Network Protocol

➢ **A network protocol** is an established set of rules that determine how data is transmitted between different devices in the same network. It allows connected devices to communicate with each other, regardless of any differences in their internal processes, structure or design.

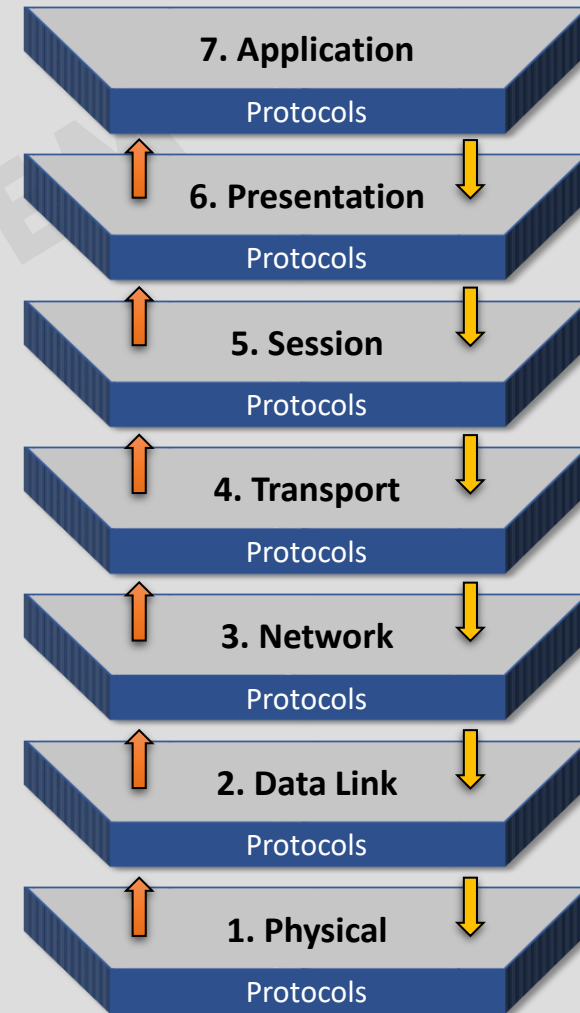➢ **A protocol suite** is a collection of protocols that are designed to work together.

➢ List of Network Protocols :

- Communication
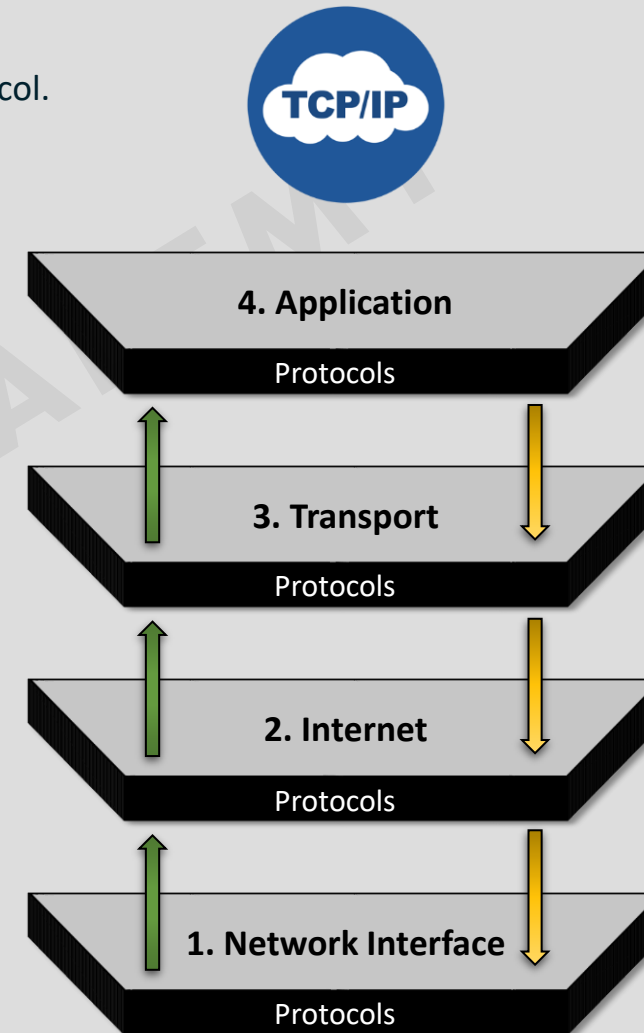
- Network management

- Security

Open Systems Interconnection model (OSI Model)

➢ **OSI model** is a conceptual model which provides standards and enables divers communication systems to communicate with each other.

➢ **OSI model** created by the International Organization for Standardization (ISO).

➢ **OSI model** was published in 1984.

➢ **OSI model** partitions a communication system into 7 abstraction layers.

➢ **A layer** serves the layer above it and is served by the layer below it.

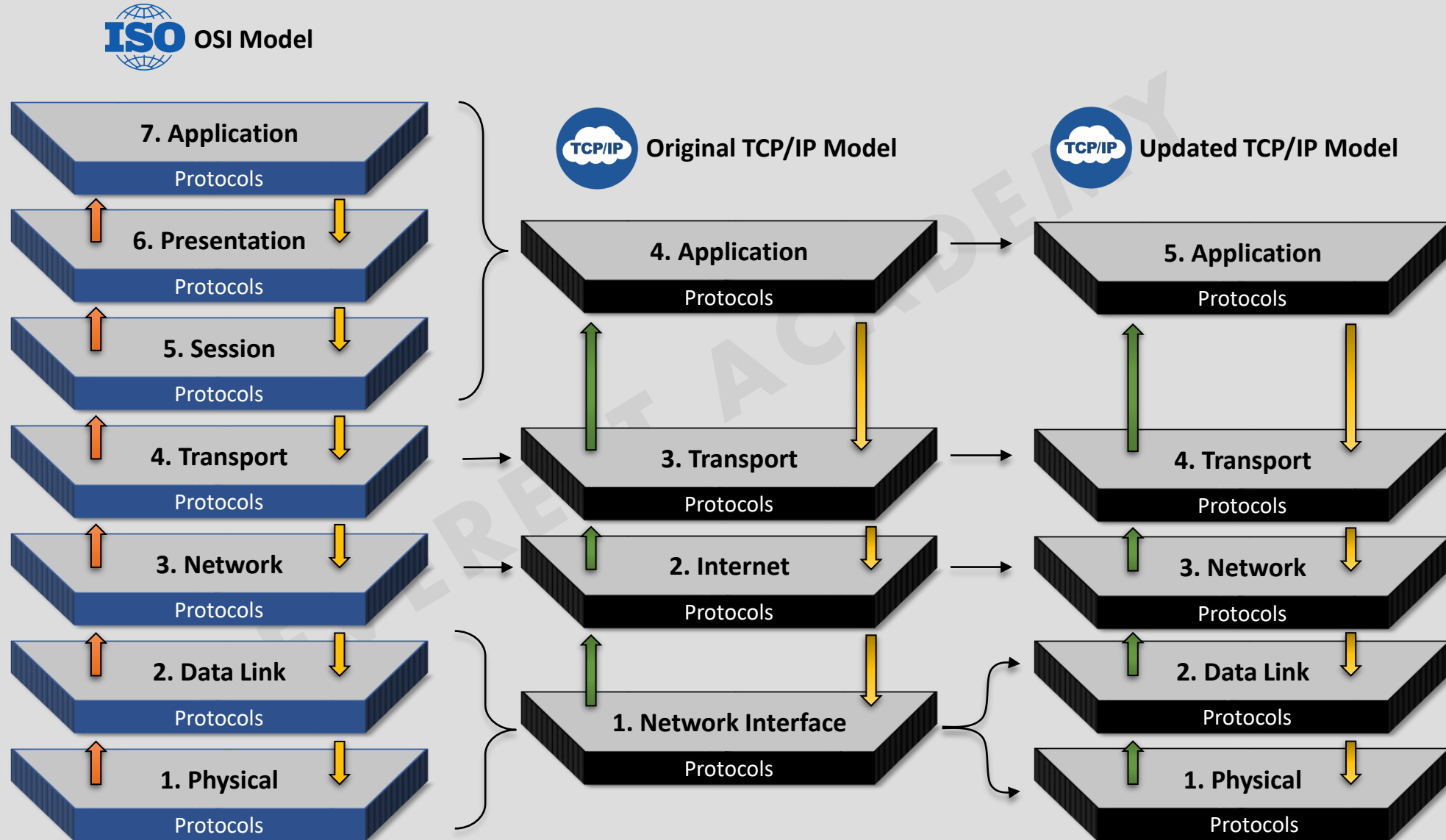➢ **Each layer** has a set of protocols.

ISO

| 7. Application |
| Protocols |
| 6. Presentation |
| Protocols |
| 5. Session |
| Protocols |
| 4. Transport |
| Protocols |
| 3. Network |
| Protocols |
| 2. Data Link |
| Protocols |
| 1. Physical |
| Protocols |

TCP/IP Model

➢ **TCP/IP** stands for Transmission Control Protocol/Internet Protocol.

➢ **TCP/IP Model** was designed in 1970s.

➢ **TCP/IP Model** is a set of communications protocols used for communicating computers over the Internet.

➢ **TCP/IP Model** is named from two of the most important protocols in it : the Transmission Control Protocol (TCP) and the Internet Protocol (IP).

➢ **The original TCP/IP Model** consists of four layers.

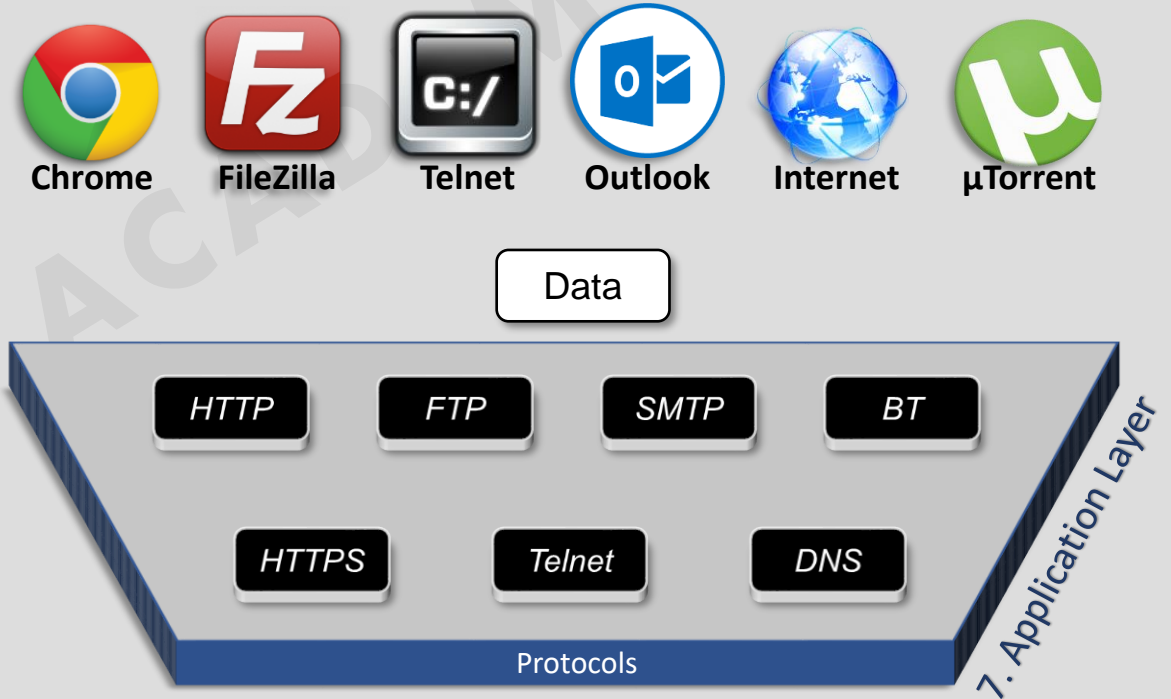➢ **TCP/IP Model** known as Internet Protocol Suite (TCP/IP).

TCP/IP

| 4. Application |
| Protocols |
| 3. Transport |
| Protocols |
| 2. Internet |
| Protocols |
| 1. Network Interface |
| Protocols |

Comparison of TCP/IP and OSI Layering

ISO OSI Model

TCP/IP Original TCP/IP Model

TCP/IP Updated TCP/IP Model

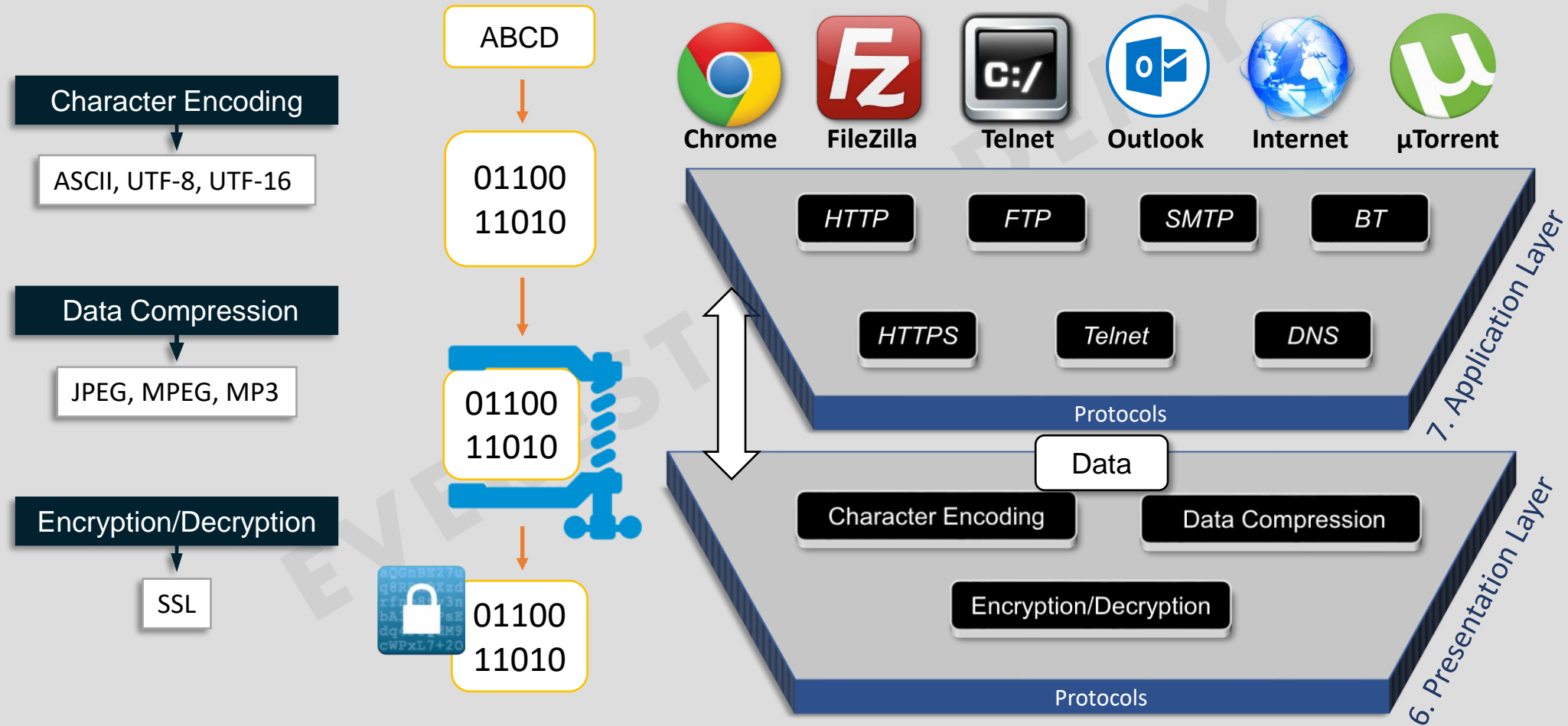| OSI Model	Original TCP/IP Model	Updated TCP/IP Model
7. Application — Protocols	4. Application — Protocols	5. Application — Protocols
6. Presentation — Protocols		
5. Session — Protocols		
4. Transport — Protocols	3. Transport — Protocols	4. Transport — Protocols
3. Network — Protocols	2. Internet — Protocols	3. Network — Protocols
2. Data Link — Protocols	1. Network Interface — Protocols	2. Data Link — Protocols
1. Physical — Protocols		1. Physical — Protocols

Layer 7 (Application Layer)

➢ **The Application Layer** contains a variety of protocols that are commonly needed by applications.

- ➢ Hypertext Transfer Protocol (HTTP).
- ➢ Hypertext Transfer Protocol Secure (HTTPS)
- ➢ File Transfer Protocol (FTP).
- ➢ Teletype Network (Telnet).
- ➢ Simple Mail Transfer Protocol (SMTP).
- ➢ Domain Name System (DNS).
- ➢ BitTorrent (BT)

Chrome   **FileZilla**   **Telnet**   **Outlook**   **Internet**   **µTorrent**

Data

| HTTP | FTP | SMTP | BT |

| HTTPS | Telnet | DNS |

Protocols

7. Application Layer

Layer 6 (Presentation Layer)

➢ **The Presentation layer** is responsible for the formatting and delivery of information to the application layer for further processing or display.

Character Encoding

ASCII, UTF-8, UTF-16

Data Compression

JPEG, MPEG, MP3

Encryption/Decryption

SSL

ABCD

01100 11010

01100 11010

01100 11010

Chrome   **FileZilla**   **Telnet**   **Outlook**   **Internet**   **µTorrent**

HTTP   FTP   SMTP   BT

HTTPS   Telnet   DNS

Protocols

7. Application Layer

Data

Character Encoding   Data Compression

Encryption/Decryption

Protocols

6. Presentation Layer

Layer 5 (Session Layer)

➢ **The Session Layer** provides the mechanism for opening, closing and managing a session between end-user application processes.
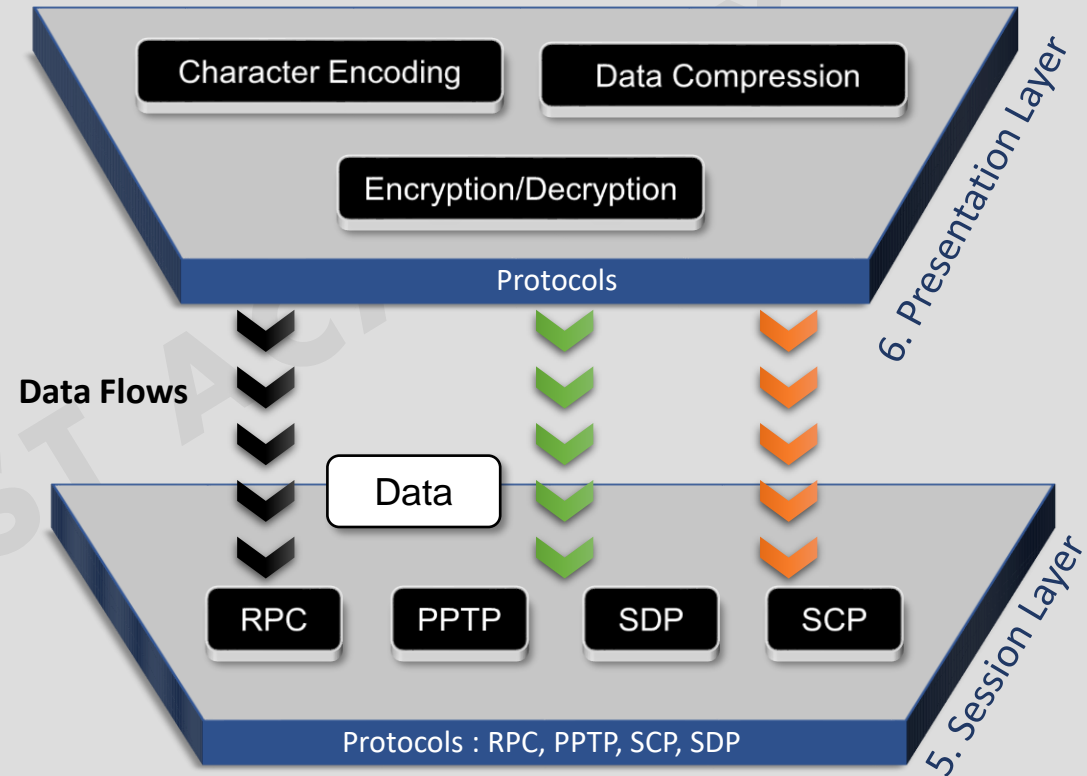
❖ **Services :**

Authentication

Authorization

user
****

☑ read
☒ write

Character Encoding   Data Compression

Encryption/Decryption

Protocols

Data Flows

Data

RPC   PPTP   SDP   SCP

6. Presentation Layer

5. Session Layer

Protocols : RPC, PPTP, SCP, SDP

❖ **Protocols :**

- Remote procedure call protocol (RPC)
- Point-to-Point Tunneling Protocol (PPTP)
- Session Control Protocol (SCP)
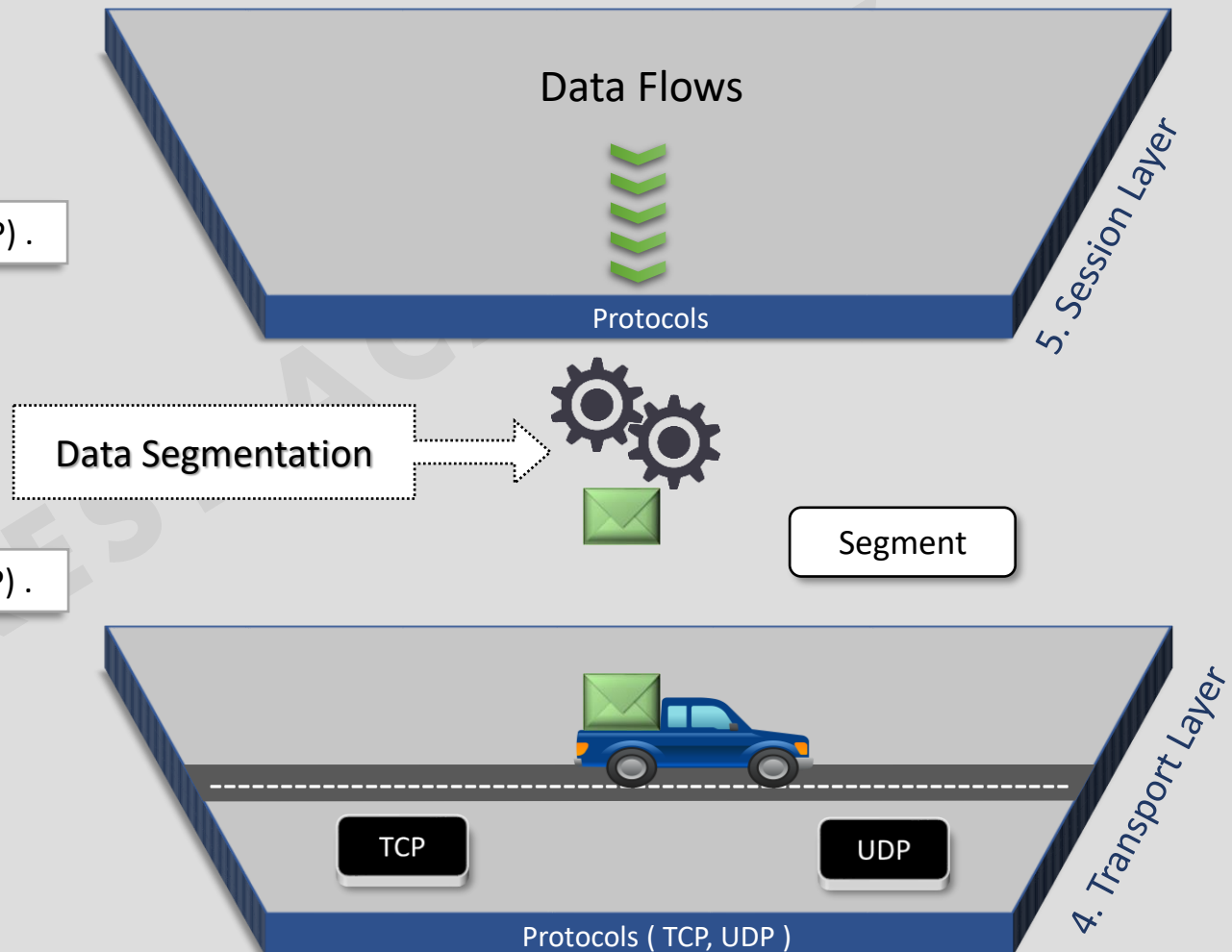- Session Description Protocol (SDP).

Layer 4 (Transport Layer)

➢ **The Transport Layer** provides the communication services directly to the application processes running on different hosts.

❖ **Protocols :**

- Transmission Control Protocol (TCP) .

- User Datagram Protocol (UDP) .

❖ **Services :**

- Connection-oriented network (TCP) .

- Connectionless network (UDP) .

- Segmentation and reassembly .

- Errer Recovery .

Data Flows

Protocols

5. Session Layer

Data Segmentation

Segment

TCP   UDP

Protocols (TCP, UDP)
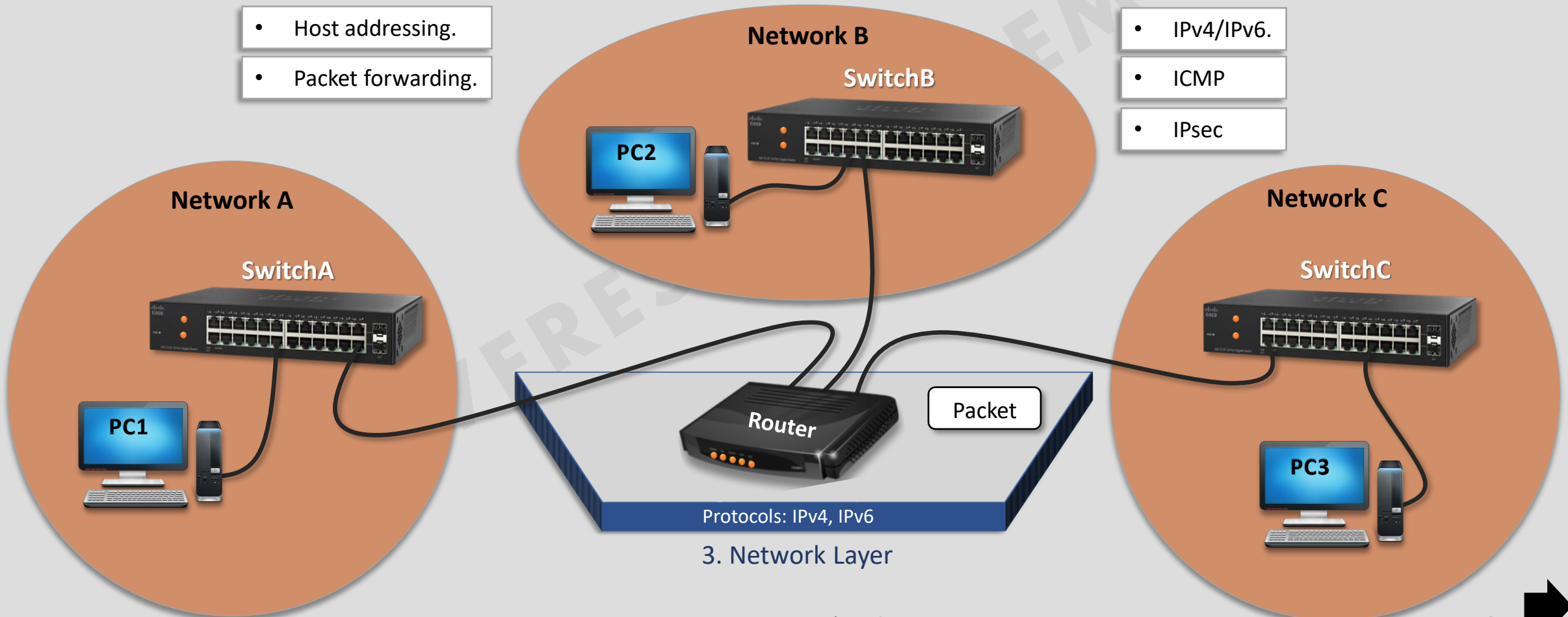
4. Transport Layer

Layer 3 (Network Layer)

➢ **The Network layer** is responsible for packet forwarding between different networks through intermediate routers.

❖ **Services :**

- Host addressing.
- Packet forwarding.

❖ **Protocols :**

- IPv4/IPv6.
- ICMP
- IPsec

Network B

SwitchB

PC2

Network A

SwitchA

PC1

Network C

SwitchC

PC3

Router

Packet

Protocols: IPv4, IPv6

3. Network Layer
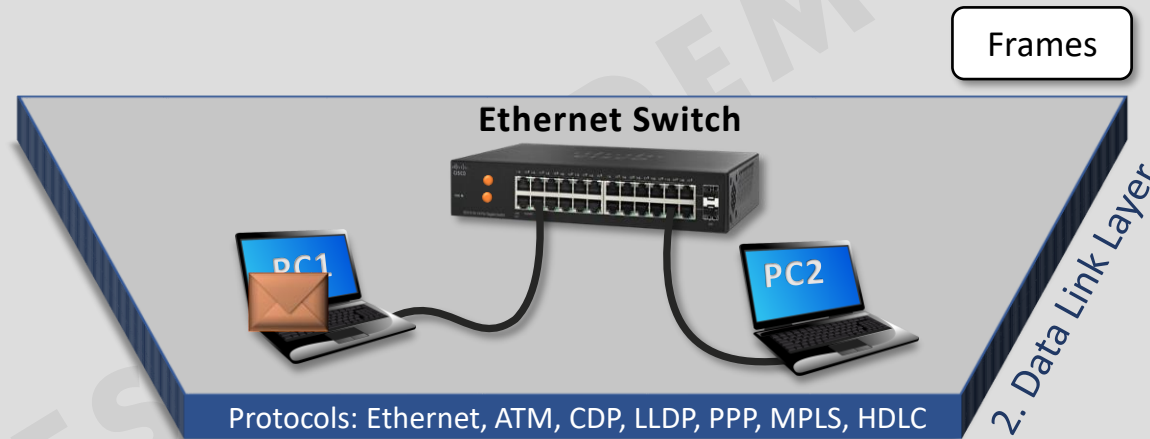
Layer 2 (Data Link Layer)

➢ **The Data Link Layer** transfers data between adjacent network nodes in WAN, MAN and LAN.

❖ **Services :**

- Encapsulation of packets into frames.
- Frame synchronization.
- Flow control.
- Physical addressing.
- Frame Switching.
- Error detection and correction.

Frames

Ethernet Switch

PC1

PC2

Protocols: Ethernet, ATM, CDP, LLDP, PPP, MPLS, HDLC

2. Data Link Layer

❖ **Protocols :**

- Ethernet.
- Asynchronous Transfer Mode (ATM).
- Cisco Discovery Protocol (CDP) .
- Link Layer Discovery Protocol (LLDP).

- Point-to-Point Protocol (PPP).
- Multiprotocol Label Switching (MPLS).
- High-Level Data Link Control (HDLC).

Layer 2 (Data Link Layer) - Sublayers

➢ **The Data Link Layer** is an interface between the network and physical layer. It is further subdivided into two protocol sublayers medium access control (MAC) and logical link control (LLC).

Frames

2. Data Link Layer

Protocols

(LLC) sublayer

Protocols

(MAC) sublayer

Protocols
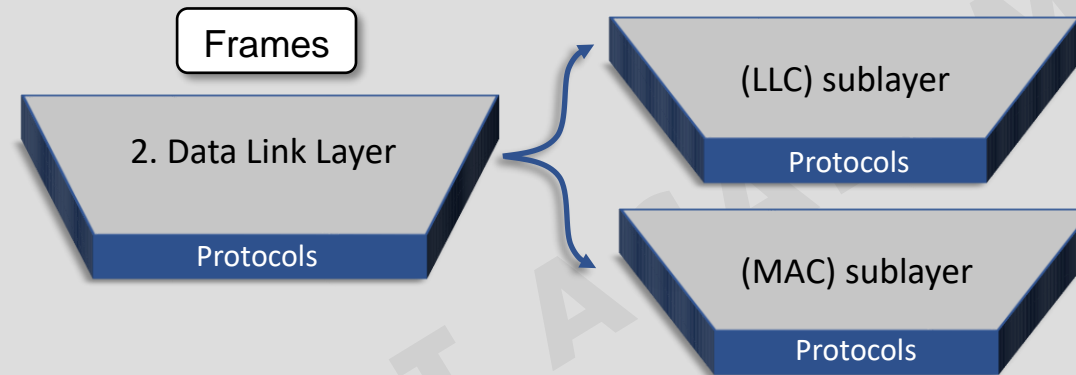
➢ The medium access control (MAC) sublayer.	➢ The logical link control (LLC) sublayer.
• Prepend/remove preamble.	• Synchronization.
• Append/remove/check FCS.	• Flow control.
• Discard malformed frames.	• Error management.
• Moving data frames from one NIC to another.	
• Control for accessing the transmission medium.	

Layer 2 (Data Link Layer) - MAN

> **Data Link Layer** transfers data between adjacent network switches in a MAN network.

> **Multiservice Switch**
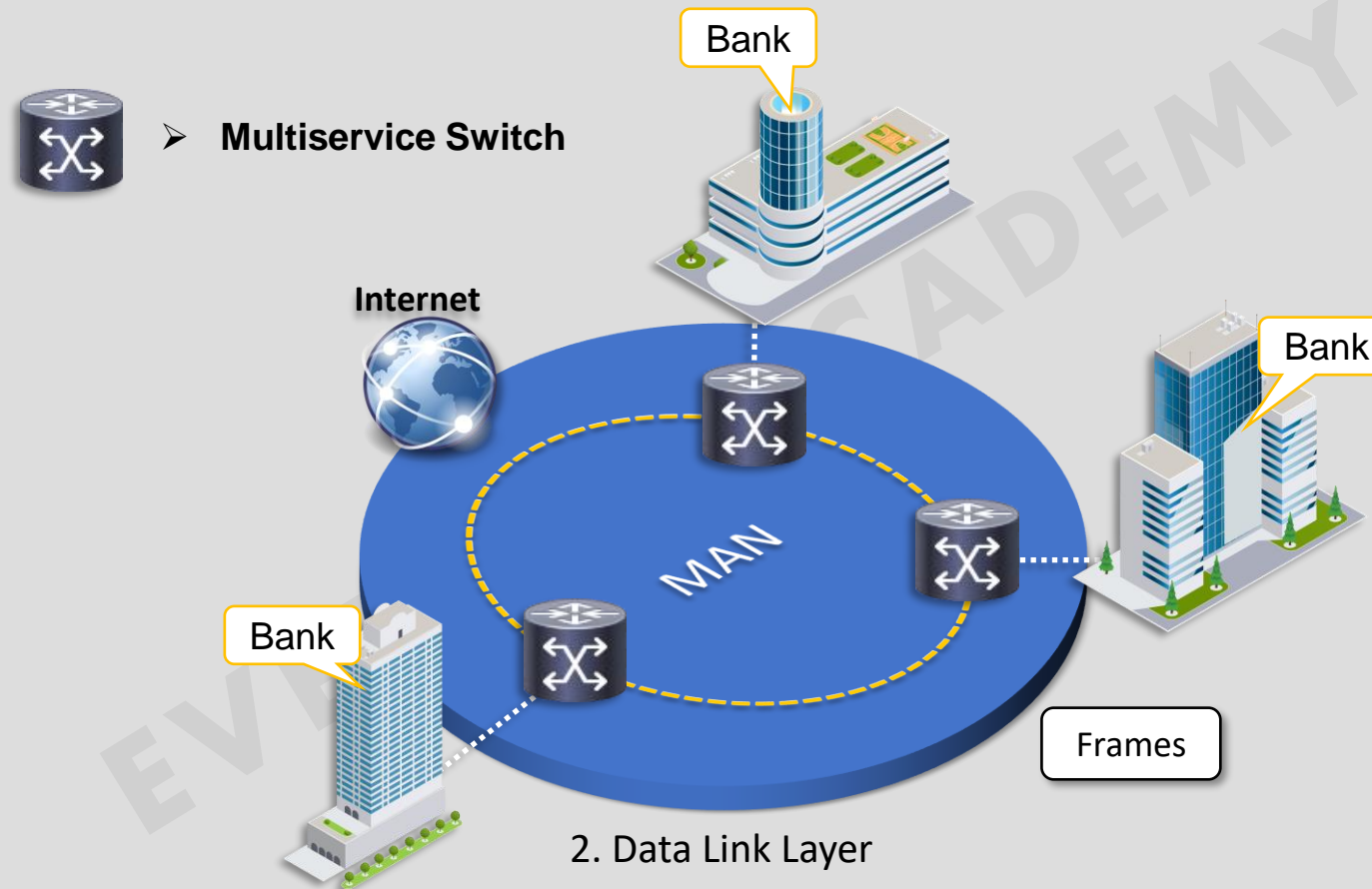
2. Data Link Layer

Layer 2 (Data Link Layer) - WAN

➢ **Data Link Layer** transfers data between adjacent network routers in a WAN network.

2. Data Link Layer
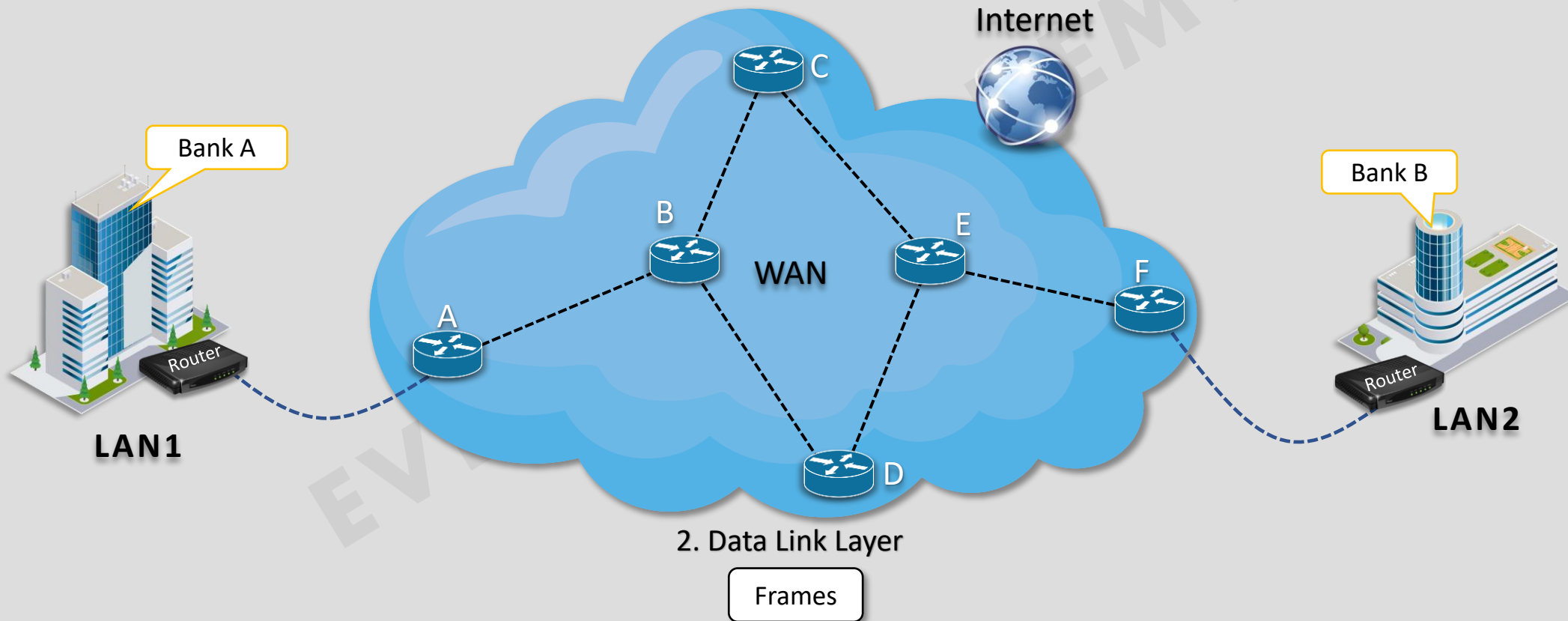
Frames

Layer 1 (Physical Layer)

➢ **The Physical Layer converts** data link layer frames into bits and puts them on the network medium.

- Electrical signals (Analog or Digital).

- Wi-Fi signals.

- LED Light or Laser pulses.

2. Data Link Layer

Frame   Frame

Frames

Protocols

1. Physical Layer

0011001101   0011001101

bits

Protocols : Media, Signal, Binary Transmission.
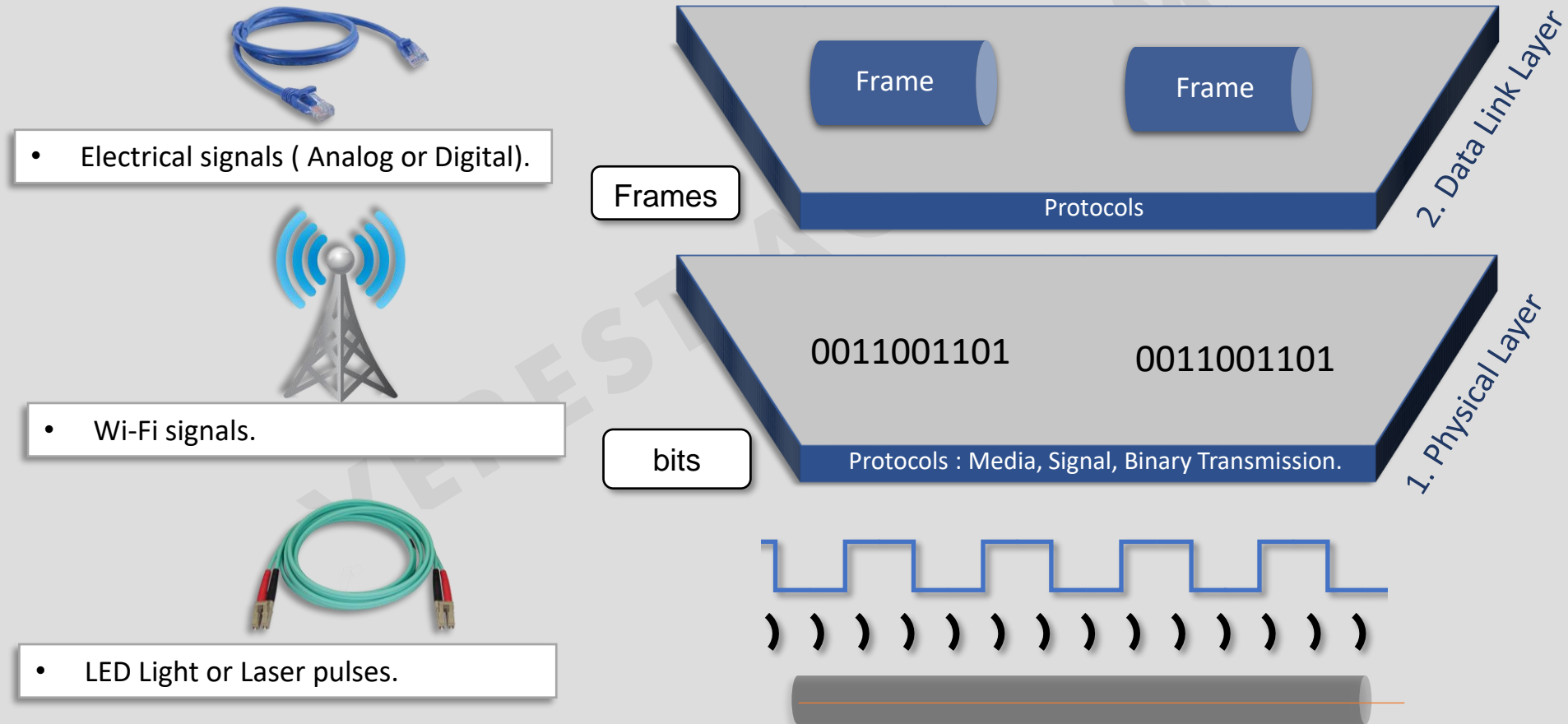
Data Encapsulation (OSI model)

➢ **Data Encapsulation** is the process of putting **headers** or **trailers** to the data supplied by the higher layer.

➢ **The header and data** at each layer are **called Protocol Data Unit (PDU).**

Layer	PDU
7. Application — Protocols	Data | L7 Header — **L7 PDU**
6. Presentation — Protocols	Data | L6 Header — **L6 PDU**
5. Session — Protocols	Data | L5 Header — **L5 PDU**
4. Transport — Protocols	Data | L4 Header — **L4 PDU**
3. Network — Protocols	Data | L3 Header — **L3 PDU**
2. Data Link — Protocols	L2 Trailer | Data | L2 Header — **L2 PDU**
1. Physical — Protocols	01011010100010111010010110111000101010110001010110110100

Data De-encapsulation (OSI model)

➢ **Data De-encapsulation** is the process of removing the **header** and the **trailer** from the PDU before passing it up to the higher layer.

OSI Layer	PDU
7. Application — Protocols	Data / L7 Header — **L7 PDU**
6. Presentation — Protocols	Data / L6 Header — **L6 PDU**
5. Session — Protocols	Data / L5 Header — **L5 PDU**
4. Transport — Protocols	Data / L4 Header — **L4 PDU**
3. Network — Protocols	Data / L3 Header — **L3 PDU**
2. Data Link — Protocols	L2 Trailer / Data / L2 Header — **L2 PDU**
1. Physical — Protocols	0101101010001011101001011011100010101011000101011011100100
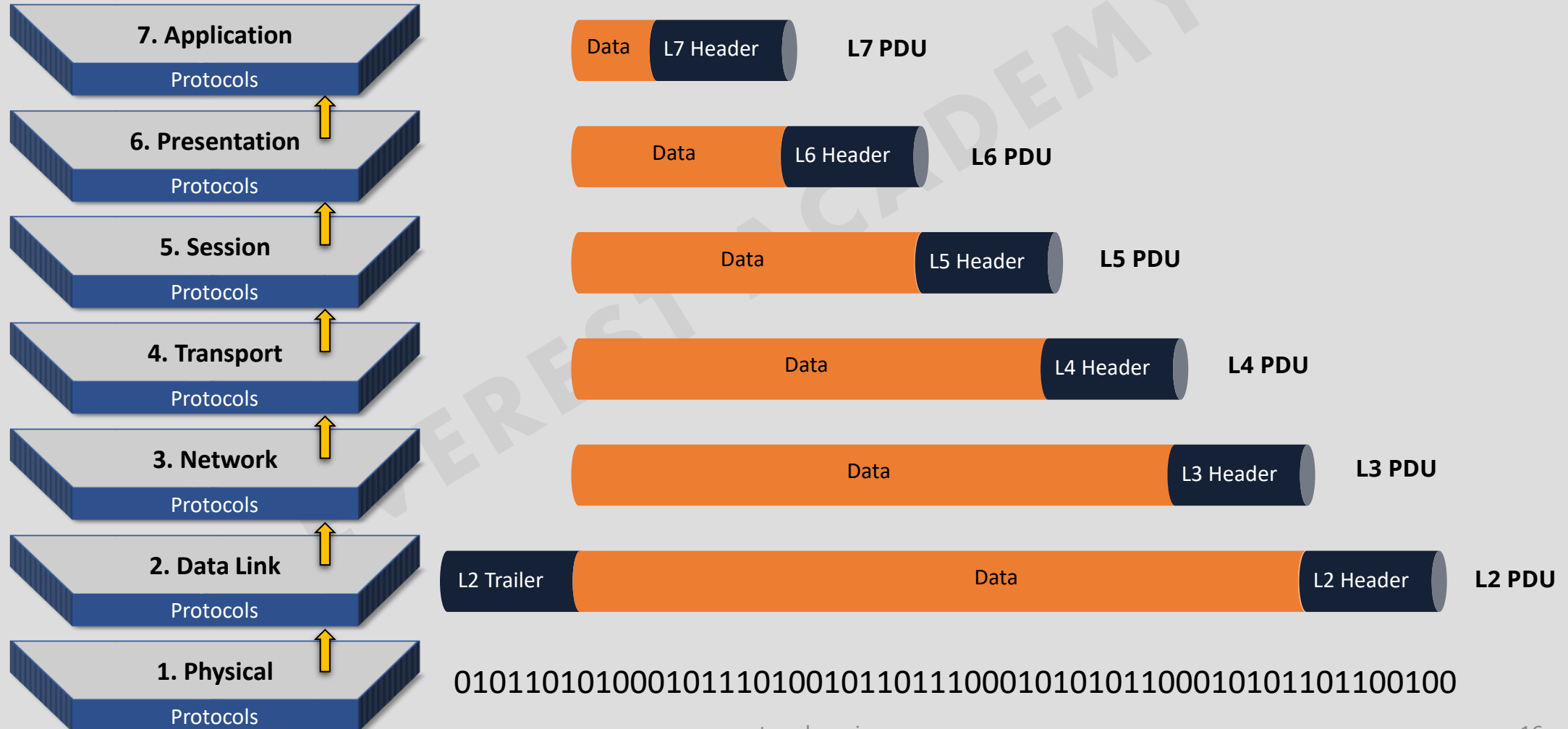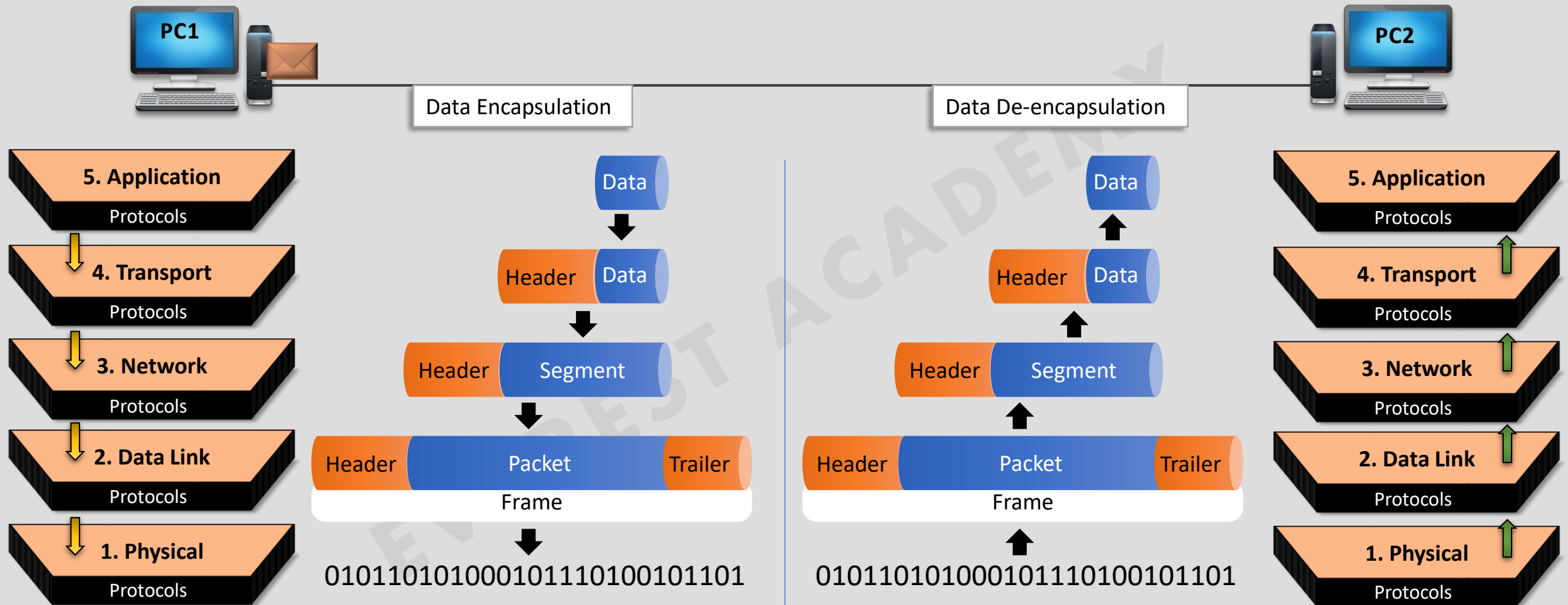
Data Encapsulation and De-encapsulation (TCP/IP model)

Data Encapsulation and De-encapsulation (TCP/IP model)

PC1

Switch

Data Encapsulation

Data De-encapsulation

5. Application
Protocols

4. Transport
Protocols

3. Network
Protocols

2. Data Link
Protocols

1. Physical
Protocols

Data

Header | Data

Header | Segment

Header | Packet | Trailer
Frame

01011010100010111010 0101101

Header | Packet | Trailer
Frame

01011010100010111010 0101101

2. Data Link
Protocols

1. Physical
Protocols

Data Encapsulation and De-encapsulation (TCP/IP model)

Switch

Router

Data Encapsulation

Data De-encapsulation

3. Network
Protocols

2. Data Link
Protocols

Header	Segment

2. Data Link
Protocols

Header	Packet	Trailer
Frame

Header	Packet	Trailer
Frame

2. Data Link
Protocols

1. Physical
Protocols

01011010100010111010010110l

01011010100010111010010110l

1. Physical
Protocols

Data Encapsulation and De-encapsulation (TCP/IP model)

Router

Switch

Data Encapsulation

Data De-encapsulation

3. Network
Protocols

2. Data Link
Protocols

1. Physical
Protocols

| Header | Segment |

| Header | Packet | Trailer |
Frame

0101101010001011101001 01101

| Header | Packet | Trailer |
Frame

0101101010001011101001 01101

2. Data Link
Protocols

1. Physical
Protocols

Data Encapsulation and De-encapsulation (TCP/IP model)

Switch

PC2

Data Encapsulation

Data De-encapsulation

Data

Header	Data

Header	Segment

Header	Packet	Trailer
Frame

Header	Packet	Trailer
Frame

2. Data Link
Protocols

1. Physical
Protocols

0101101010001011101001011 01

0101101010001011101001011 01

5. Application
Protocols

4. Transport
Protocols

3. Network
Protocols

2. Data Link
Protocols

1. Physical
Protocols