



BATCH : B146-149 CS & DevOps
LESSON : Network
DATE : 03.07.2023
SUBJECT : Network Models

ZOOM GİRİŞLERİNİZİ LÜTFEN **LMS** SİSTEMİ ÜZERİNDEN YAPINIZ





NETWORK Day 2

- Bugünkü dersin pre-class materyalini incelediniz mi?

ARPANET is the beginning of network and Internet.

Network is **connection of nodes, computers**.

Hub, switch, router are nodes that connect computers/networks.

Data is packed and converted to signals **depending on some rules called protocols**.

Networks are classified according to **geographical** or **topological** installation. LAN, MAN, WAN or Star, Mesh, Tree ..



Contents

- Network Models
- OSI
- TCP/IP

İçerik

- Network Modelleri
- OSI Modeli
- TCP/IP Modeli





Introduction

Network device manufacturers produced devices and those could not communicate with each other. To have compliance among devices some standards were developed.

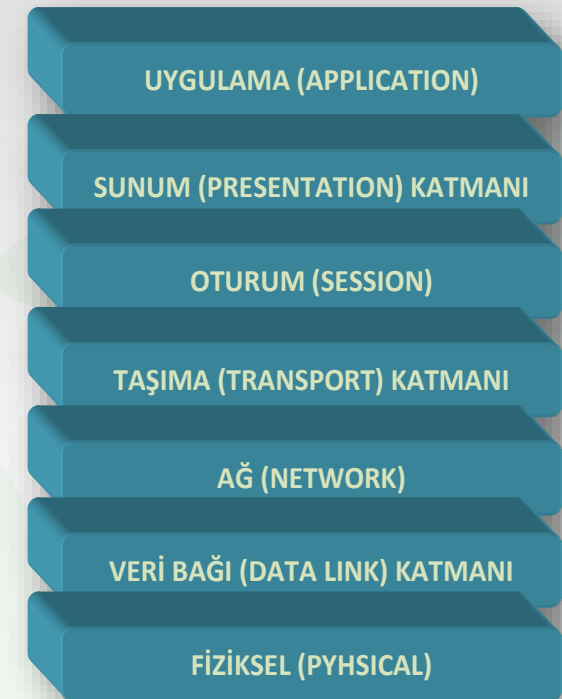
The most common standards are:

- ❖ IEEE 802 Community Standards,
- ❖ Open System InterConnection - OSI Standards or as we name it, **OSI Model (1983)**,
- ❖ The Standards that are based on the Project of US Department Of Defense, as we name it **TCP/IP**,
- ❖ The Hybrid Model (TCP/IP Updated) that combines both.



OSI Model

- ❖ Developed to enable communication of different computer systems.
- ❖ Accepted by ISO in 1984.
- ❖ OSI model suggests a 7 layer network system in order to solve communication problem.





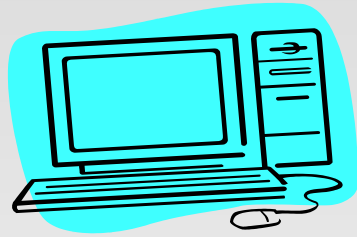
OSI Model

7 Layer OSI Model offers:

- ❖ Avoiding chaos and helping people develop expertise on specific layers.
- ❖ Enable different hardware and software products to work in cooperation.
- ❖ Enable cooperation of experts on various areas or co-work and task sharing.
- ❖ A modification on a layer may not affect others.
- ❖ Layer functions may be understood easily.
- ❖ Detection and solution of a problem might be easy.



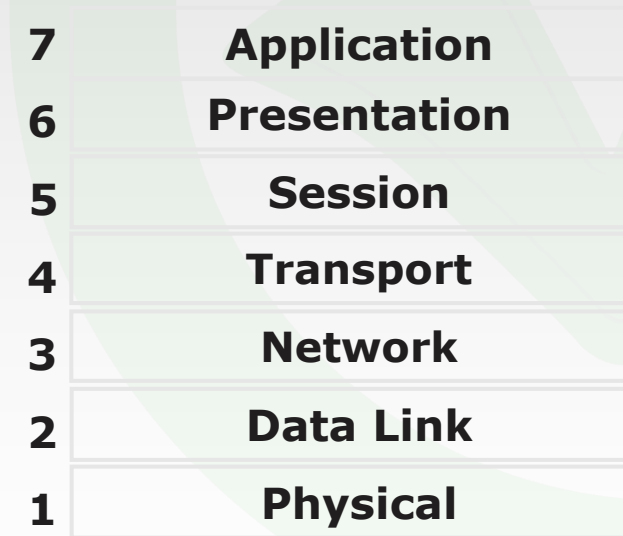
OSI Model



Terminal A



Terminal B





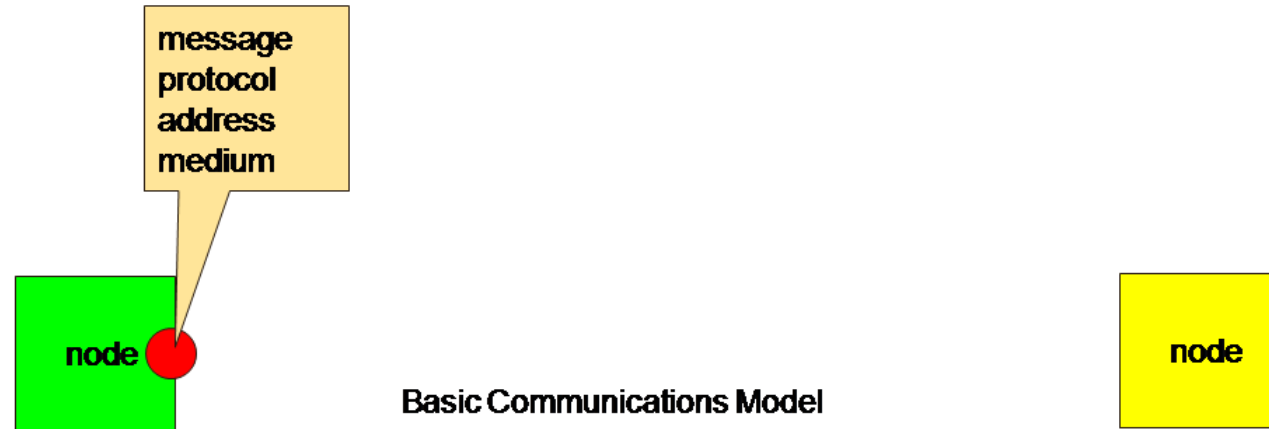
OSI Model



What is a Network?

Network Elements

- Nodes
- Protocol
- Medium
- Network Software

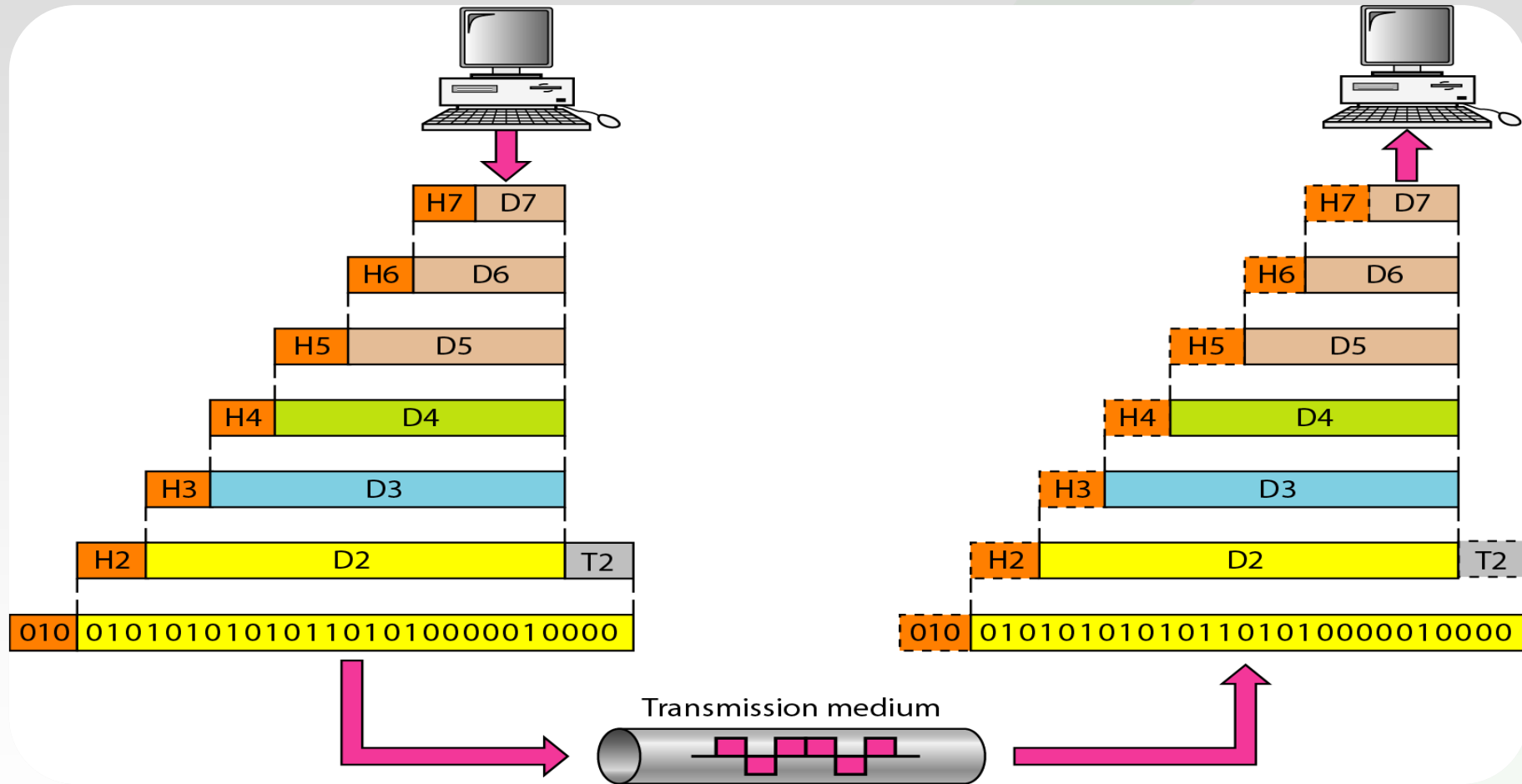


How does a Network operate?

In a computer network, data (voice, video, text) is packed according to a set of rules named as protocol. Then these packets of data are converted to signals. These signals are sent to the other node by means of a medium such as a copper wire, a fiber optical cable or radio waves. The message goes to the address of the other node. Address can be a MAC address or IP address.

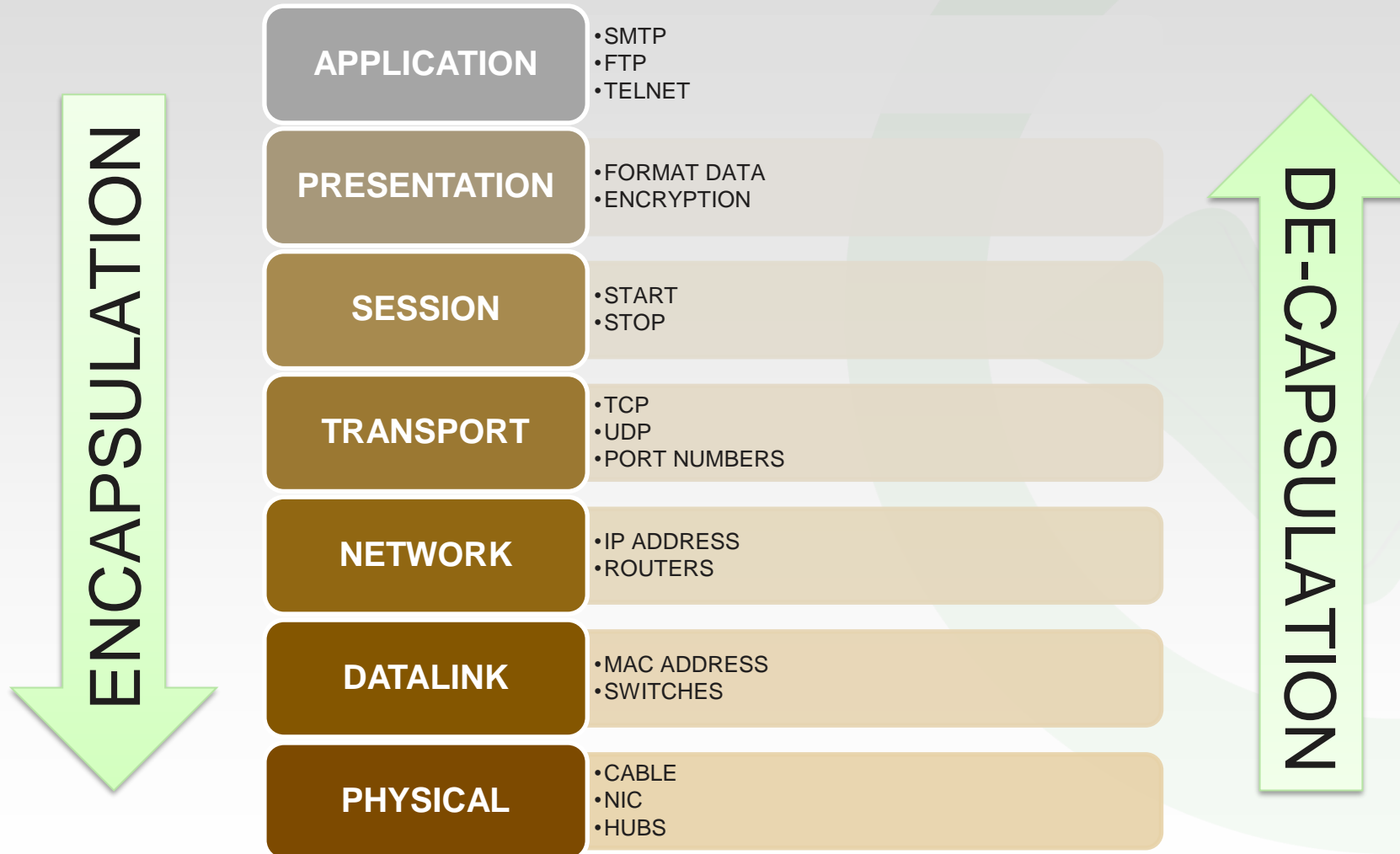


OSI Model



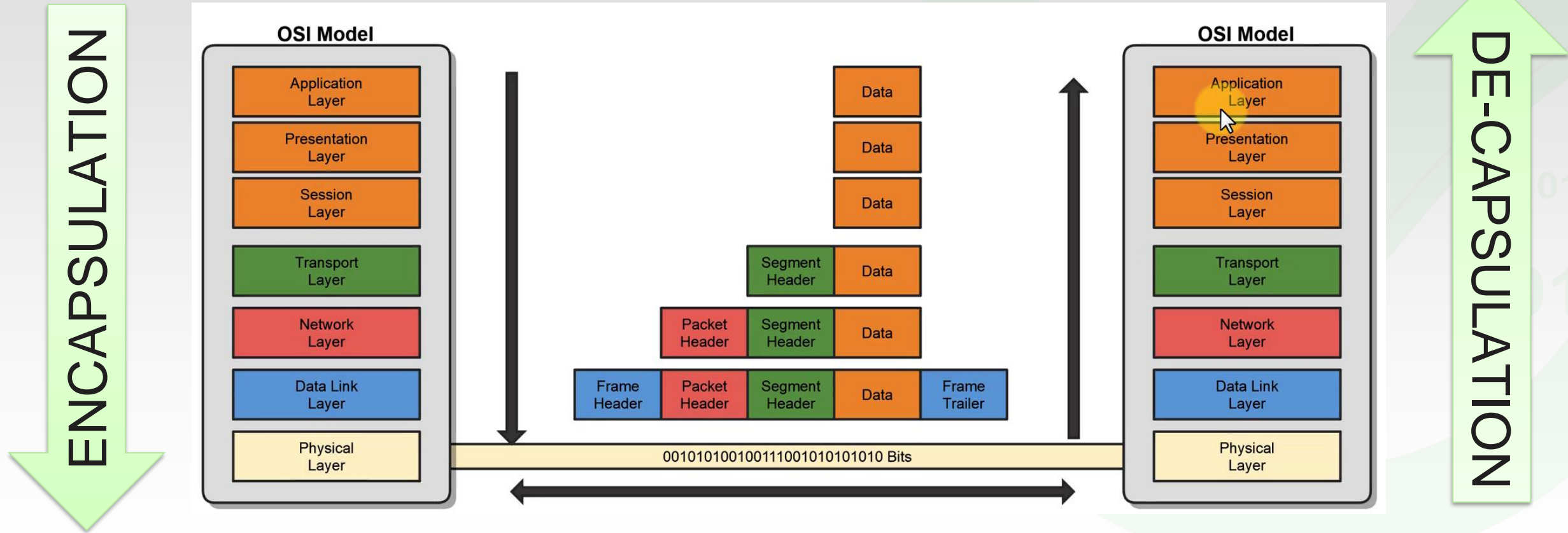


OSI Model





OSI Model





7) Application Layer

- ❖ Application layer, also called as Desktop Layer, is the top layer, closest to the user. Network communication system and applications operate in this layer.
- ❖ File sharing, queuing documents to print, e-mailing and database management are all taking place on this layer.
- ❖ Provides the network services to the user and serves as a window for the application services to access the network and for displaying the received information to the user.
- ❖ Applications run by the user sit on this layer. These applications produce the data which has to be transferred over the network.
- ❖ If you can interact with the application, it is on application layer.



7) Application Layer

- ❖ HTTP(Hyper Text Transfer Protocol) port number: 80
- ❖ FTP (File Transfer Protocol) port numbers: 20, 21
- ❖ HTTPS(Secure HTTP) port number: 443
- ❖ SMTP (Simple Mail Transfer Protocol) – Sending e-mail port numbers: 25, 465, 587 and 2525
- ❖ POP3 (Sending and Receiving whole e-mail) port numbers: 110, 995
- ❖ IMAP (Receiving e-mail partially) port numbers: 143, 993
- ❖ TELNET port number: 23



6) Presentation Layer

- ❖ Also known as Translation Layer, Presentation layer is responsible to deliver data coming from the Session Layer to the Application Layer.
- ❖ In other words, it is a connection between the user programs and the network.
- ❖ All processing made on data is done on this layer. Data compression, encryption and translation are all handled on this layer.
- ❖ **Operations like compression/decompression, encoding/decoding, EBCDIC-ASCII translation take place here. Presentation layer controls the presentation or formatting of the data content such as JPEG, MPEG file types.**
- ❖ Presentation layer is a part of the Operating System.
- ❖ SSL(Secure Sockets Layer), Lightweight Presentation Protocol(LPP)



6) Presentation Layer

ASCII TABLE

Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char
0	0	[NULL]	32	20	[SPACE]	64	40	@	96	60	`
1	1	[START OF HEADING]	33	21	!	65	41	A	97	61	a
2	2	[START OF TEXT]	34	22	"	66	42	B	98	62	b
3	3	[END OF TEXT]	35	23	#	67	43	C	99	63	c
4	4	[END OF TRANSMISSION]	36	24	\$	68	44	D	100	64	d
5	5	[ENQUIRY]	37	25	%	69	45	E	101	65	e
6	6	[ACKNOWLEDGE]	38	26	&	70	46	F	102	66	f
7	7	[BELL]	39	27	'	71	47	G	103	67	g
8	8	[BACKSPACE]	40	28	(	72	48	H	104	68	h
9	9	[HORIZONTAL TAB]	41	29	)	73	49	I	105	69	i
10	A	[LINE FEED]	42	2A	*	74	4A	J	106	6A	j
11	B	[VERTICAL TAB]	43	2B	+	75	4B	K	107	6B	k
12	C	[FORM FEED]	44	2C	,	76	4C	L	108	6C	l
13	D	[CARRIAGE RETURN]	45	2D	-	77	4D	M	109	6D	m
14	E	[SHIFT OUT]	46	2E	.	78	4E	N	110	6E	n
15	F	[SHIFT IN]	47	2F	/	79	4F	O	111	6F	o
16	10	[DATA LINK ESCAPE]	48	30	0	80	50	P	112	70	p
17	11	[DEVICE CONTROL 1]	49	31	1	81	51	Q	113	71	q
18	12	[DEVICE CONTROL 2]	50	32	2	82	52	R	114	72	r
19	13	[DEVICE CONTROL 3]	51	33	3	83	53	S	115	73	s
20	14	[DEVICE CONTROL 4]	52	34	4	84	54	T	116	74	t
21	15	[NEGATIVE ACKNOWLEDGE]	53	35	5	85	55	U	117	75	u
22	16	[SYNCHRONOUS IDLE]	54	36	6	86	56	V	118	76	v
23	17	[ENG OF TRANS. BLOCK]	55	37	7	87	57	W	119	77	w
24	18	[CANCEL]	56	38	8	88	58	X	120	78	x
25	19	[END OF MEDIUM]	57	39	9	89	59	Y	121	79	y
26	1A	[SUBSTITUTE]	58	3A	:	90	5A	Z	122	7A	z
27	1B	[ESCAPE]	59	3B	;	91	5B	[	123	7B	{
28	1C	[FILE SEPARATOR]	60	3C	<	92	5C	\	124	7C	|
29	1D	[GROUP SEPARATOR]	61	3D	=	93	5D	]	125	7D	}
30	1E	[RECORD SEPARATOR]	62	3E	>	94	5E	^	126	7E	~
31	1F	[UNIT SEPARATOR]	63	3F	?	95	5F	_	127	7F	[DEL]



6) Presentation Layer

TABLE 6
EBCDIC (IBM MAINFRAME) CHARACTER CODES

Each code is shown in decimal, hexadecimal, and character form.

129	81	a	193	C1	A	240	F0	0
130	82	b	194	C2	B	241	F1	1
131	83	c	195	C3	C	242	F2	2
132	84	d	196	C4	D	243	F3	3
133	85	e	197	C5	E	244	F4	4
134	86	f	198	C6	F	245	F5	5
135	87	g	199	C7	G	246	F6	6
136	88	h	200	C8	H	247	F7	7
137	89	i	201	C9	I	248	F8	8
						249	F9	9
145	91	j	209	D1	J	64	40	blank
146	92	k	210	D2	K	76	4C	<
147	93	l	211	D3	L	77	4D	(
148	94	m	212	D4	M	78	4E	+
149	95	n	213	D5	N	79	45	|
150	96	o	214	D6	O	80	50	&
151	97	p	215	D7	P	90	5A	!
152	98	q	216	D8	Q	91	5B	\$
153	99	r	217	D9	R	92	5C	*
						93	5D)
162	A2	s	226	E2	S	94	5E	;
163	A3	t	227	E3	T	96	60	-
164	A4	u	228	E4	U	97	61	/
165	A5	v	229	E5	V	107	6B	,
166	A6	w	230	E6	W	108	6C	%
167	A7	x	231	E7	X	109	6D	=
168	A8	y	232	E8	Y	110	6E	>
169	A9	z	233	E9	Z	111	6F	?
122	7A	:	125	7D	,			
123	7B	#	126	7E	=			
124	7C	@	127	7F	"			



5) Session Layer

- ❖ Login sessions are started, managed and stopped on nodes by this layer.
- ❖ Session layer serves as a dialogue controller. Two systems start communication in simplex, half or full duplex form.
- ❖ When the data flows one way, session layer decides whose turn to send data. This way prevents two parties from attempting the same critical operation at the same time.
- ❖ The session layer responds to the service requests from the presentation layer and then issue service requests to the Transport layer.
- ❖ Session layer synchronizes the communication and maintains it.
- ❖ Incompatibility problems when systems use different protocols are solved by this layer.
- ❖ RPC(Remote Procedure Call) protocol, SCP(Session control protocol), PAP(password authentication protocol)

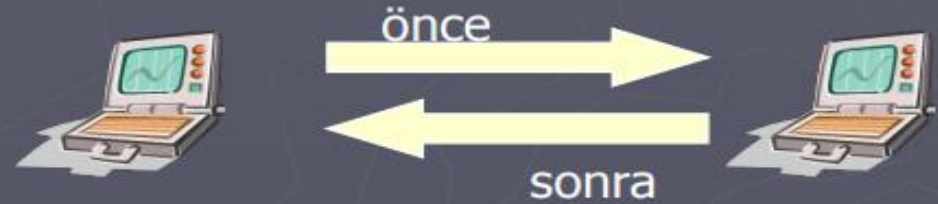


5) Session Layer

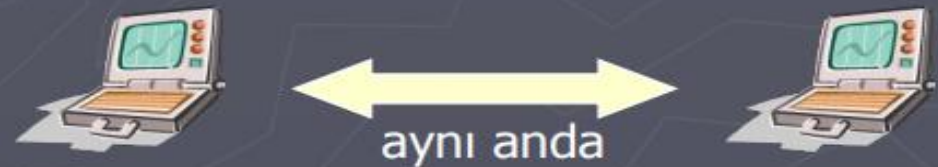
► Tek yönlü (Simplex)



► Yarı çift yönlü (Half-Duplex)



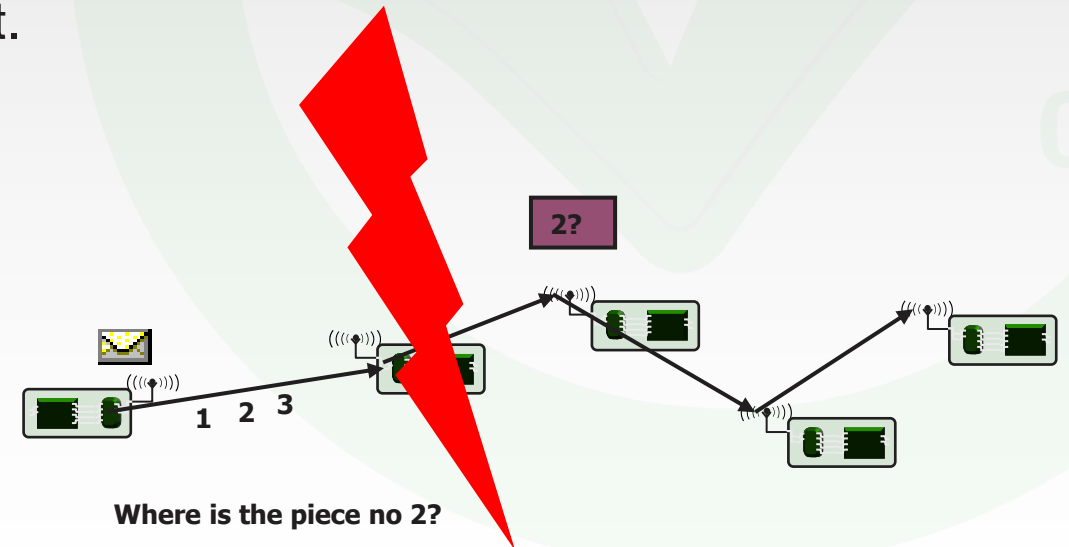
► Çift yönlü (Full-Duplex)





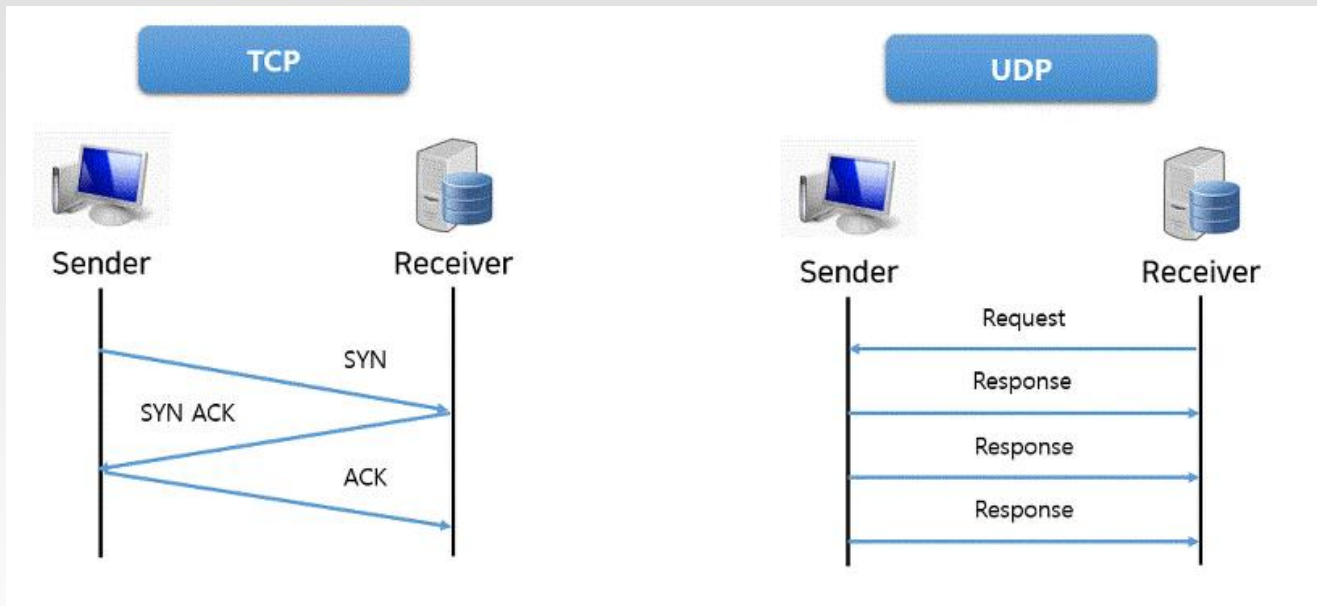
4) Transport Layer

- ❖ Responsible for securely transmitting messages from point to point.
- ❖ Big sized data is divided into small pieces called segments.
- ❖ Each segment is given a sequence number. If a piece is missing, it provides it and makes sure the message is complete and intact.
- ❖ Checks for bottlenecks.
- ❖ TCP(Transmission Control Protocol)
- ❖ UDP(User Datagram Protocol)





TCP and UDP on Transport Layer



Protocol	TCP	UDP
Connection	connection-oriented	connectionless
Usage	high reliability, critical-less transmission time	fast, efficient transmission, small queries, huge numbers of clients
Ordering of data packets	rearranges packets in order	no inherent order
Reliability	yes	no
Streaming of data	read as a byte stream	sent and read individually
Error checking	error checking and recovery	simply error checking, no error recovery
Acknowledgement	acknowledgement segments	no acknowledgment

TCP is good for file transfers, e-mail and web browsing. UDP is good for live video, online games and audio calls.



4) Transport Layer

Common TCP and
UDP ports

PORT NUMBER	TRANSPORT PROTOCOL	SERVICE NAME	RFC
20, 21	TCP	File Transfer Protocol (FTP)	RFC 959
22	TCP and UDP	Secure Shell (SSH)	RFC 4250-4256
23	TCP	Telnet	RFC 854
25	TCP	Simple Mail Transfer Protocol (SMTP)	RFC 5321
53	TCP and UDP	Domain Name Server (DNS)	RFC 1034-1035
67, 68	UDP	Dynamic Host Configuration Protocol (DHCP)	RFC 2131
69	UDP	Trivial File Transfer Protocol (TFTP)	RFC 1350
80	TCP	HyperText Transfer Protocol (HTTP)	RFC 2616
110	TCP	Post Office Protocol (POP3)	RFC 1939
119	TCP	Network News Transport Protocol (NNTP)	RFC 8977
123	UDP	Network Time Protocol (NTP)	RFC 5905
135-139	TCP and UDP	NetBIOS	RFC 1001-1002
143	TCP and UDP	Internet Message Access Protocol (IMAP4)	RFC 3501
161, 162	TCP and UDP	Simple Network Management Protocol (SNMP)	RFC 1901-1908, 3411-3418
179	TCP	Border Gateway Protocol (BGP)	RFC 4271
389	TCP and UDP	Lightweight Directory Access Protocol	RFC 4510
443	TCP and UDP	HTTP with Secure Sockets Layer (SSL)	RFC 2818
500	UDP	Internet Security Association and Key Management Protocol (ISAKMP) / Internet Key Exchange (IKE)	RFC 2408 - 2409
636	TCP and UDP	Lightweight Directory Access Protocol over TLS/SSL (LDAPS)	RFC 4513
989/990	TCP	FTP over TLS/SSL	RFC 4217

<https://ipwithease.com>

<https://www.iana.org/assignments/service-names-port-numbers/service-names-port-numbers.xhtml>



3) Network Layer

- ❖ This layer establishes the connection and finds the way to the destination address.
- ❖ **Routers work on this layer.**
- ❖ This layer makes **data packets** pass through nodes from source to destination. This is where the **IP addresses** and routing live.
- ❖ Which way the data will take is determined at this layer. Network status, data priority and other parameters play role.
- ❖ Internet Protocols IPv4/v6, Internet Control Message Protocol (ICMP), Distance Vector Multicast Routing Protocol (DVMRP), Internet Group Management Protocol (IGMP)
- ❖ Address Resolution Protocol (ARP), Internet Protocol Security (IPsec), Routing Information Protocol (RIP)



2) Data Link Layer

- ❖ Layer 2 provides faultless data transmission from sender to receiver.
- ❖ Ethernet, Bluetooth, WIFI works on this layer. **MAC addresses and Frames** are on this layer.
- ❖ It adds **error control bits** to the **data packets that arrive from Network Layer** and **sends them to Physical Layer as a frame**.
- ❖ Checks if the destination received the messages from Physical Layer correctly.
- ❖ If destination did not get messages correctly, it orders the message to be resent.
- ❖ It has two sublayers:
 - ❖ Media Access Control (**MAC**)
 - ❖ Logical Link Control (**LLC**)
- ❖ **Network Bridge and Switch** work on this layer.

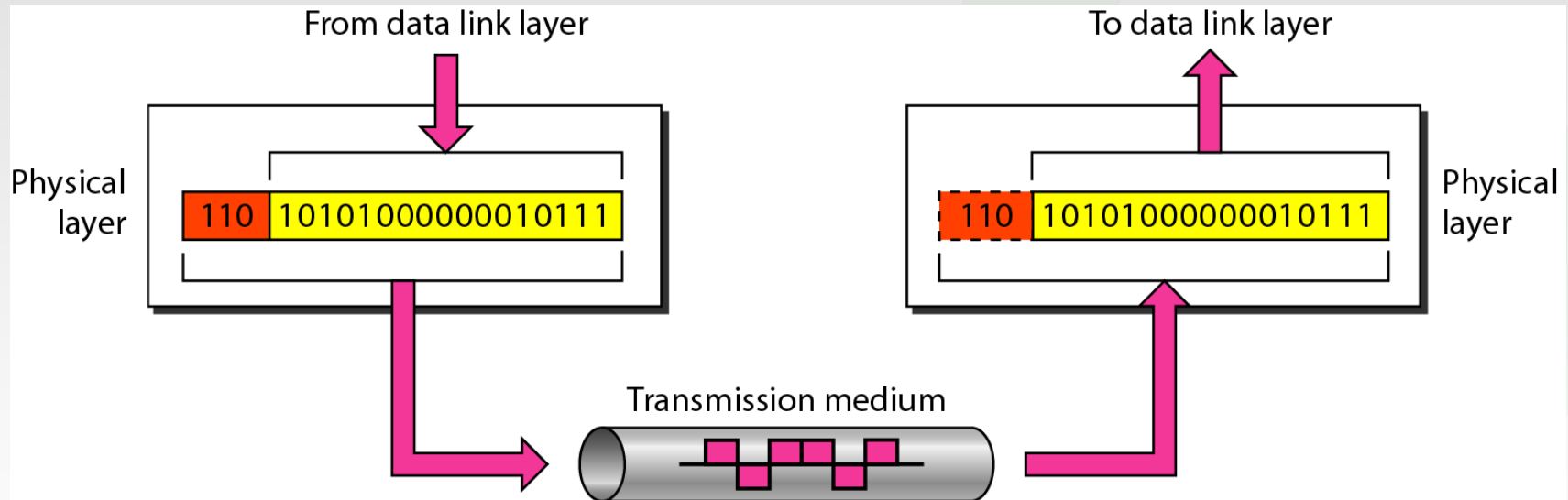


1) Physical Layer

- ❖ Data is physically received and transmitted on this layer.
- ❖ This layer starts the physical communication, manages and stops it.
- ❖ The electrical signals and connections make up this layer.
- ❖ The **NIC(Network Interface Cards), repeaters and hubs** work on this layer.
- ❖ **Physical layer is mostly related with the hardware and the hardware settings like, connector type, cable type, modulation type, working voltage, transmitting frequency etc.**



1) Physical Layer

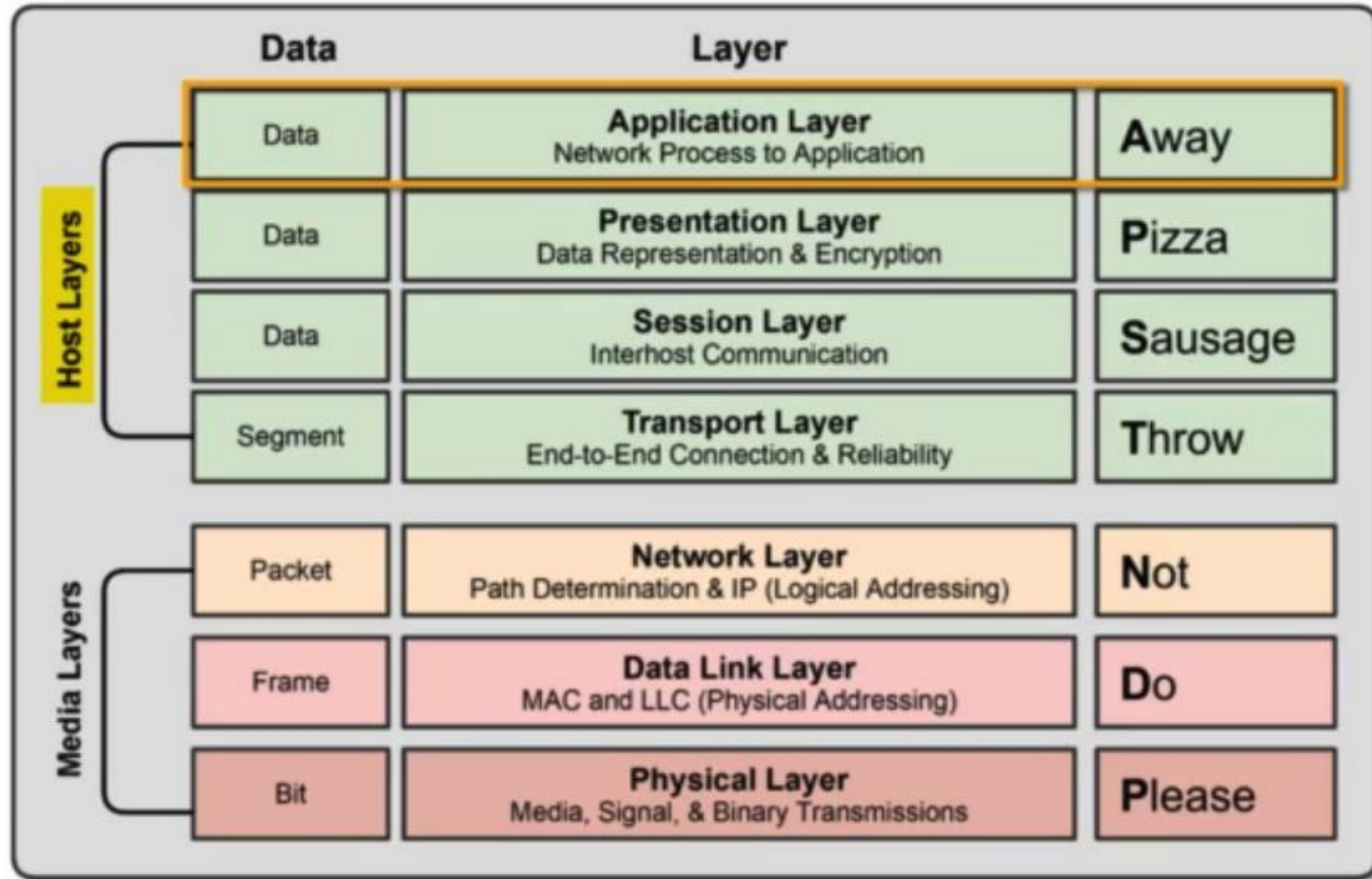


OSI Model

OSI (Open Source Interconnection) 7 Layer Model						
Layer	Application/Example		Central Device/Protocols		G A T E W A Y	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			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	F I L T E R I N G P A C K E T	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			



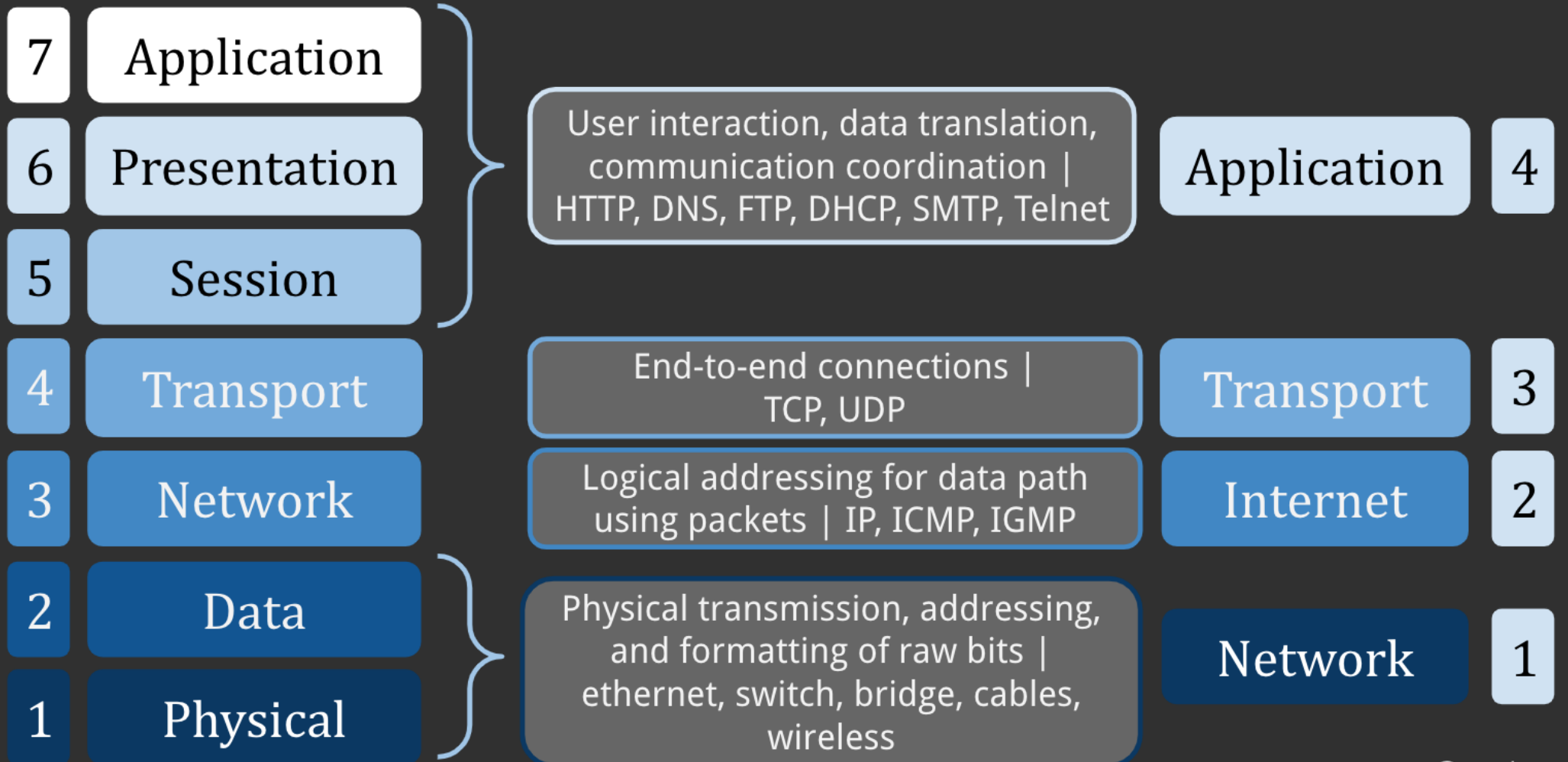
OSI Model





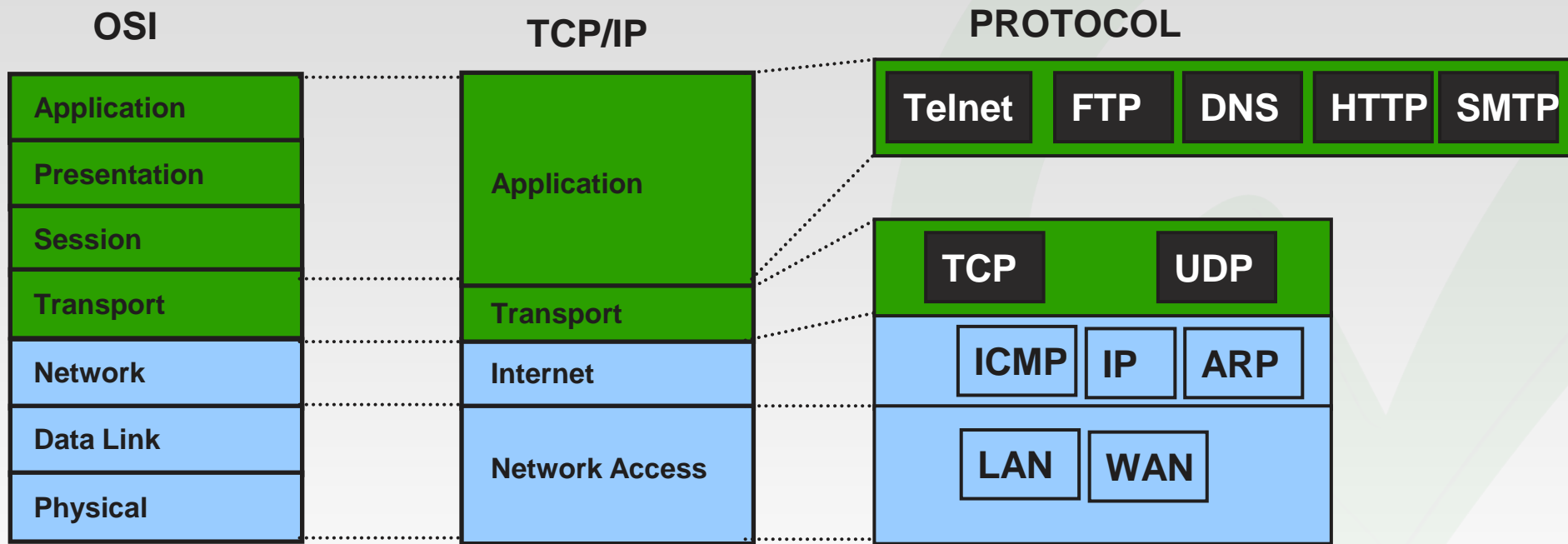
OSI Model – TCP/IP Model

7-layer OSI Model vs. 4-layer TCP/IP Model





TCP/IP Model



- ❖ OSI model has 7 layers, TCP/IP model has 4 layers.
- ❖ OSI model defines the standards, TCP/IP is more related with the application side.
- ❖ TCP (Transmission Control Protocol) and IP (Internet Protocol) gives the name.
- ❖ Data is broken into pieces and sent in order from one computer to another thanks to TCP/IP.



TERMS and DEFINITIONS

TCP/IP

Transmission Control Protocol/Internet Protocol

packet

data pieces at Network Layer

NIC

Network Interface Card

frame

Data pieces at Data Link Layer

Hub

A network device that repeats an incoming data to all its ports.

SSH

Secure Shell connection protocol encrypts data on Presentation Layer

OSI

Open System InterConnection

Port Numbers

A port number is the logical address or gate of each application or process on the network. A port is a virtual point where network connections start and end.

Switch

A smart network device that connects computers and other network devices to usually form a LAN.

ASCII

American Standard Codes for Information Interchange

UDP

User Datagram Protocol for transferring streaming video, audio or games. Connectionless

SOHO

All-in-one small office home office device that has capability of Router, Wireless Access Point, Firewall, Switch, DHCP Server, NAT

ARP

Address Resolution Protocol discovers and links IP with physical address of a device

Router

A router connects 2 or more networks. It controls network traffic by forwarding data packets to the correct address.



Sample Questions

Which OSI layer is responsible for dividing data into frames so it can be sent across the network?

- a) Network
- b) Data Link**
- c) Physical
- d) Session
- e) Transport

Which layer of the OSI model is responsible for establishing, managing, and terminating communications sessions between two computers?

- a) Session**
- b) Network
- c) Physical
- d) Transport
- e) Data Link
- f) Application

At which layer of the OSI model do TCP and UDP reside?

- a) Session
- b) Network
- c) Physical
- d) Transport**
- e) Data Link
- f) Application
- g) Presentation

E-mail and FTP services work at which OSI layer?

- a) Presentation
- b) Session
- c) Application**

What layer of the OSI model places the signal on the cable?

- a) Physical**
- b) Network
- c) Data Link
- d) Transport



Sample Questions

What layer of the OSI model ensures packets are delivered error free, in sequence, and without losses?

- a) Network
- b) **Transport**
- c) Physical
- d) Data Link

Which layer of the OSI model makes sure that data is in a readable format for the Application layer?

- a) Application
- b) **Presentation**
- c) Session
- d) Transport

Which layer of the OSI model keeps track of communication sessions in order to send the right response to the right computer?

- a) Application
- b) Presentation
- c) **Session**
- d) Transport

Which layer of the OSI model involves routing?

- a) Physical
- b) Transport
- c) **Network**
- d) Data Link

Which of the following OSI layers converts the ones and zeros (i.e. the data bits) into electrical signals and places these signals on the cable?

- a) **Physical**
- b) Transport
- c) Data Link
- d) Network



Sample Questions

What is the difference regarding reliability and communication type between TCP and UDP?

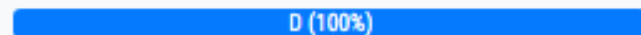
- A. TCP is reliable and is a connectionless protocol; UDP is not reliable and is a connection-oriented protocol.
- B. TCP is not reliable and is a connectionless protocol; UDP is reliable and is a connection-oriented protocol.
- C. TCP is not reliable and is a connection-oriented protocol; UDP is reliable and is a connectionless protocol.
- D. TCP is reliable and is a connection-oriented protocol; UDP is not reliable and is a connectionless protocol.

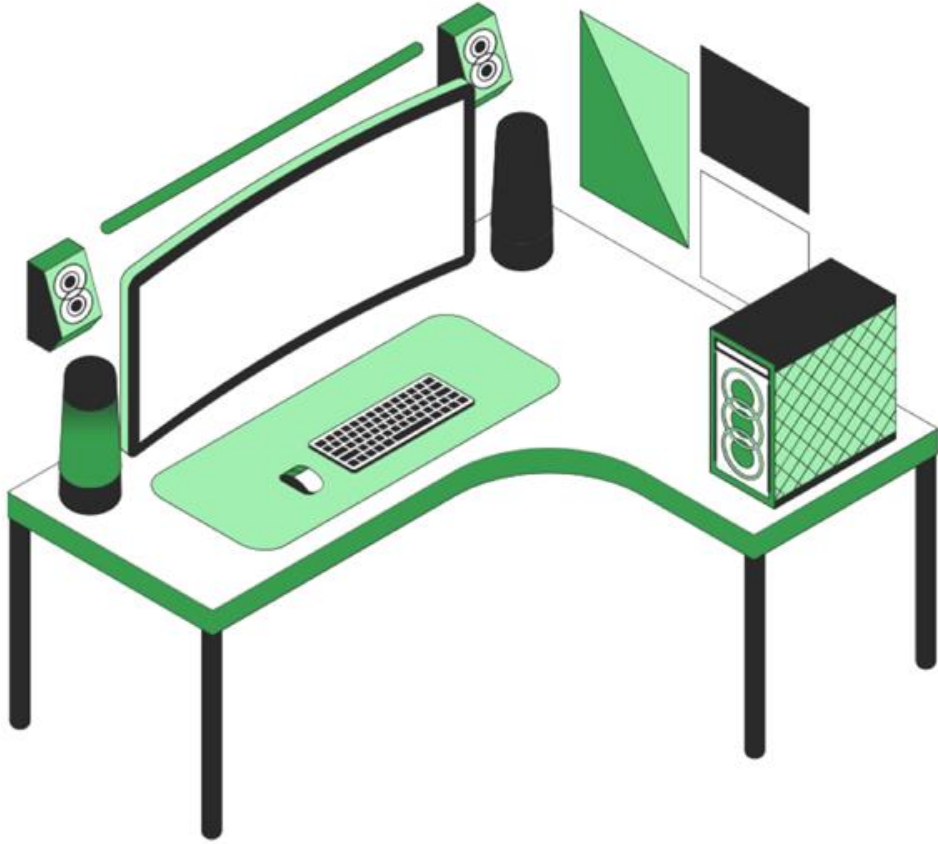
Hide Solution

Discussion 9

Correct Answer: D 🏆

Community vote distribution





Do you
have any
questions?

Send it to us! We hope you learned something new.