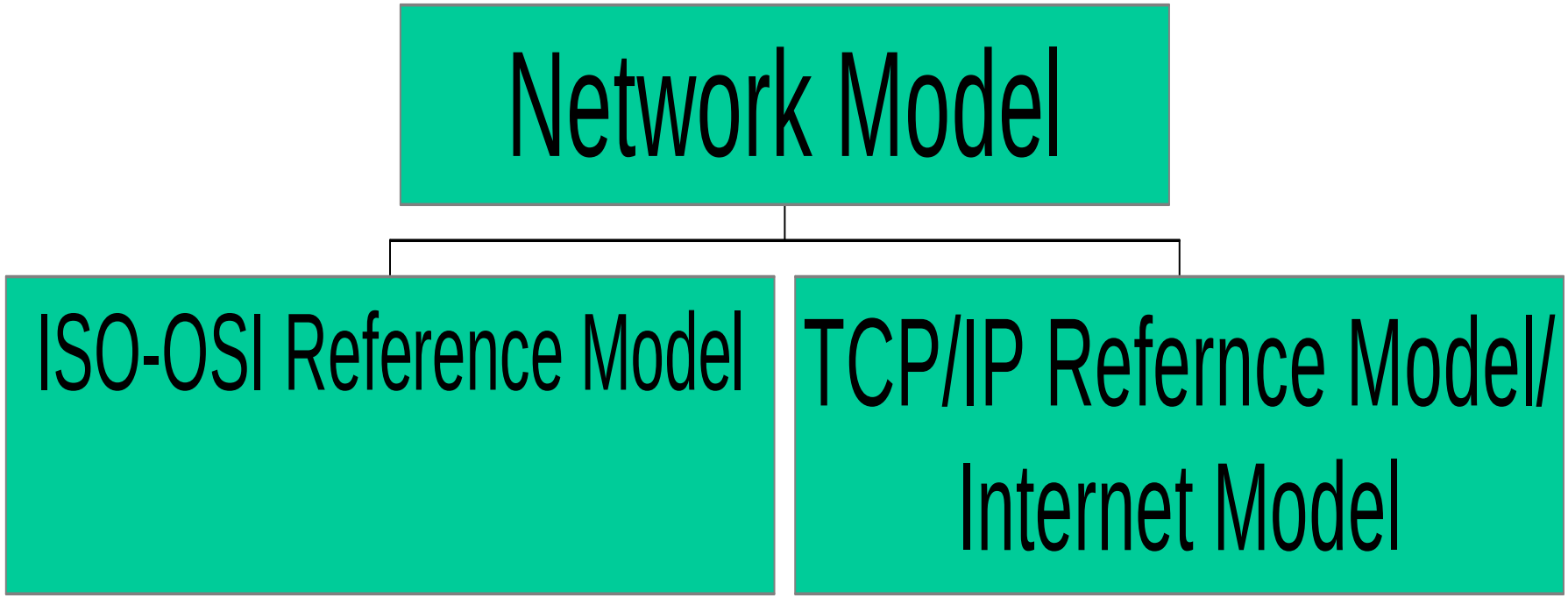
F.Y.M.Sc.(Computer Applications)
Semester - II
CSA4204
Networking Concepts
Unit – II
Network Models
Notes

Unit II. Network Models

- OSI Reference Model – functionality of each layer
- TCP/IP model – Introduction to IP, TCP and UDP, TCP/IP protocol suite
- Addressing – Physical, Logical and Port addresses

Network Model

Network Model is conceptual structure which shows how various parts are fit together and work together to transmit data.



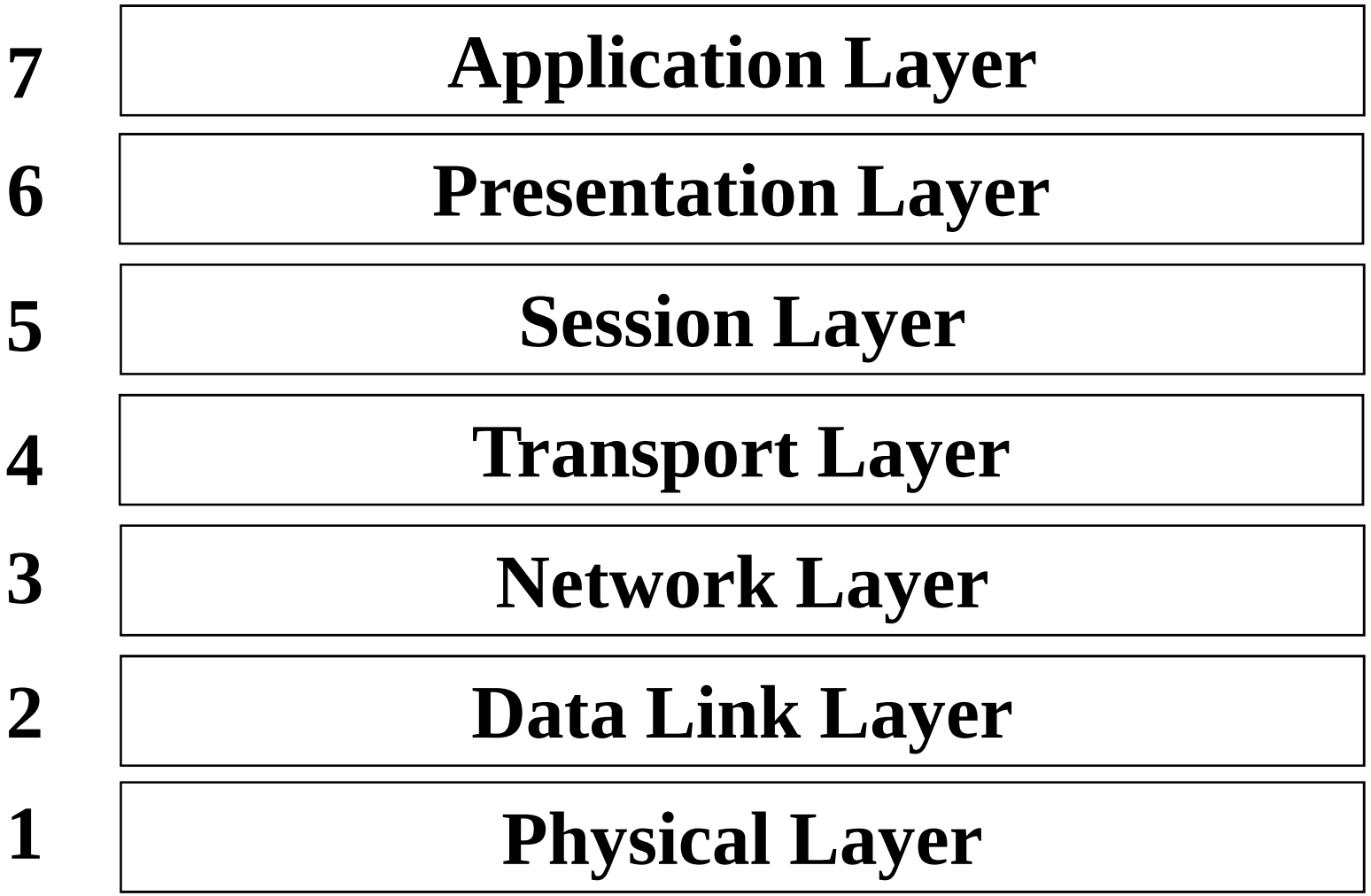
ISO-OSI Reference Model

- ISO is International Standards Organization developed in 1947. It is multinational body dedicated to worldwide agreement on international standards
- An ISO standard that covers all aspects of network communication is the Open System Interconnection (OSI) model. First introduced in the late 1970s.
- An open system is a set of protocols that allows any two different systems to communicate regardless of their underlying architecture.
- Purpose – To show how to facilitate communication between different systems without requiring changes to the logic of the underlying hardware and software.

ISO-OSI Reference Model

- Model is not protocol; it is a model for understanding and designing a network architecture that is flexible, robust and interoperable.
- The designing of the OSI model is based on the proposal developed by ISO as first step towards international standardization of protocol used in various layers.
- OSI model is layered framework for the design of network systems that allows communication between all types of computer systems.
- Consists of 7 separate but related layers, each of which defines a part of the process of moving information across a network.

ISO-OSI Reference Model

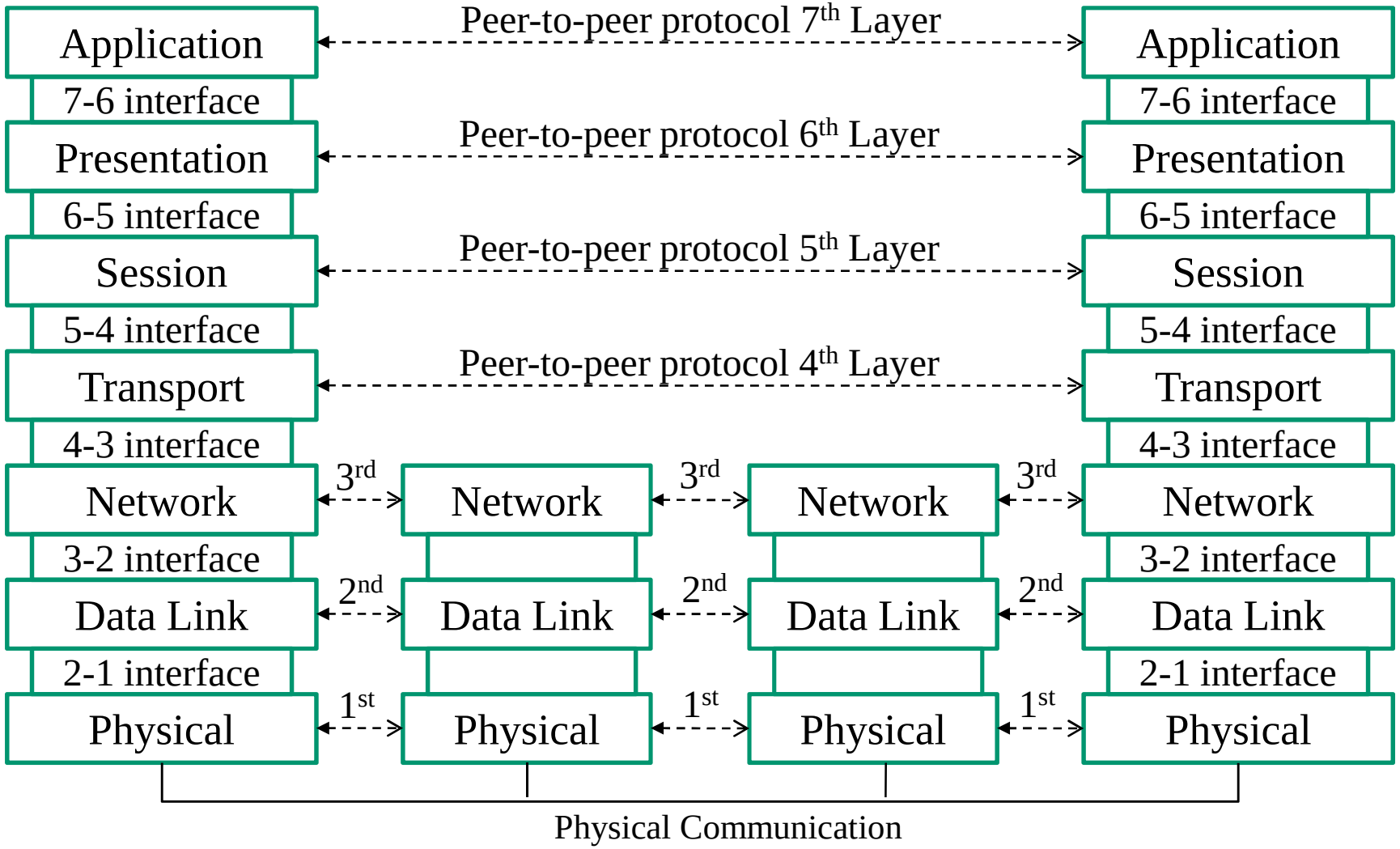


ISO-OSI Reference Model

- Layered Architecture
  - In developing model, the designers identified which networking functions had related uses and collected those functions into discrete groups that became the layers.
  - Each layer defines a family of functions distinct from those of the other layers.
  - The OSI model allows complete interoperability between otherwise incompatible system.
  - Within a single machine, each layer calls upon the services of the layer just below it. Layer 3, uses the services provided by layer 2 and provides services for layer 4.
  - Between machines, layer *x* on one machine communicates with layer *x* on another machine.
  - The processes on each machine that communicate at a given layer are called peer-to-peer processes.

ISO-OSI Reference Model

- Peer-to-Peer Processes



ISO-OSI Reference Model

- Peer-to-Peer Processes
  - At the physical layer, communication is direct: device A sends a stream of bits to device B.
  - At the higher layers, communication must move down through the layers on device A, over to device B and then back up through the layers.
  - Each layer in the sending device adds its own information to the message it receives from the layer just above it and passes the whole packages to the layer just below it.
  - At layer 1 the entire package is converted to a form that can be transmitted to the receiving device.
  - At the receiving machine, the message is unwrapped layer by layer, with each process receiving and removing the data meant for it.

Interface Between Layers

- In OSI network model the interface is achieved between each pair of adjacent layers.
- Each interface defines the information and services a layer must provide for the layer above it.
- Well-defined interfaces and layer functions provide modularity to a network.
- As long as the layer provides the expected services to the layer above it, the specific implementation of its functions can be modified or replaced without requiring changes to surrounding layers.

Organization of Layer

- In 7 layered OSI model layers 1, 2 and 3 are the network support layers. They deal with the physical aspects of moving data from one device to other.
- Layers 5,6,7 are acts as user support layers. They allows interoperability between unrelated software systems.
- Layer 4, the transport layer, links the two subgroups and ensures that what the lower layers have transmitted is in a form that the upper layers can use.
- Upper layer OSI layers are almost software dependent. Lower layer models are combination of hardware and software except for the physical layer which is mostly hardware related.

Encapsulation

- A packet (header and data) at level 7 is encapsulated in a packet at level 6. The whole packet at level 6 is encapsulated in a packet at level 5 and so on.
- The data portion of a packet at level N-1 carries the whole packet (data and header and may be trailer) from level N. Concept is encapsulation; level N-1 is not aware of which part of encapsulated packet is data and which part is the header or trailer.
- For level N-1, the whole packet coming from level N is treated as integral unit.

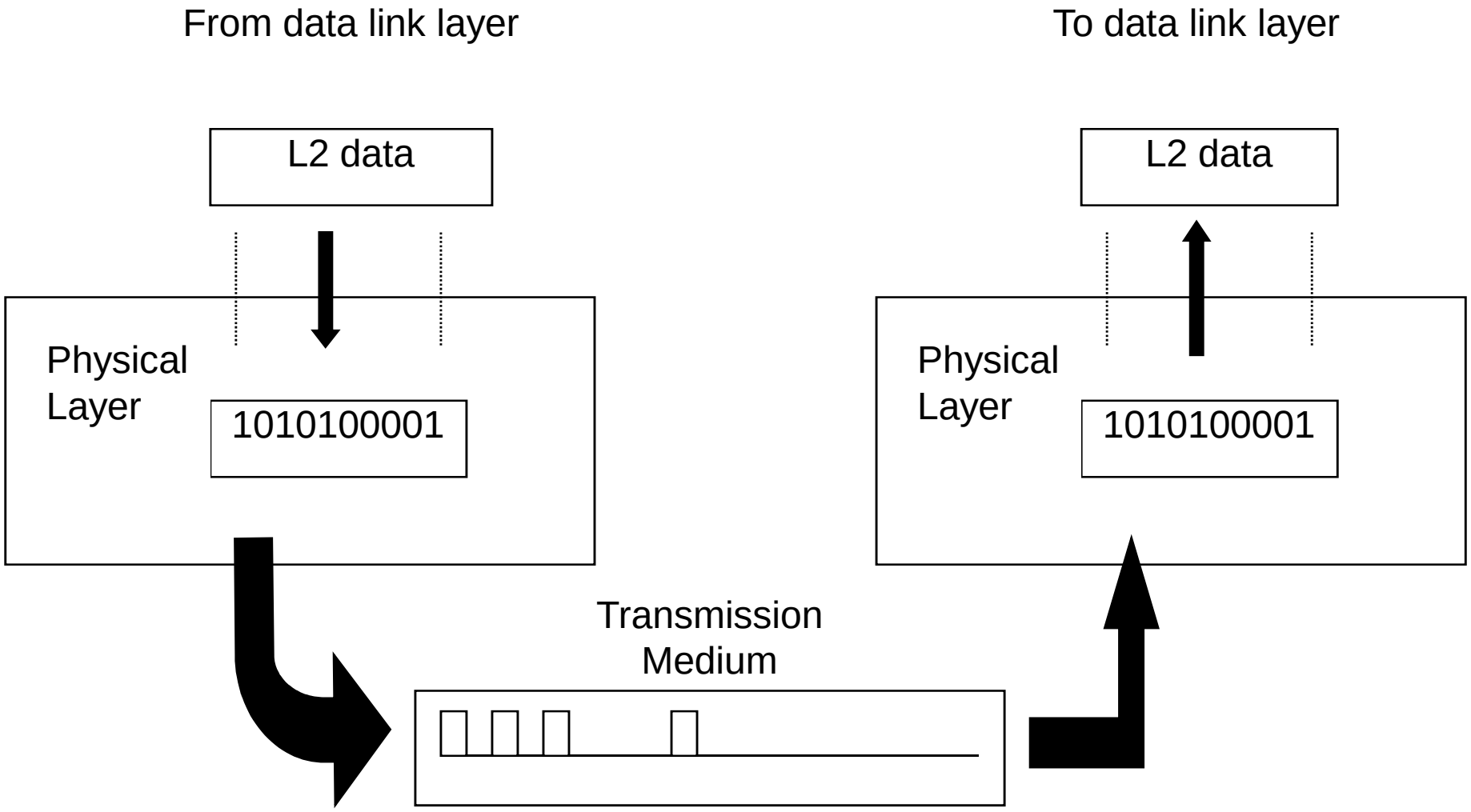
Physical Layer

- To transmit a bit stream over a physical medium.
- Deals with mechanical and electrical specification of interfaces and transmission medium.
- Defines procedure and function that physical devices and interfaces have to perform for transmission to occur.
- Physical characteristics of Interfaces
  - Defines characteristics of interface between device and transmission medium. Type of transmission medium.
- Representation of bits
  - Data consists of a stream of bits (sequence of 0s or 1s) with no interpretation. To be transmitted bits, must be encoded into signals- electrical or optical. Defines the type of encoding.

Physical Layer

- Data rate
  - Transmission rate- the number of bits per second
- Synchronization of bits
  - Sender and receiver not only must use the same bit rate but also must be synchronized. The sender and receiver clocks must be synchronized.
- Line Configuration
  - Point-to-point, two devices are connected through dedicated link. Multipoint, a link is shared among several devices.
- Physical Topology
  - How to connect devices in network
- Transmission mode
  - Simplex, Half Duplex, Full Duplex

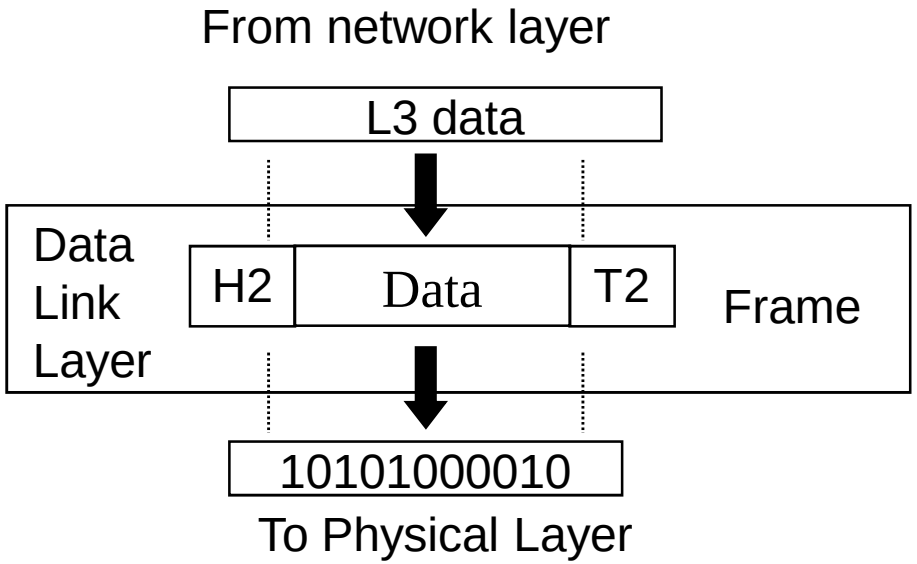
Physical Layer

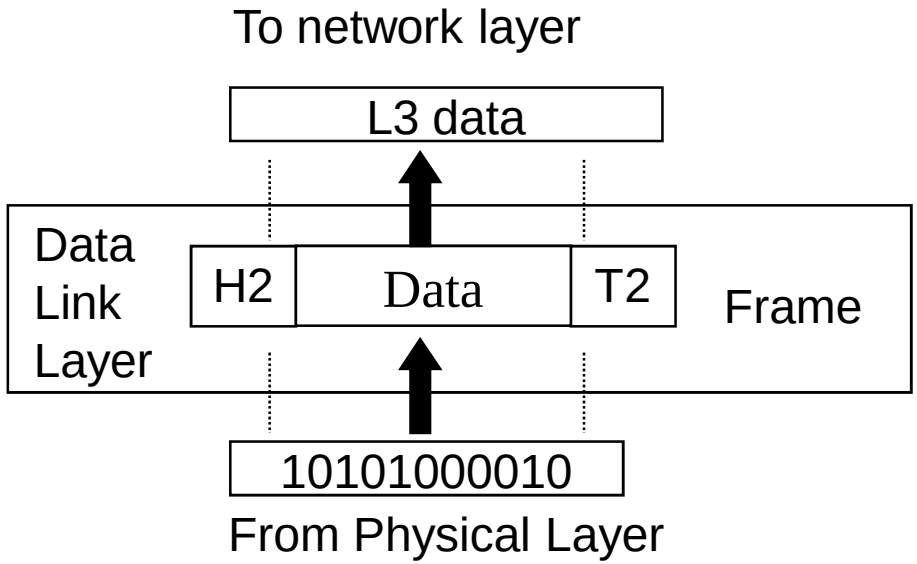


Data Link Layer

- Responsible for node-to-node delivery of frames. It makes physical layer appear error free to the upper layer.
- **Framing**
  - Divides stream of bits received form network layer into manageable data units called Frames.
- **Physical Addressing**
  - When frames are send over a network it is required to add header containing source and destination address.
- **Flow Control**
  - The rate at which data is absorbed by the receiver.
- **Error Control (Trailer)**
  - Adding mechanism to detect and retransmit damaged or lost frame
- **Access Control**
  - To determine which device has control over link at any given time.

Data Link Layer

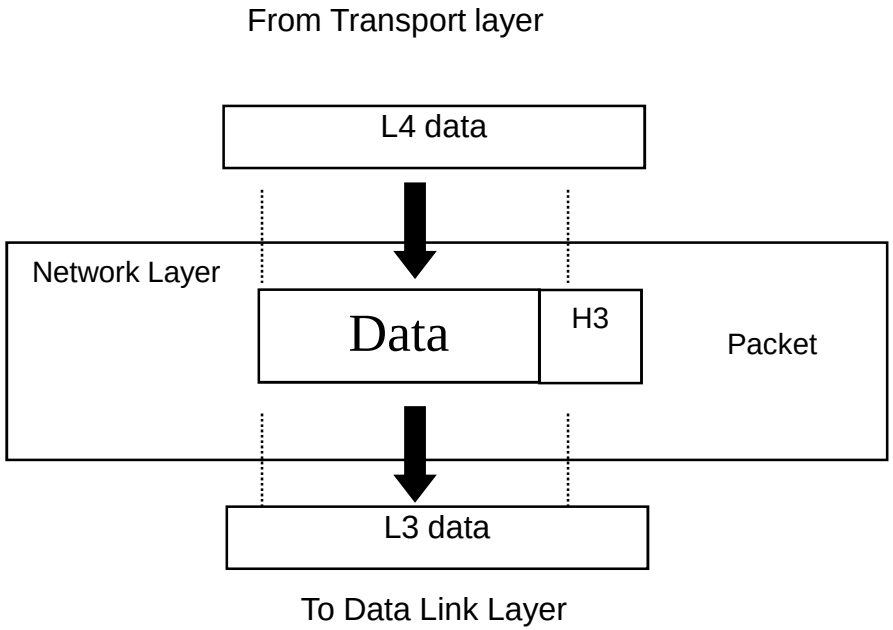


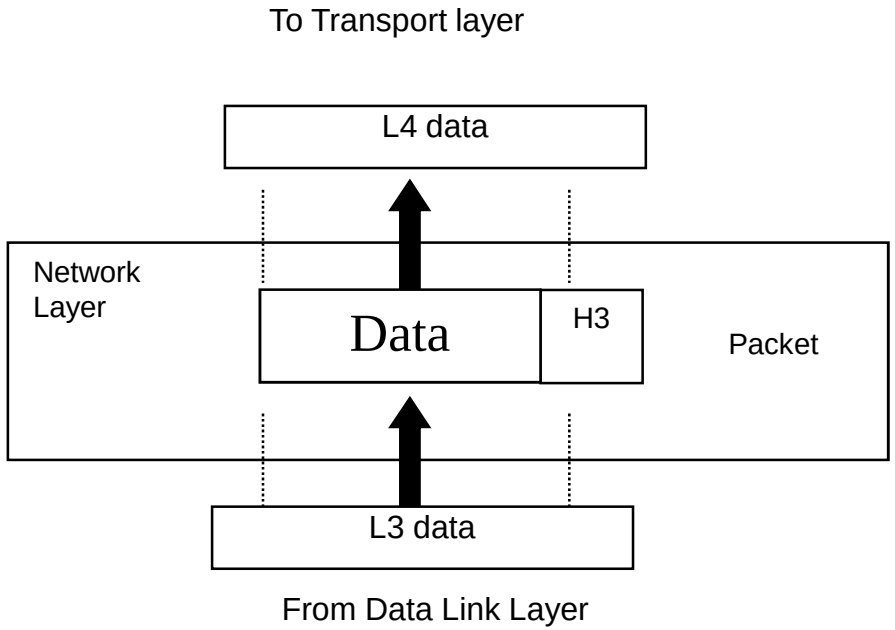


Network Layer

- Responsible for the source-to-destination delivery of packet across multiple networks (links).
- If two systems are connected to same link, no need of network layer. If systems in different networks (links) then need to implement network layer to accomplish source-to-destination delivery.
- Logical Addressing
  - To handle addressing problems over network logical addressing scheme is used.
- Routing
  - When independent networks or link are connected proper path selection should be achieved.

Network Layer





Transport Layer

- Responsible for process-to-process delivery of entire message. Process is an application program running on host. Treats each message independently.
- Ensures whole message arrived in order and an error free
- Security: implements connection between source and destination. Connection implementation involves: connection establishment, data transfer and connection release.
- Other issues are:

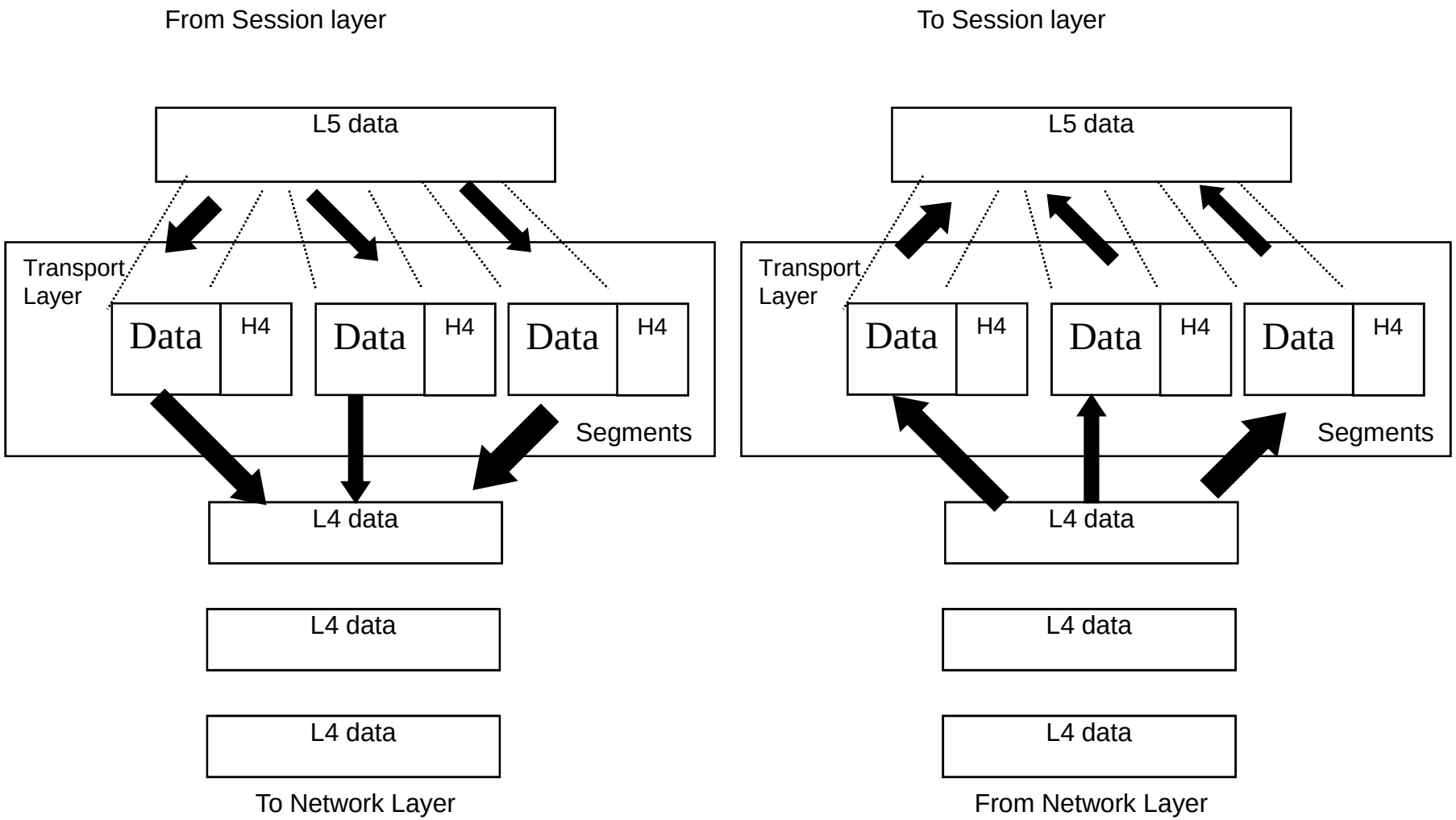
Transport Layer

- Service Point Addressing
  - Computer runs several processes (running program) at same time. So transport layer makes delivery from one running process to other running process. So it adds service point address (Port Address) to header.
- Segmentation and reassembly
  - A message is divided into transmittable segments. Sequence number is with segment, which helps to reassemble segments.

Transport Layer

- Connection Control
  - Connectionless or connection oriented. Connectionless: segment is treated independently and deliver to transport layer of destination
  - Connection oriented: after establishing connection, data is transfer and then connection is terminated.
- Flow Control
  - Here flow control is done end-to-end rather across a single link.
- Error Control
  - Here error control is done end-to-end rather across a single link.

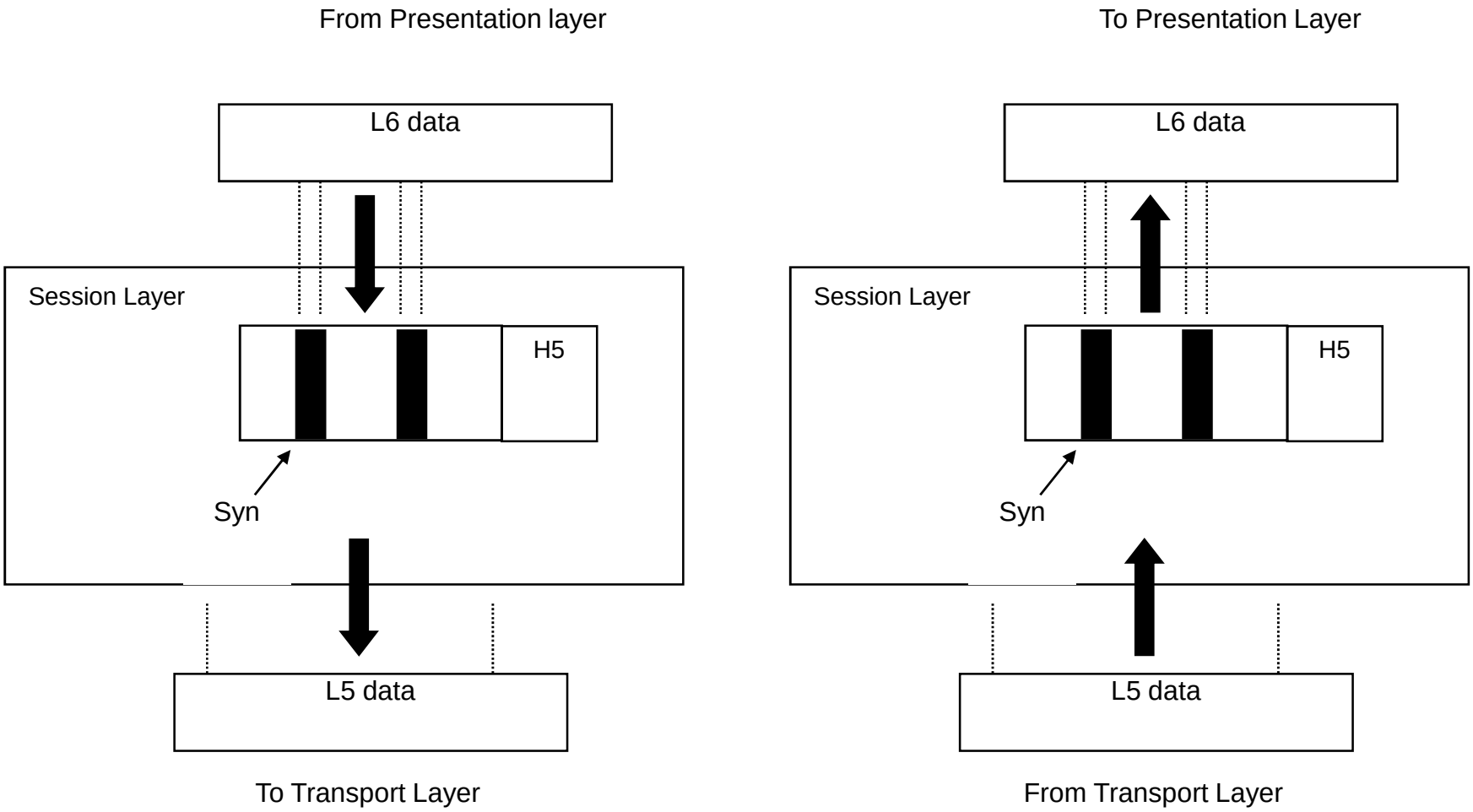
Transport Layer



Session Layer

- It is a network *dialog controller*. It establishes, maintains and synchronizes the interaction between communicating system.
- Dialog Control
  - Allows two systems to enter into a dialog. Allows communication between two processes to take place either half or full duplex.
- Synchronization
  - Allows a process to add checkpoints into a stream of data

Session Layer



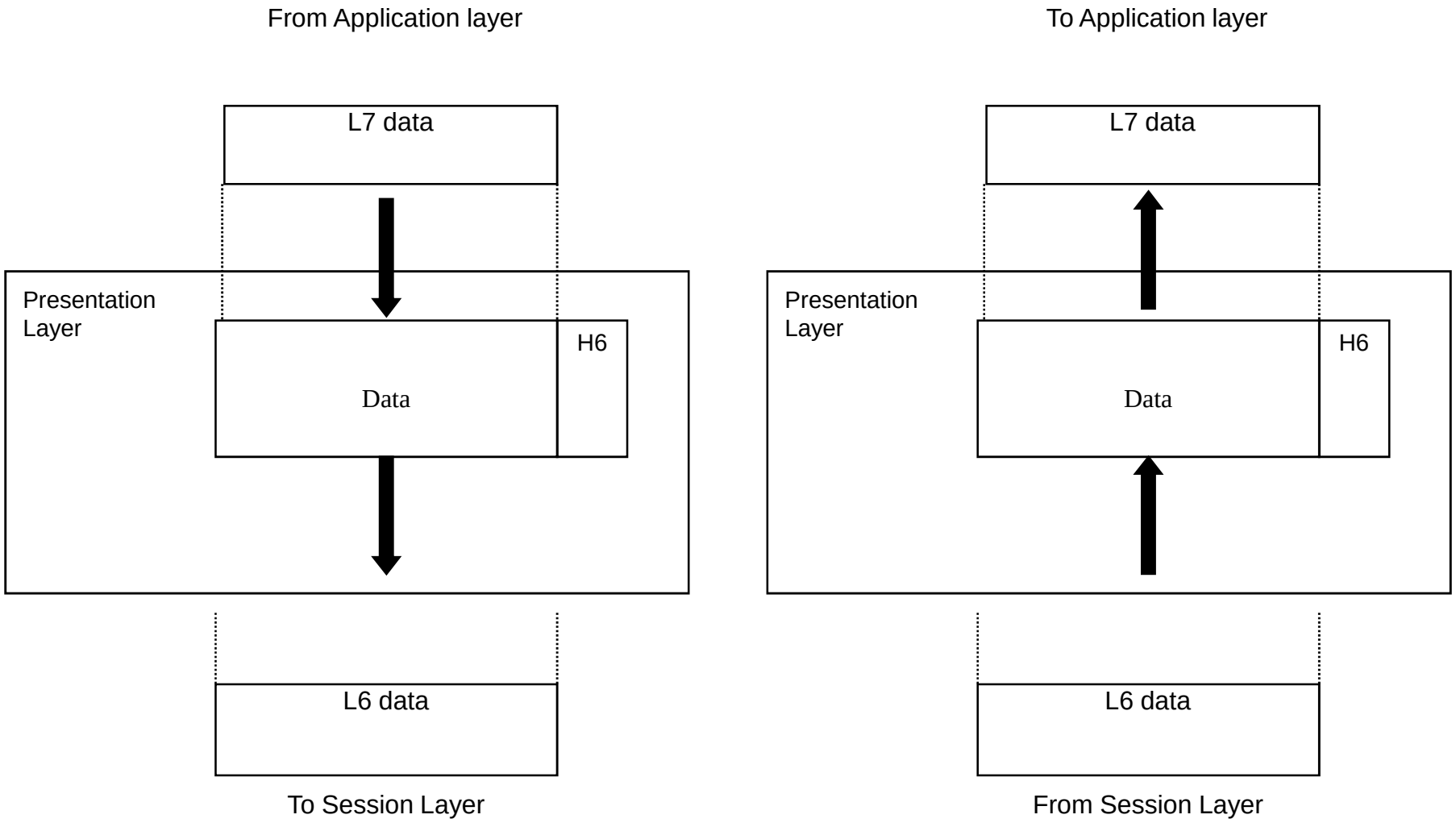
Presentation Layer

- Concerned with the syntax and semantics of the information exchanged between two systems.
- Translation
  - Exchange information: characters, numbers and so on.
  - Information must be changed to bit streams before transmitting using encoding techniques.
  - Different encoding schemes are used. So presentation layer changes sender information in sender-dependent format whereas on receiver side in receiver-dependent format.

Presentation Layer

- Encryption and Decryption
  - To carry sensitive information, privacy is important. Encryption means that the sender transforms the original information to another form and sends the resulting message out over the network. Decryption reverses the original process to transform the message back to its original form.
- Compression
  - Reduces the number of bits contained in the information. It is required in case of transmission of multimedia such as text, audio and video.

Presentation Layer



Application Layer

- Enables user , whether human or software to access the network.
- Provides user interfaces and support for services like electronic mail, remote file access and transfer, shared DBMS and other distributed type of applications.
- Other Issues

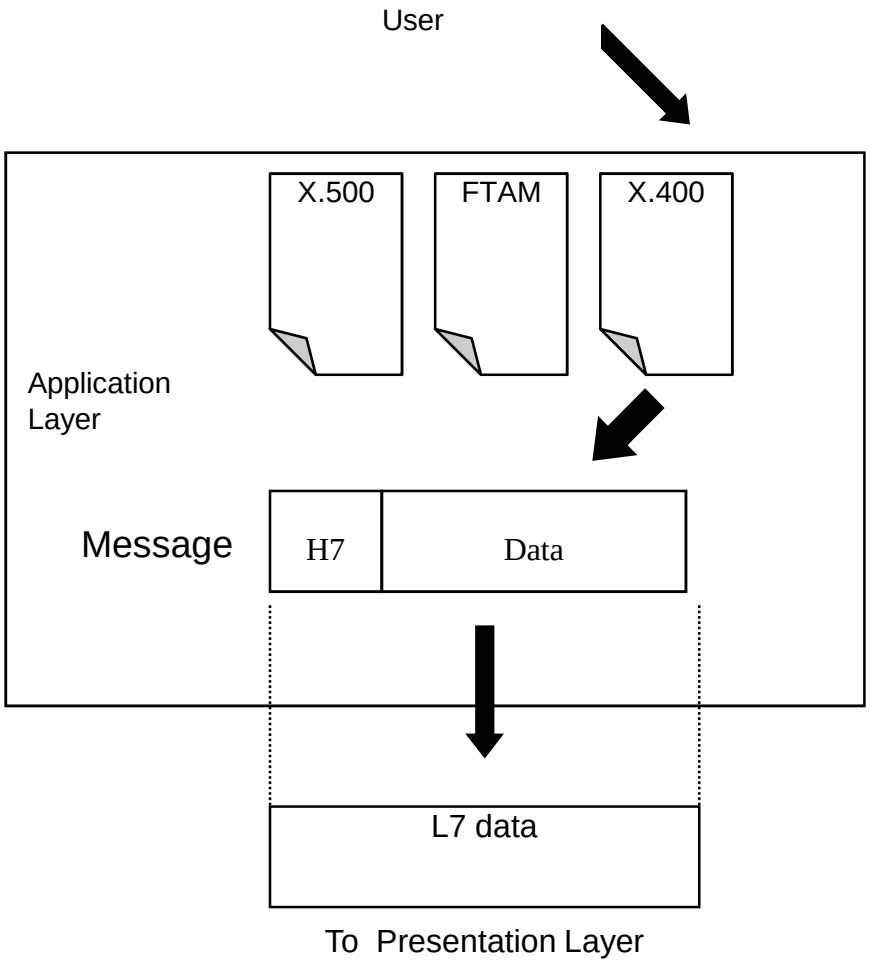
Application Layer

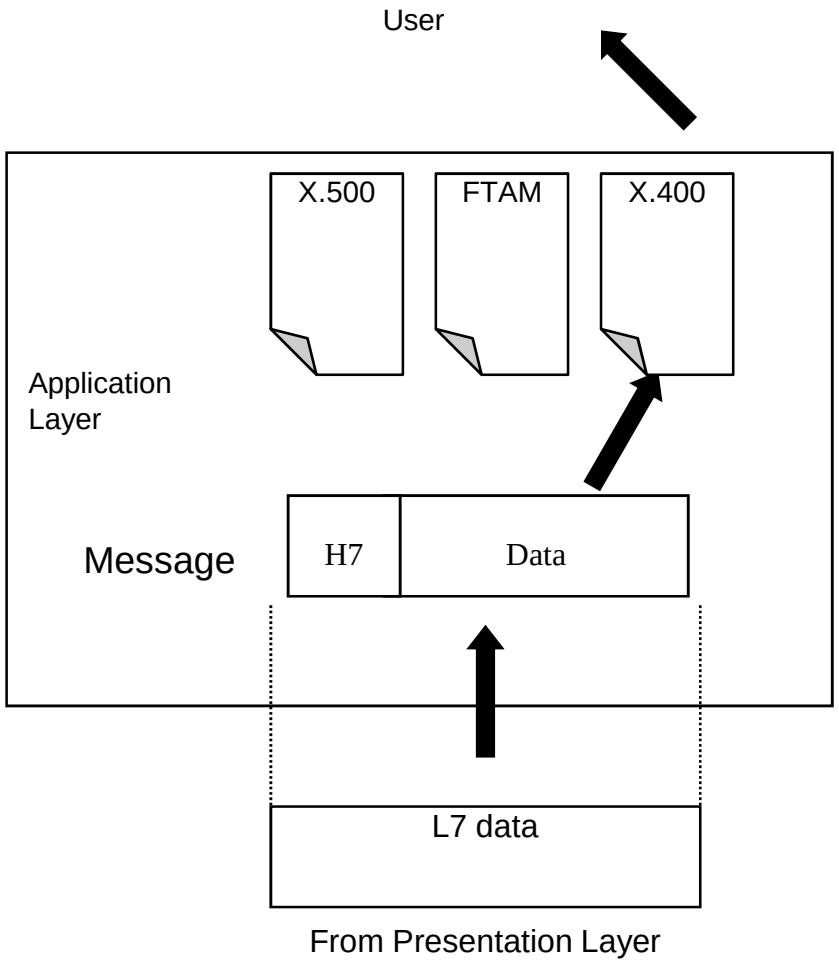
- Network Virtual Terminal
  - Is software version of physical terminal which allows user to log on to a remote host.
  - The user's computer talks to software terminal, which in turns, talks to host, and vice versa.
- File Transfer, access and Management (FTAM)
  - Allows user to access files in remote host (to make changes or read data), to retrieve files from remote computer for use in local computer and to manage or control other issues.

Application Layer

- Mail Services
  - Provides the basis for email forwarding and storage.
- Directory Services
  - Provides distributed database sources and access for global information about various objects and services.

Application Layer

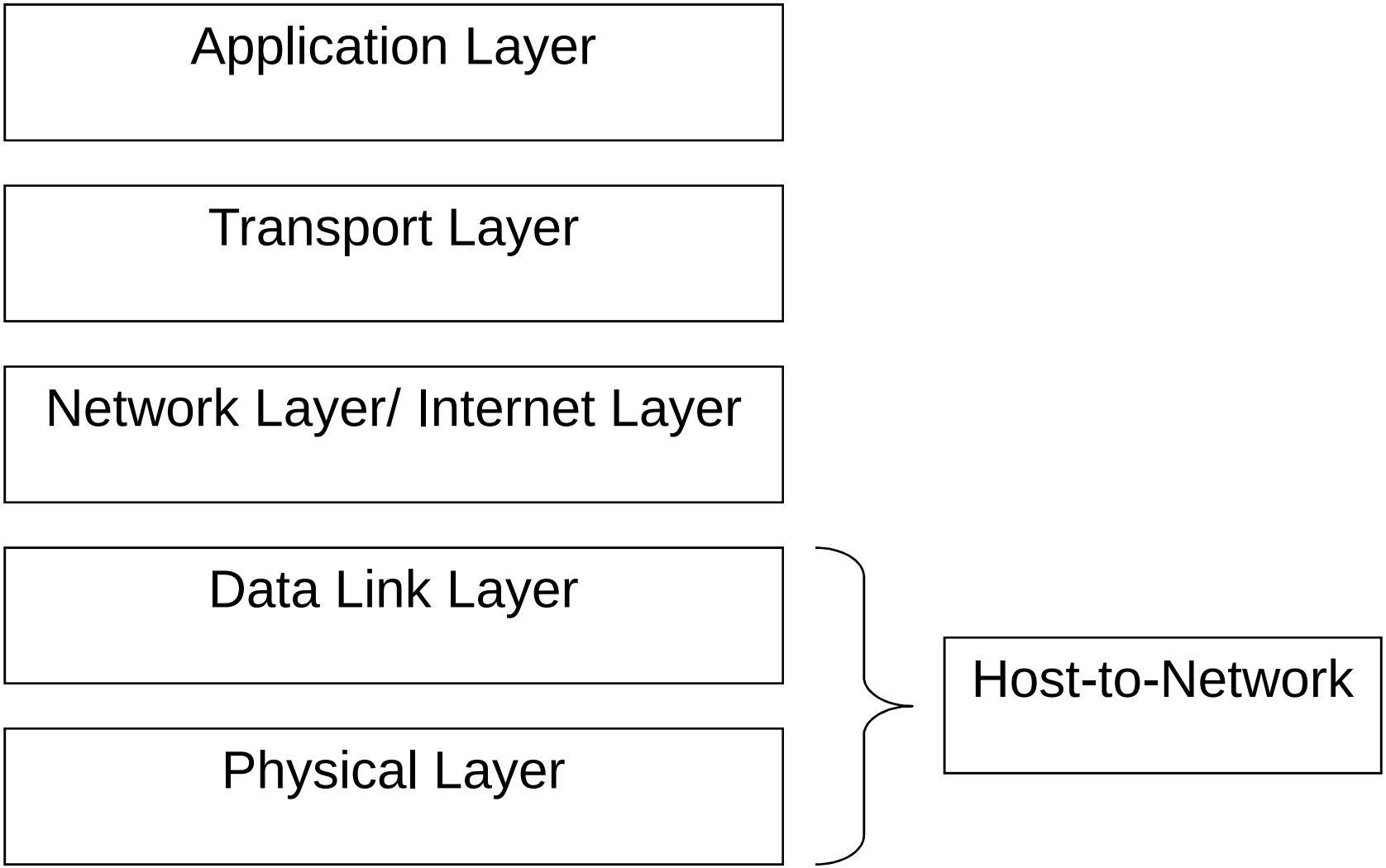




Internet Model (TCP/IP)

- ARPANET: Grandparent of computer networks and worldwide Internet.
- ARPANET was research network sponsored by DOD (Department of Defense).
- It eventually connected universities and government installations using leased telephone lines.
- When satellite and radio networks gets added there is need of new architecture.
- Goal: to connect multiple networks together in seamless way. Architecture is TCP/IP.

TCP/IP Model


Application Layer
Transport Layer
Network Layer/ Internet Layer
Data Link Layer
Physical Layer
Host-to-Network

TCP/IP Model

- The model is composed of five ordered layers:
  - Physical Layer (Layer 1)
  - Data Link Layer (Layer 2)
  - Network Layer (Layer 3)
  - Transport Layer (Layer 4)
  - Application Layer (Layer 5)
- At the time of transmitting messages the message uses intermediate nodes at lower layers.

Organization of Layers

- The lower layers physical layer, data link layer and network layer are the network support layers, deals with physical aspects of moving data from one device to other.
- Layer 5: the upper layer is application –user support layers. Allows interoperability between unrelated software systems.
- Layer 4: links two subgroups and ensures that what lower layers have transmitted in the form the upper layer understand.

Internet Layer

- It is connectionless layer. Its job is to permit hosts to inject packets into any network and have them travel independently to destination (potentially on different network)
- They may arrive in different order than they were sent. It is job of higher layer to rearrange them in order.
- Internet Layer defines an official packet format (datagram) and protocol called IP (Internet Protocol). The job of Internet layer is to deliver IP packets where they are suppose to go.

Transport Layer

- It is designed to allow peer entities on the source and destination hosts to carry on a conversation
- Transport layer of this model deals with two end-to-end protocols.
- TCP (Transmission Control Protocol)
- UDP(User Datagram Protocol)

Application Layer

- It consists of all higher-level protocols. It uses various protocols like: TELNET, SMTP, FTP etc.
- TELNET allows user on one machine to log into distant machine and work there.
- FTP provides a way to move data efficiently from one machine to other.
- SMTP protocol is used for electronic mail facility.
- In addition it provides DNS for mapping host names onto their network addresses and HTTP: World Wide Web.

Host-to-Network Layer

- Layer is developed by combining physical layer and data link layer.
- In addition to OSI model functionality it adds a special protocol which helps to send IP packets over it.

Comparison of OSI and TCP/IP

Issues	OSI	TCP/IP
No. Layer	7	4
Naming Conventions – layer 4	Network Layer	Network / Internet Layer
Naming Conventions – layer 1 and 2	Physical and Data Link Layer	Physical and Data combine to call it as Host-Network Layer
Organization of Layer	Physical, DLL, and Network are hardware and software supporting layers. Session, Presentation and Application User support Layer	Host-to-network and Internet layer are network support layer Application layer (Session + Presentation and Application) is user support layer.
Services	Supports both Connectionless and connection oriented in the network layer, but only connection oriented in the transport layer.	Supports only connectionless in the network layer but both connection oriented and connectionless in transport layer.
Diagrams		

TCP/IP Protocol Suite

- Developed prior to the OSI model. The layers in the TCP/IP protocol suit do not exactly match those in the OSI model.
- The protocol suite was defined as having four layers: host-to-network, internet, transport and application.
- When TCP/IP is compared to OSI we can say that the host-to-network layer is equivalent to the combination of the physical and data link layers.

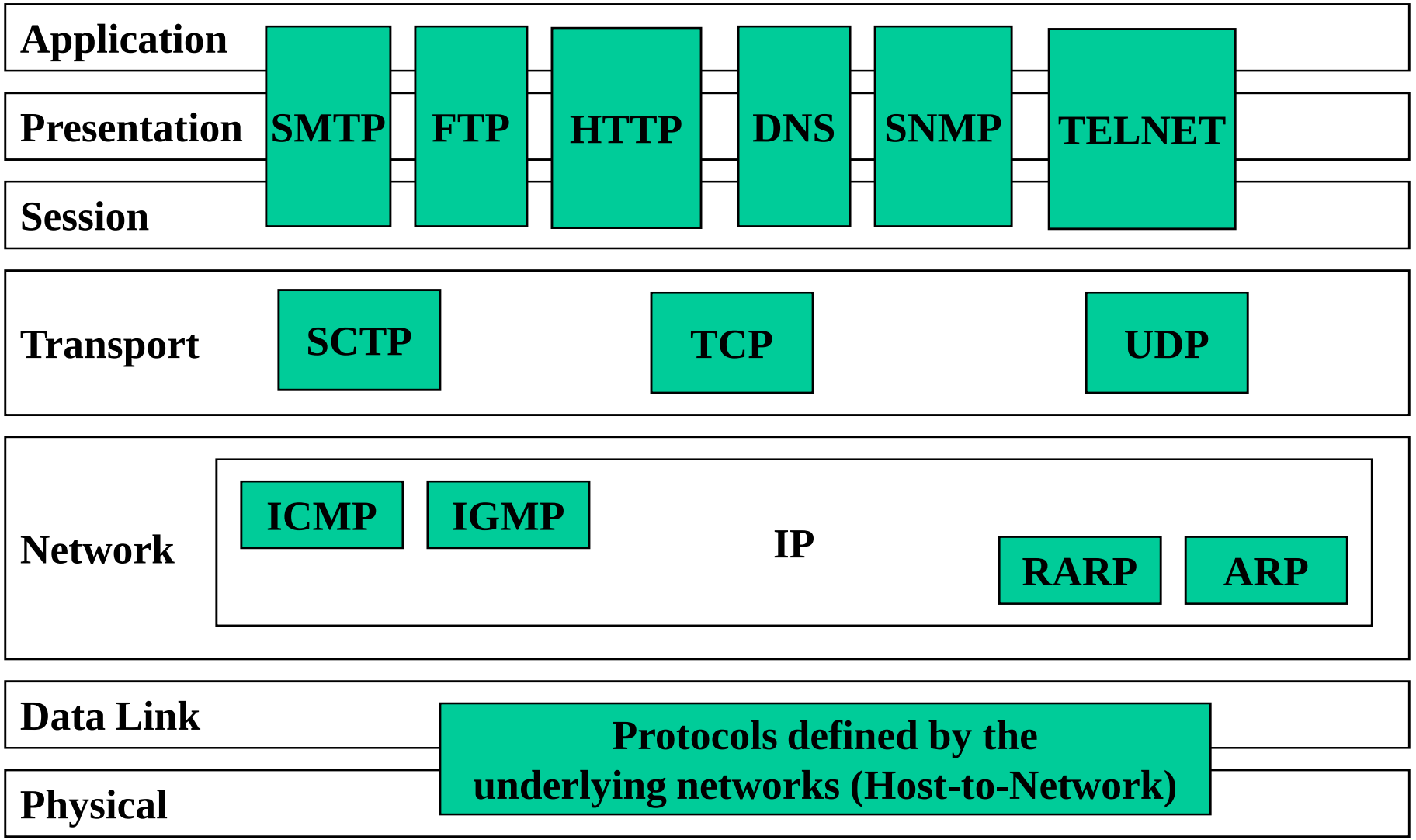
TCP/IP Protocol Suite

- The internet layer is equivalent to the network layer
- Application layer is roughly doing the job of the session, presentation and application layers with the transport layer in TCP/IP taking care of part of the duties of the session layer.
- We assume that the TCP/IP protocol suite is made of five layers: physical, data link, network, transport and application.

TCP/IP Protocol Suite

- The first four layers provide physical standards, network interfaces, internetworking and transport functions that corresponds to the first four layers of the OSI model.
- The three topmost in the OSI model, are represented in TCP/IP by a single layer called the application layer.

Protocol Stack



Internet Protocol (IP)

- IP is the transmission mechanism used by the TCP/IP protocols. Unreliable and connectionless datagram protocol- best effort delivery services.
- Best effort means IP provides no error checking or tracking.
- Assumes the unreliability of the underlying layers and does its best to get a transmission but with no guarantee.
- Transports data in packets called datagram, each transported separately. Datagrams travel along different routes and can arrive out of sequence or duplicated.
- Doesn’t keep track of the routes and has no facility for reordering datagrams once they arrive at their destination.

Transmission Control Protocol

- Is reliable connection-oriented protocol.
- Allows byte stream originating on one machine to be delivered without error on any other machine in internet.
- It fragments the incoming byte stream into discrete messages and passes each one onto internet layer.
- At the destination, the receiving TCP process reassembles the received messages into output stream. Also handles flow control to synchronize senders and receivers clock.

User Datagram Protocol

- It is unreliable connectionless protocol for applications that do not want TCP's sequencing or flow control and wish to provide their own.
- It is widely used for one-shot client server Request-Reply queries and applications in which prompt delivery is more important than accurate delivery.

Addressing

- Physical Addresses
  - Also known as the link address, is the address of a node as defined by its LAN or WAN.
  - Included in the frame used by the data link layer. It is the lowest-level address.
  - The size and format of these addresses vary depending on the network.
  - Example: Ethernet uses a 6-byte (48 bit) physical addresses, imprinted on the NIC. LocalTalk (Apple), has a 1-byte dynamic address that changes each time the station comes up.

Addressing

- Logical Addresses
  - Necessary for universal communications that are independent of underlying physical networks.
  - Physical addresses are not adequate in an internetwork where different networks can have different address formats.
  - In universal addressing system each host can be identified uniquely, regardless of the underlying physical network.
  - In the internet currently it is 32-bit address that can uniquely define a host connected to the Internet. No two hosts have same IP address.

Addressing

- Port Addresses
  - The IP address and the physical address are necessary for a quantity of data to travel from source to destination host.
  - Arrival at the destination host is not the final objective of data communications on the Internet. End objective of the Internet communication is process communicating with another process.
  - Computers are devices that can run multiple processes at the same time.
  - For these processes to receive data simultaneously, we need to label the different processes.
  - Means they need addresses. The label assigned to a process is called port address. It is 16 bits in length.

Addressing

- Special Addresses
  - Some applications have user friendly addresses that are designed for that specific addresses.
  - Example: email – defines the recipient of an email, URL used to find document on the World Wide Web
  - These addresses, get changed to the corresponding port and logical addresses by the sending computer.

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