TEE 843 – Sistem Telekomunikasi

10. Komunikasi Data

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DATA COMMUNICATION

(Basics of data communication, OSI layers.)

K.K.DHUPAR
SDE (NP-II)
ALTTC

Data Communications History

- 1838: Samuel Morse & Alfred Veil Invent Morse Code Telegraph System
- 1876: Alexander Graham Bell invented Telephone
- 1910:Howard Krum developed Start/Stop Synchronisation

History of Computing

- 1930: Development of ASCII Transmission Code
- 1945: Allied Governments develop the First Large Computer
- 1950: IBM releases its first computer IBM 710
- 1960: IBM releases the First Commercial Computer IBM 360

Main Contributors of Data Comm.

- Transmission Technology
- Packet Switching Technology
- Internet
  - 1967: ARPANET by Advanced Research Project Agency (ARPA) of U.S.
  - 1975: TCP/IP protocol
- LAN Technology
  - DIX-Ethernet & IEEE 802 Networks
- WAN
  - 1976: ISO releases HDLC & CCITT releases X.25 (PSPDN)

Various Networks

- Home Area Network (HAN)
- Local Area Network (LAN)
- Metropolitan Area Network (MAN)
- Wide Area Network (WAN)
- Global Area Network (GAN)

Voice & Data

- In 70's & 80's main thrust in Wide Area Networking (WAN) was to put *Data on Voice Circuits* using Modem & on ISDN lines
- In 90's the trend is reverse. Major Efforts were on putting *Voice Over Data* using:
  - Voice Over Frame Relay
  - Voice Over Internet
  - Voice Over ATM etc

What is Data Communications?

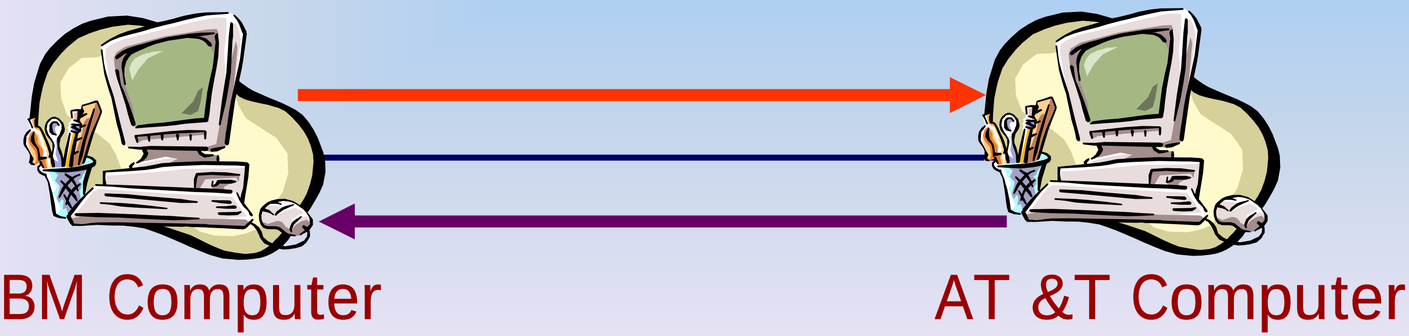
- Exchange of digital information between two digital devices is data communication

Networking

- Networking is the convenient way of making information accessible to anyone, anytime & anywhere.
- Evolution of Networking
  - Computers handling Large Data were developed
    - viz. text, graphics,animation, sound & video
  - Improvements in Personal Computers
    - Small, powerful & cheap user friendly systems.
  - Emergence of Computer Networks
    - Distributed, Intelligent, High-speed LAN/WAN

What is Interoperability ?

- The Capability of two or more computers of different vendors to transmit & receive data and to carry out processes as expected by the user is called Interoperability.



Requirements of Data Communications

- At least Two Devices ready to communicate
- A Transmission Medium
- A set of Rules & Procedure for proper communication (Protocol)
- Standard Data Representation
- Transmission of bits either Serial or Parallel
- Bit synchronisation using Start/stop bits in case of Asynchronous Transmission
- In Synchronous Transmission the agreed pattern of Flag
- Signal encoding rules viz. NRZ or RZ
- And other higher layer protocol

Data Representations

- A group of bits are used to represent a character/number/ special symbol/Control Characters
- 5-bit code can represent 32 symbols ($2^5=32$)
- 7-bit code can represent 128 symbols ($2^7=128$) &
- 8-bit code can represent 256 symbols ($2^8=256$)

Code Set

- A code set is the set of codes representing the symbols
- Very common code sets are :
  - *ASCII* : this is ANSI's 7-bit American Standard Code for Information Interchange
    - ASCII code(7-bit) is often used with an 8th bit known as parity bit used for detecting errors during Data Transmission
    - Parity bit is added to the Most Significant bit (MSB)
  - *EBCDIC* : this is IBM's 8-bit Extended Binary Coded Decimal Interchange Code

ASCII Code

- ASCII is defined in ANSI X3.4
  - Corresponding CCITT recommendation is IA5 (International Alphabet No.5)
  - ISO specification is ISO 646
- Total 128 codes
  - 96 codes are graphic symbols (in Col. 2~7).
    - 94 codes are printable
    - And 2 codes viz. SPACE & DEL characters are non printable
  - 32 codes control symbols (Col. 0 & 1)
    - All are non printable

EBCDIC Code

- It is an 8-bit code with 256 symbols
- No parity bit for error checking
- The graphic symbols are almost same as ASCII
- Several differences in Control characters as compared to ASCII

Baudot Teletype code

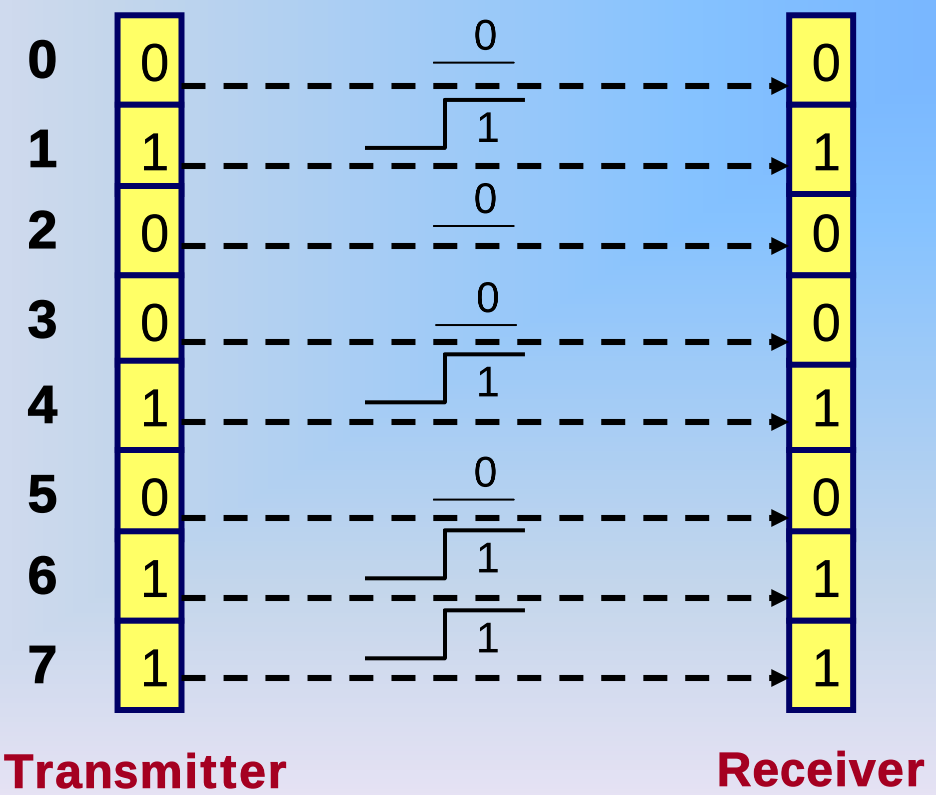
- It is a 5-bit code also known as ITA2 (International Telegraph Alphabet No. 2).
- 32 codes are possible. With the help of Letter shift & Figure shift key same code is used to represent two symbols.
- Maximum symbols in this code are 58
- Used in Telegraphy/Telex

Data Transmission

- Data Transmission means movement of the bits over a transmission medium connecting two devices
- Two types of Data Transmission are:
  - Parallel Transmission
  - Serial Transmission

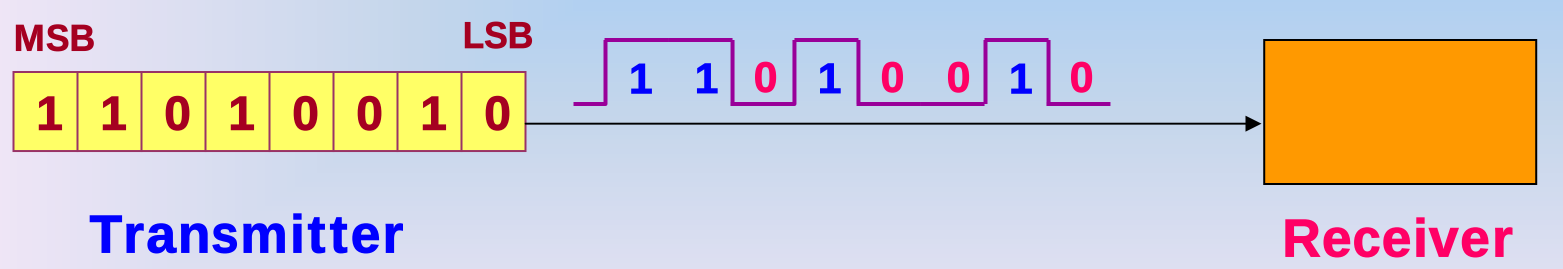
Parallel Transmission

- In this all the bits of a ***byte*** are transmitted simultaneously on separate wires.
- Practicable if two devices are close to each other e.g. Computer to Printer, Communication within the Computer



Serial Transmission

- Bits are transmitted one after the other
- Usually the Least Significant Bit (LSB) has been transmitted first
- Serial Transmission requires only one circuit interconnecting two devices
- Suitable for Transmission over Long distance

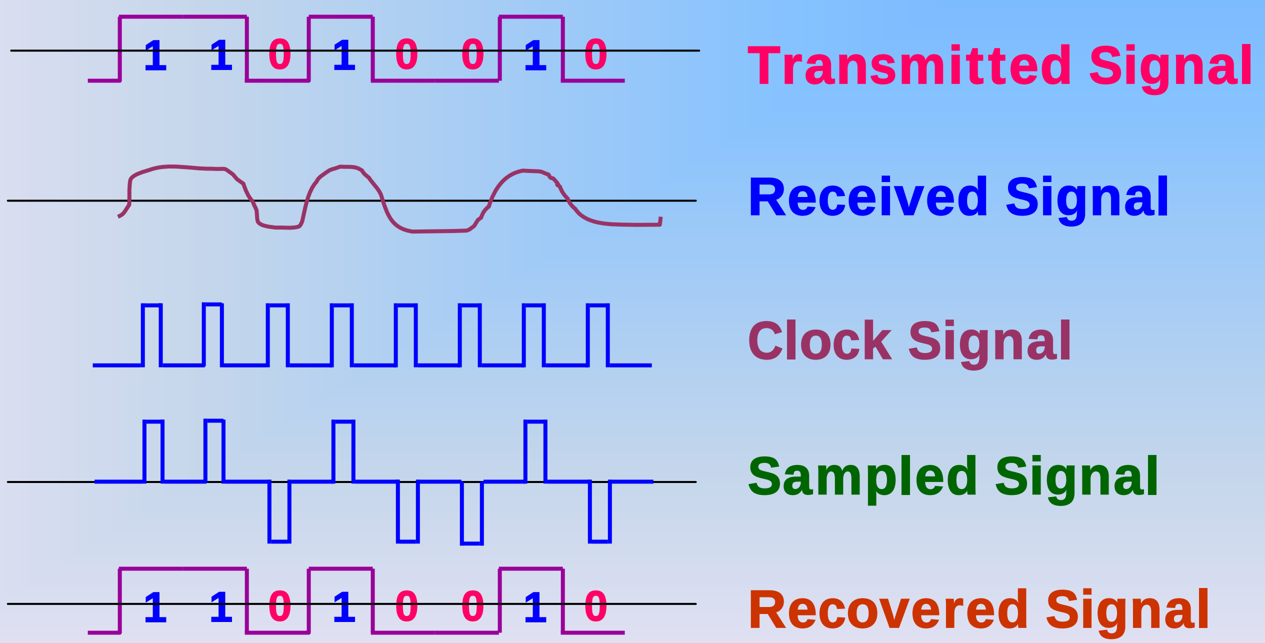


What is a Bit Rate ?

- Number of bits that can be transmitted in 1 second
- If t_p is the duration of the bit then the Bit rate $R = 1/t_p$
- Bit duration need not be same as the pulse duration

Receiving Data bits

- Received Signal is never same as transmitted
- Clock signal samples & regenerates the original bits as it was transmitted
- Received Signal should be sampled at right instant. Otherwise it will cause bit error

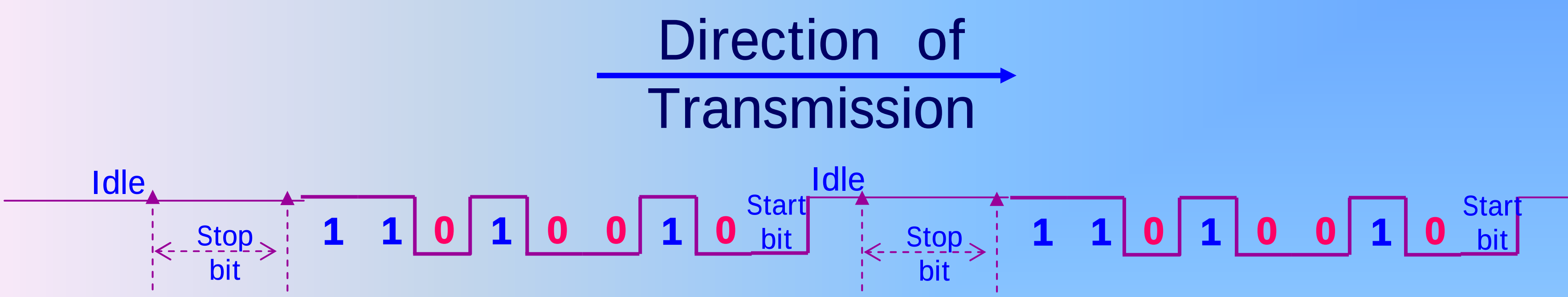


Modes of Transmission

- Two methods for Timing control for receiving bits
  - Asynchronous Transmission
    - Sending end commences the Transmission of bits at any instant of time
    - No time relation between the consecutive bits
    - During idle condition Signal ‘1’ is transmitted
    - “Start bit” before the byte and “Stop bit” at the end of the byte for Start/Stop synchronisation
  - Synchronous Transmission
    - is carried out under the control of the timing source
    - No Start/Stop bits
    - Continuous block of Data are encapsulated with Header & Trailer along with Flags

Asynchronous Transmission

Start- Stop Synchronisation



Note:

Start bit is always 1 bit duration

Start bit is always equal to ‘0’

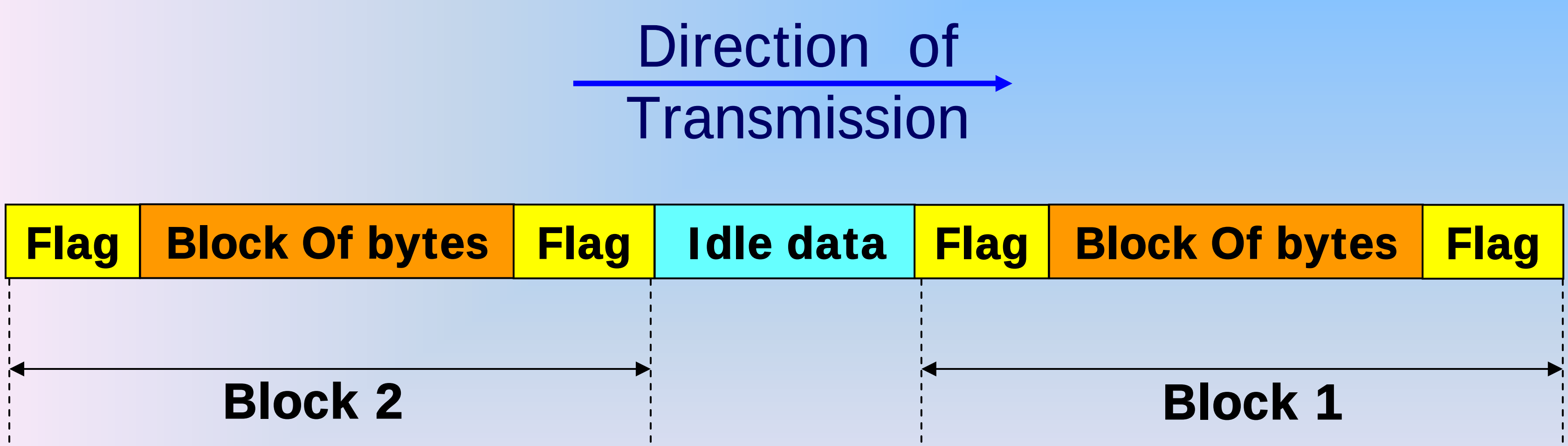
Stop bit may be 1 or 1.5 or 2 bits duration

Stop bit is always equal to ‘1’

Idle period time is arbitrary (variable)

Synchronous Transmission

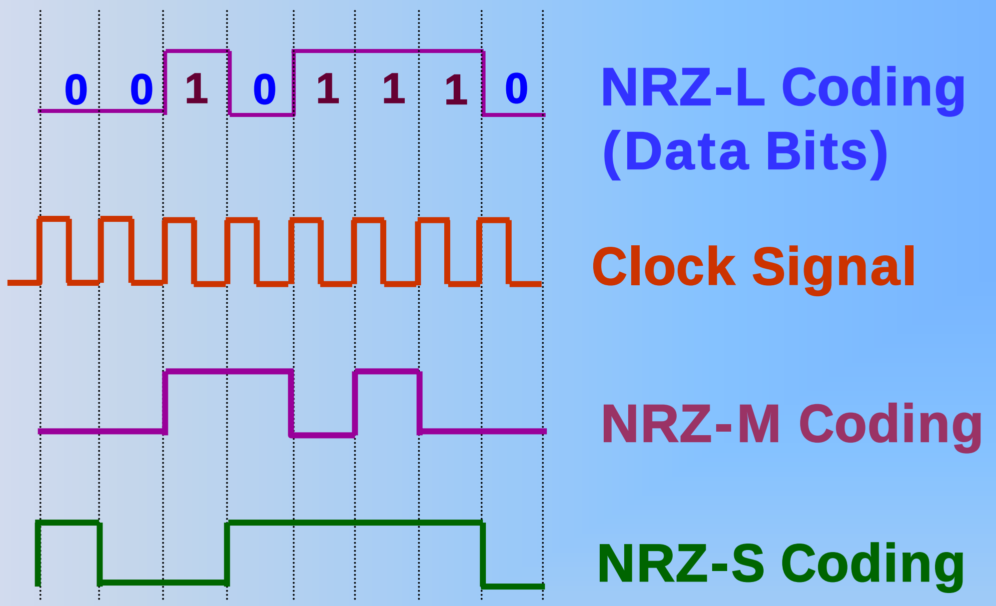
- Flag identifies the Start and End of the block
- Receiver first detects the Flag (usually a fixed pattern) and then detects the other bits/bytes in the data field
- Complete Block along with the Flags is called a *FRAME*



Signal Encoding

- For transmission of bits into electrical signals for two binary states simple +ve and –ve voltages are not sufficient.
- Sufficient Signal transition should be present to recover the clock properly at the receiving end
- Bandwidth of the signal should match with transmission medium
- Several ways to represent the bits as electrical signals
- Two broad classes are:
  - Non-Return to Zero (NRZ) and
  - Return to Zero (RZ)

Non Return to Zero (NRZ) Codes



NRZ-L : Non-Return to Zero Level (coded according to binary values of the Data bits)

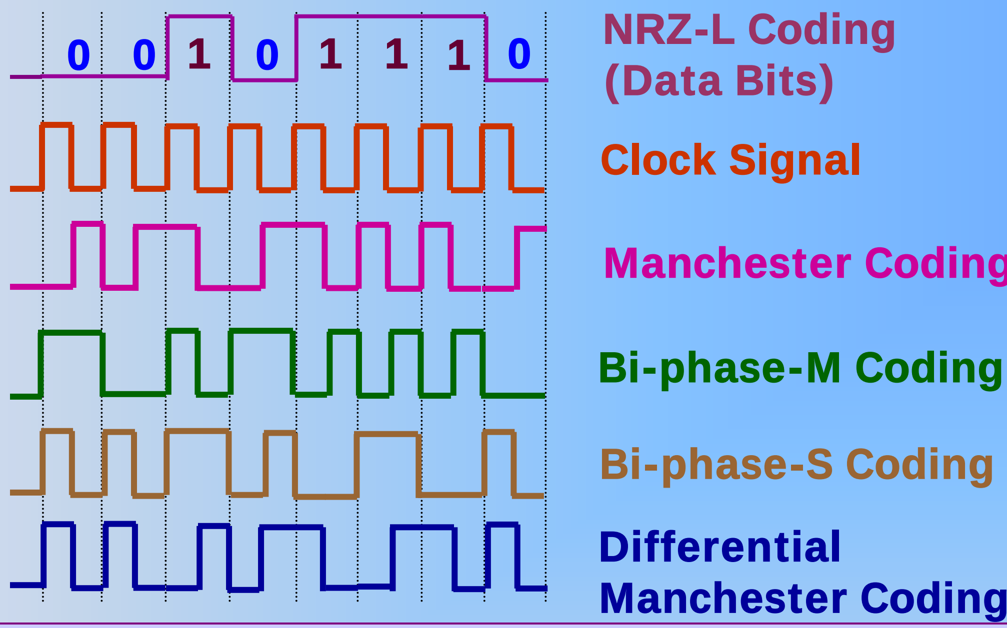
NRZ-M : Non-Return to Zero on Mark (Voltage Transition takes place on Mark (1)

NRZ-S : Non-Return to Zero on Space (Voltage Transition takes place on Space (0)

Return to Zero (RZ) Codes

- If there is continuous string of ‘0’s or ‘1’s in NRZ code it is very difficult to recover the clock signal
- Hence Return to Zero code (RZ) was implemented
- Clock can be extracted from the Return to Zero code by the receiver using lot of transitions
- RZ signals are the combination of “NRZ-L Signal + Clock Signal”
- Various RZ codes are:
  - Manchester Code
  - Bi-phase-M Code
  - Bi-phase-S Code
  - Differential Manchester Code

Return to Zero (RZ) Codes



Manchester Code: Binary 1 is logical AND of ‘1’ & Clock & binary 0 is logical AND of ‘0’ & Clock. Also known as Bi-phase-L code

Bi-Phase-M Code: Transition always at the beginning of bit interval and Binary ‘1’ has another transition in the middle of the bit interval

Bi-Phase-S Code: Transition at the beginning of bit interval as in Bi-Phase-M code and Binary ‘0’ has another transition in the middle of the bit interval

Differential Manchester Code: Transition always at the Middle of bit interval and Binary ‘0’ has another transition in the beginning of the bit interval

Data Transmission & Data Communication

- Data Transmission deals with:
  - the physical movement of information.
  - polarity, synchronisation, clock, electrical characteristics, modulation, demodulation etc.
- Data Communication deals with:
  - Meaningful exchange of information between the communication entities
  - e.g. dialogue discipline, interpretation of messages, acknowledgement etc.

Synchronous & Asynchronous Communication

- Synchronous Communication is:
  - more disciplined information exchange
  - entities send a message only when it is permitted to do so
- Asynchronous Communication is:
  - less disciplined
  - can send a message whenever it wishes to

Directional Capabilities for Data Exchange

- Three possibilities are:
  - Transfer in one direction only
  - Transfer in either direction but one at a time
  - Transfer in both the direction simultaneously

Direction Capability	Transmission	Communication
One Direction only	Simplex (SX)	One Way (OW)
One direction at a time	Half Duplex (HDX)	Two-Way Alternate (TWA)
Both directions at the same time	Full Duplex (FDX)	Two-Way Simultaneous (TWS)

OSI Layers

- The OSI model is built of seven ordered layers:
  - Layer-1: Physical
  - Layer-2: Data Link
  - Layer-3: Network
  - Layer-4: Transport
  - Layer-5: Session
  - Layer-6: Presentation
  - Layer-7: Application

Application
Presentation
Session
Transport
Network
Data Link
Physical

OSI Layers

- The seven layers can be thought of as belonging to three sub groups
  - Network Support Layers (Layers 1-3)
    - Deal with the physical aspects of moving data from one device to another
  - User Support Layers (Layers 5-7)
    - Allow interoperability among unrelated software systems
  - Layer-4 ensures end to end reliable data transmission

Hierarchical communication.

- Within a single machine, each layer calls upon the services of the layer just below it
- The passing of data and network information is made possible by an interface between each pair of adjacent layers
- The messages exchanged between the adjacent layers, to obtain the required services, are called Interface Control Information (ICI)

Data Units

- Protocol Control Information (PCI)
  - (N)-PCI is the protocol control information exchanged between the (N)-entities to coordinate their functions
- Service Data Units (SDU)
  - (N)-SDU is the data unit transferred between the ends of a (N)-connection whose identity is preserved during the transfer
- Protocol Data Unit (PDU)
  - (N)-PDU is the combination of (N)-PCI and (N)-SDU

Layer-1(Physical)

A
P
S
T
N
D
P

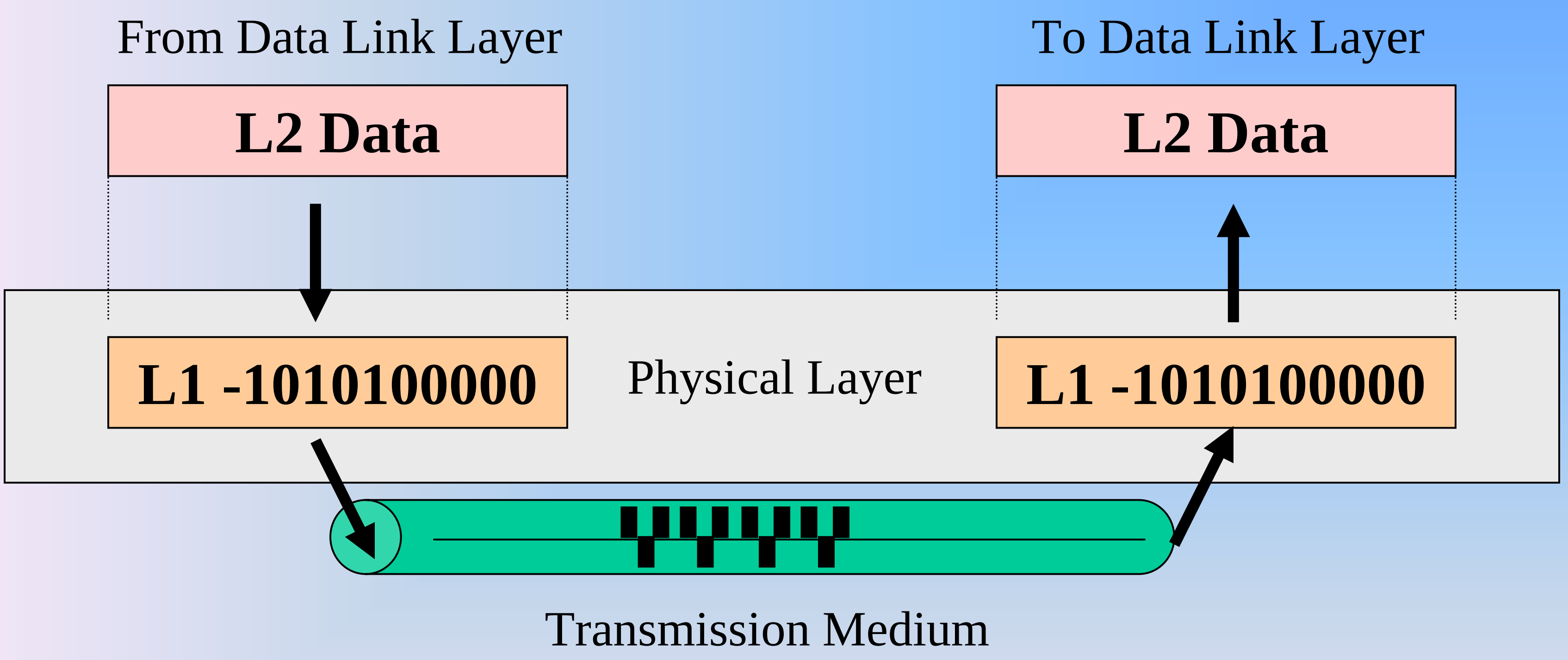
- First of three network support layers
- Concerned with physical transmission of data bits and ensures that a bit entering at one end of the transmission media reaches the other end
- Deals with the mechanical and electrical specifications of the interface and transmission medium e.g. Optical, coax, RF, twisted pair etc.
- Defines the type of encoding i.e. how 0s and 1s are changed to signals
- Defines data rate / transmission rate i.e. defines the duration of a bit

Layer-1(Physical)

A
P
S
T
N
D
P

- Responsible for synchronisation of sender and the receiver clocks
- Concerned with the connection of the devices to the medium
  - Point-to-point configuration
  - Multipoint configuration
- Physical topology
  - Mesh; Star; Ring; Bus
- Transmission Mode
  - Simplex; Half-Duplex; Full-Duplex

Layer-1(Physical)

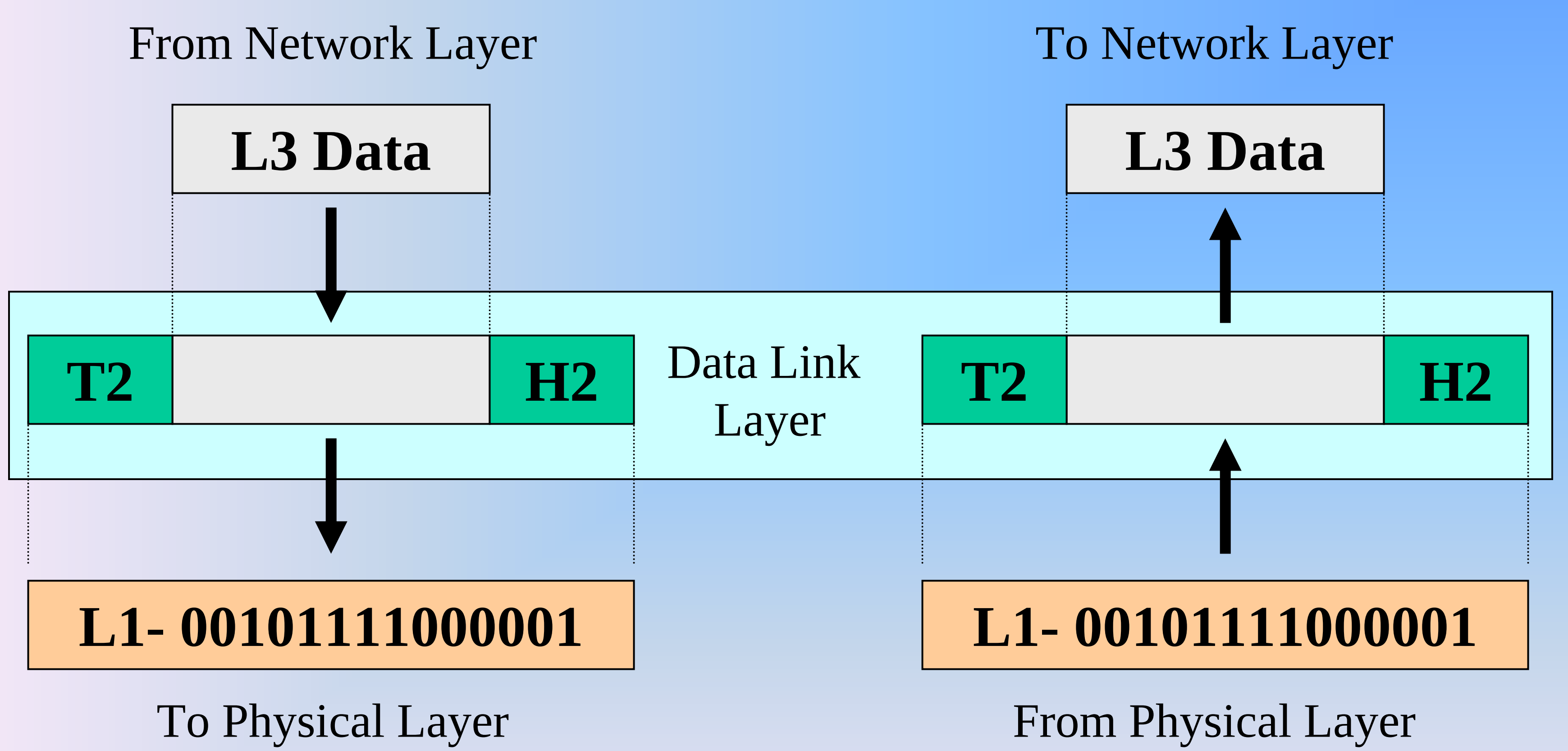


Layer-2 (Data Link)

A
P
S
T
N
D
P

- Second of three network support layers
- Divides the bit stream received from network layer into manageable data units called frames
- Transforms the physical layer to a reliable link by adding mechanism to detect and retransmit damaged frames
- Responsible for physical addressing of the devices
- Responsible for link-by-link flow control and error free delivery of data
- Responsible for Media Access Control

Layer-2 (Data Link)

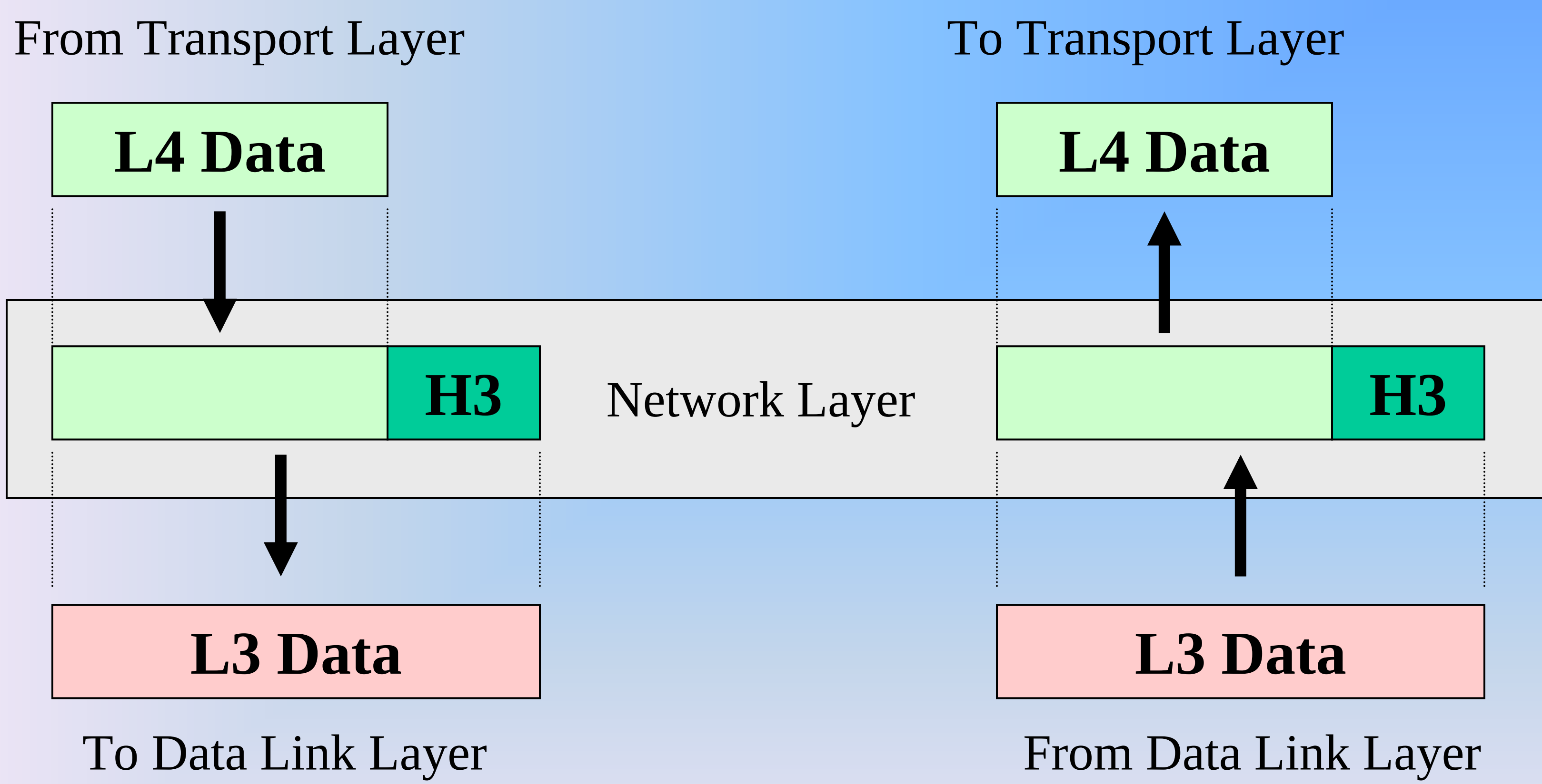


Layer-3 (Network)

A
P
S
T
N
D
P

- Last of the three network support layers
- Responsible for Source-to-Destination delivery of individual packets across multiple links
- If two systems are connected to the same link there is usually no need for a network layer
- Responsible for the unique logical addressing of the sender and the receiver
- Responsible for routing of packets

Layer-3(Network)

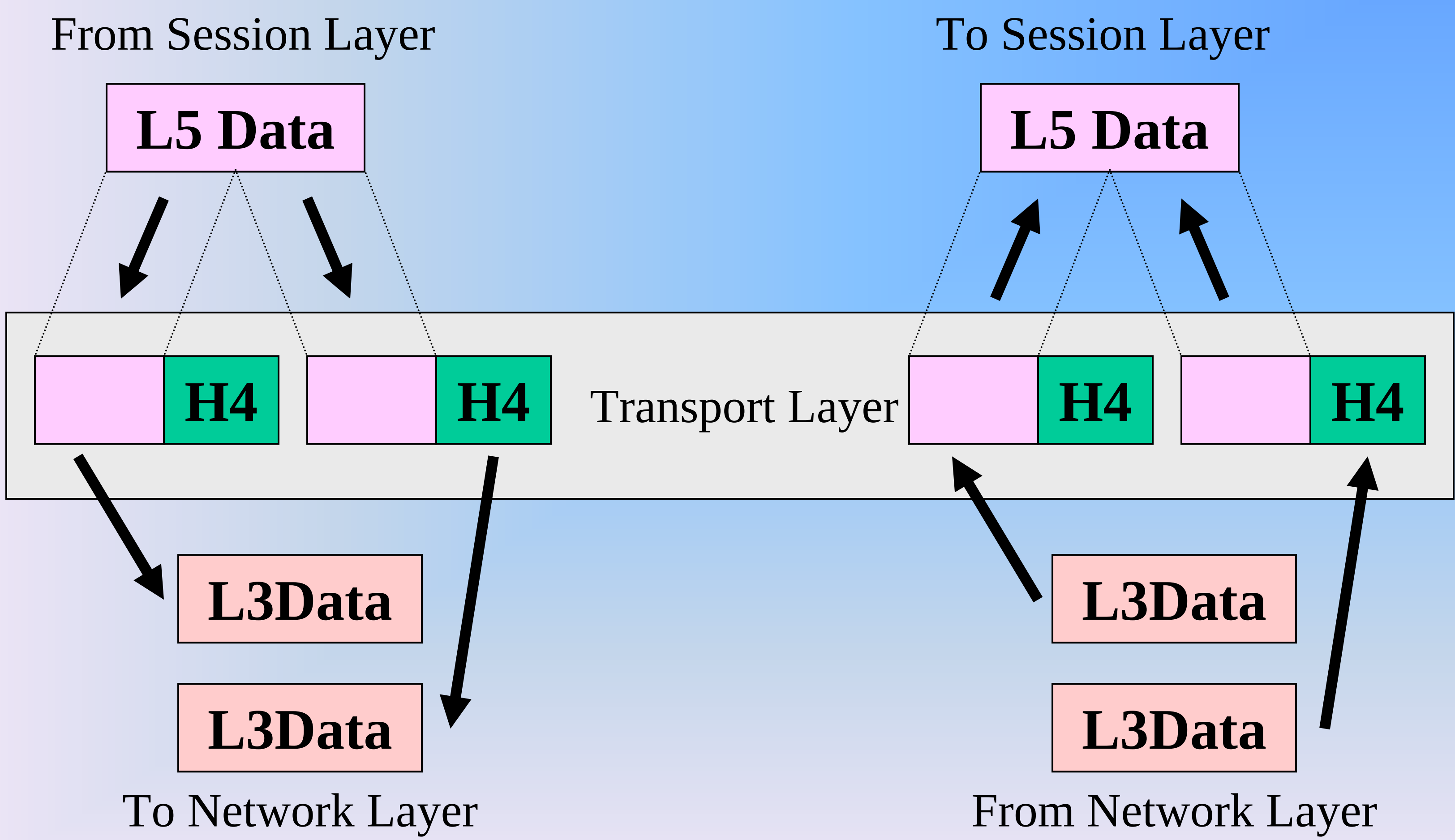


Layer-4 (Transport)

A
P
S
T
N
D
P

- Responsible for Source-to-Destination delivery of the entire message
- Uses service-point address (port address) for end-to-end delivery
- Network layer gets each packet to correct computer, transport layer gets the entire message to the correct process
- Responsible for segmenting a message into transmittable segments
- At the destination the message is correctly reassembled

Segmentation and Reassembly



Layer-4 (Transport)

A
P
S
T
N
D
P

- Utilises network layer to ensure reliable, sequenced data exchange
- Transport layer can be connectionless or connection oriented
  - A connectionless transport layer treats each segment as an independent packet
  - A connection oriented transport layer makes a connection with the transport layer at the destination machine before delivering the packets
  - After all the data is transmitted, the connection is terminated

Layer-4 (Transport)

A
P
S
T
N
D
P

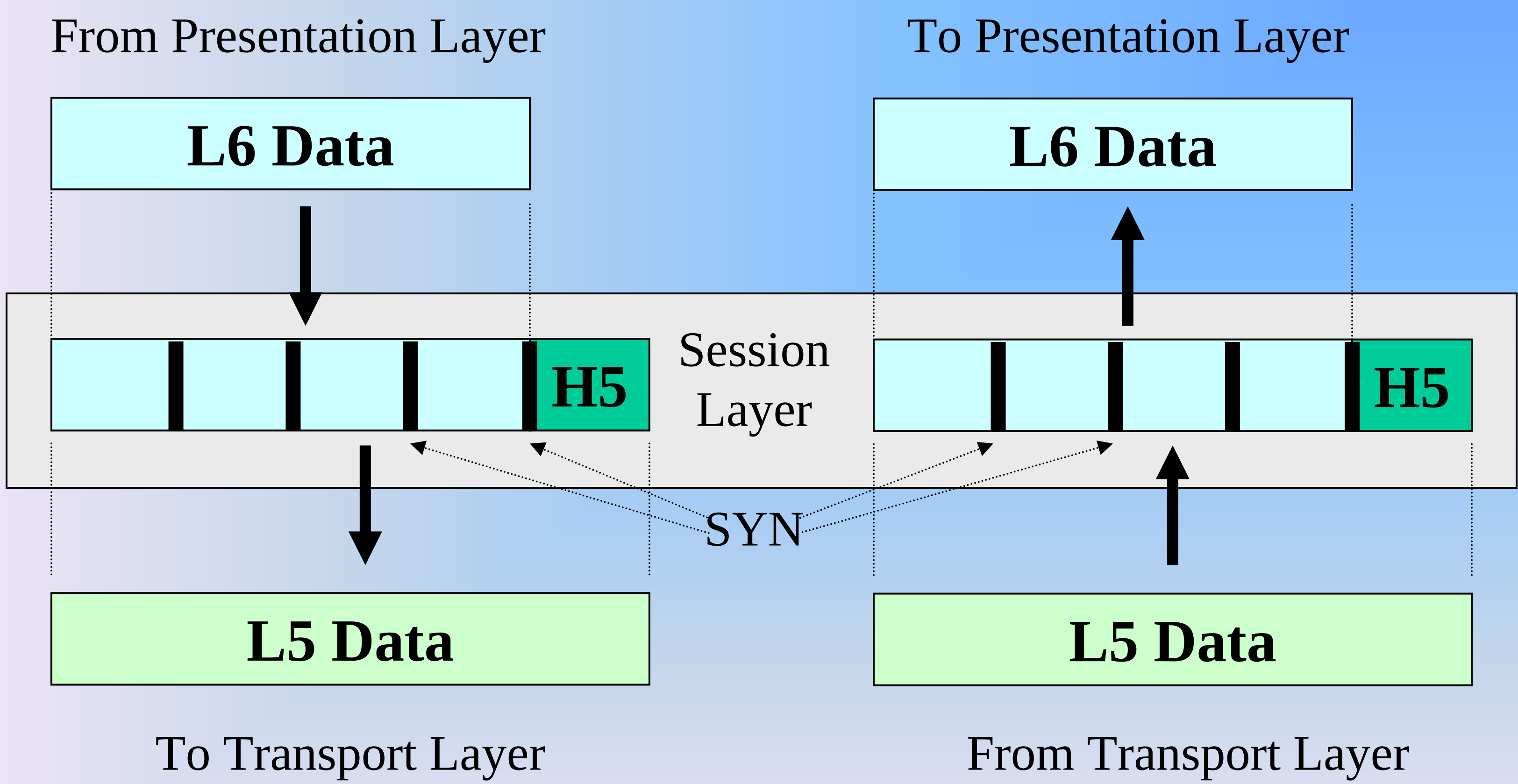
- Responsible for end-to-end flow control of data
- Responsible for end-to-end error control of data
  - Error correction is usually achieved through retransmission

Layer-5(Session)

A
P
S
T
N
D
P

- First of the three user support layers
- It is the network dialog controller
- It establishes, maintains, and synchronises the interaction between communicating systems
- It allows the communication between two processes to take place either in half-duplex or full-duplex
- Allows a process to add checkpoints (synchronisation points) into a stream of data

Layer-5(Session)



Layer-6 (Presentation)

A
P
S
T
N
D
P

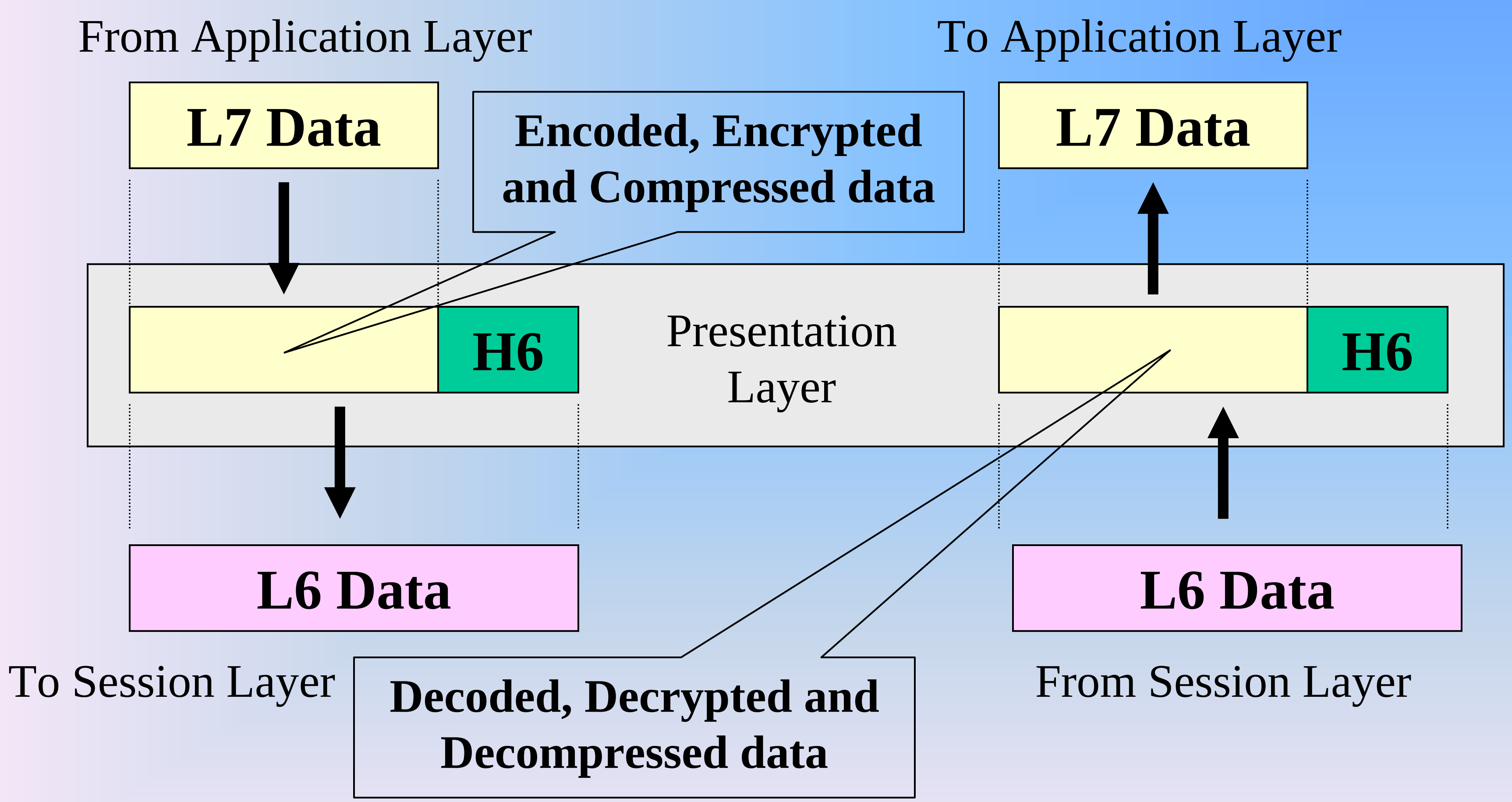
- Second of the three user support layers
- Concerned with the syntax and semantics of the information exchanged between two systems
- At sender end, changes the information from sender dependent format into a common format
- At the receiving end, changes the information from common format into its receiver dependent format

Layer-6 (Presentation)

A
P
S
T
N
D
P

- Responsible for encryption and decryption of sensitive information
- Responsible for data compression of the data to be transmitted

Layer-6(Presentation)



Layer-7(Application)

A
P
S
T
N
D
P

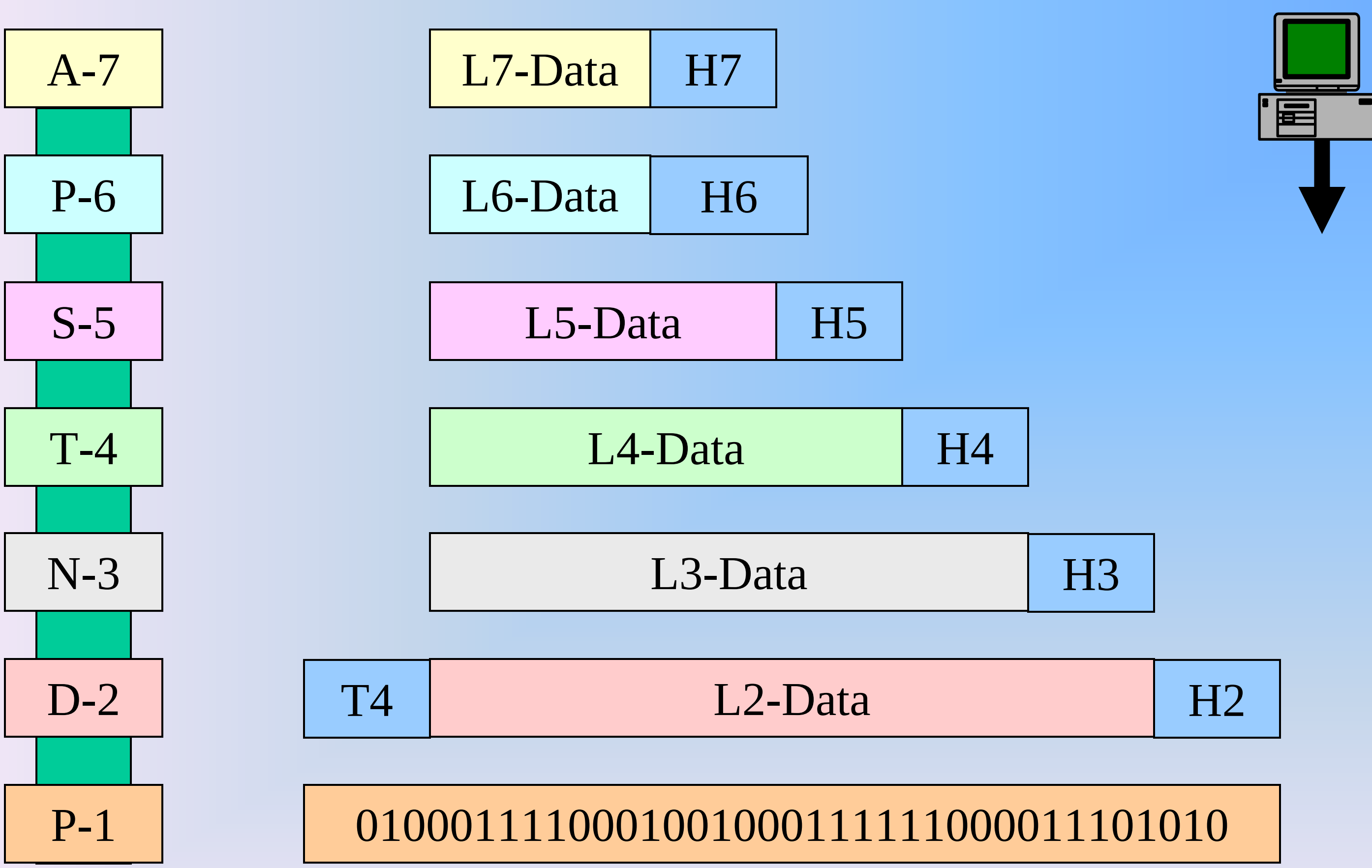
- Top of the three user support layers
- Enables the user, human or software, to access the network
- It provides user interfaces and support for services e.g. electronic mail, remote file access and transfer, shared database management and other types of distributed information services

Layer-7(Application)

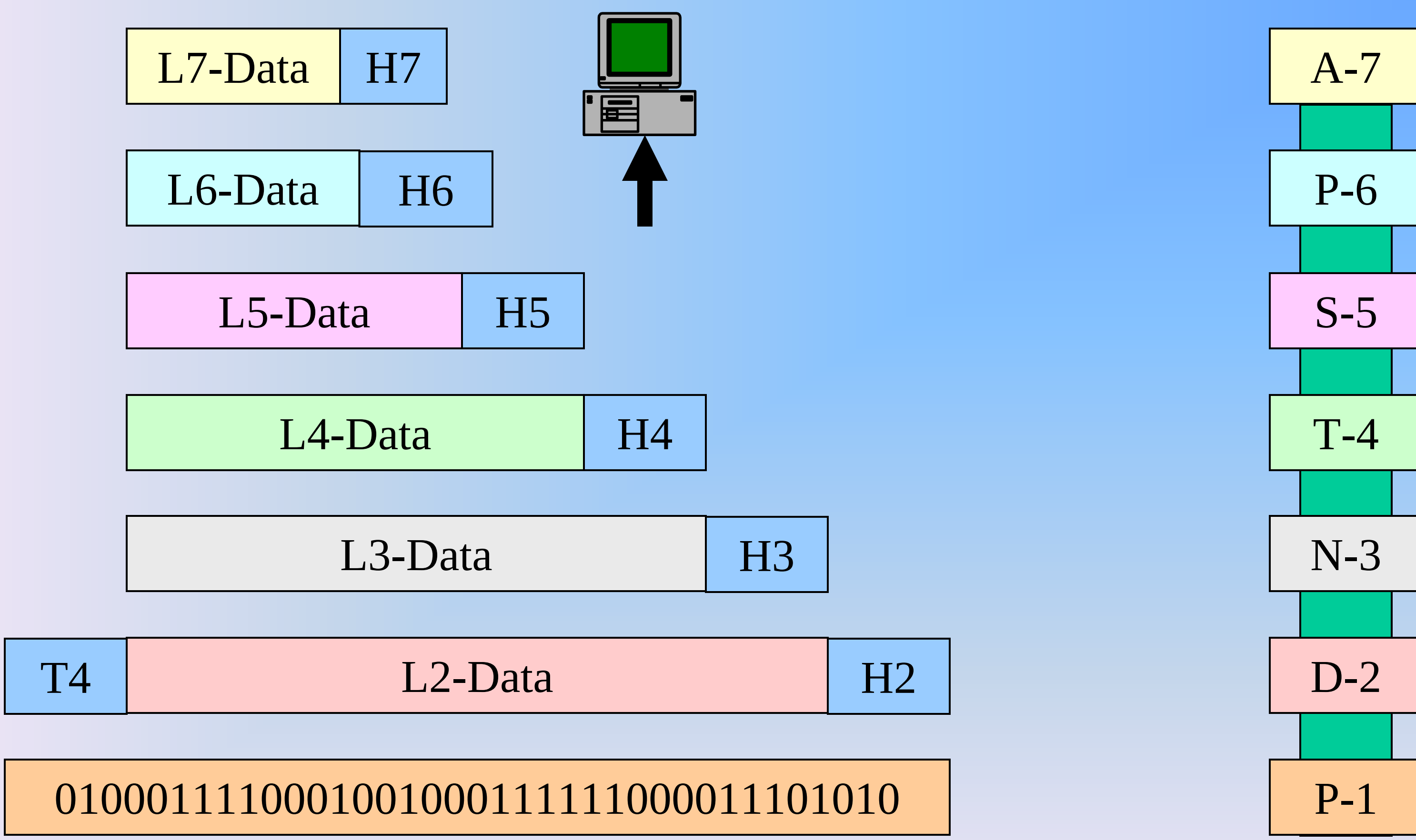
A
P
S
T
N
D
P

- Specific services provided by the application layer include
  - Network Virtual terminal
    - Software version of a physical terminal
    - Allows user to log on to a remote host
  - File Transfer, Access and Management
    - Allows user to access, retrieve, manage and control files in a remote computer
  - Mail Services
    - Provides basis for e-mail forwarding and storage
  - Directory Services
    - Provides distributed database sources and access for global information about various services

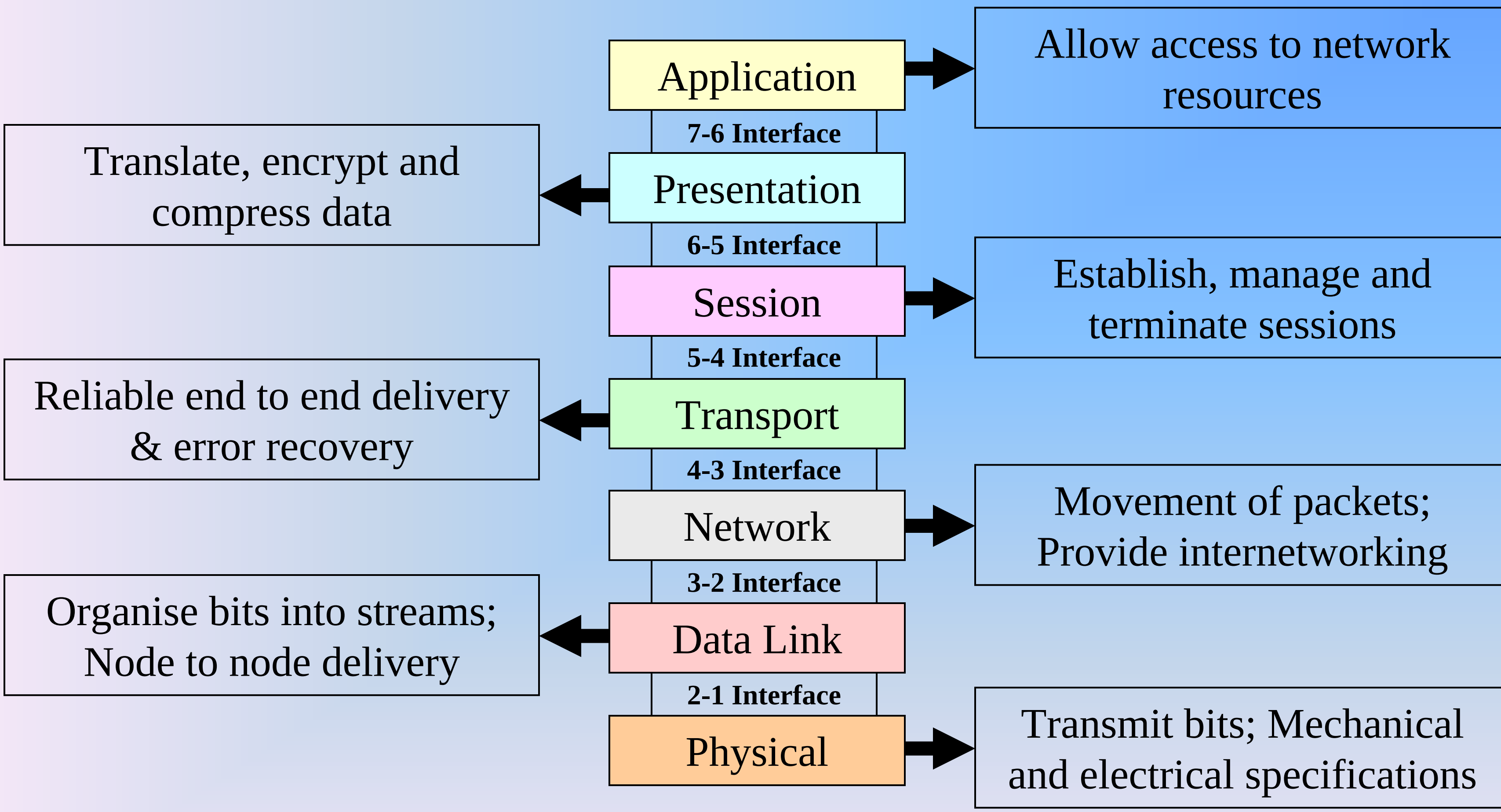
An exchange using OSI model



An exchange using OSI model



Summary of OSI Layers Functions



Thank You

Any Questions ?

TEE 843 – Sistem Telekomunikasi

10. Komunikasi Data (tambahan)

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Lhokseumawe, 2016

Kode Morse

A	• —	J	• — — —	S	• • •
B	— • • •	K	— • —	T	—
C	— • — •	L	• — • •	U	• • —
D	— • •	M	— —	V	• • • —
E	•	N	— •	W	• — —
F	• • — •	O	— — —	X	— • • —
G	— — •	P	• — — •	Y	— • — —
H	• • • •	Q	— — • —	Z	— — • •
I	• •	R	• — •		

1	• — — — —	6	— • • • •
2	• • — — —	7	— — • • •
3	• • • — —	8	— — — • •
4	• • • • —	9	— — — — •
5	• • • • •	0	— — — — —

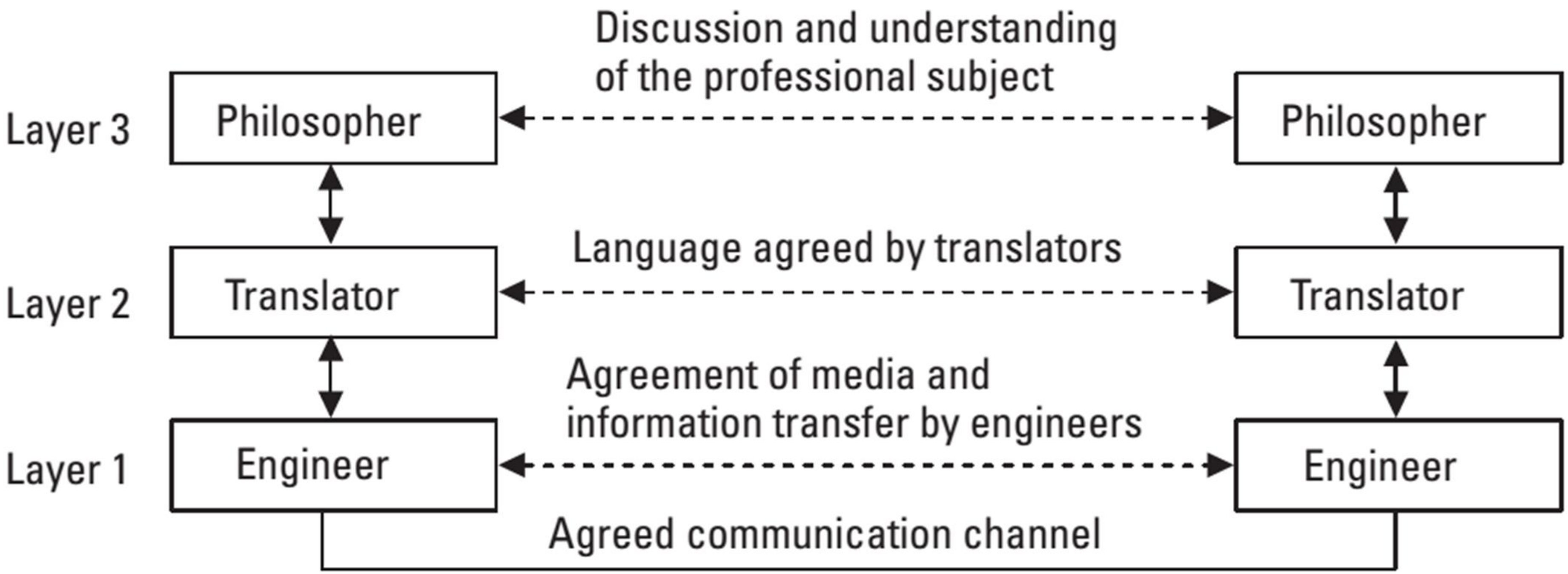
Kode ASCII

Decimal - Binary - Octal - Hex – ASCII Conversion Chart

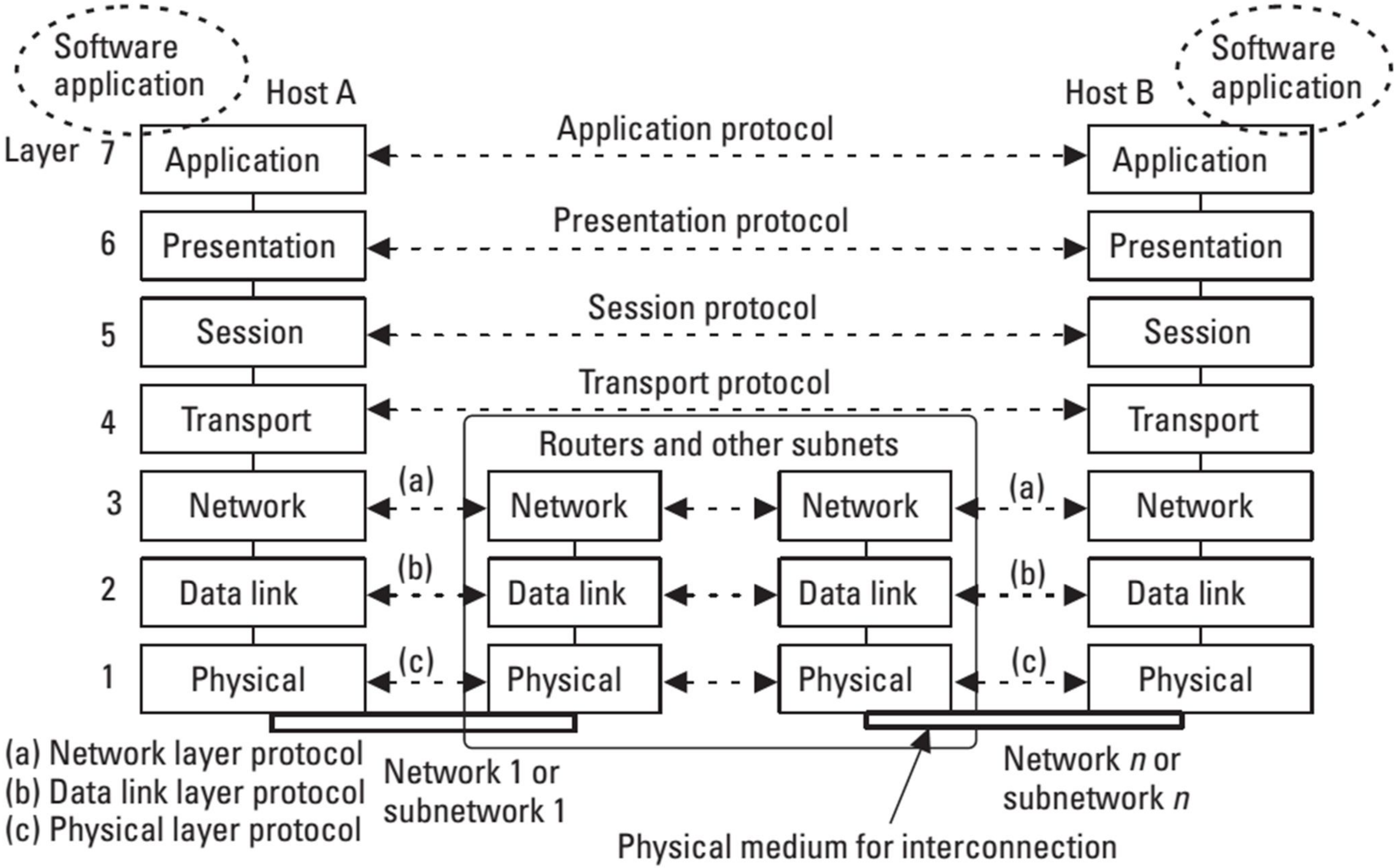
Decimal	Binary	Octal	Hex	ASCII	Decimal	Binary	Octal	Hex	ASCII	Decimal	Binary	Octal	Hex	ASCII	Decimal	Binary	Octal	Hex	ASCII
0	00000000	000	00	NUL	32	00100000	040	20	SP	64	01000000	100	40	@	96	01100000	140	60	`
1	00000001	001	01	SOH	33	00100001	041	21	!	65	01000001	101	41	A	97	01100001	141	61	a
2	00000010	002	02	STX	34	00100010	042	22	"	66	01000010	102	42	B	98	01100010	142	62	b
3	00000011	003	03	ETX	35	00100011	043	23	#	67	01000011	103	43	C	99	01100011	143	63	c
4	00000100	004	04	EOT	36	00100100	044	24	$	68	01000100	104	44	D	100	01100100	144	64	d
5	00000101	005	05	ENQ	37	00100101	045	25	%	69	01000101	105	45	E	101	01100101	145	65	e
6	00000110	006	06	ACK	38	00100110	046	26	&	70	01000110	106	46	F	102	01100110	146	66	f
7	00000111	007	07	BEL	39	00100111	047	27	'	71	01000111	107	47	G	103	01100111	147	67	g
8	00001000	010	08	BS	40	00101000	050	28	(	72	01001000	110	48	H	104	01101000	150	68	h
9	00001001	011	09	HT	41	00101001	051	29	)	73	01001001	111	49	I	105	01101001	151	69	i
10	00001010	012	0A	LF	42	00101010	052	2A	*	74	01001010	112	4A	J	106	01101010	152	6A	j
11	00001011	013	0B	VT	43	00101011	053	2B	+	75	01001011	113	4B	K	107	01101011	153	6B	k
12	00001100	014	0C	FF	44	00101100	054	2C	,	76	01001100	114	4C	L	108	01101100	154	6C	l
13	00001101	015	0D	CR	45	00101101	055	2D	-	77	01001101	115	4D	M	109	01101101	155	6D	m
14	00001110	016	0E	SO	46	00101110	056	2E	.	78	01001110	116	4E	N	110	01101110	156	6E	n
15	00001111	017	0F	SI	47	00101111	057	2F	/	79	01001111	117	4F	O	111	01101111	157	6F	o
16	00010000	020	10	DLE	48	00110000	060	30	0	80	01010000	120	50	P	112	01110000	160	70	p
17	00010001	021	11	DC1	49	00110001	061	31	1	81	01010001	121	51	Q	113	01110001	161	71	q
18	00010010	022	12	DC2	50	00110010	062	32	2	82	01010010	122	52	R	114	01110010	162	72	r
19	00010011	023	13	DC3	51	00110011	063	33	3	83	01010011	123	53	S	115	01110011	163	73	s
20	00010100	024	14	DC4	52	00110100	064	34	4	84	01010100	124	54	T	116	01110100	164	74	t
21	00010101	025	15	NAK	53	00110101	065	35	5	85	01010101	125	55	U	117	01110101	165	75	u
22	00010110	026	16	SYN	54	00110110	066	36	6	86	01010110	126	56	V	118	01110110	166	76	v
23	00010111	027	17	ETB	55	00110111	067	37	7	87	01010111	127	57	W	119	01110111	167	77	w
24	00011000	030	18	CAN	56	00111000	070	38	8	88	01011000	130	58	X	120	01111000	170	78	x
25	00011001	031	19	EM	57	00111001	071	39	9	89	01011001	131	59	Y	121	01111001	171	79	y
26	00011010	032	1A	SUB	58	00111010	072	3A	:	90	01011010	132	5A	Z	122	01111010	172	7A	z
27	00011011	033	1B	ESC	59	00111011	073	3B	;	91	01011011	133	5B	[	123	01111011	173	7B	{
28	00011100	034	1C	FS	60	00111100	074	3C	<	92	01011100	134	5C	\	124	01111100	174	7C	|
29	00011101	035	1D	GS	61	00111101	075	3D	=	93	01011101	135	5D	]	125	01111101	175	7D	}
30	00011110	036	1E	RS	62	00111110	076	3E	>	94	01011110	136	5E	^	126	01111110	176	7E	~
31	00011111	037	1F	US	63	00111111	077	3F	?	95	01011111	137	5F	_	127	01111111	177	7F	DEL

Catatan: Bit pertama adalah bit paritas, tidak mesti 0. Ini akan bergantung pada kode paritas yg digunakan; *Even Parity Check* ataupun *Old Parity Check*.

Purpose and value of layering

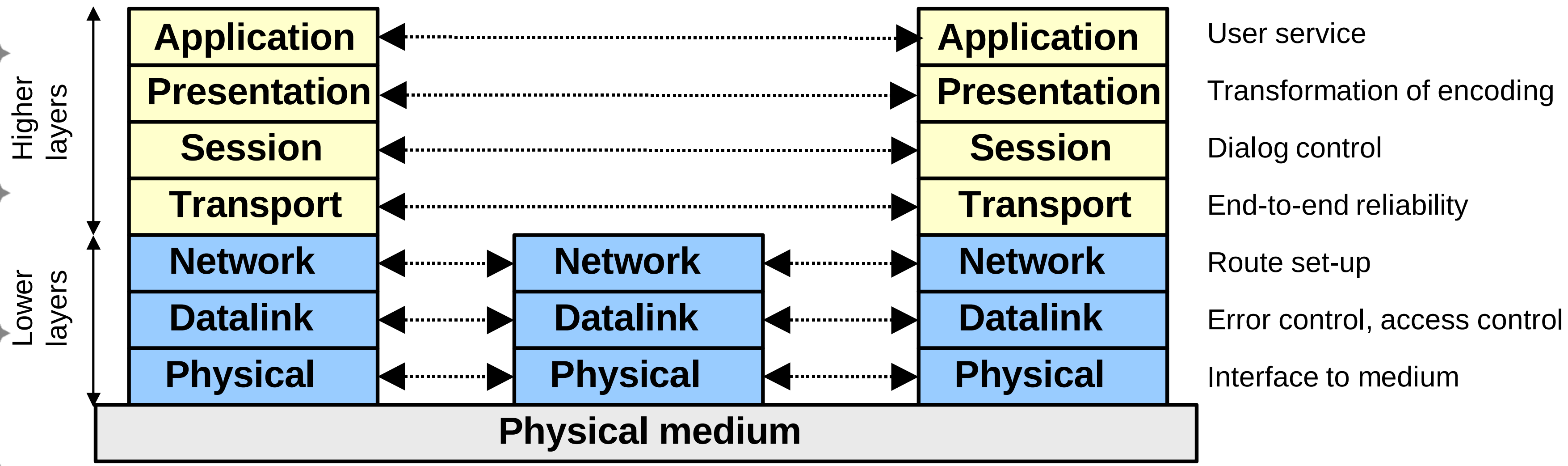


Open System Interconnection (OSI) Reference Model



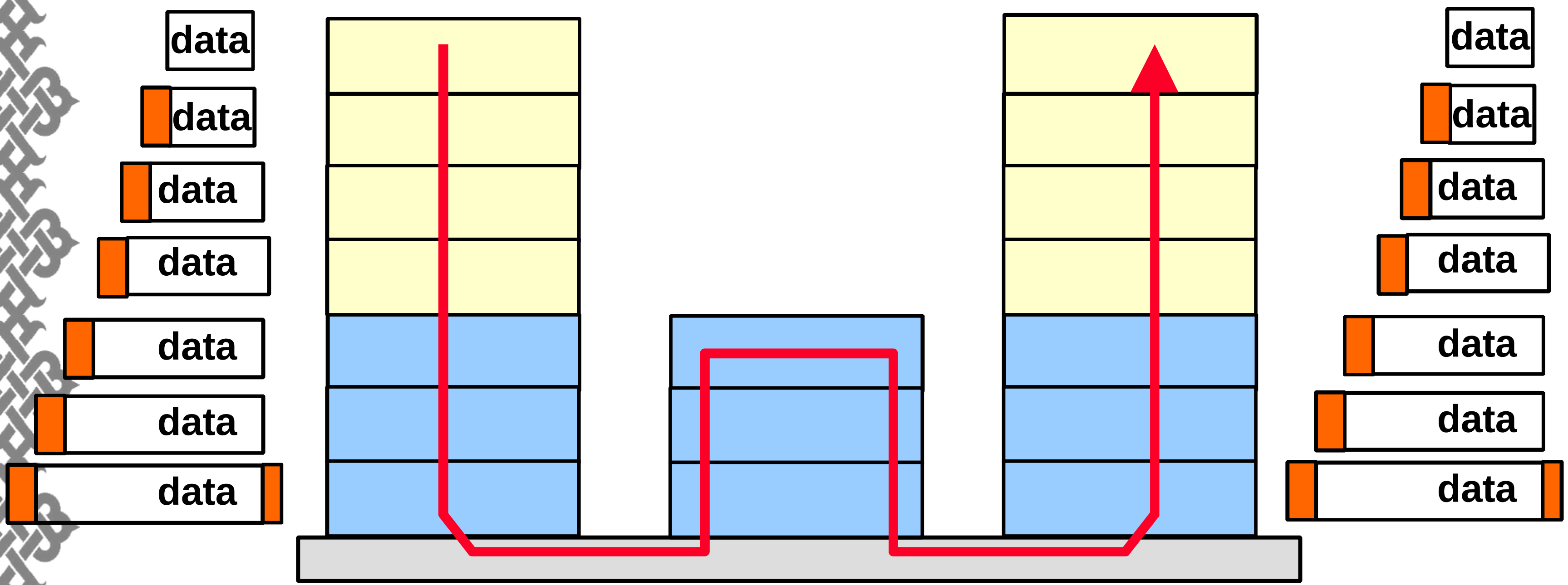
Model referensi OSI

- Skenario komunikasi dan fungsi utama masing-masing layer



Model referensi OSI

- Proses pembentukan dan pembuangan protocol headers



OSI vs TCP/IP

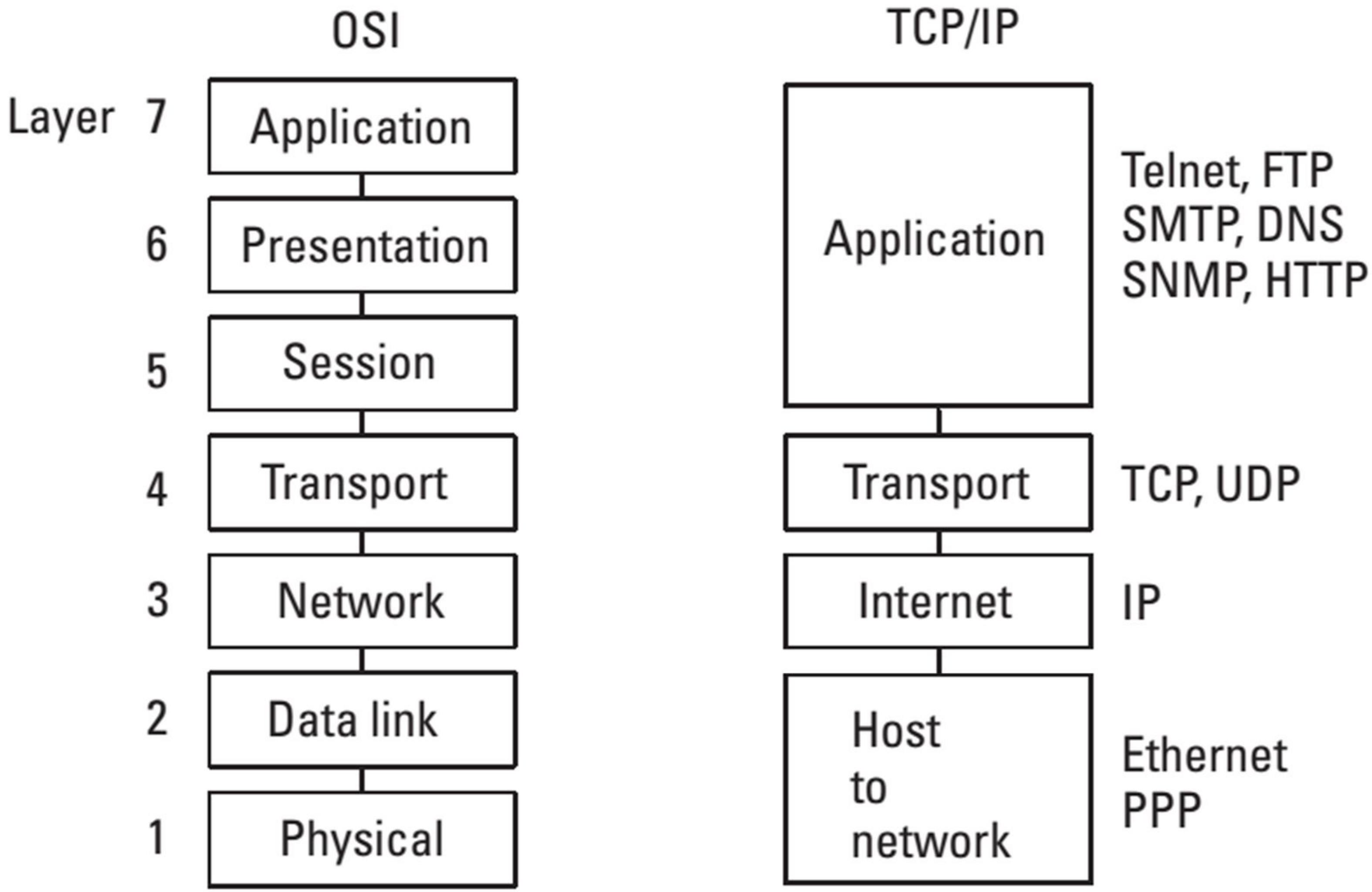
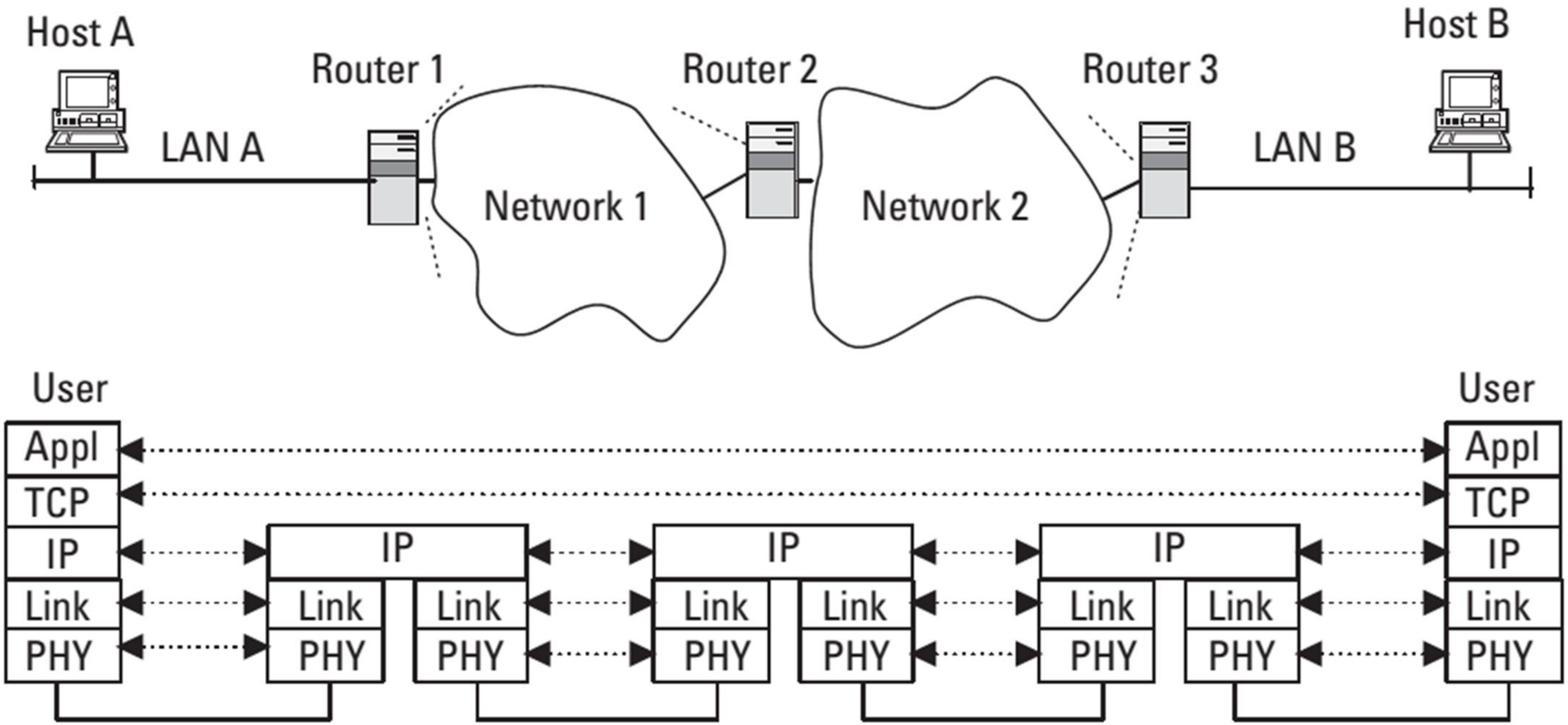


Figure 6.11 The TCP/IP stack and OSI reference model.

Example Internet connection



PR-10

1. Compare parallel and serial data transmission principles and applications.
2. Explain what is meant by asynchronous and synchronous data transmission.
3. ASCII strings “A” [1000001] and “2” [1000110] (first bit on the left) are sent and a parity bit for even parity is added in the end of each character. What are the transmitted 8-bit strings?
4. Compare circuit-switched service and packet-switched networks. What are their advantages and disadvantages? List three examples of both circuit- and packet-switched networks.

PR-10 (lanjutan)

5. What does protocol mean in data communications? Give some examples of protocols. Why do we use a layered protocol structure in data communications?
6. Explain the basic principle and structure of the OSI reference model. Explain also the functions of the layers of OSI reference model, respectively.
7. Compare the TCP/IP stack with the OSI reference model.

Sekian, terima kasih, semoga berkah.

Ada pertanyaan?

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