OSI MODEL (OPEN SYSTEM INTERCONNECTION)

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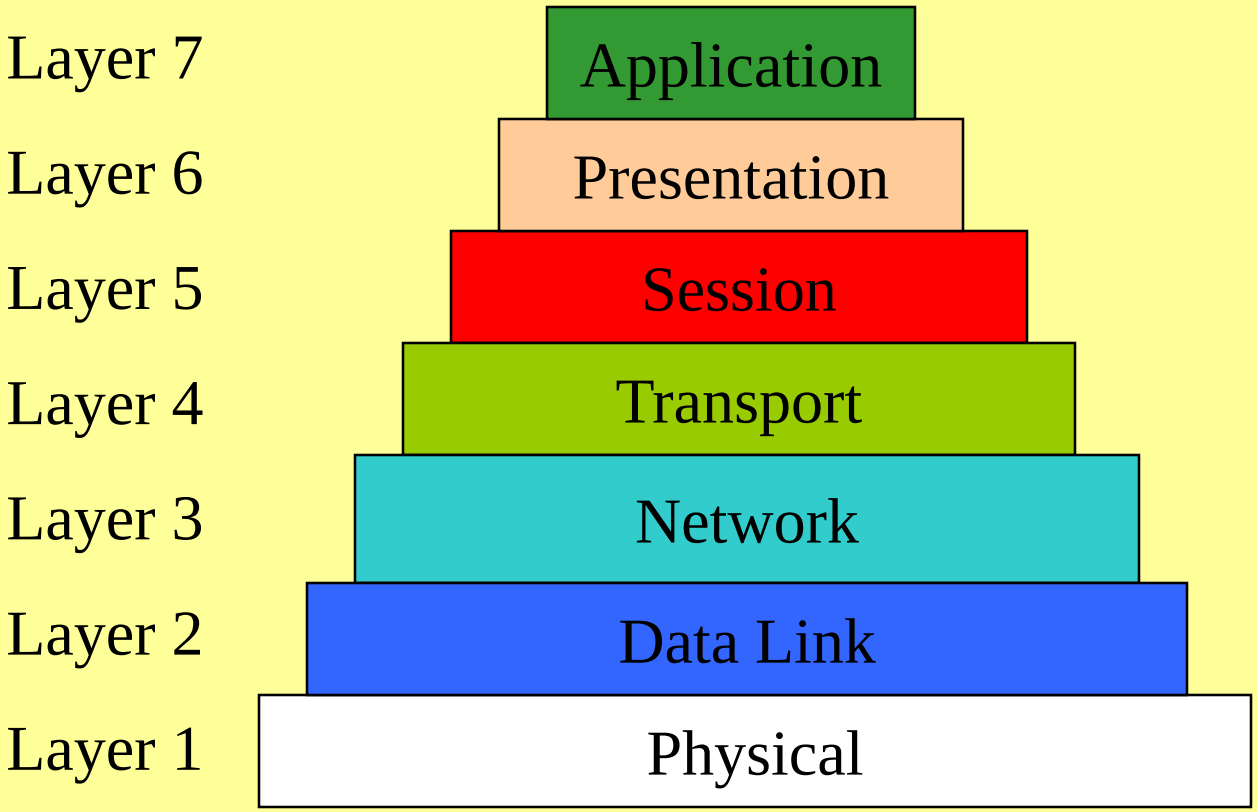
Contents

- Purpose of the OSI model and its seven layers
- Function of each layer
- Process for communication between devices
- TCP/IP Model

What is the OSI model ?

- **O**pen **S**ystems **I**nterconnection model is fundamental to all communications between network devices.
- Developed in 1974 by *ISO* after the American Department of Defence began using the TCP/IP suite of protocols.
- Finally adopted in 1977. It is now the *theoretical model* for how communication takes place between network devices.

What are the seven layers ?



Layers

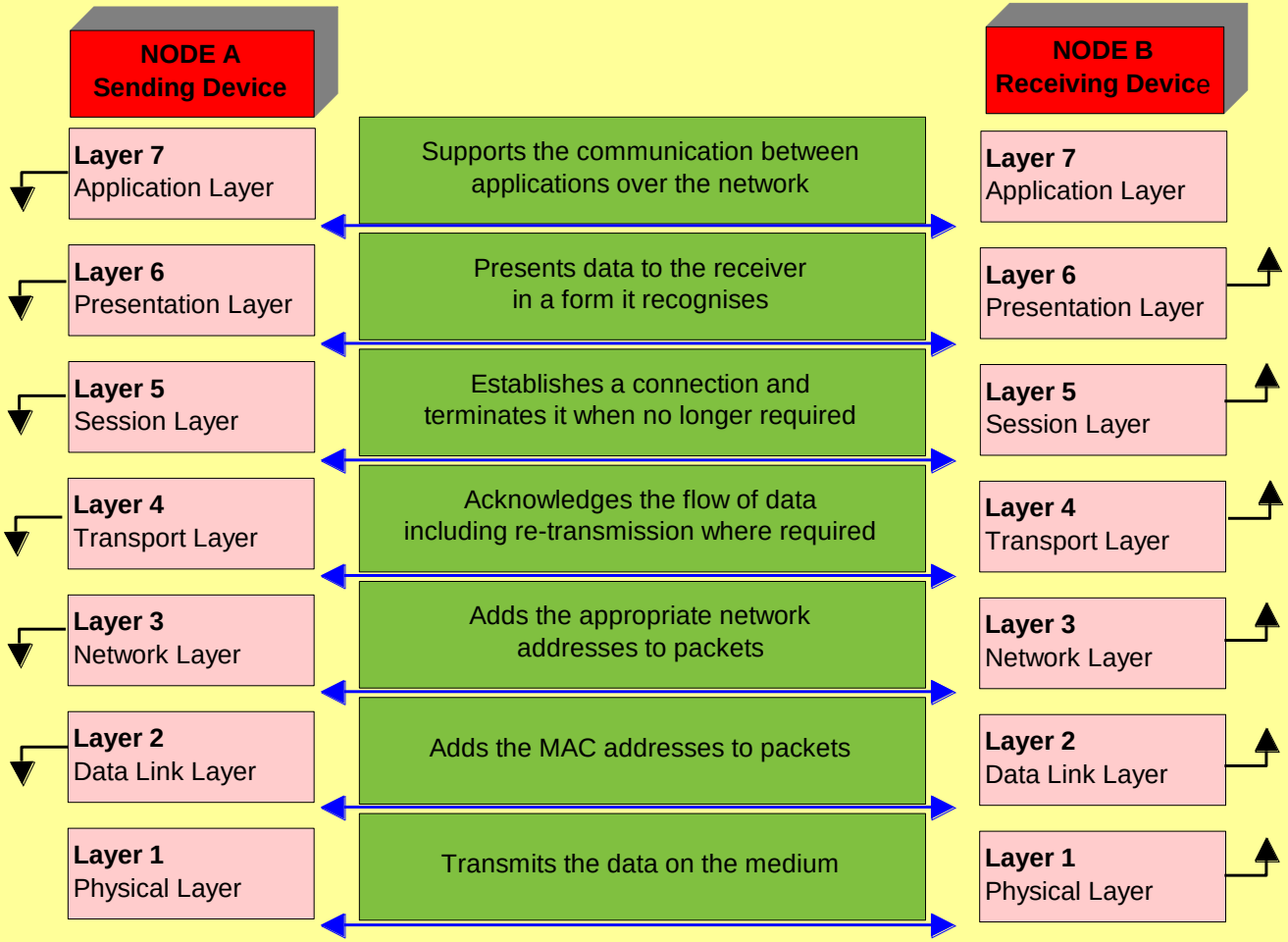
- In the sense of purpose and responsibility, each layer is separate and independent
- Each has its own function, but also provides a service to those layers above and below itself
- The model should be considered an aid to understanding the nature of communication on the network – and useful in sorting out troubles that might occur on a network
- By providing, it allows both software engineers and hardware manufacturers ensure their products work together.

The Layers at Work

As the next slide shows:

- When communicating, each OSI layer talks with the same layer in the other device
- E.g. the Application Layer of Device A communicates with the Application Layer of Device B, by passing the data through the other layers
- The Application Layer of each device is not concerned with how the other layers are functioning, but it does rely on them to do their job

The layers at Work



Remembering the Layers

Application	**A**ll
Presentation	**P**eople
Session	**S**eem
Transport	**T**o
Network	**N**eed
Data Link	**D**ata
Physical	**P**rocessing

How does data flow ?

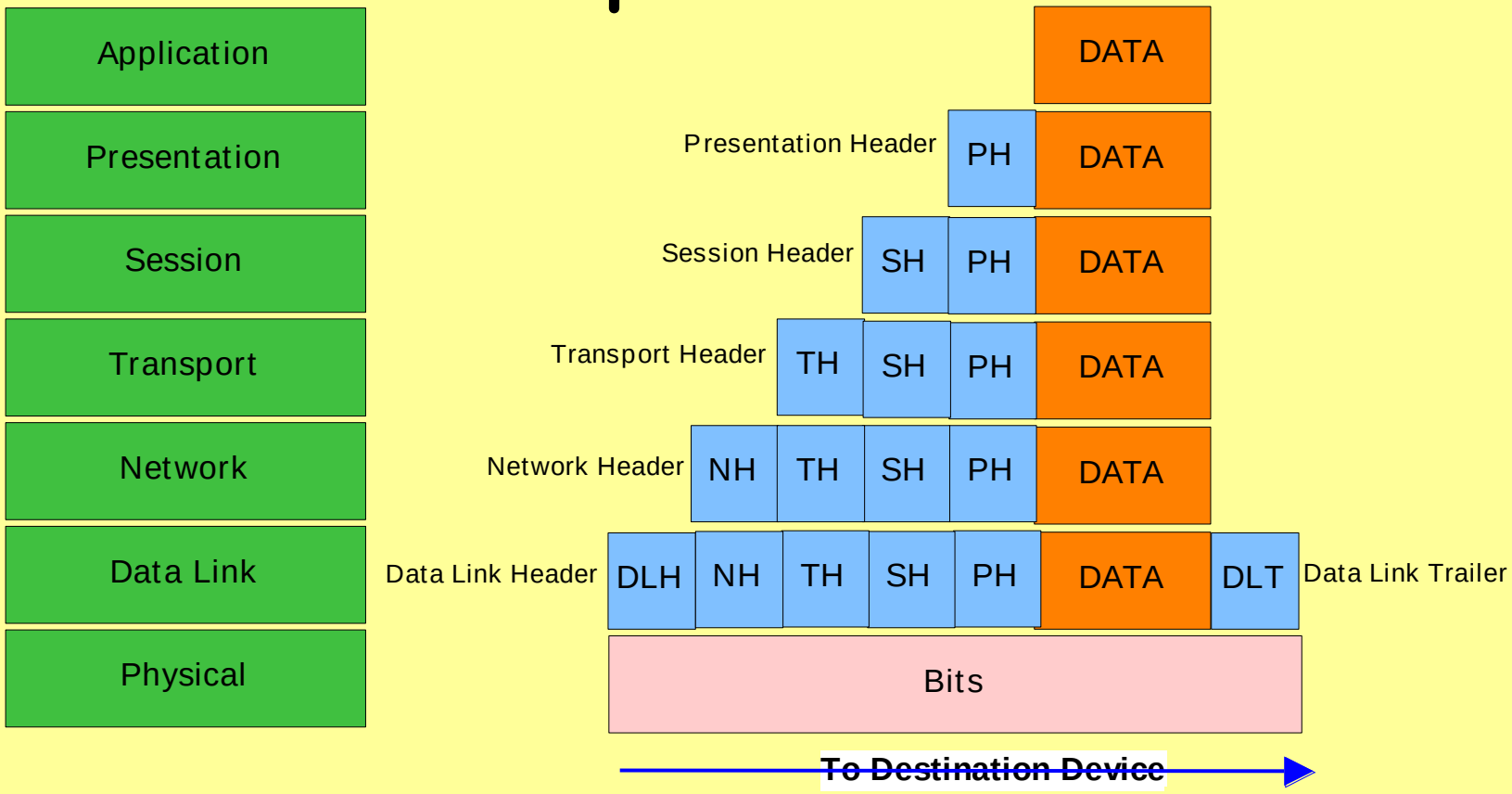
When data is sent from the application on the source computer the following happens

- Data in the form of a *packet* moves down through the layers
- When it reaches the Physical Layer it is ready to be sent along the cable
- At the Physical Layer the bits may be *analogue* or *digital*, in the form of *electrical*, *light* or *radio waves*

How does data flow ? (2)

- The data is transmitted to the destination device
- It travels up through the layers of the OSI model, reaching the user.
- As data moves down through the layers it is *encapsulated* – ie additional information is added as *headers* or *trailers*
- The data in the packet does **not** change
- See the following diagram

Encapsulation



Application Layer

- 'Closest' layer to the user
- Works with the applications you use to communicate over the network
- E.g.. Services include SMTP, HTTP and FTP
- Clicking on a link on a web page issues a command for the browser to retrieve the relevant information from the Internet
- In this example your computer is the source, and the host of the web site information is the destination
- The application completes your request and delivers the information to your computer

Application Services

- File Services
- Electronic-mail Services
- Network-printing Services
- Application Services
- Database Services

Presentation Layer

This layer has three fundamental functions

(1) Data Presentation

- Enables receiving device to understand the information sent from the source
- Converts data from native format (*abstract syntax*) to a common format (*transfer syntax*), e.g. ASCII

Presentation Layer (2)

(2) Data Compression

- By reducing the volume of data, transfers can take place in less time
- Packets are examined and such things as spaces in text removed
- The destination device returns the data to its original format before passing to the Application Layer

Presentation Layer (3)

(3) Data Encryption

- Allows data to be converted to a form which hides its meaning, apart from those you wish to see it
- Not all data is encrypted on its journey across the network
- In order for decryption to occur at the destination device a '*key*' is required

Session Layer

- Primarily responsible for handling the *session* between devices (beginning, maintaining and finishing)
- Enforces order in the communication between devices
- Regulates the flow of data
- It takes responsibility for the following ….

Session Services

The following services are provided:

- Establishing a Connection
- Maintaining the Session
- Ending the Connection
- Dialogue Control
- Dialogue Separation

Session Services (2)

- Handshaking – *SYN* and *ACK* packets
- 'Keep alive messages'
- Session must be terminated (otherwise one device will be still transmitting without any device actually listening)
- Dialogue Control (simplex, half-duplex, full-duplex)
- Dialogue Separation – checkpoints within the transmission which allow the detection of lost packets, and subsequent re-transmission

Transport Layer

- Ensures reliable transport of packets from source to destination
- Also manages the speed of transmission – flow control
- There are two types of transmission (Connection-Oriented Transmissions and Connectionless Transmissions) – see next slide

Connection-Oriented Transmissions

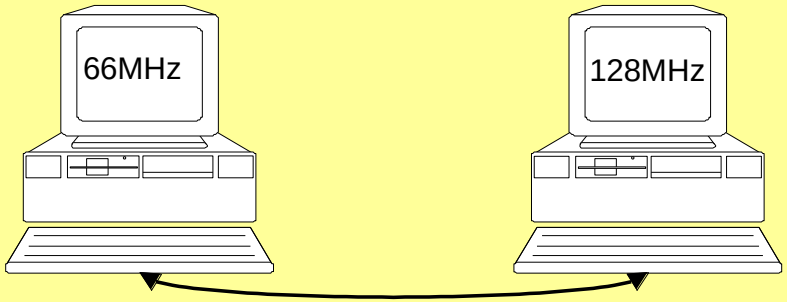
- Also known as ' Reliable Transport Method' – uses acknowledgement (ack) packets on successful receipt of data
- Extra packets slows down communication
- Features are
  - Reliability
  - Slower Communication
  - Packets are re-transmitted if unrecognisable or not received
- Once all the data is received successfully , the packet is re-assembled and the Transport Layer passes it to the Session Layer

Connectionless Transmissions

- In this mode the transmitting device does not require acknowledgements from the receiver, and continues to transmit on the assumption that the data was received
- Features are:
  - Little or No Reliability
  - Faster Transmission
  - Packets are not Re-transmitted

Flow Control

- Establishes the maximum speed at which both sender and receiver can communicate at
- Transport Layer determines largest packet size which can be sent
- Packets are numbered – to allow re-assembly in the correct order



Network Layer

- Responsible for the correct addressing and delivery of packets of data
- These are known as *datagrams*
- Uses the network address (this is a logical address – and does not depend upon any hardware in the device, or the device's physical location)
- Physical and Logical *Topologies* will be discussed in a later lecture

Network Layer (2)

The Network Layer does the following:

- Adds the address to the packet (encapsulation)
- Maps the network address to the devices physical address
- Determines the best path for the packet (*routing*)
- Ensures that the packet is in the correct format for the destination

See Diagram =➔

How does it work ?

- Encapsulation at the Transport Layer involves adding the address of the sender to the datagram
- The destination address is now added. Both addresses are **logical**.
- Both addresses are necessary for packets to move between *end systems*.
- If a packet must move to another network, a routing protocol is required
- If different packet lengths are used on the different networks, the Network Layer formats the data accordingly
- The primary piece of hardware which works on this layer is the *router*. (covered in detail, later in course)

Data Link Layer

- Has two sub layers of its own:
  - Logical Link Control (LLC)
  - Media Access Control (MAC)
- LLC acts between protocols such as Internet Protocol (IP) and the MAC method.
- MAC is responsible for the connection to the physical media (eg cable)

MAC

- Each NIC has a unique number hard coded in to the card – its *physical address*
- The first 6 digits denote the manufacturer, the next six are unique) – type "winipcfg" on your PC
- When the *MAC address* is added to the packet it is now known as a *frame*
- It now has all the information required to travel from the source to the destination

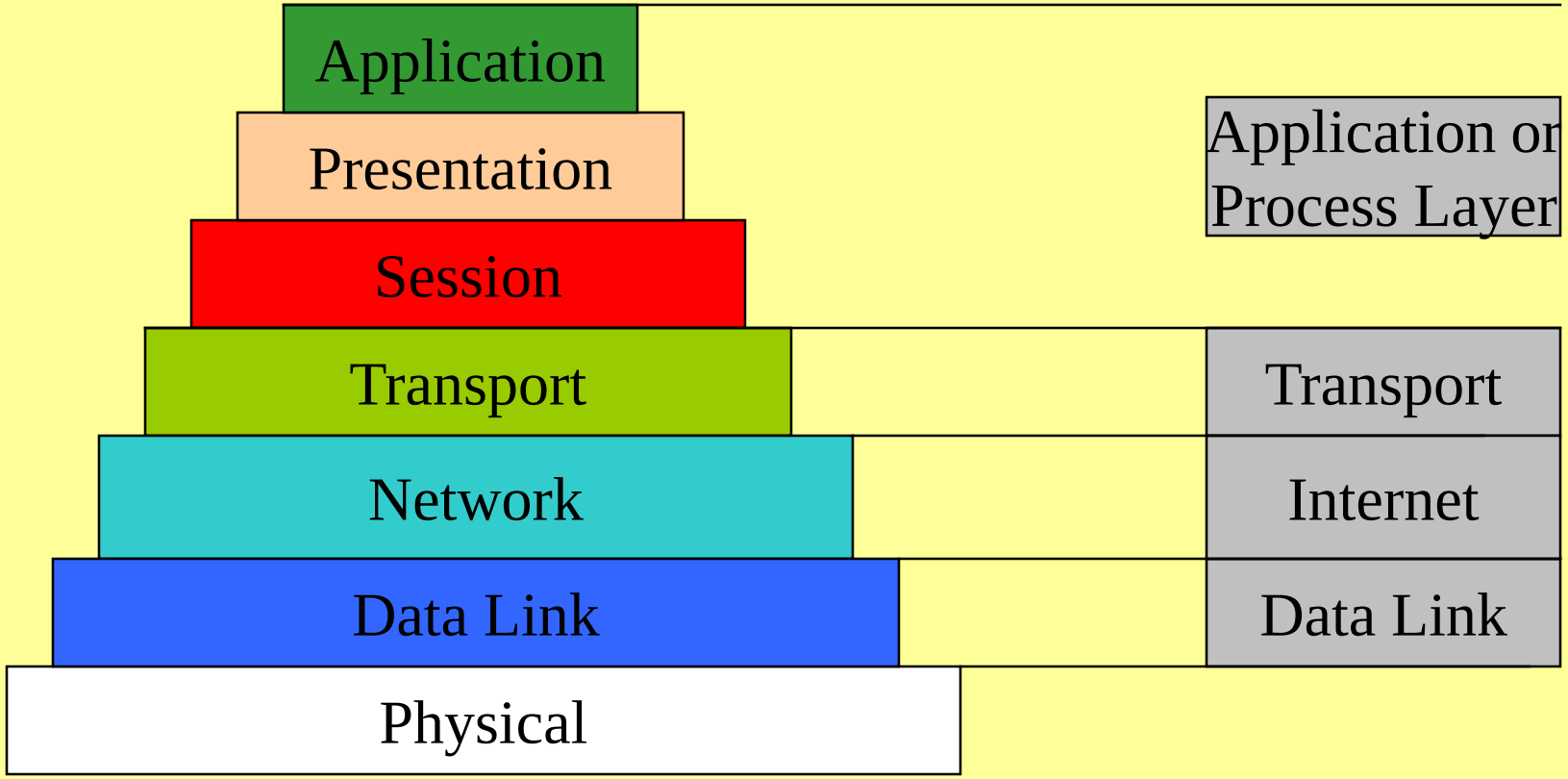
Physical Layer

- The lowest, bottom, layer – responsible for the physical connection between devices
- The NIC converts the data (bits) in to transmission signals.
- Transmissions may be analogue or digital
- Responsible for the rate of transmission
- Includes all components such as the type of connector (RJ-45, Token Ring, BNC, SC connector)
- Devices at this level include NICs, *repeaters*, *hubs* and *concentrators*

OSI versus TCP/IP Model

- OSI model is an important concept
- Protocol most in use on modern networks is *TCP/IP*
- TCP/IP does not map its layers precisely to OSI model
- OSI = 7 layers, TCP/IP = 4 layers (sometimes a 5th physical layer is referred to)

OSI vs TCP/IP


Application
Presentation
Session
Transport
Network
Data Link
Physical
Application or Process Layer
Transport
Internet
Data Link

TCP/IP Model – Summary

- Application or Process Layer – concerned with how data at both ends is handled.
- Transport Layer – manages flow of data
- Internet Layer – consists of several protocols, primary protocol is IP (providing hierarchical addressing scheme
- Data Link (or Network Interface) Layer – manages transmission of data within the network
- Physical Layer – not really defined, TCP/IP leaves the physical connection to manage itself

Summary

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- Function of each layer
- Process for communication between devices
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- ***ADDITIONAL READING IS STRONGLY RECOMMENDED***

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