OSI Reference Model

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Objectives

- Data communication among heterogeneous systems – difficulties and solutions
- The need for layered architecture
- Design issues for the layers
- The OSI model

Network complexities

- Different types of hardware and software
- Different operating systems
- Different types of data to be transferred – text, images, music, video, etc
- Data must be transferred without errors
- Many different paths may have to be taken
- Yet computers must communicate with each other in a network

Network complexities

- Data formats and data exchange conventions vary between manufacturers
  - E.g., ASCII, EBCDIC, etc.
- This can be resolved only if computers follow certain common set of rules or protocols

How to Reduce this complexity

- Recall concepts of functions, data hiding, passing values to as function, getting results from a function
- How the function works is not important – what inputs it requires and what outputs it produces are important
- “Black box” approach – services provided are known but the details are hidden

What is a protocol?

- It is a formal description of message formats and the rules that two computers must follow in order to exchange messages.
- This set of rules describes how data is transmitted over a network.

Why are protocols needed?

- Protocols are needed for communication between any two devices.
  - In what **format** will the messages be transmitted?
  - At what **speed** should messages be transmitted?
  - What to do if **errors** take place?
  - What to do if parts of a message are **lost**?

Protocols in daily life

- How does conversation take place between human beings
  - *“Hello”*
  - *“Goodbye”*
  - *Handshake*
- Letters
  - *“Dear Sir”*
  - “*Yours faithfully”*
  - *No splleing mistakes !*

Network Model

- What is a model? – A hypothetical description of a complex entity or process.
- Network model - A method of describing and analyzing data communications networks by breaking the entire set of communications process into a number of layers
- Each layer has a specific function

Open Systems Interconnect (OSI) Model

- Who made:
  - International Standards Organization (ISO)
- A Model of How Protocols and Networking Components Could be Made
- "*Open*" means the concepts are non-proprietary; can be used by anyone.
- OSI is not a protocol. It is a model for understanding and designing a network architecture that is flexible and robust.

Open Systems Interconnect (OSI) Model

- The OSI model describes how data flows from one computer, through a network to another computer
- The OSI model divides the tasks involved with moving information between networked computers into 7 smaller, more manageable sub-task .
- A task is then assigned to each of the seven OSI layers.
- Each layer is reasonably self-contained so that the tasks assigned to each layer can be implemented independently.

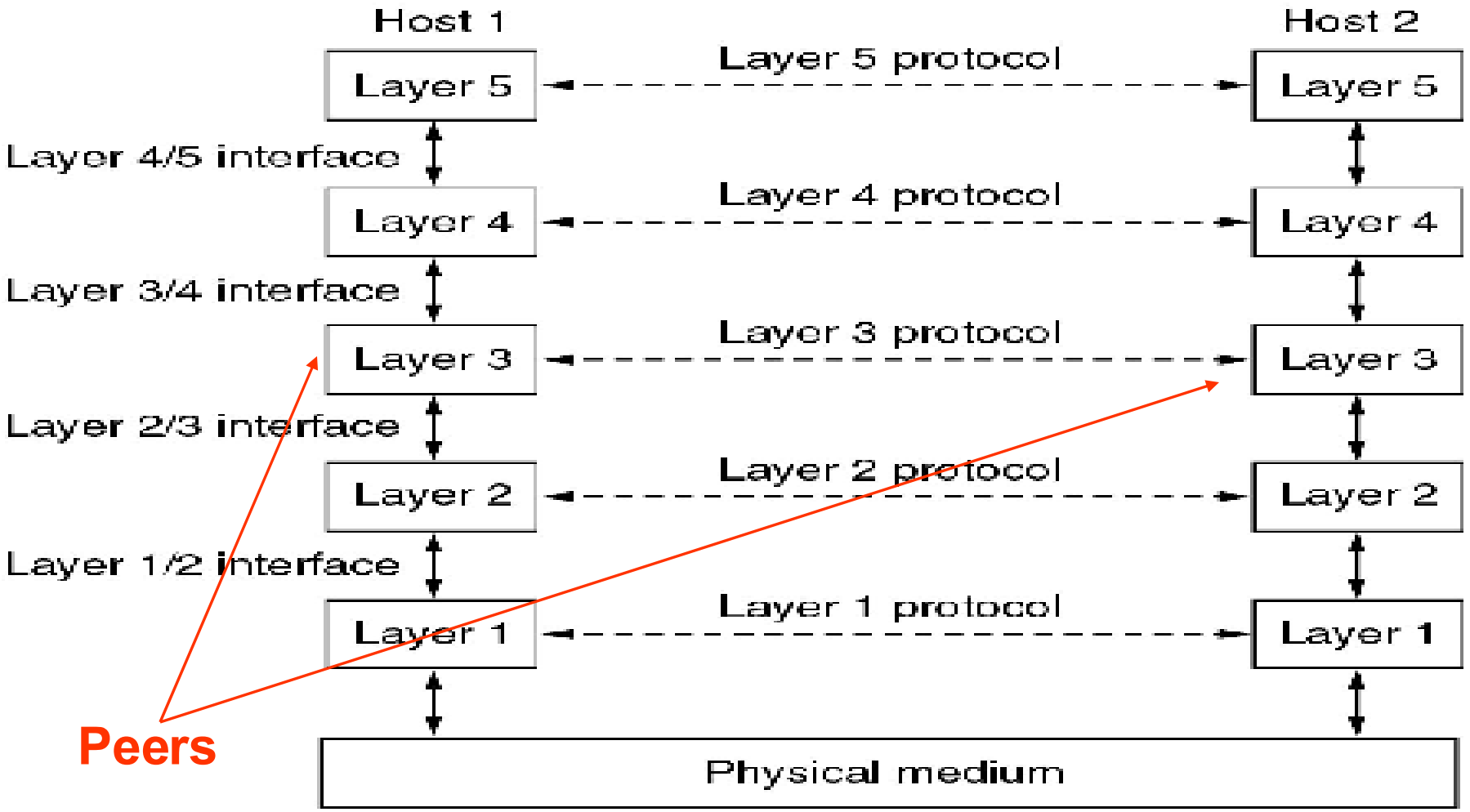
Network Architecture

- A set of layers and protocols is called a network architecture
- It refers to the physical and logical design of a network

7-layer OSI model

- Why so many layers?
  - To reduce complexity, networks are organized as a **stack** of layers, one below the other
  - Each layer performs a specific task. It provides services to an adjacent layer
  - This is similar to the concept of a function in programming languages – function does a specific task

Layered Approach



Layered Approach

- The entities comprising the corresponding layers on different machines are called peers
- It is the peers that communicate by using the protocols
- Actually, data is not transferred from layer *n* on one machine to layer *n* on another machine
- Each layer passes data and control information to the layer immediately below it, until the lowest layer is reached
- Actual data communication takes place through the lowest layer – the physical layer

Design Issues for the Layers

- Addressing
- Error control
- Order of messages must be preserved
- Flow control – fast sender and slow receiver !
- Disassembling, transmitting, and reassembling large messages
- Multiplexing / de-multiplexing
- Routing

Concept of Services and Protocols

- A service is a set of operations that a layer provides to the layer above it
- Service defines what operations the layer is prepared to perform
- A service relates to the interface between two layers – the lower layer is service provider and the upper layer is service user

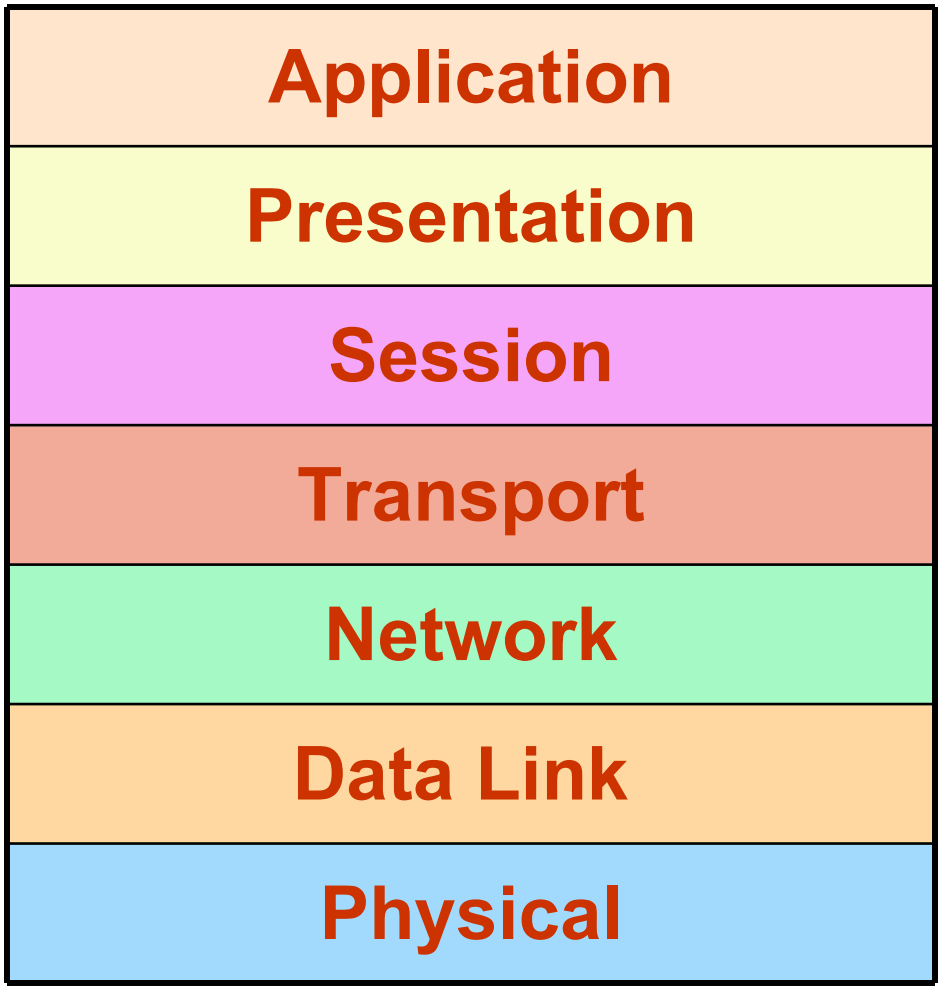
Concept of Services and Protocols

- A protocol is a set of rules governing the format and meaning of the packets
- Protocols relate to packets sent between peer entities on different machines
- Entities use protocols
- Protocols can be changed provided the services visible to the user do not change. Thus services and protocols are completely decoupled

Services and Protocols

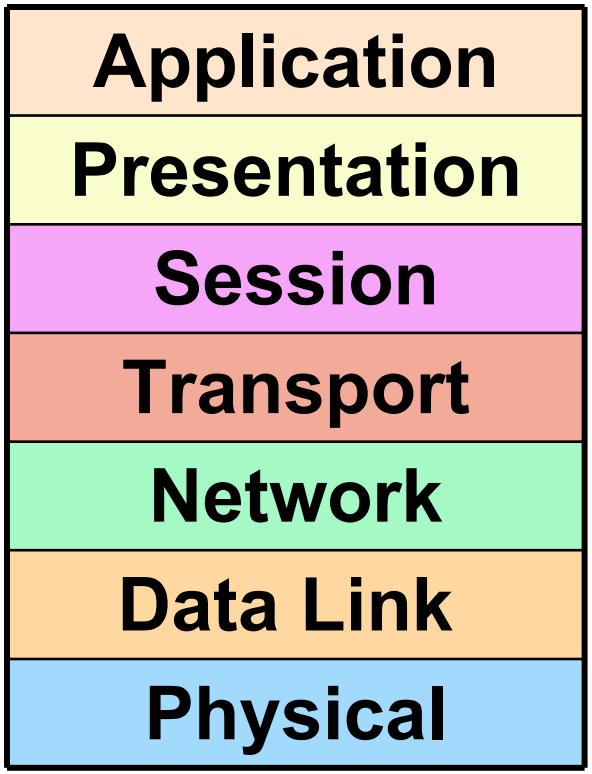
- Analogy with programming languages
  - A service is like an object in an object-oriented language
  - What operations can be performed on this object is defined
  - How these operations are to be performed is not defined
- Protocol relates to the *implementation* of the service – how it is done

The Layers of the OSI Model



The Layers of the OSI Model
Some Mnemonics

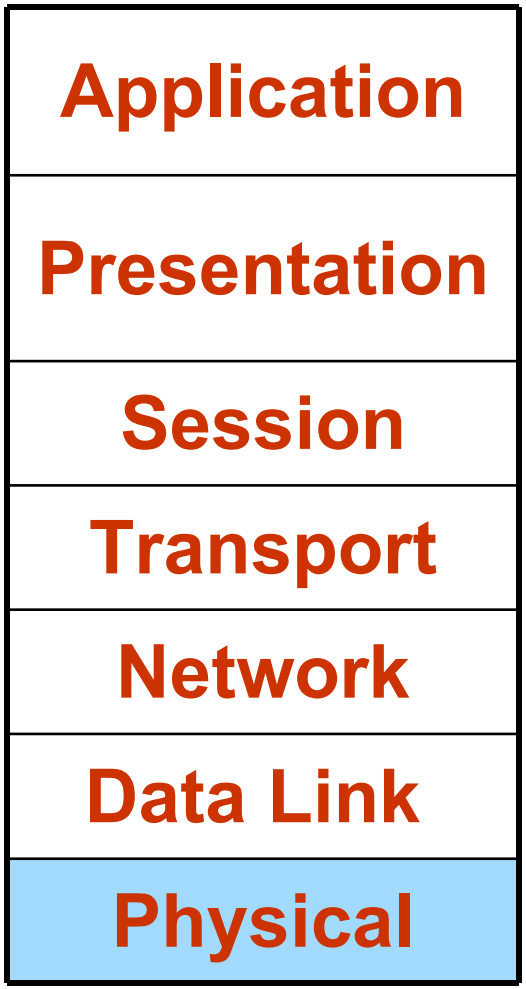
All
People
Seem
To
Need
Data
Processing



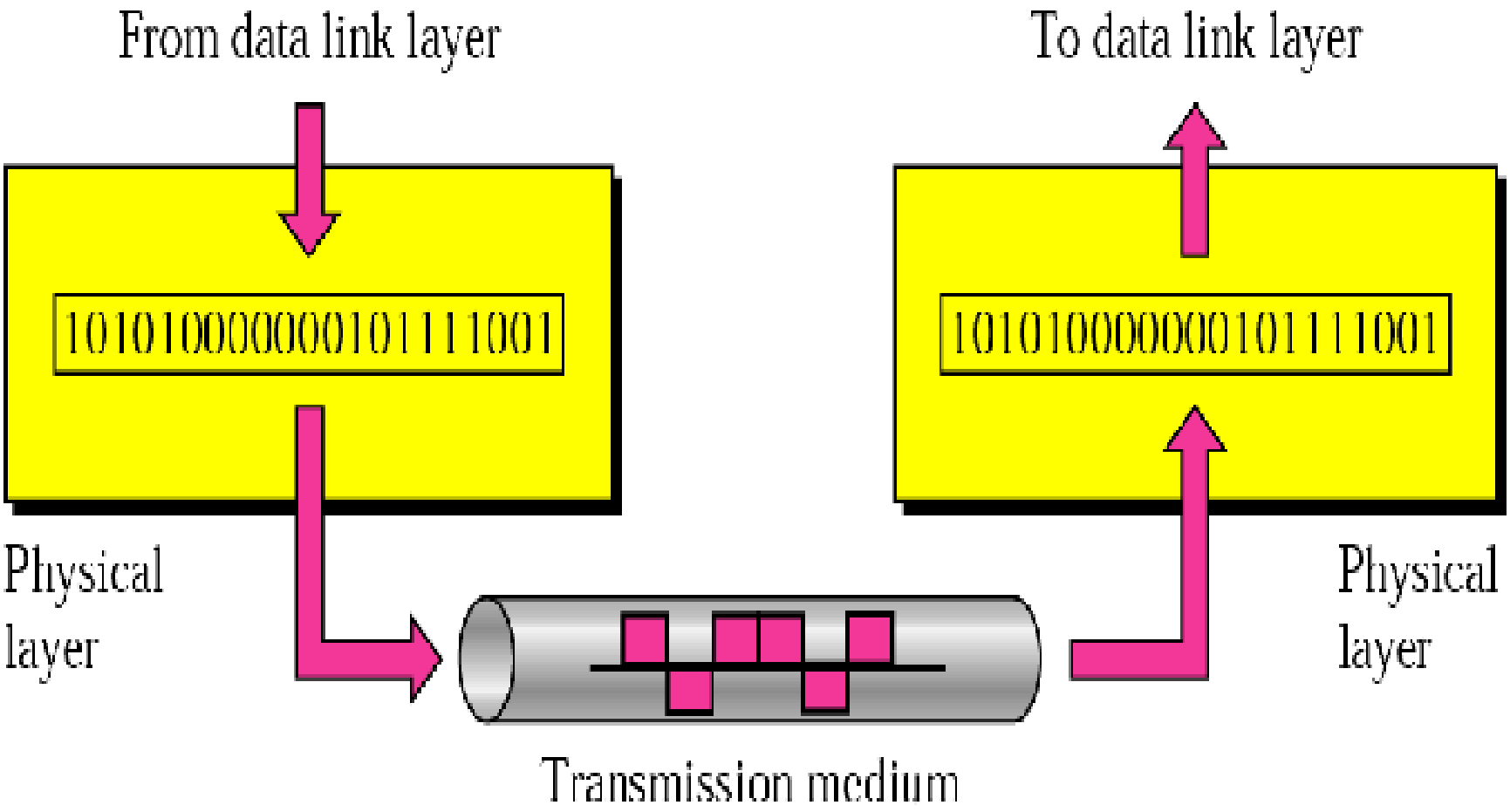
Please
Do
Not
Tell
Secret
Passwords
Anytime

Physical layer

- Specifications for the physical components of the network.
- Functions of Physical Layer:
  - Bit representation – encode bits into electrical or optical signals
  - Transmission rate – The number of bits sent each second
  - Physical characteristics of transmission media
  - Synchronizing the sender and receiver clocks
  - Transmission mode – simplex, half-duplex, full duplex
  - Physical Topology – how devices are connected – ring, star, mesh, bus topology



Physical Layer



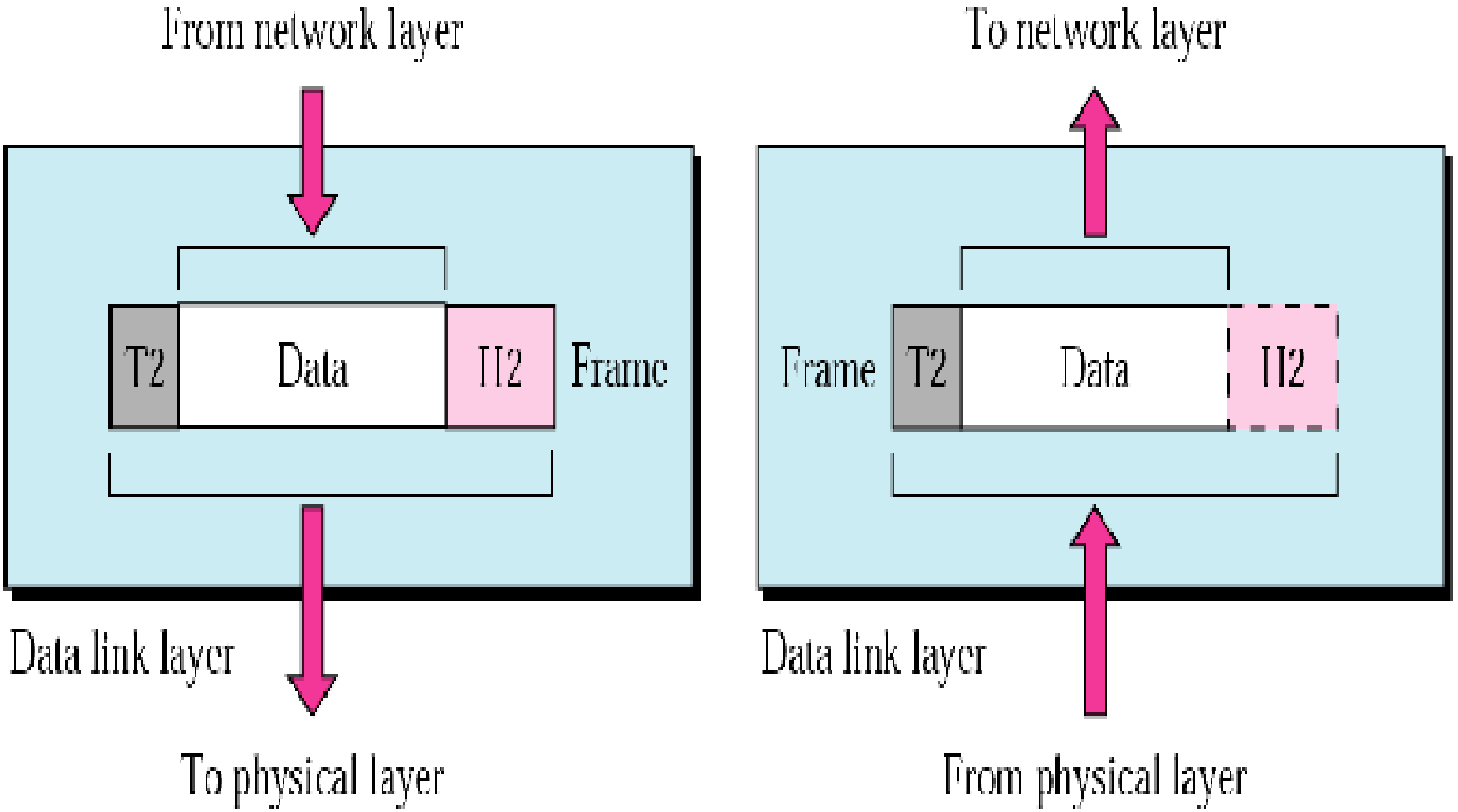
Data Link Layer

Responsible for delivery of data between two systems on the same network

Main functions of this layer are:

- Framing – divides the stream of bits received from network layer into manageable data units called frames.
- Physical Addressing – Add a header to the frame to define the physical address of the source and the destination machines.
- Flow control – Impose a flow control – control rate at which data is transmitted so as not to flood the receiver (Feedback-based flow control)
- Error Control – Adds mechanisms to detect and retransmit damaged or lost frames. This is achieved by adding a trailer to the end of a frame

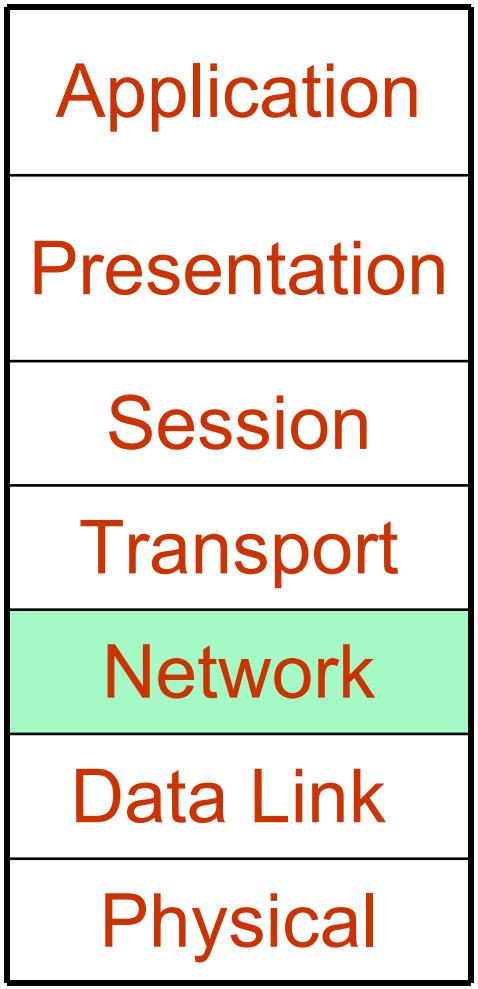
Data Link Layer



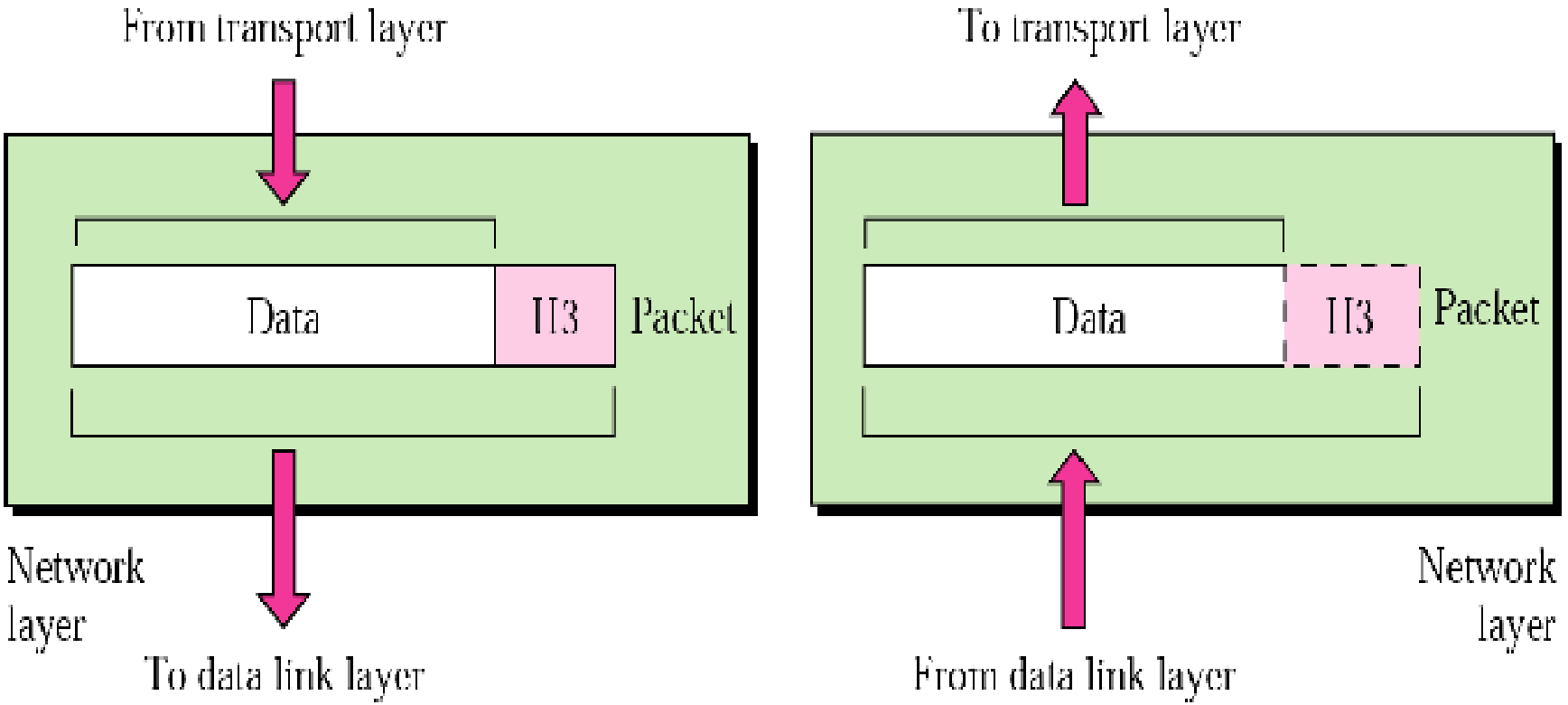
Network Layer

Main functions of this layer are:

- Responsible for delivery of packets across multiple networks
- Routing – Provide mechanisms to transmit data over independent networks that are linked together.
- Network layer is responsible only for delivery of individual packets and it does not recognize any relationship between those packets



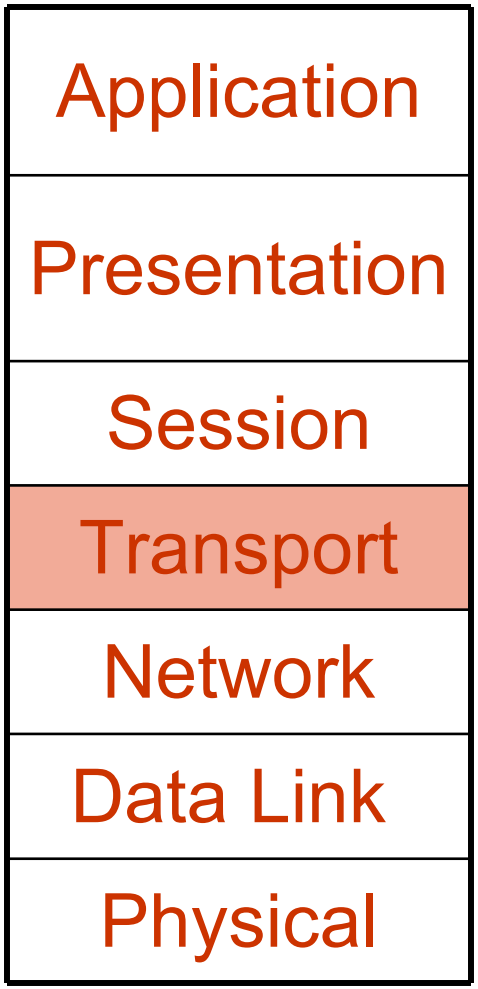
Network Layer



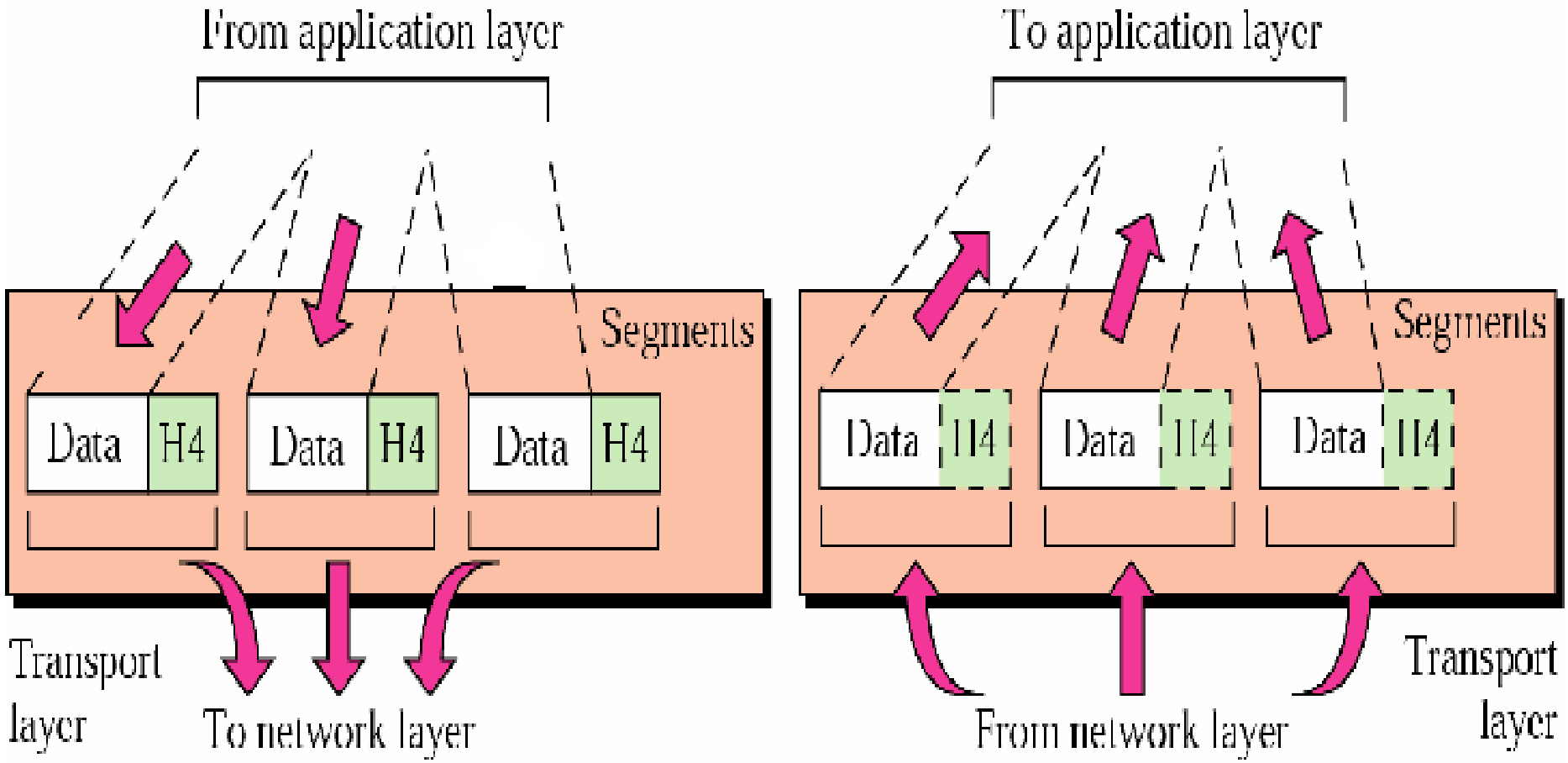
Transport Layer

Main functions of this layer are:

- Responsible for source-to-destination delivery of the entire message
- Segmentation and reassembly – divide message into smaller segments, number them and transmit. Reassemble these messages at the receiving end.
- Error control – make sure that the entire message arrives without errors – else retransmit.



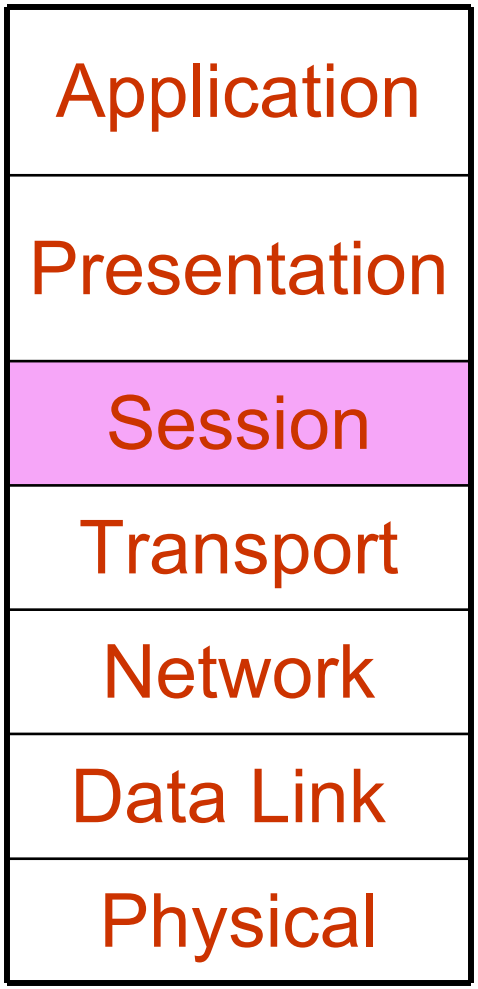
Transport Layer



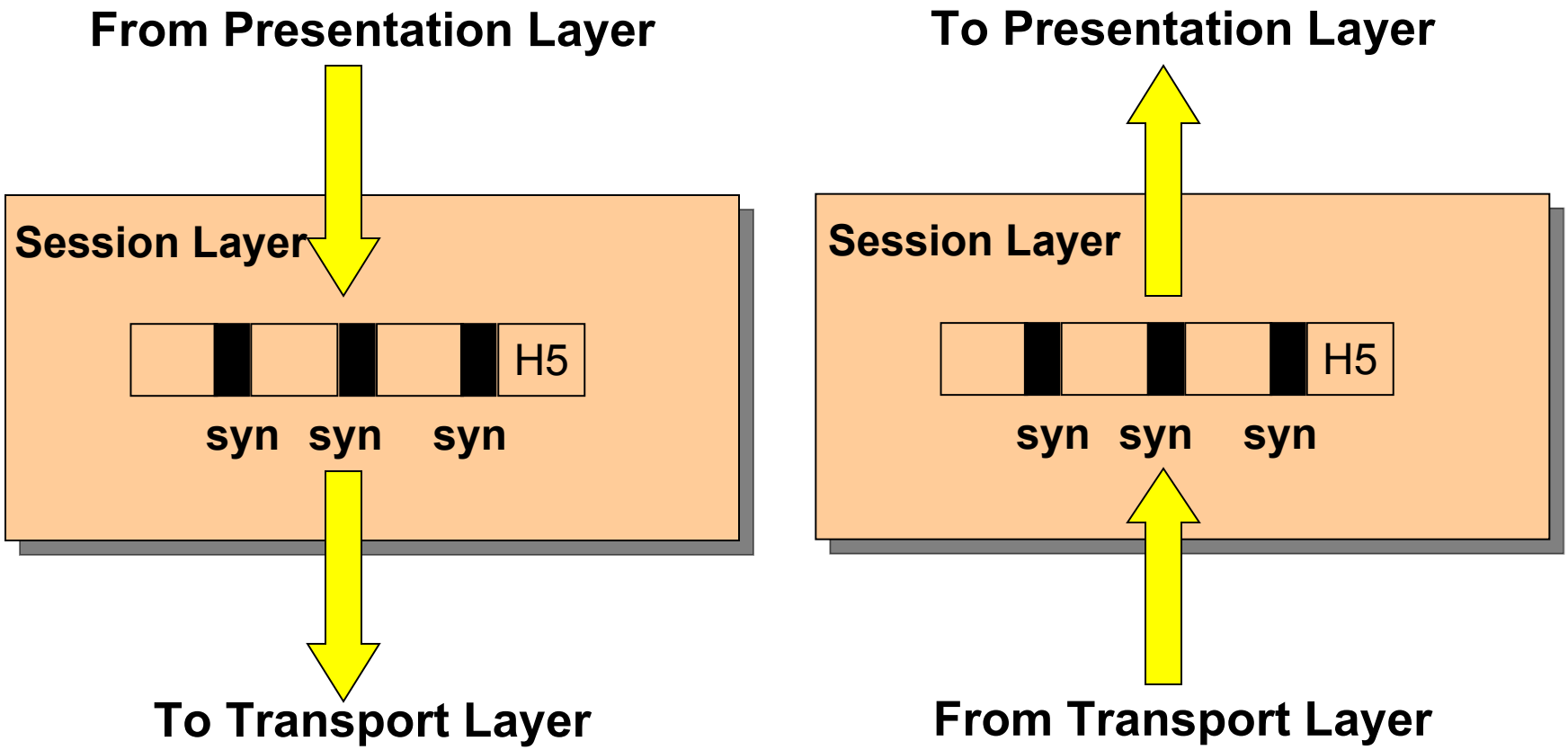
Session Layer

Main functions of this layer are:

- Dialog control – allows two systems to enter into a dialog, keep a track of whose turn it is to transmit
- Synchronization – adds check points (synchronization points) into stream of data.



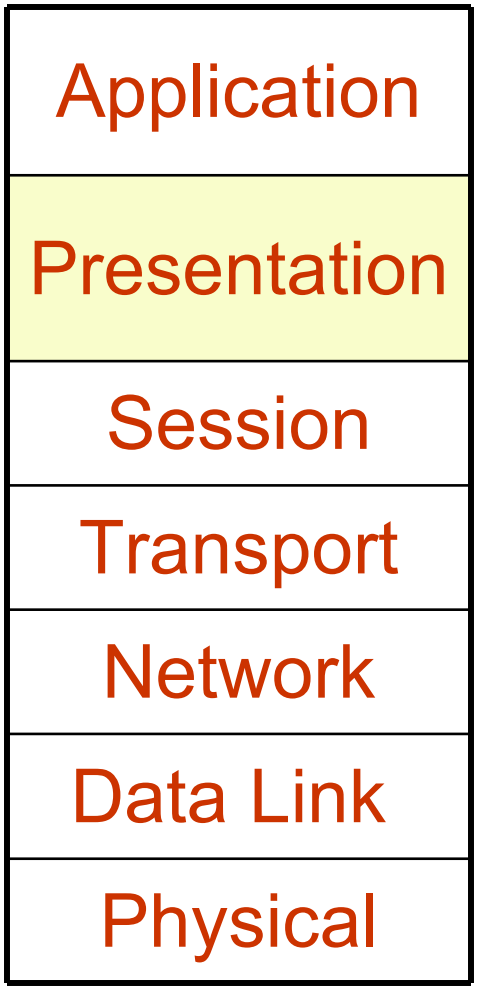
Session Layer



Presentation Layer

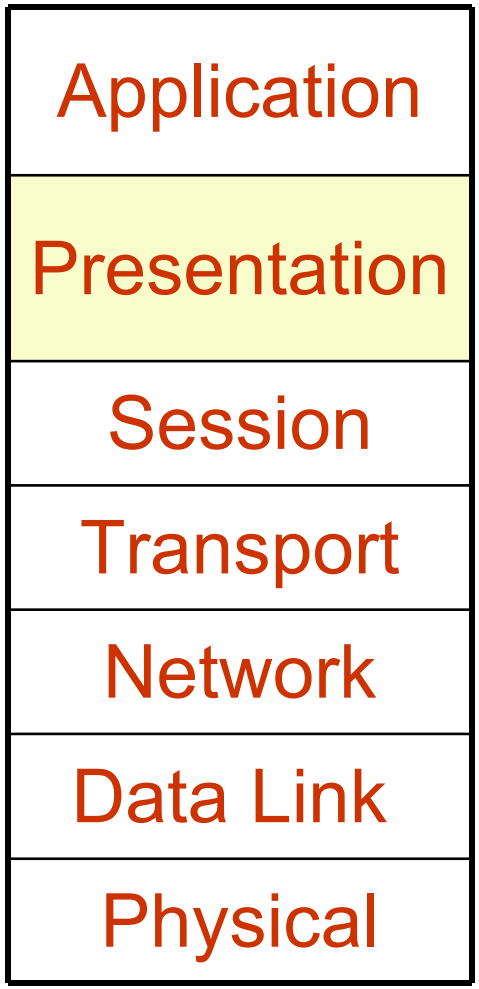
Responsibilities of this layer are:

- Translation
  - Different computers use different encoding systems (bit order translation)
  - Convert data into a common format before transmitting.
  - Syntax represents info such as character codes - how many bits to represent data – 8 or 7 bits
- Compression – reduce number of bits to be transmitted



Presentation Layer

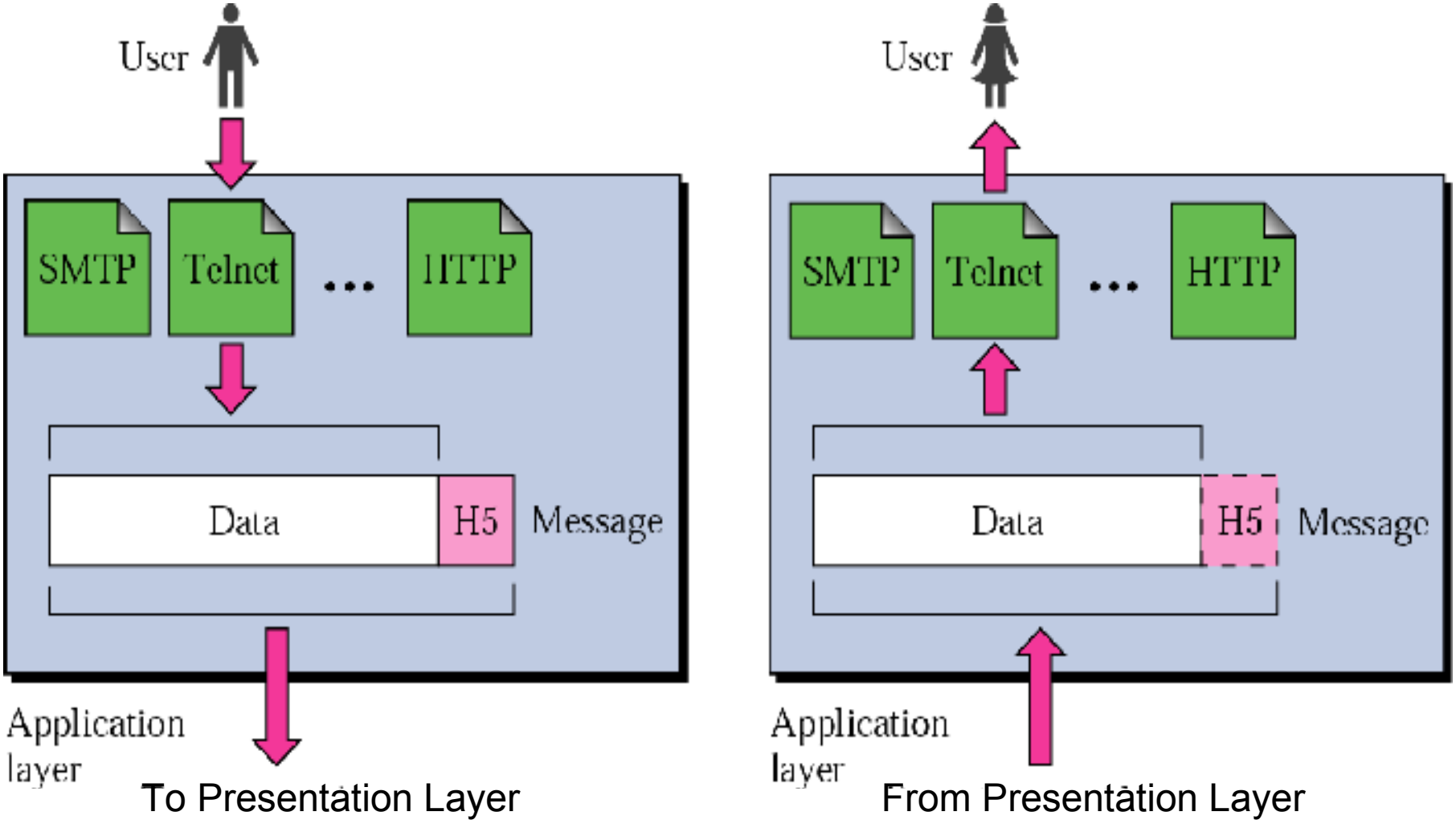
- Encryption – transform data into an unintelligible format at the sending end for data security
- Decryption – at the receiving end



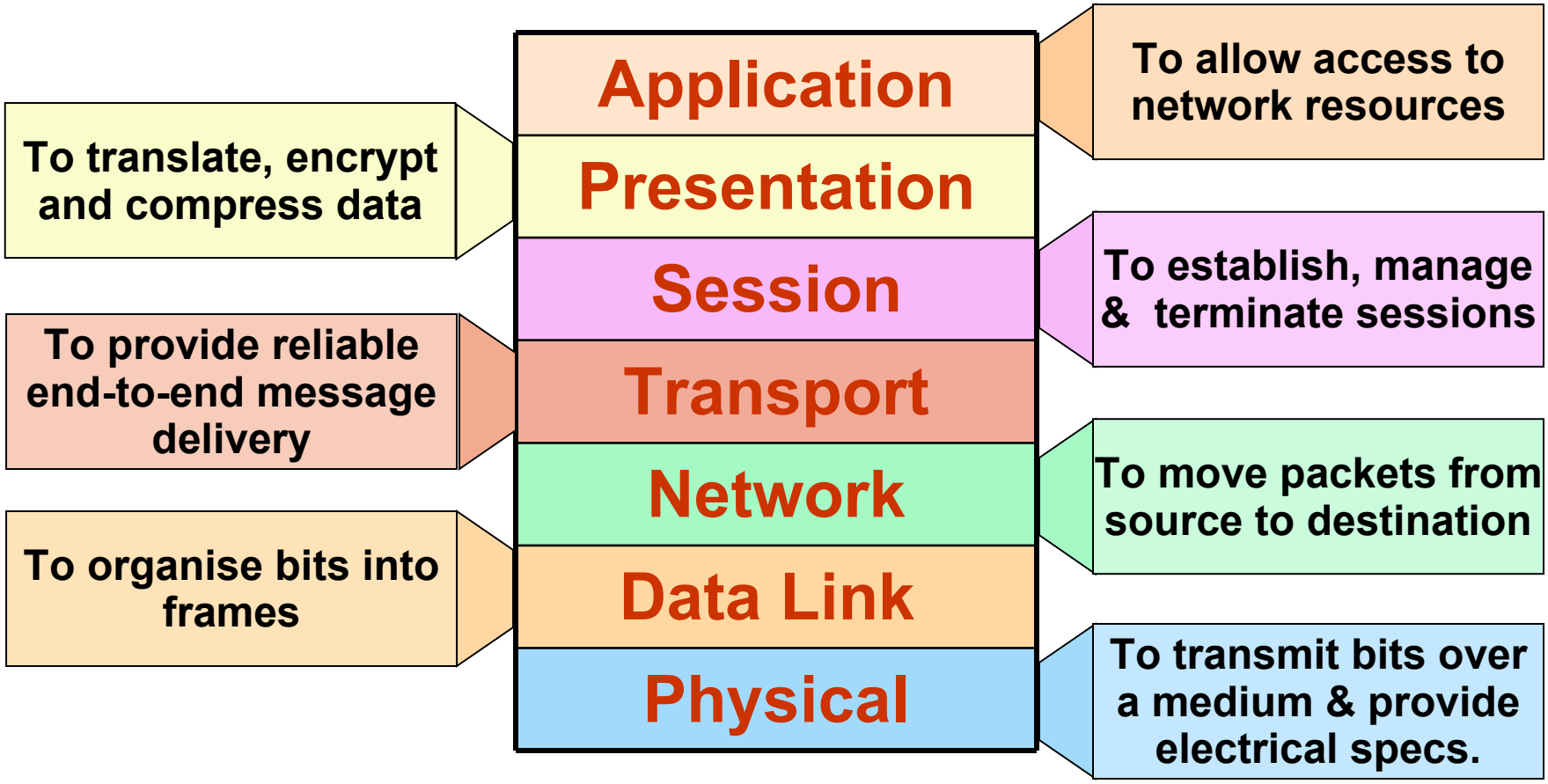
Application Layer

- Contains protocols that allow the users to access the network (FTP, HTTP, SMTP, etc)
- Does not include application programs such as email, browsers, word processing applications, etc.
- Protocols contain utilities and network-based services that support email via SMTP, Internet access via HTTP, file transfer via FTP, etc

Application Layer



Summary of Functions of Layers



References

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Thank You