to the network layer. All these happen at data sender's side.

At the destination side, transport layer reads the port number from its header and forwards the data which it has received to the respective application. It also performs sequencing and reassembling of the segmented data. Because segmentation makes tiny pieces of data segments from the data/message to be sent, it is required to be re-assembled at receiver's transport layer keeping the actual sequence of segmentation.

ISO/OSI Protocol Model

Transport Layer (4th Layer) continued……

The functions of the transport layer are :

►**Segmentation and Reassembly:** This layer accepts the message from the (session) layer , breaks the message into smaller segments . Each of the segment produced has a header associated with it. The transport layer at the destination station reassembles the message.

►**Service Point Addressing:** In order to deliver the message to correct process, transport layer header includes a type of address called service point address or port address. Thus by specifying this address, transport layer makes sure that the message is delivered to the correct process of correct application.

Transport layer is handled by the OS and responding to session layer's call for data transmission, transport layer (by OS) initiates the transfer.

ISO/OSI Protocol Model

Network Layer (3rd Layer)

Network layer works for the transmission of data from one host to the other located in different networks by doing packet routing which involves selection of the shortest path to transmit the packet, from the number of routes available. The sender & receiver's IP address are placed in the header by the network layer and we now call the segments packets.

The functions of the network layer are :

►**Routing:** The network layers find shortest suitable route from source to destination and this function is known as routing.

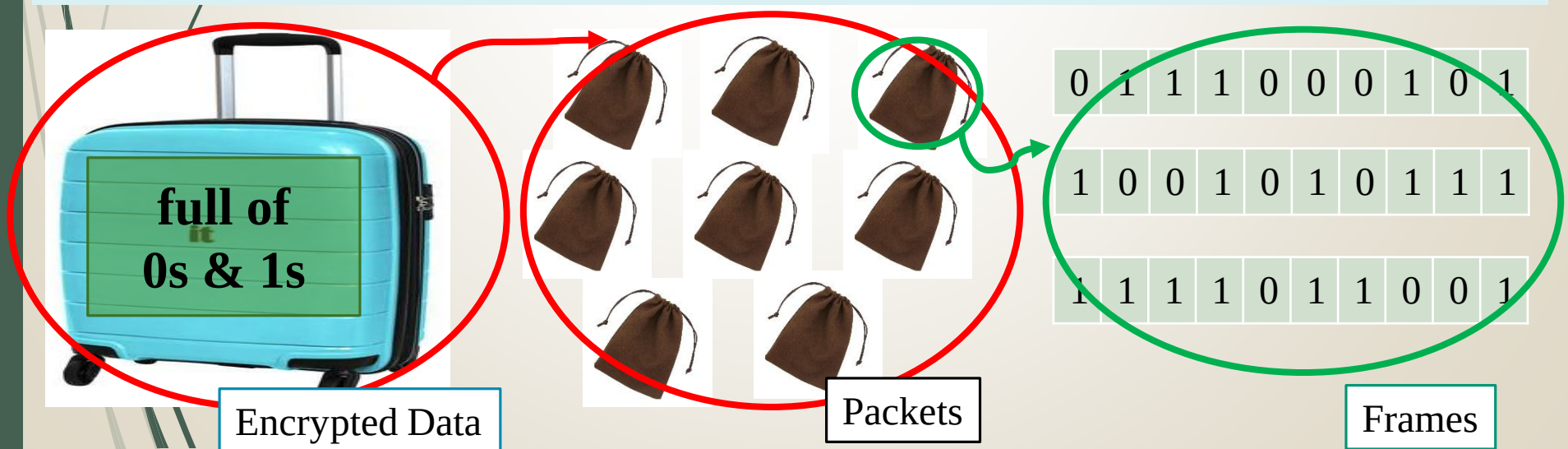
►**Logical Addressing:** The sender & receiver's IP address are placed in the header by network layer. Such an address distinguishes each device uniquely and universally and helps the packets to reach its destination.

ISO/OSI Protocol Model

Data Link Layer (DLL) (2nd Layer)

The data link layer is responsible for the node to node delivery of the message. The main function of this layer is to make sure data transfer is error-free from one node to another, over the physical layer.

The packet received from network layer is further divided into frames depending on the frame size of NIC(Network Interface Card). To do that, DLL adds the MAC address of both the receiver and the sender.



ISO/OSI Protocol Model

Data Link Layer (DLL) (2nd Layer) continued…….

The functions of the data Link layer are :

►**Framing:** Making series of 0s and 1s is called framing. During frame making, DLL attaches special bit patterns to the beginning and end of a frame.

►**Physical addressing:** After framing, DLL adds MAC address of sender and/or receiver in the header of each frame.

►**Error control:** DLL uses a mechanism of error control in which it detects and retransmits damaged or lost frames.

►**Flow Control:** The data rate must be constant on both sides else the data may get corrupted and DLL uses flow control to take care of that.

►**Access control:** When a single communication channel is shared by multiple devices, DLL uses MAC to determine which device has control over the channel at a given time.

ISO/OSI Protocol Model

Physical Layer (1st Layer)

The lowest layer of the OSI model is the physical layer. This layer is responsible for the actual physical connection between the devices. The physical layer contains information in the form of **bits.** It is responsible for transmitting individual bits from one node to the next. When receiving data, this layer will get the signal received and convert it into 0s and 1s and send them to the data link layer, which will put the frame back together.

Hub, Repeater, Modem, Cables are physical layer devices.

Switch and Network Bridge are data link layer devices.

Router and High Performance Switches are network layer devices.

ISO/OSI Protocol Model

Physical Layer (1st Layer) continued…….

The functions of the physical layer are :

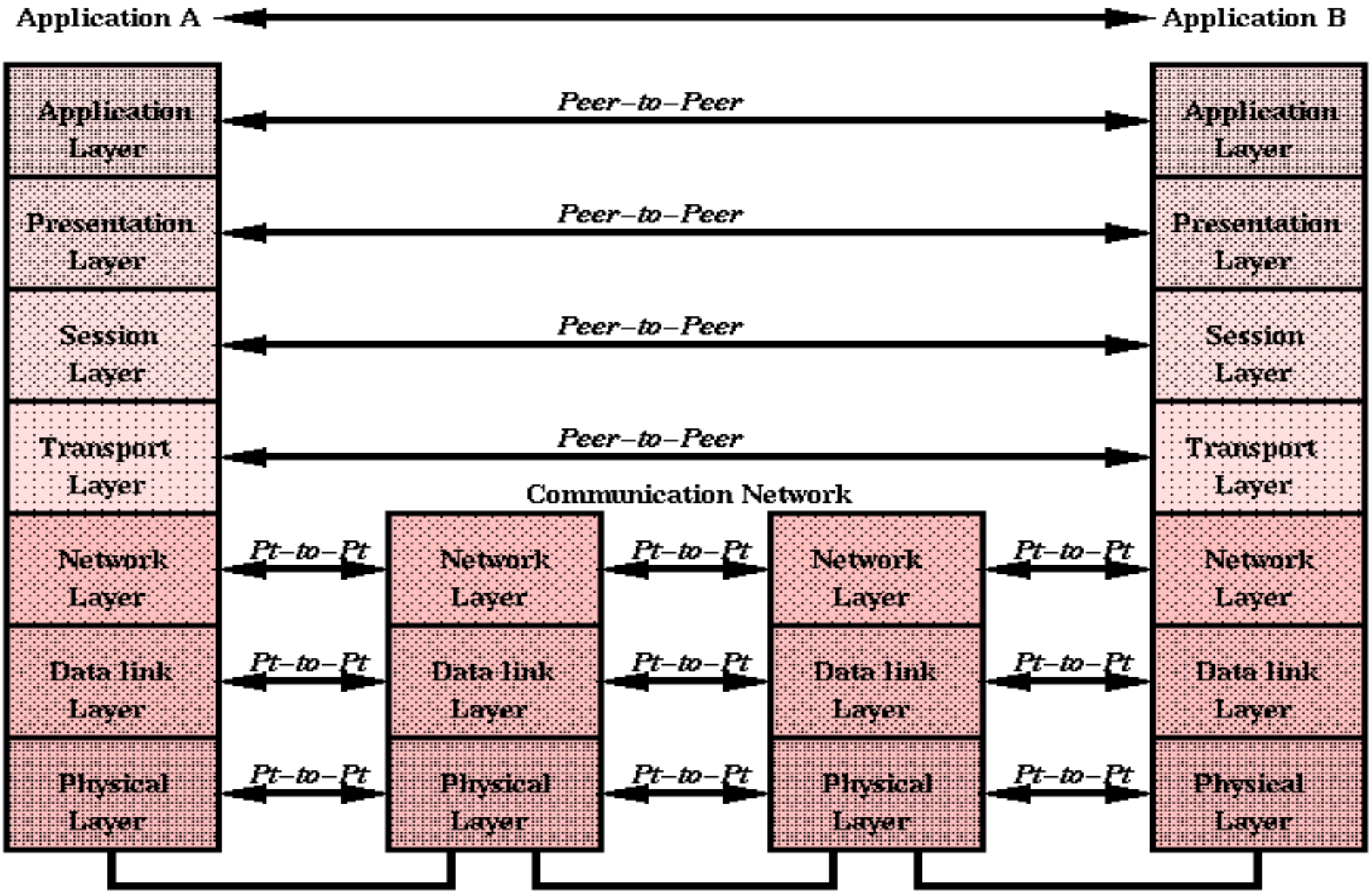
►**Bit synchronization:** The physical layer provides the synchronization of the bits by providing a clock at both sender and receiver ends.

►**Bit rate control:** The physical layer also defines the transmission rate as the number of bits sent per second.

►**Physical topologies:** Physical layer specifies the way in which the different, devices/nodes are arranged in a network i.e. bus, star or mesh topology.

►**Transmission mode:** Physical layer also defines the way in which the data flows between the two connected devices. The various transmission modes possible are: Simplex, half-duplex and full-duplex.

ISO/OSI Protocol Model



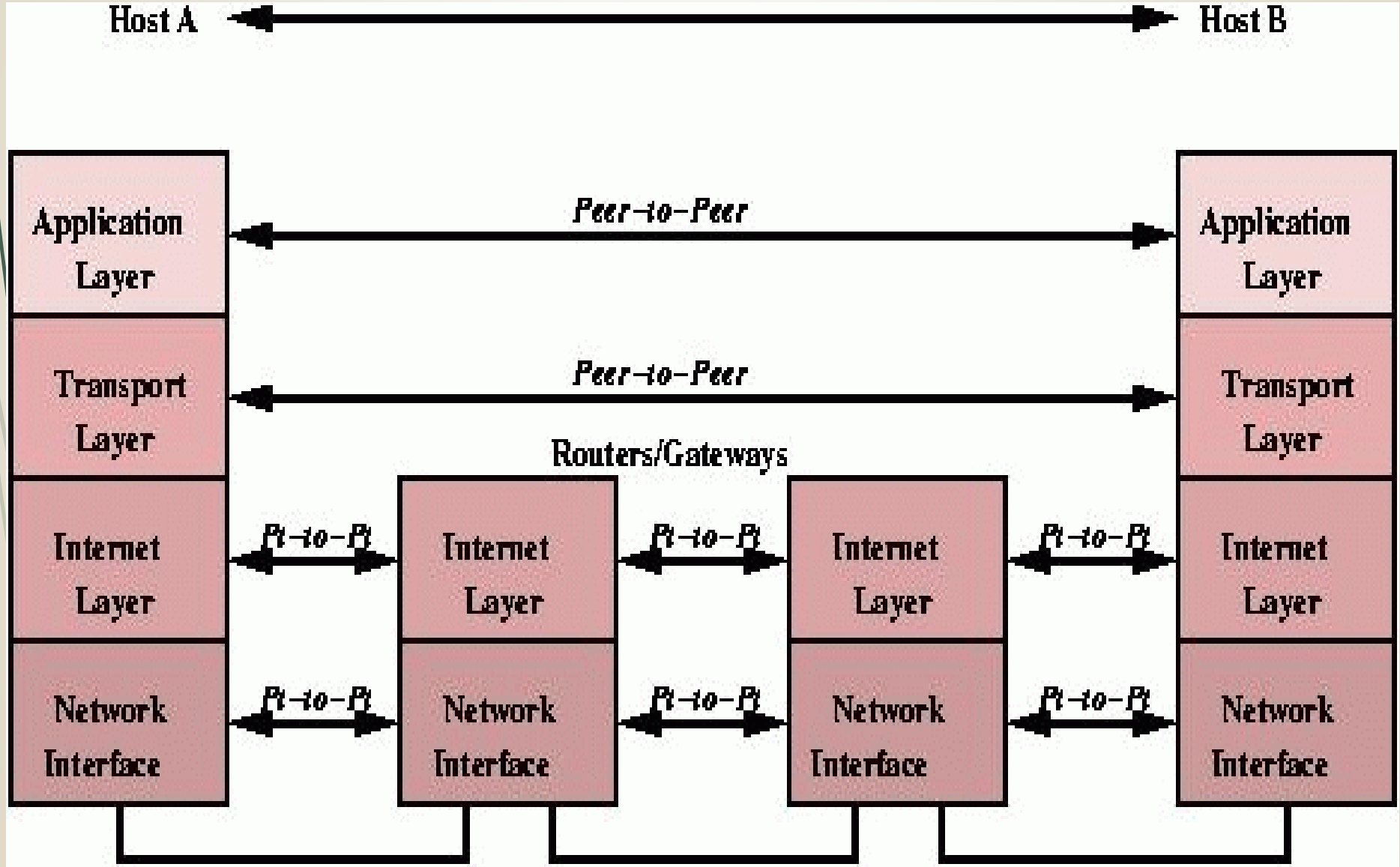
TCP/IP Model

TCP/IP model was designed and developed by Department of Defense (DOD) of USA in 1960s and is based on standard protocols. It stands for Transmission Control Protocol/Internet Protocol. The TCP/IP model is a concise version of the OSI model. It contains four layers (working over the physical layer), unlike seven layers in the OSI model.

The layers are:

- ►Application Layer (Process)
- ►Transport Layer (Host to Host)
- ►Internet Layer (Like the Network Layer)
- ►Network Access or Interface (Like the Data Link Layer)

TCP/IP Model


Host A
Host B
Application Layer
Peer-to-Peer
Application Layer
Transport Layer
Peer-to-Peer
Transport Layer
Routers/Gateways
Internet Layer
Pt-to-Pt
Internet Layer
Pt-to-Pt
Internet Layer
Pt-to-Pt
Internet Layer
Network Interface
Pt-to-Pt
Network Interface
Pt-to-Pt
Network Interface
Pt-to-Pt
Network Interface

TCP/IP Model

Application Layer

This layer performs the functions of top three layers of the OSI model: Application, Presentation and Session Layer. It is responsible for node-to-node data communication and controls user-interface specifications. (*Include all the top 3 layer functions from OSI here*)

Transport or Host to Host Layer

This layer is analogous to the transport layer of the OSI model. It is responsible for end-to-end communication and error-free delivery of data. It shields the upper-layer applications from the complexities of data. (*Just write down the functions of transport layer of OSI model here*)

TCP/IP Model

Internet Layer

This layer performs somewhat like the Network Layer of OSI model. It chooses it own protocols which are responsible for logical transmission of data over the entire network. It finds a route to reach its packet's destination and put appropriate IP address on packet header so that the packet reaches its receiver.

Network Access Layer or Network Interface

This layer is the combination of Data Link Layer and Physical Layer of the OSI model. (*Just write down the functions of data link layer and physical layer of OSI model here*)

IP Address or IP Number

An Internet Protocol address is also known as IP address. This address is actually like a numerical label which is assigned to each device connected to a computer network where IP is required for communication.

IP address act as an identifier for a specific machine on a particular network. IP address specifies the technical format of the addressing and packet routing scheme.

Currently there are two types of IP addressing schemes. They are:

I. IPv4
II. IPv6

IP Address or IP Number

IPv4

IPv4 was the first version of IP. It was deployed for networking in the ARPANET in 1983. Today it is most widely used IP version. It is used to identify devices on a network using an addressing system. The IPv4 uses a 32-bit address scheme allowing to store 2^32 addresses which is more than 4 billion addresses. Till date, it is considered the primary Internet Protocol and carries 94% of Internet traffic.

In Decimal	Any of 0 to 255	Any of 0 to 255	Any of 0 to 255	Any of 0 to 255
In Binary	0 to 1111 1111	0 to 1111 1111	0 to 1111 1111	0 to 1111 1111

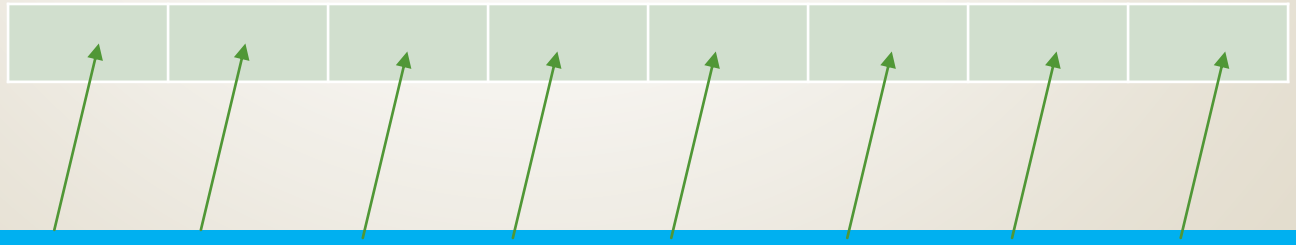
A total of 4.2 Billion

IP Address or IP Number

IPv6

It is the most recent version of the Internet Protocol. Internet Engineer Taskforce initiated it in early 1994. The design and development of that suite is now called IPv6.

This new IP address version is being deployed to fulfill the need for more Internet addresses. It was aimed to resolve issues which are associated with IPv4. With 128-bit address space, it allows 340 undecillion unique address space. IPv6 also called IPng (Internet Protocol next generation).



Any Hexadecimal number between 0000 to FFFF

IPv4 vs. IPv6

IPv4 VS IPv6

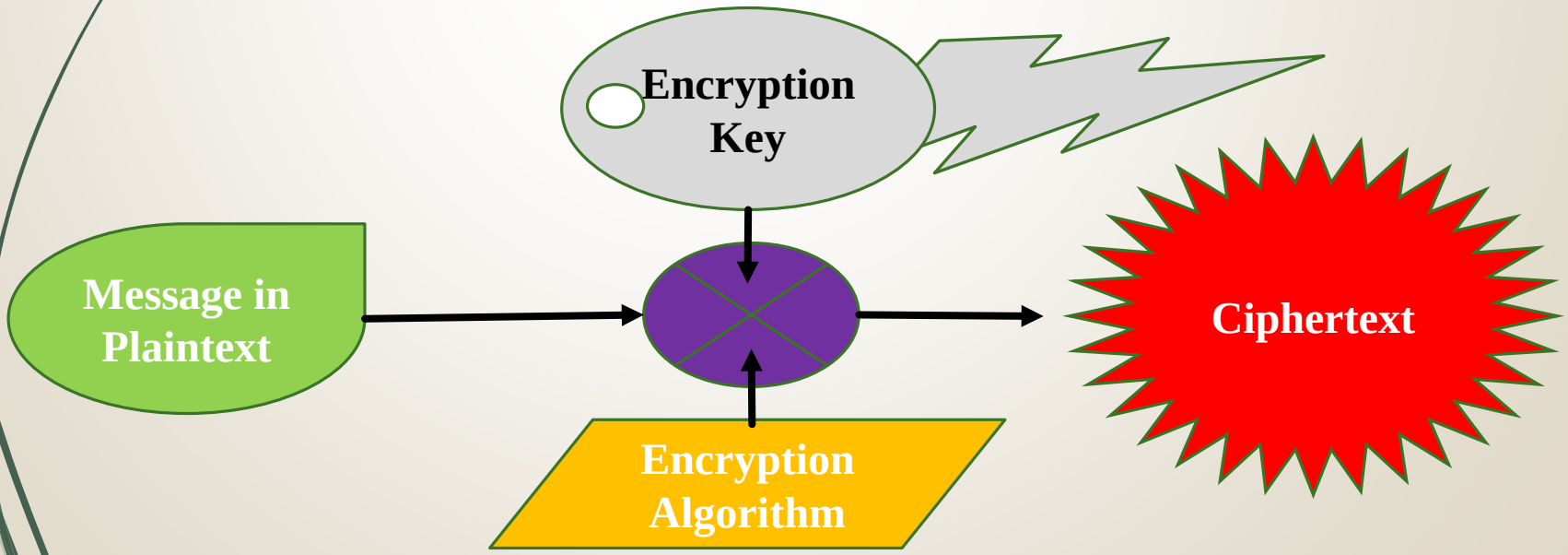
Example: 127.255.255.255

Example:
2001:0db8:85a3:0000:0000:8a2e:0370:7334

Encryption

Encryption is the method by which information is converted into secret code that hides the information's true meaning. The science of encrypting and decrypting information is called cryptography.

In computing, unencrypted data is also known as plaintext, and encrypted data is called ciphertext. The process of converting a plaintext into ciphertext is called encryption.



Stay Home, Stay Safe

Always put on a mask when you are in public!