GENERAL SIR JOHN KOTELAWALA DEFENCE UNIVERSITY

Communication Networks

ET 3102

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Outline

Overview on ISO/OSI reference model for open systems, packet and distributed systems and Topologies.

Physical and Data Link Layers.

Network (IP) and Transport Layers (TCP/UDP).

Session Layer, Presentation and Application Layer.

Local Area Network and Wide Area Networks.

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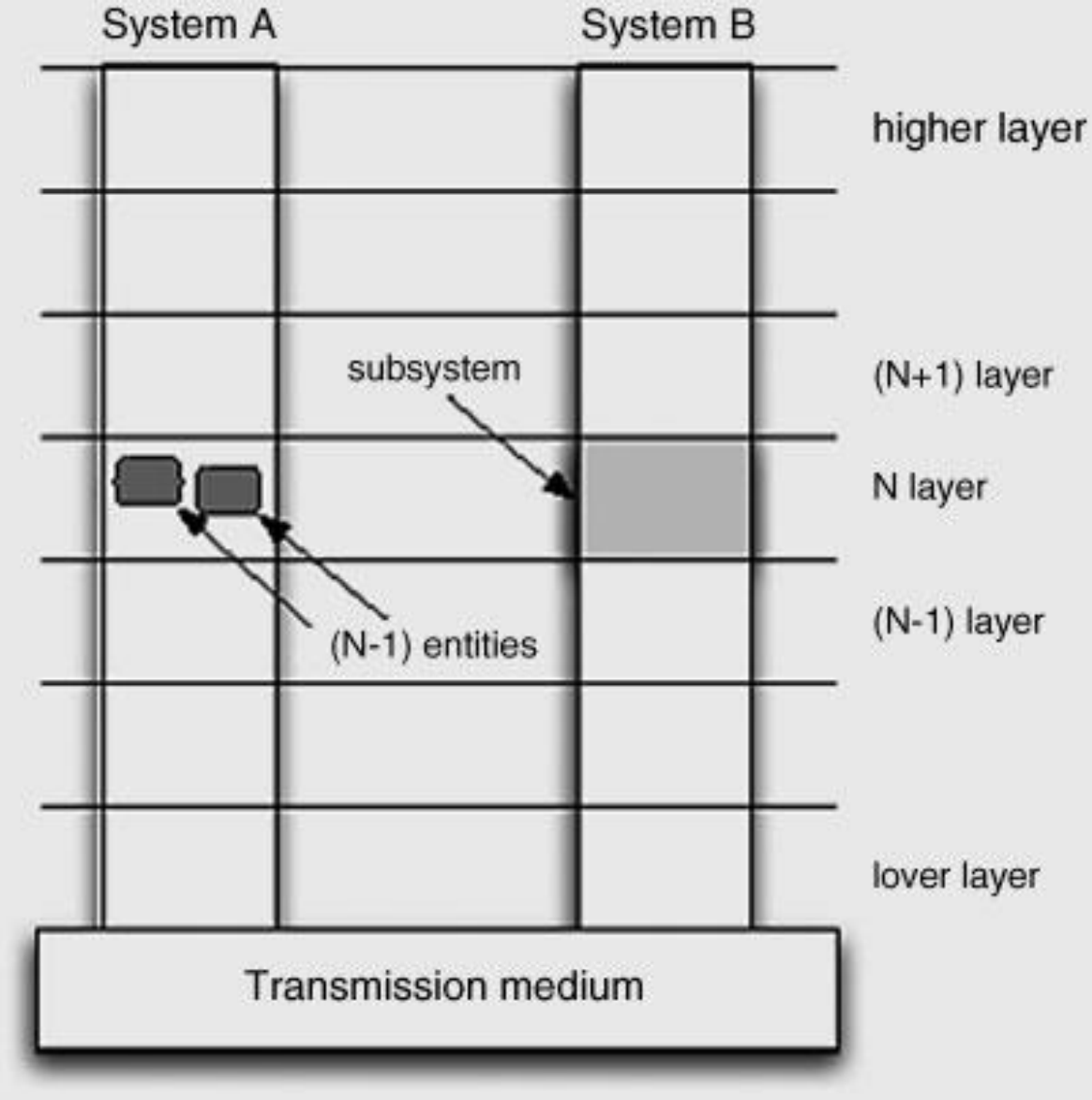
The ISO/OSI Model

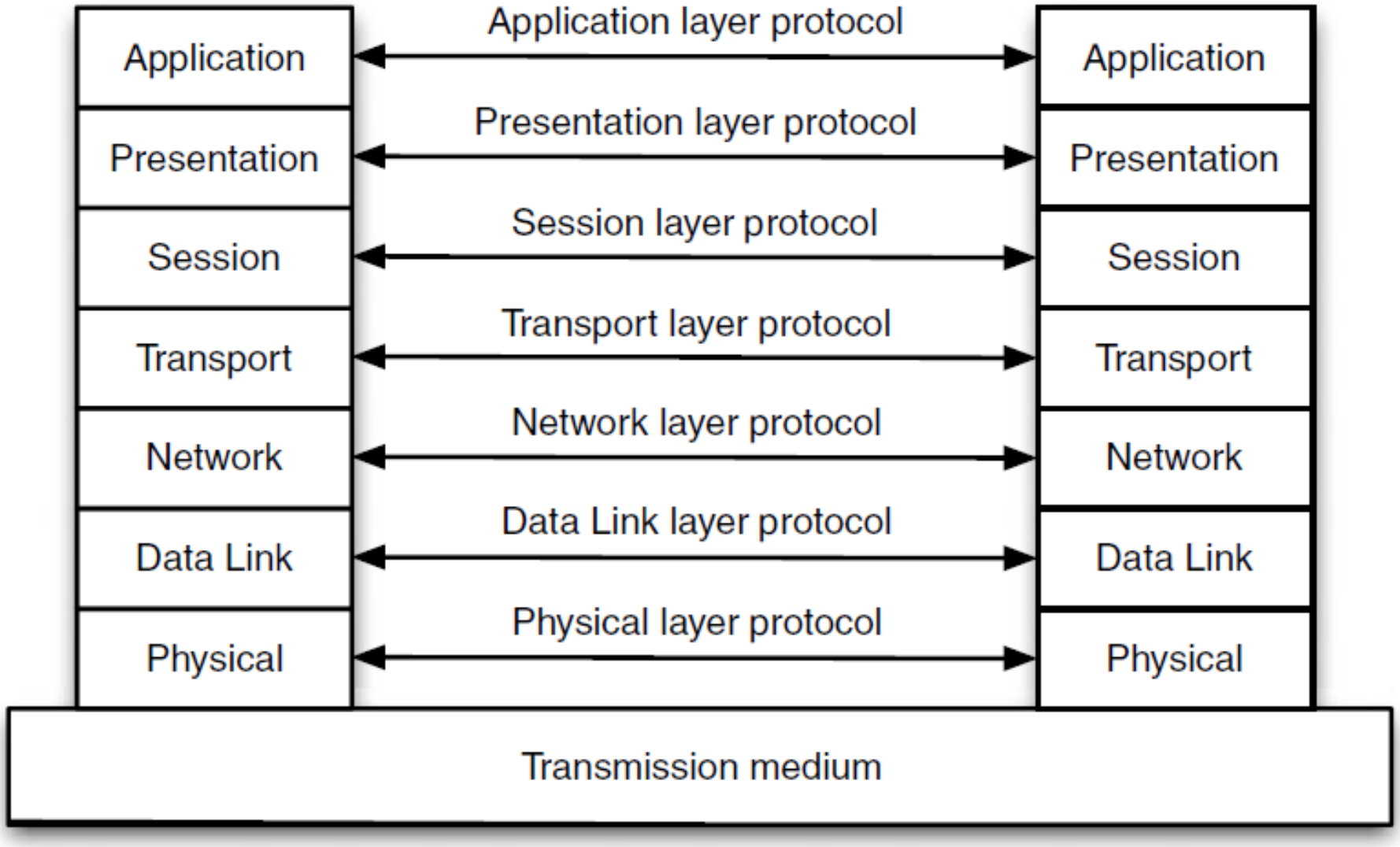
Protocol

- First we introduce the notion of protocol as a set of rules defining telecommunication systems interact.
- To reduce the unavoidable confusion that could be generated by describing protocols without any guideline, a kind of template has been defined to enable :
  - a consistent definition of different protocols;
  - an easier comparison between them; and
  - a translation of one protocol into another, through a suitable conversion.

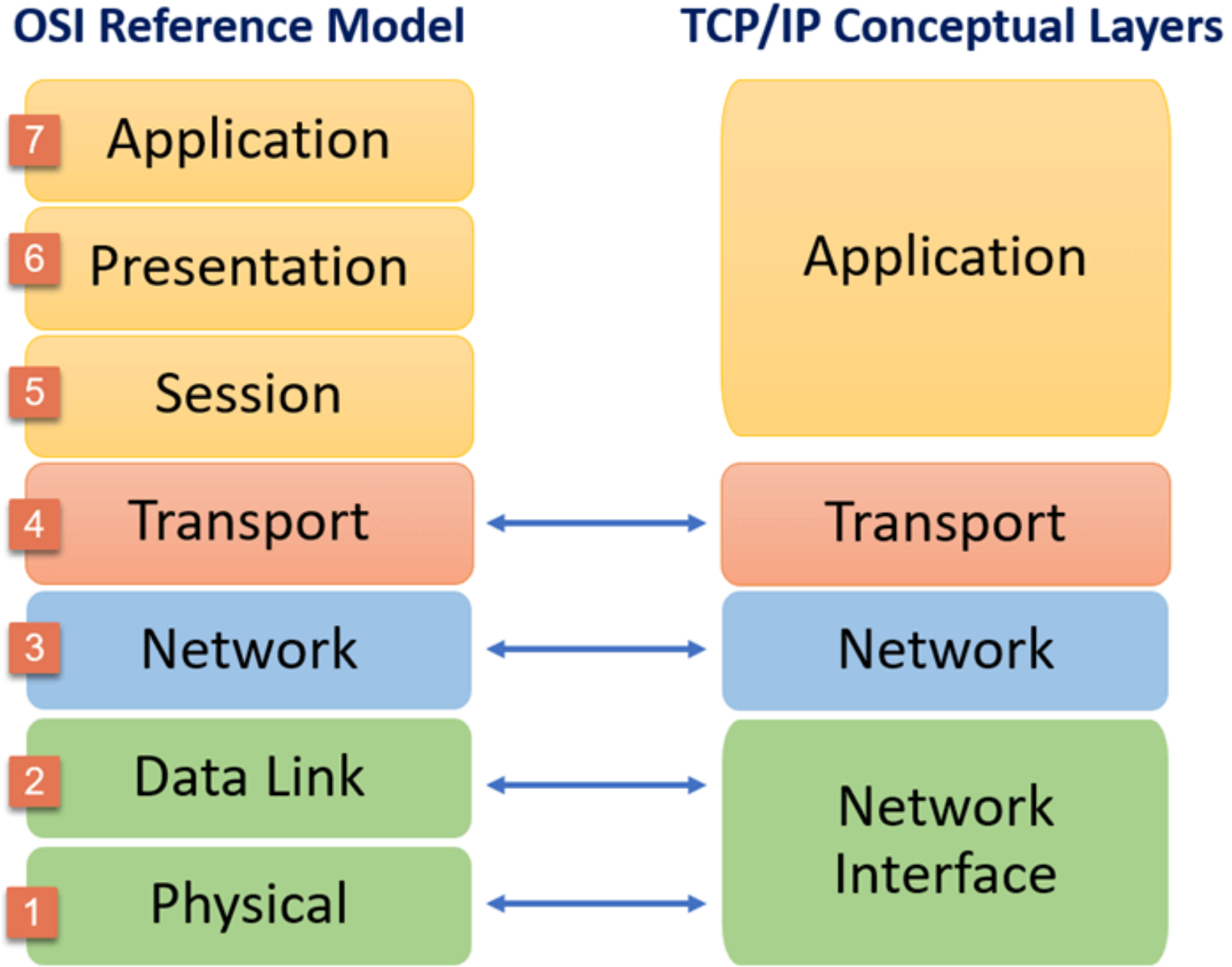
The Layered Model



The ISO/OSI Model



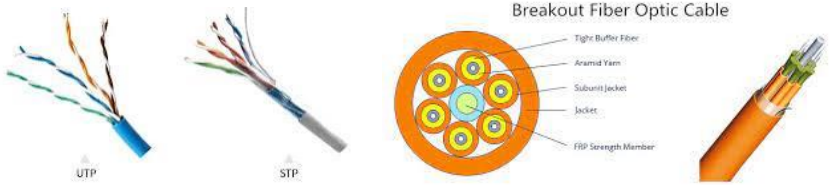
A Comparison



The Physical Layer – Layer 1

Devices/Protocols: **Hub**

- The lowest layer of the OSI model is responsible for
  - carrying raw bits on a physical medium.
- The physical medium could be: electrical wire or optical fibre, radio waves.



- Transmission medium standards such as types of connectors, wire specifications and signalling modes are all defined at this layer.

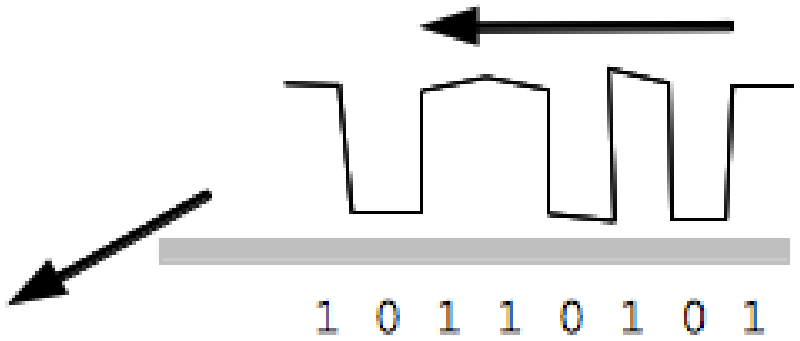
  - Data unit: Bits
  - Delivery type: Local

Functional Summary:

- Data Encoding,
- Physical Medium Attachment,
- Transmission,
- Baseband or Broadband,
- Physical medium transmission: Bits and Volts

The Physical Layer – Layer 1

2. Electrical wave, traveling down the wire



1. Send: write the bits on the wire, 3 volts for 1, 0 volts for 0.

10110101
00100011
...

packet

3. Receive: observe voltage pattern on the wire, reconstruct the 0's and 1's

The Datalink Layer – Layer 2

Devices: **Switch, Bridge**

Protocols: WAP, PPP, SLIP

- The second layer of the OSI model is responsible for providing local delivery of frames between two directly-connected devices.
- The Data Link layer has two components:
  - Media Access Control (MAC)
  - Logical link Control (LLC)
  - Data unit: Frames
  - Delivery type: Local

Functional Summary:

- Establishment & terminate the logical link between nodes
- Frame traffic control
- Frame Sequencing
- Frame Acknowledgement
- Frame delimiting
- Frame error checking
- Media access control

The Media Access Control (MAC) Layer

Media Access Control (MAC)

- The MAC component controls
  - the transmission and reception from the physical medium of layer 1.
  - It employs either the
    - Carrier Sense Multi Access with Collision Detection (CSMA/CD) or
    - Carrier Sense Multi Access with Collision Avoidance (CSMA/CA) algorithm for this purpose.

The Media Access Control (MAC) Layer

Media Access Control (MAC)

- Its main responsibilities include:
  - Check whether the physical link is free. If yes, transmit, otherwise receive.
  - Check if any collision occurred while transmitting.
    - If yes, it sends a signal to instruct other hosts to stop transmitting,
    - it then times out for a random period of time and then attempts retransmission.

The Logical Link Control (LLC) Layer

- Logical link Control (LLC)

- The LLC component provides the following capabilities:

  - Flow control
  - Error checking

  - Data unit: Frames
  - Delivery type: Local

The Logical Link Control (LLC) Layer

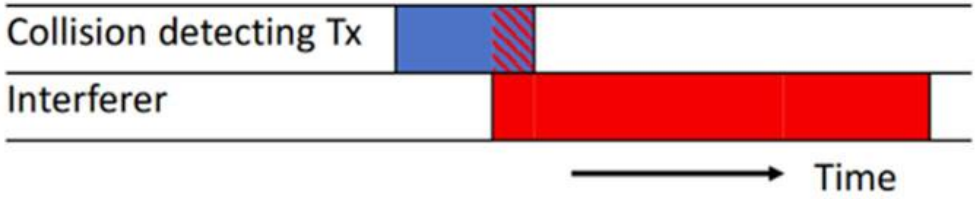
Logical link Control (LLC)

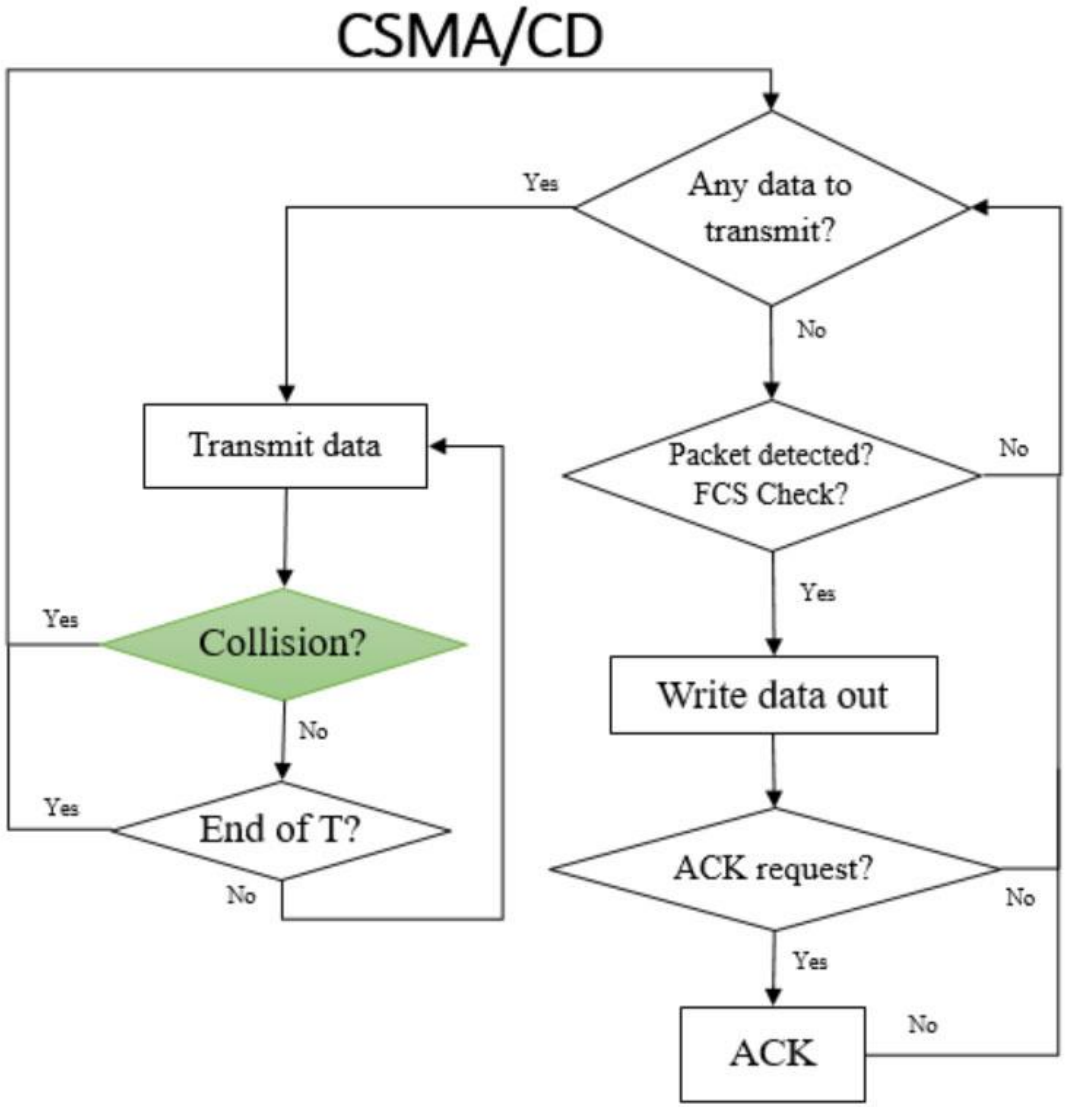
- Flow control - this prevents a fast sender from overwhelming a slow receiver.
  - Note that in actual network implementations, this LLC component is rarely used.
  - Flow control is generally provided by the Transport layer of the OSI model.

- Error checking - this allows retransmission of corrupt frames.
  - Like flow control, this is also rarely used.
  - In actual networks, error checking and retransmission is usually done in an end-to-end manner between two hosts.
  - However, in case of highly-lossy links such as WiFi, error checking of the LLC component is commonly used.

- Multiplexing of layer 3 protocols - this allows identifying which layer 3 protocol is encapsulated in a frame's data unit.

The Datalink Layer





The Network Layer – Layer 3

Router

Devices: **Routers**

Protocols: IP/IPX/ICMP

- The third layer is responsible for
  - providing global delivery of datagrams between two devices, that are not necessarily directly connected in a network.
  - The two devices may be in different networks with multiple routers and switches in between them, but as long as there is a single path available the Network layer can try (best-effort) to deliver datagrams.

- Data unit: Datagrams
- Delivery type: Global

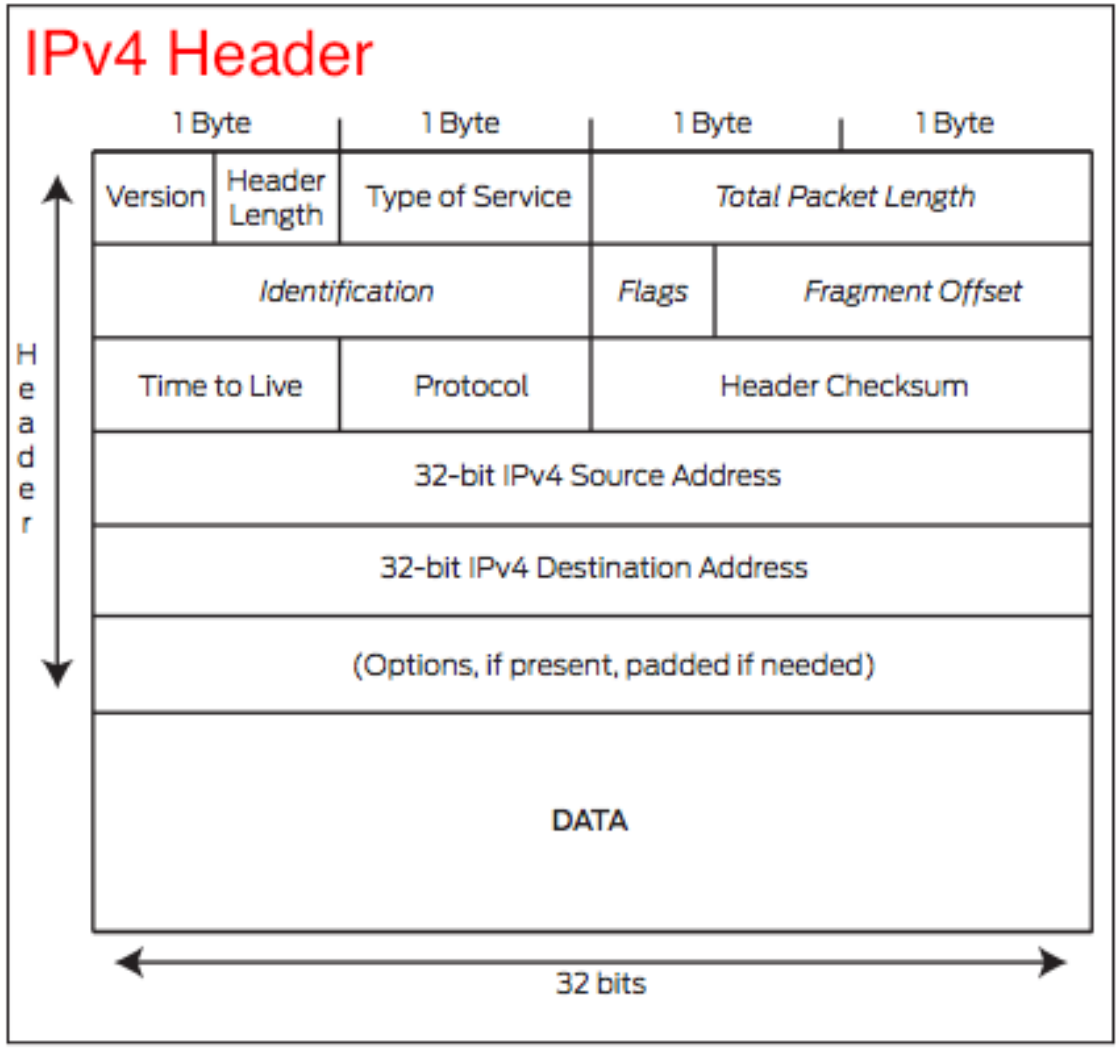
Functional Summary:

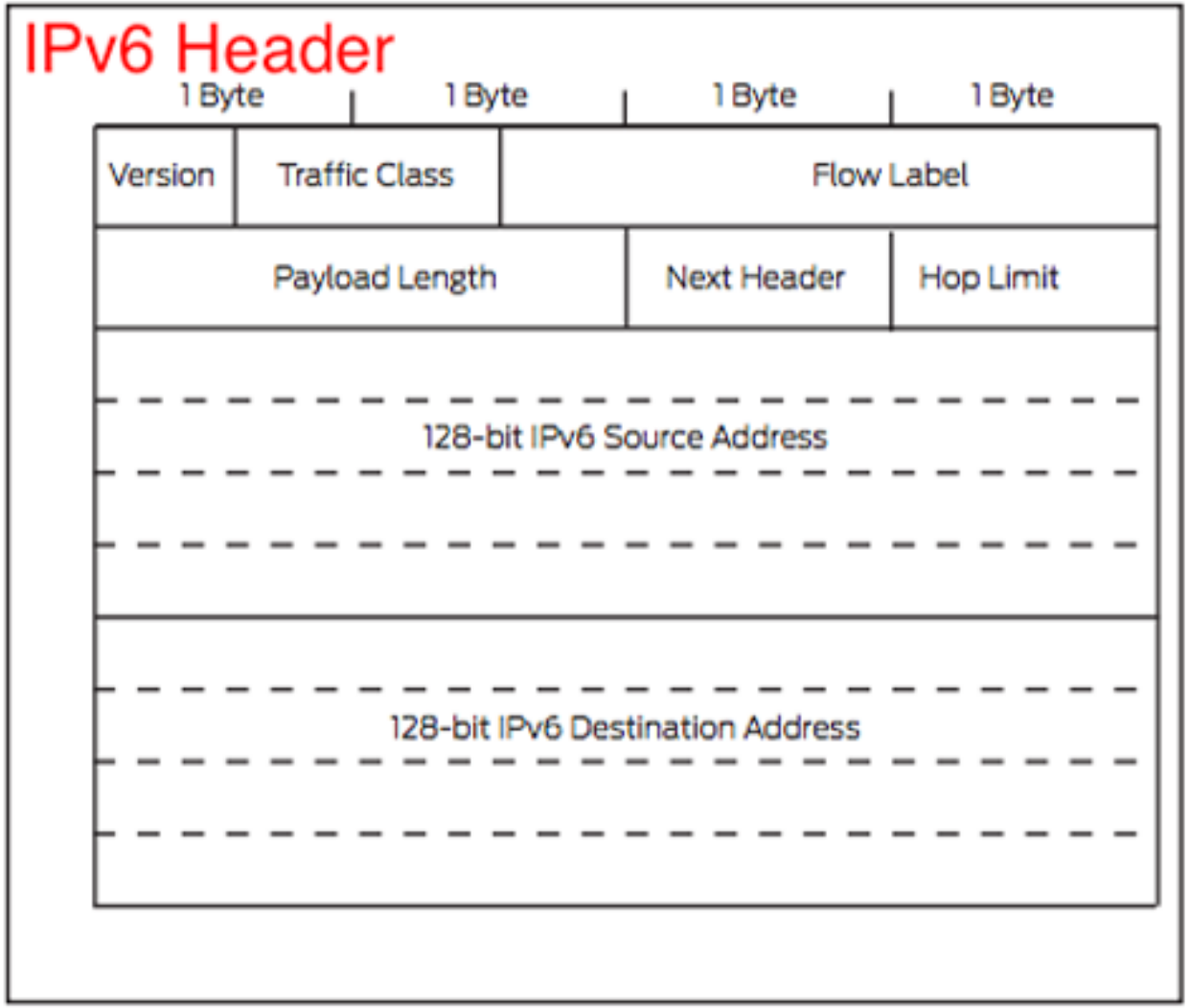
- Routing
- Subnet traffic control
- Frame fragmentation
- Logical-physical address mapping
- Subnet usage accounting

The Network Layer – Layer 3

- The network layer provides a best-effort delivery of datagrams with no guarantees on the following:
  - Ordering - datagrams may not necessarily be delivered in the same order as they were sent.
  - Integrity - datagrams may be corrupt.
  - Reliability - datagrams may be dropped and hence never make it to the receiver.
- Other than datagram forwarding, the Network layer is also responsible for host addressing.
- In the Internet Protocol (IP) each device on a network is identified using a 32-bit address (IPv4) or a 128-bit address (IPv6).

The Network Layer – Layer 3





The Transport Layer – Layer 4

Devices/Protocols: TCP/SPX/ UDP

- The Transport layer of the OSI model is responsible for
  - providing global delivery of segments between two devices, that are not necessarily directly connected in a network.

  - Data unit: Segments
  - Delivery type: Global

Functional Summary:

- Message segmentation
- Message acknowledgement
- Message traffic control
- Session multiplexing

The Transport Layer – Layer 4

- The Transport layer can provide both of the following:
  - Best-effort delivery of segments with no guarantees on
    - ordering,
    - integrity,
    - reliability and
    - with no congestion and flow control.
    - This is done using the User Datagram Protocol (UDP).
  - Reliable, in-order, intact delivery of segments
    - with both, flow and congestion control.
    - This is done using the Transmission Control Protocol (TCP).
  - While UDP and TCP are the most common level 4 protocols, there are other lesser-known transport protocols such as Stream Control Transmission Protocol (SCTP) which is used in cellular networks.

The Session Layer – Layer 5

Devices: Local ports

Protocols: RPC/SQL/NFS, NetBIOS

- The Session layer of the OSI model is responsible for
  - setting up,
  - breaking down and
  - managing a communication session for communication between two hosts.

- Data unit: Application Data
- Delivery type: Global

Functional Summary:

- Session establishment
- Session maintenance & termination
- Session support
- Security
- Name recognition
- Logging

The Session Layer – Layer 5

- The Session layer controls the following session-specific parameters:
  - Communication mode (full-duplex or half-duplex)
  - Check pointing interval (for fault-tolerance)
  - Authentication (for session security)

- In the TCP/IP model, the Session layer responsibilities are bundled into the Application later.

The Presentation Layer – Layer 6

Devices/Protocols:

ASCII, EBDIC, JPEG, TIFF, GIF

- The Presentation layer of the OSI model, also commonly known as the Syntax layer, is responsible for
  - managing how application data is formatted and
  - serialized in a packet.

- Data unit: Application Data
- Delivery type: Global

Functional Summary:

- Character code translation
- Data conversion
- Data compression
- Data encryption
- Character set translation

The Presentation Layer – Layer 6

- The Presentation layer manages the following data presentation parameters:
  - Encryption/Decryption (for security of data)
  - Compression (for bandwidth management)
  - Serialization (for managing how complex multi-dimensional data structures are to be represented as a linear array of 1s and 0s)

- Like Layer 5, the Presentation layer responsibilities are bundled into the Application layer in the TCP/IP model.

The Application Layer – Layer 7

Devices/Protocols: SMTP

- The top-most layer of the OSI model is responsible for
  - providing network access to end-users.
  - It abstracts away most the technicalities associated with network communication.

  - Data unit: Application Data
  - Delivery type: Global

Functional Summary:

- Resource sharing
- Remote file access
- Remote printer access
- Directory services
- Network management

The Application Layer – Layer 7

- Common layer 7 protocols include
  - Hyper Text Transfer protocol (HTTP),
  - File Transfer Protocol (FTP),
  - BitTorrent protocol and
  - many custom application-specific protocols such as those used by instant messaging applications.

Functions Summary

OSI (Open Source Interconnection) 7 Layer Model

Layer	Application/Example		Central Device/ Protocols		DOD4 Model
Application (7) Serves as the window for users and application processes to access the network services.	**End User layer** Program that opens what was sent or creates what is to be sent Resource sharing • Remote file access • Remote printer access • Directory services • Network management		**User Applications** SMTP	GATEWAY Can be used on all layers	Process
Presentation (6) Formats the data to be presented to the Application layer. It can be viewed as the "Translator" for the network.	**Syntax layer** encrypt & decrypt (if needed) Character code translation • Data conversion • Data compression • Data encryption • **Character Set Translation**		JPEG/ASCII EBDIC/TIFF/GIF PICT		
Session (5) Allows session establishment between processes running on different stations.	**Synch & send to ports** (logical ports) Session establishment, maintenance and termination • Session support - perform security, name recognition, logging, etc.		**Logical Ports** RPC/SQL/NFS NetBIOS names		
Transport (4) Ensures that messages are delivered error-free, in sequence, and with no losses or duplications.	**TCP** Host to Host, Flow Control Message segmentation • Message acknowledgement • Message traffic control • Session multiplexing	PACKET FILTERING	TCP/SPX/UDP		Host to Host
Network (3) Controls the operations of the subnet, deciding which physical path the data takes.	**Packets** ("letter", contains IP address) Routing • Subnet traffic control • Frame fragmentation • Logical-physical address mapping • Subnet usage accounting		**Routers** IP/IPX/ICMP		Internet
Data Link (2) Provides error-free transfer of data frames from one node to another over the Physical layer.	**Frames** ("envelopes", contains MAC address) [NIC card — Switch — NIC card] (end to end) Establishes & terminates the logical link between nodes • Frame traffic control • Frame sequencing • Frame acknowledgment • Frame delimiting • Frame error checking • Media access control		**Switch Bridge WAP** PPP/SLIP	Land Based Layers	Network
Physical (1) Concerned with the transmission and reception of the unstructured raw bit stream over the physical medium.	**Physical structure** Cables, hubs, etc. Data Encoding • Physical medium attachment • Transmission technique - Baseband or Broadband • Physical medium transmission Bits & Volts		**Hub**		

Signaling

Signaling

- The communication between two end-points involves two *planes*:
  - a *user* plane and
  - a *control* plane.

Signaling

The control flow of information is called signaling.

Control plane protocols are called signaling protocols.

A coordinated set of signaling protocols and entities is called a signaling system.

References

1. Nevio Benvenuto and Michele Zorzi, (2011). Principles of Communications Networks and Systems, John Wiley.

2. Thomas Robertazzi, (2011). Basics of Computer Networking (Springer Briefs in Electrical and Computer Engineering), Springer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