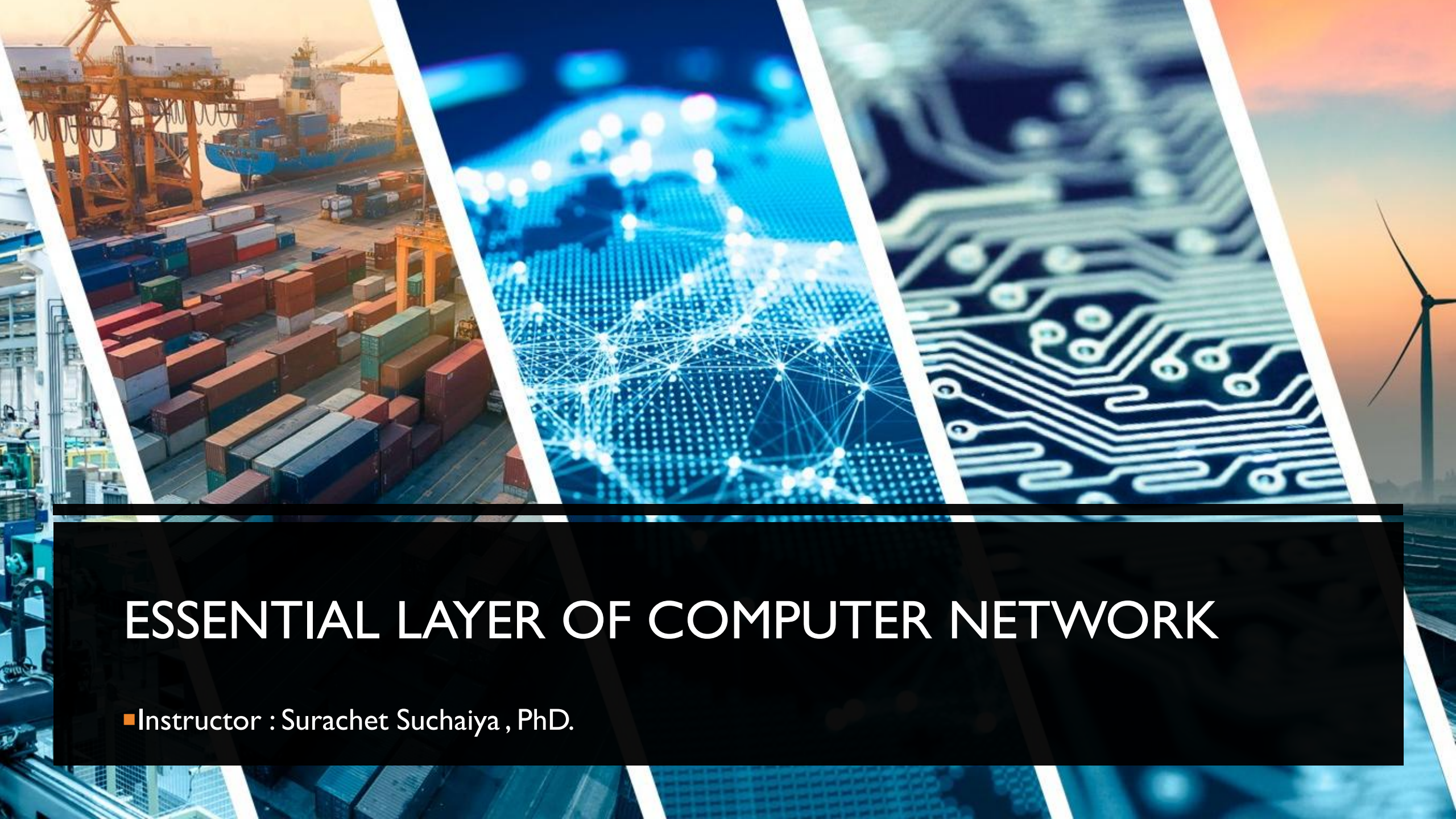


ESSENTIAL LAYER OF COMPUTER NETWORK

- Instructor : Surachet Suchaiya , PhD.

INSTRUCTOR

ประวัติการศึกษา ประกาศนียบัตรที่ได้รับการฝึกอบรม ประวัติการทำงาน ความเชี่ยวชาญ ประสบการณ์ และ งานวิจัยของอาจารย์

อยู่ใน Website หากสนใจสามารถ Scan QR Code เข้าไปดูได้

TOPICS

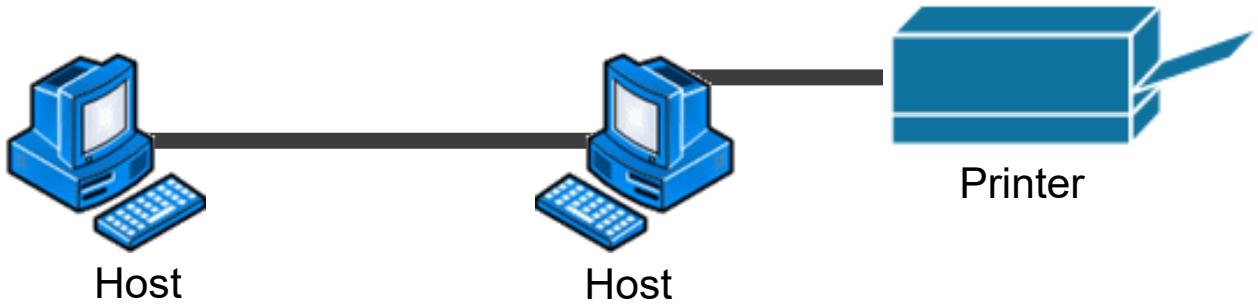
Essential Layer of Computer Network I

1. Introduction to Network Topologies
2. OSI Model and Layers
3. Network Connectors and Wiring Standards
4. Network Devices
5. Ethernet Specifications

CHAPTER 1
INTRODUCTION TO NETWORK TOPOLOGIES

1.INTRODUCTION TO NETWORK TOPOLOGIES

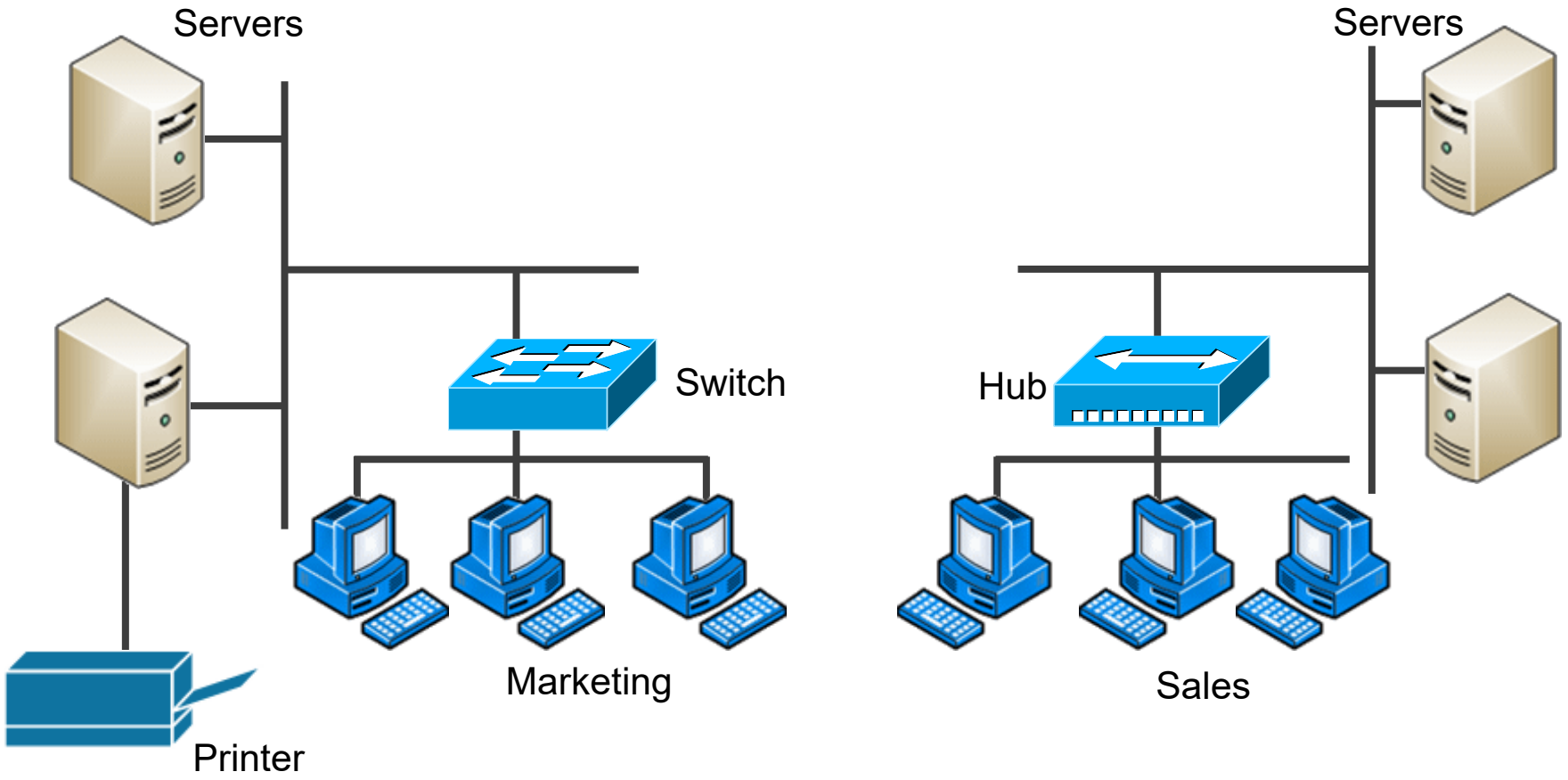
What is a Network?



- Share Data and Application
- Share Office Machines (Print , Scanner)
- Share Internet Connection

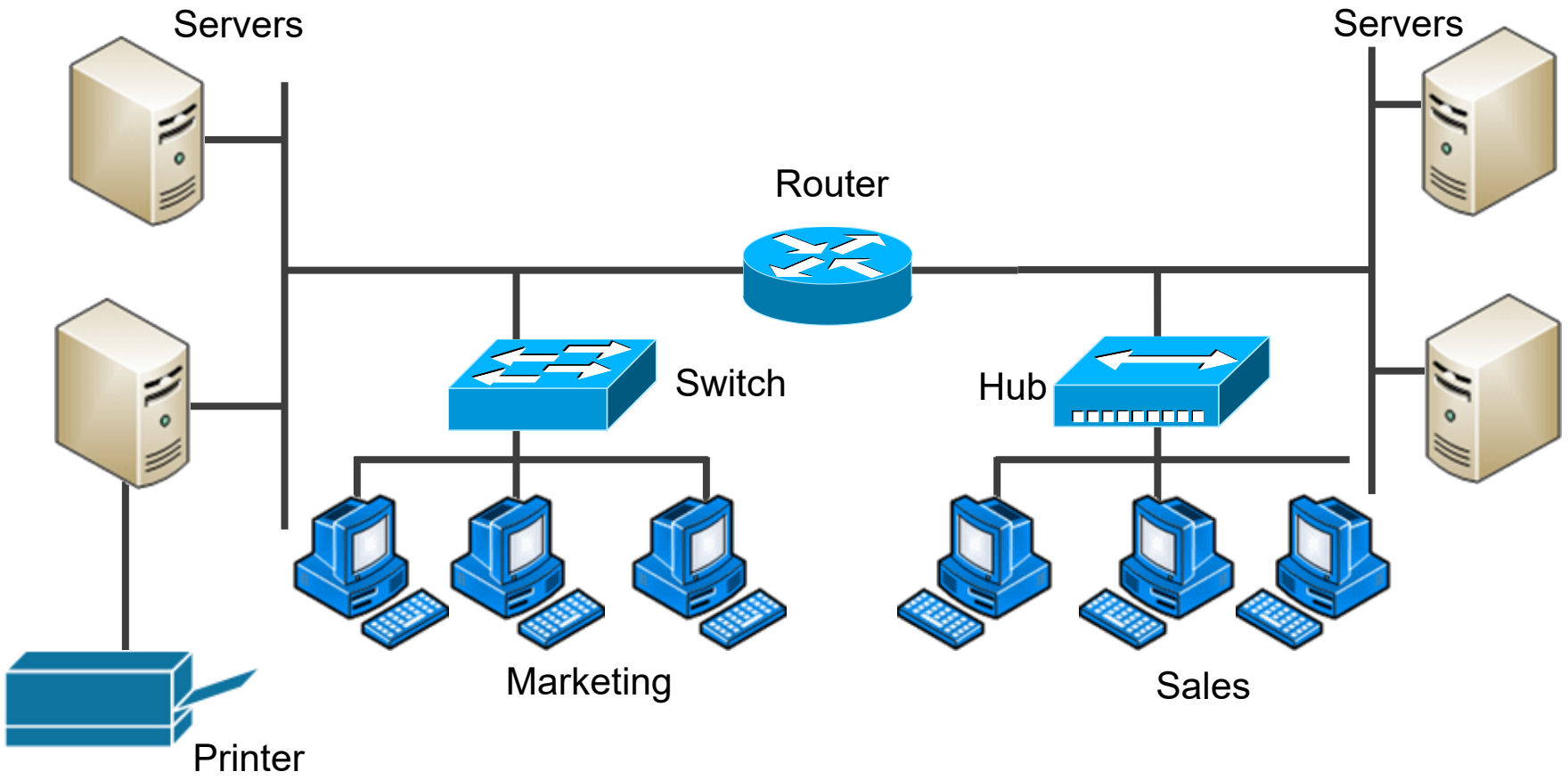
1.INTRODUCTION TO NETWORK TOPOLOGIES

What is a Network?



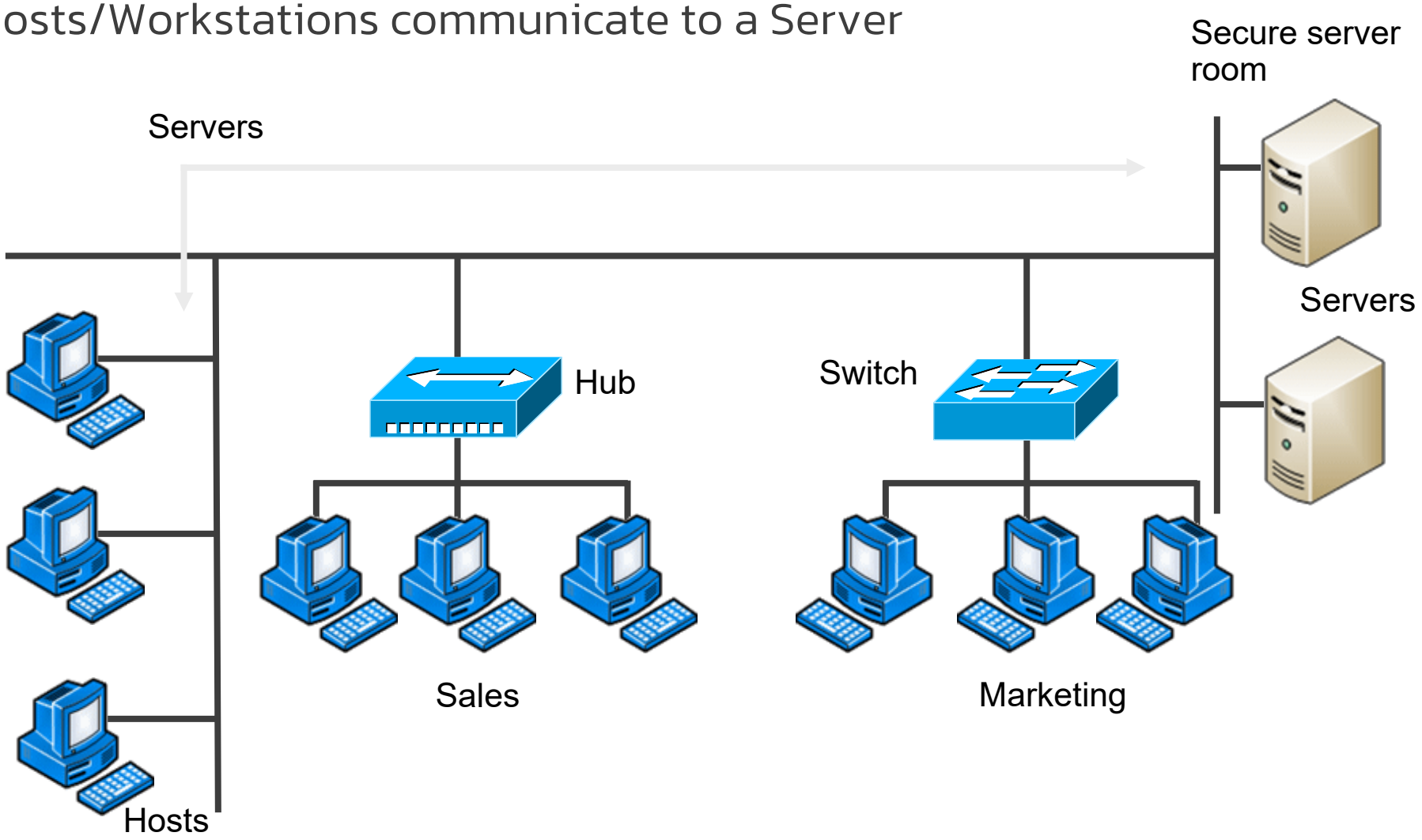
1.INTRODUCTION TO NETWORK TOPOLOGIES

Connect other LANs together.



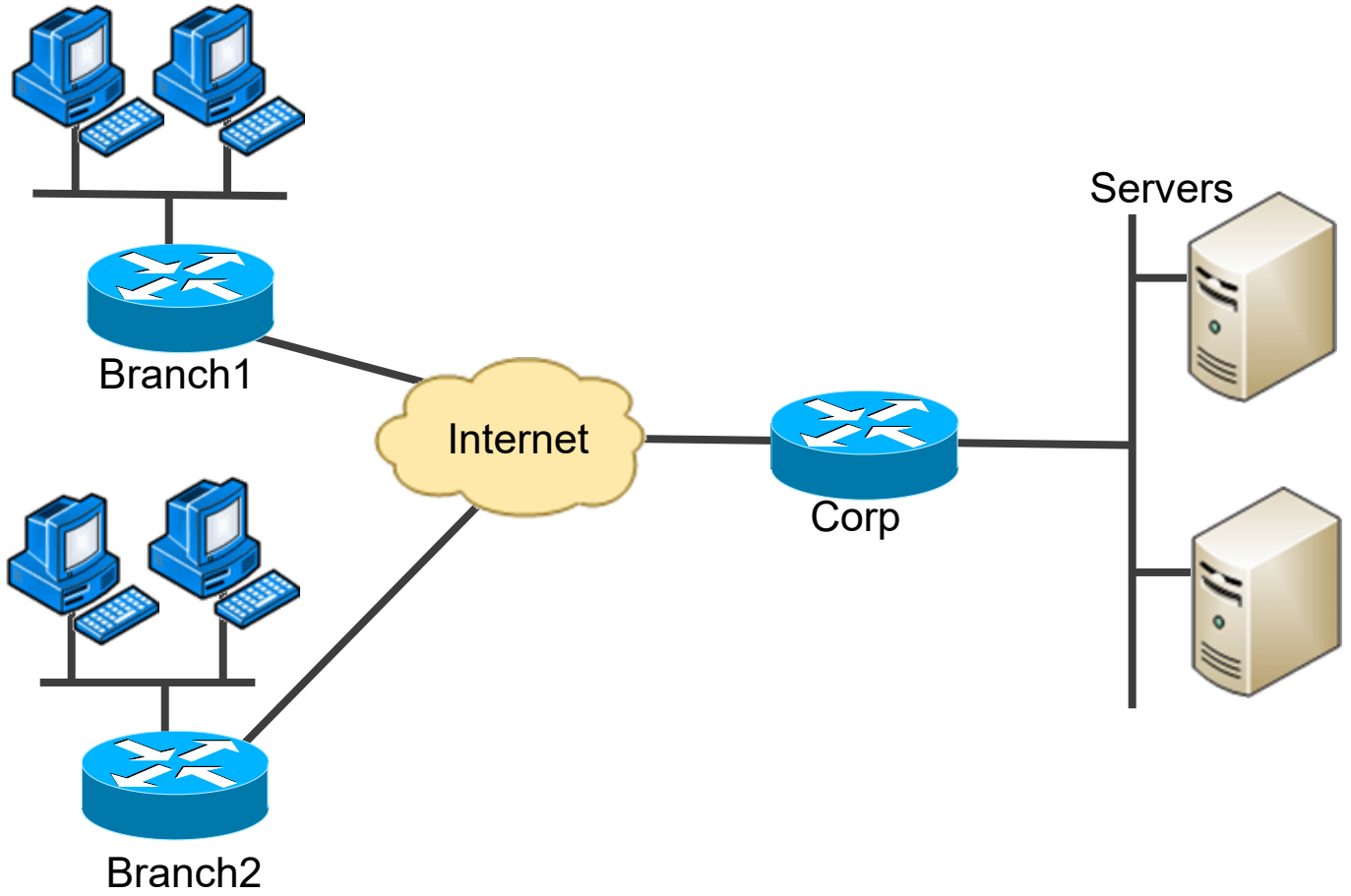
1.INTRODUCTION TO NETWORK TOPOLOGIES

Hosts/Workstations communicate to a Server



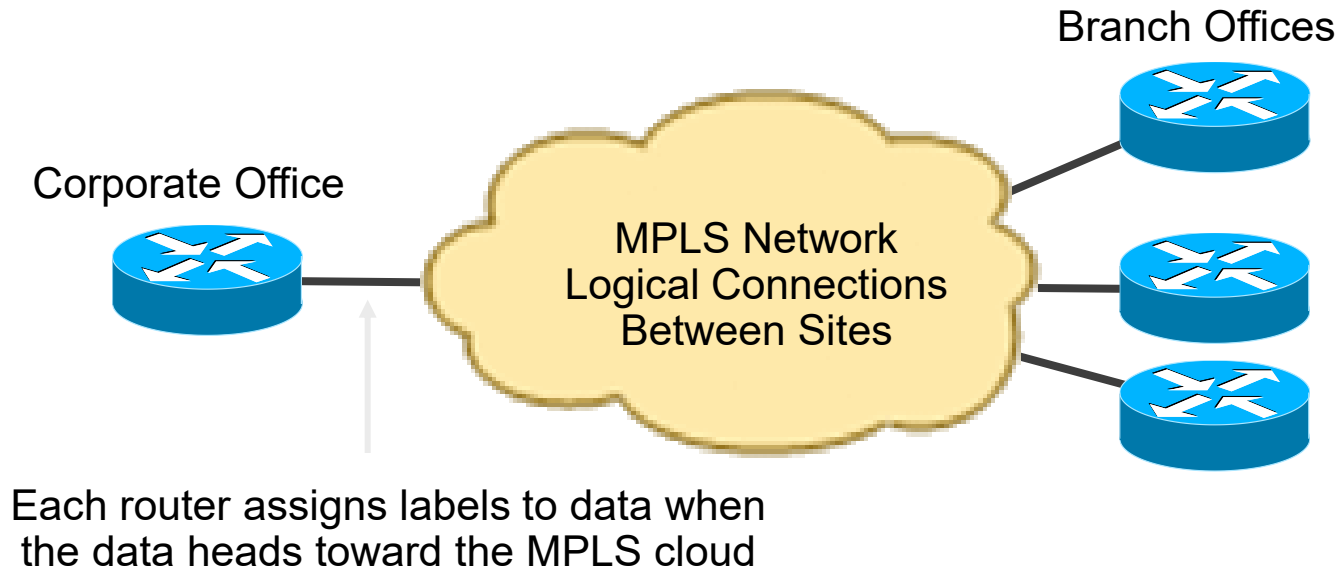
1.INTRODUCTION TO NETWORK TOPOLOGIES

Wide Area Networks



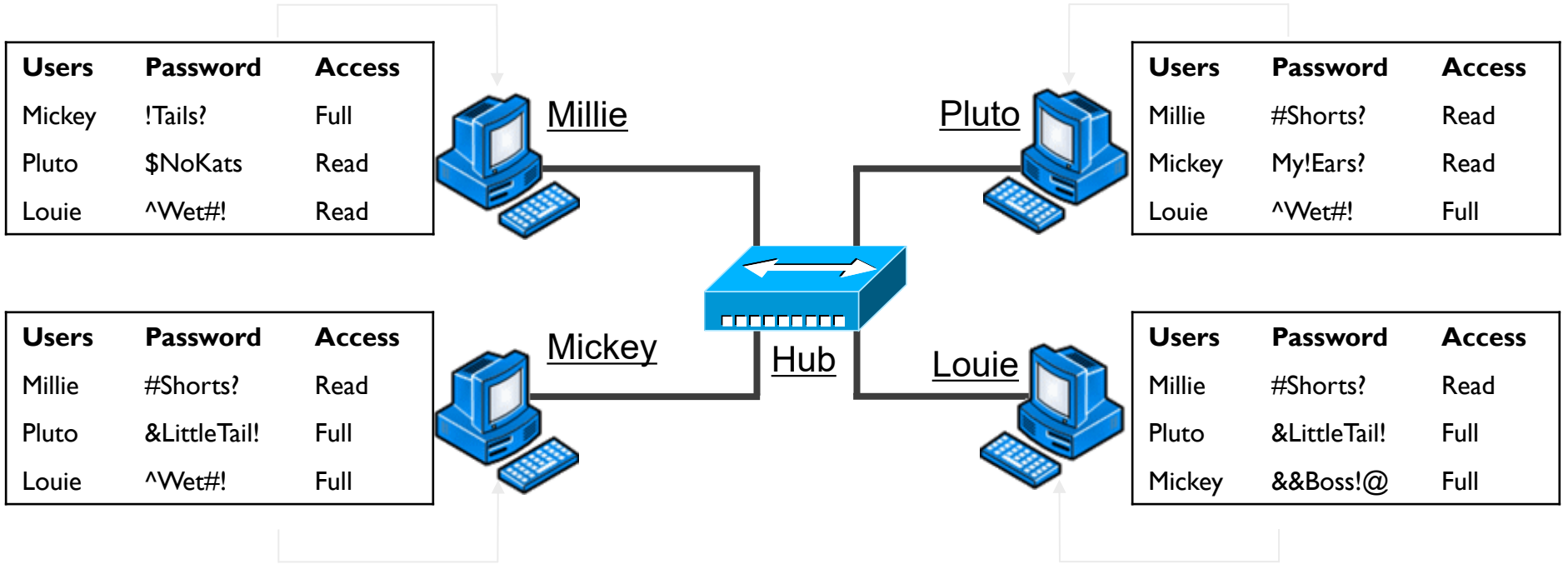
1.INTRODUCTION TO NETWORK TOPOLOGIES

Wide Area Networks :
MPLS (Multiprotocol Label Switching)



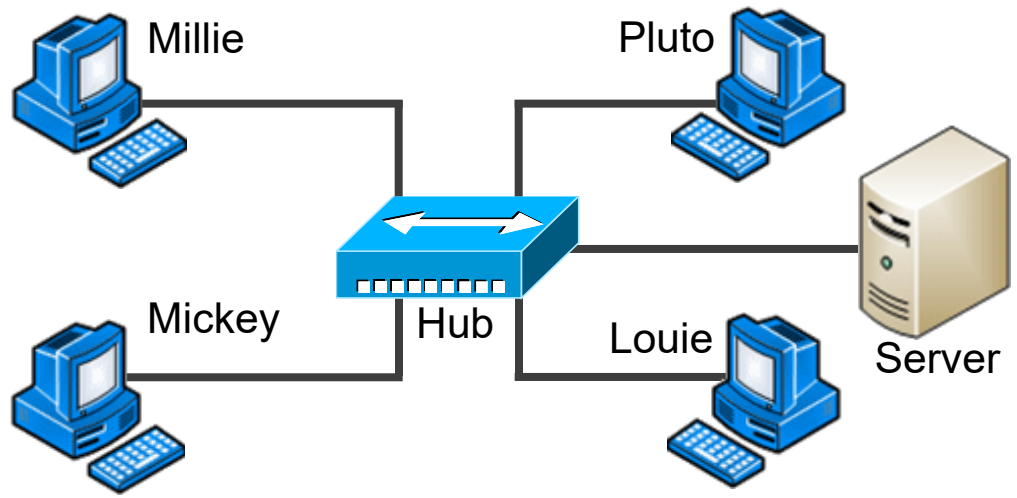
1.INTRODUCTION TO NETWORK TOPOLOGIES

Peer-to-Peer Networking



1.INTRODUCTION TO NETWORK TOPOLOGIES

Client Server Networks



Users	Password	Access
Millie	#Shorts?	Read
Pluto	&LittleTail!	Full
Louie	^Wet#!	Full
Mickey	--Earls?	Write

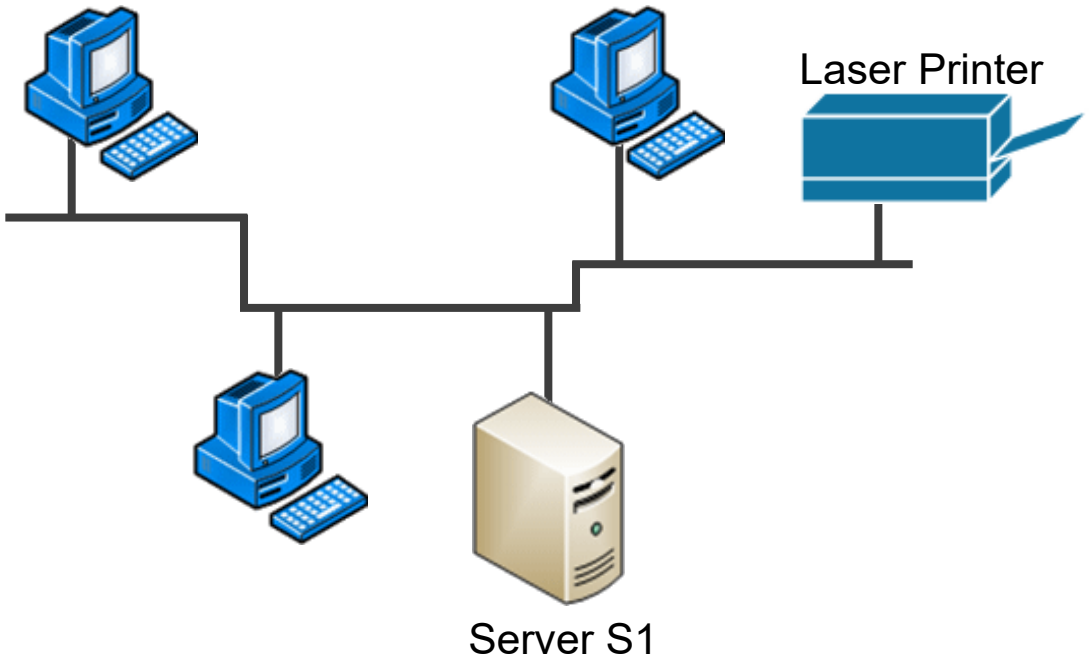
1.INTRODUCTION TO NETWORK TOPOLOGIES

Physical Topologies

- Bus
- Star
- Ring
- Mesh
- Point-to-Point
- Point-to-Multipoint
- Hybrid

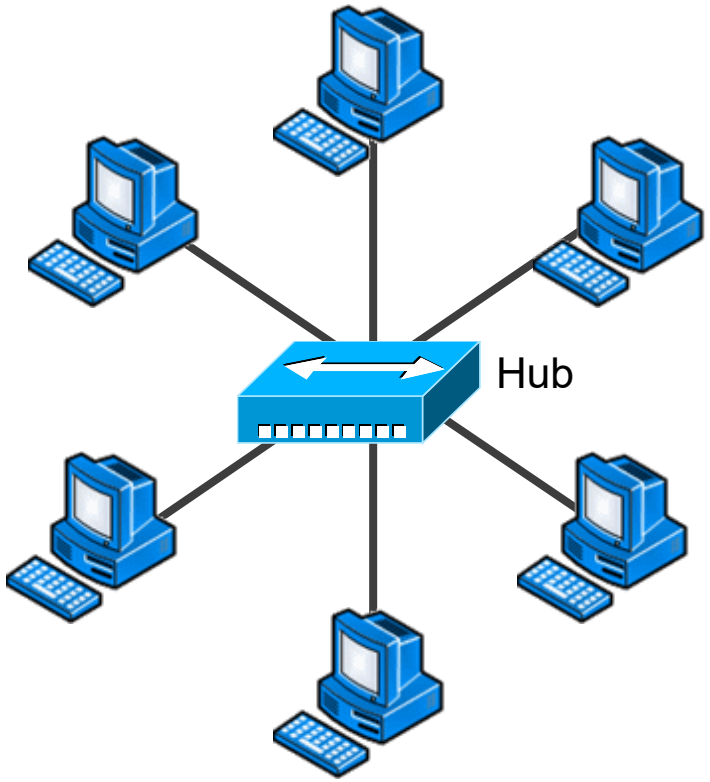
1.INTRODUCTION TO NETWORK TOPOLOGIES

Physical Topologies : Bus



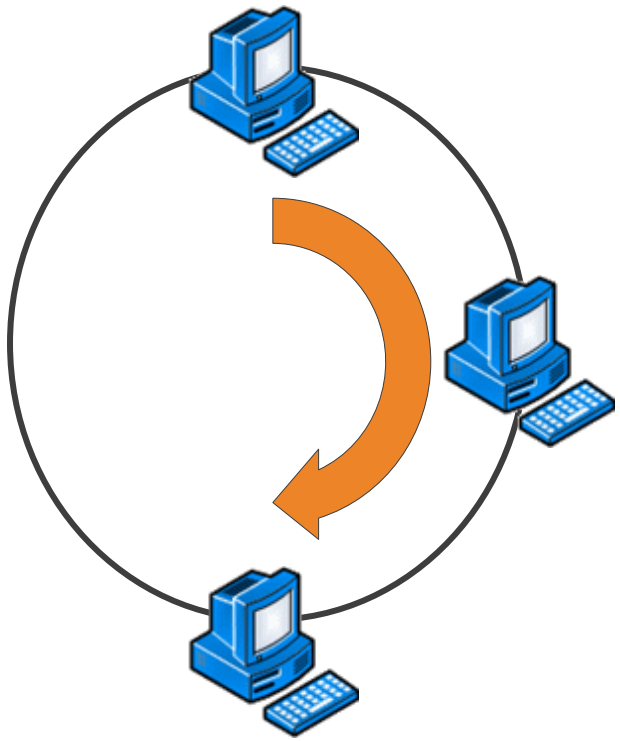
1.INTRODUCTION TO NETWORK TOPOLOGIES

Physical Topologies : Star



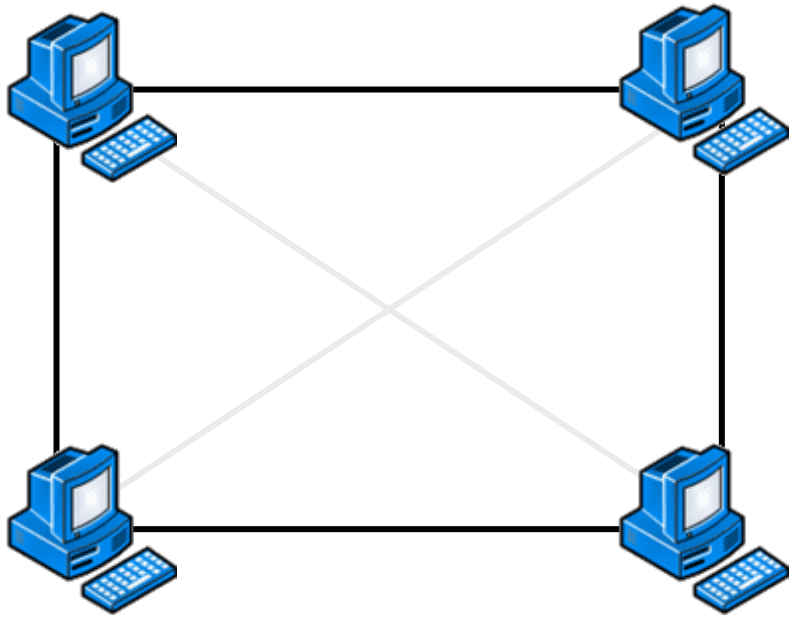
1.INTRODUCTION TO NETWORK TOPOLOGIES

Physical Topologies : Ring



1.INTRODUCTION TO NETWORK TOPOLOGIES

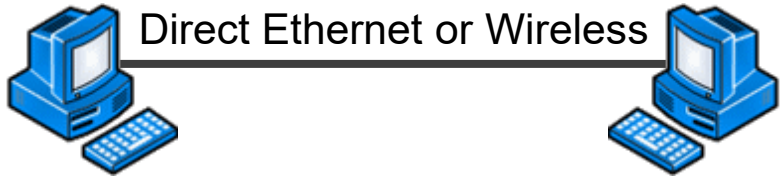
Physical Topologies : Mesh

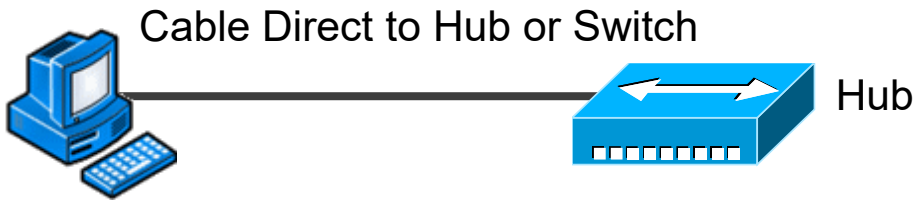


1.INTRODUCTION TO NETWORK TOPOLOGIES

Physical Topologies : Point-to-Point

Serial Connection, Like a T1 between Routers

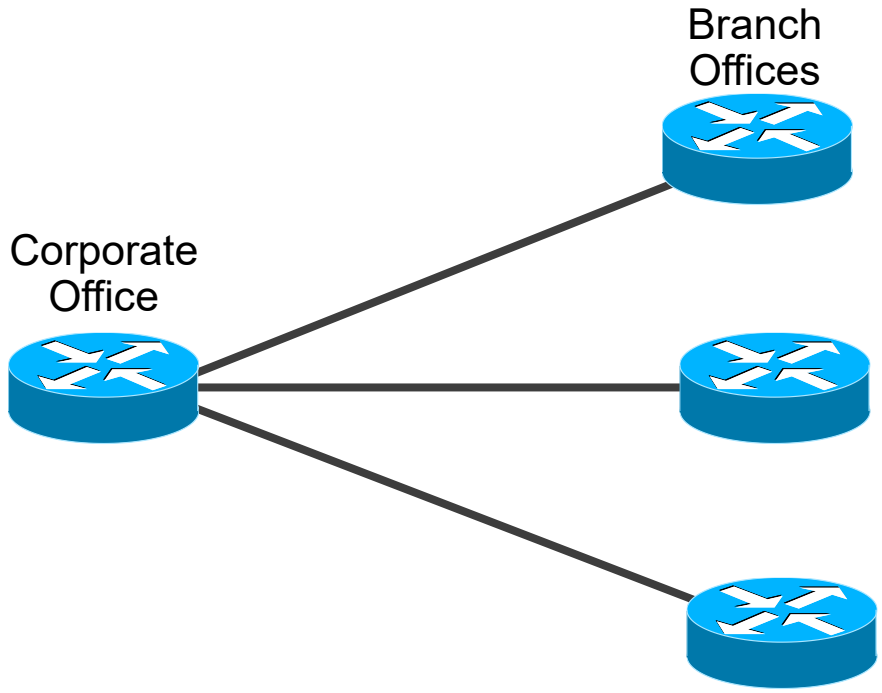




1.INTRODUCTION TO NETWORK TOPOLOGIES

Physical Topologies : Point-to-Multipoint

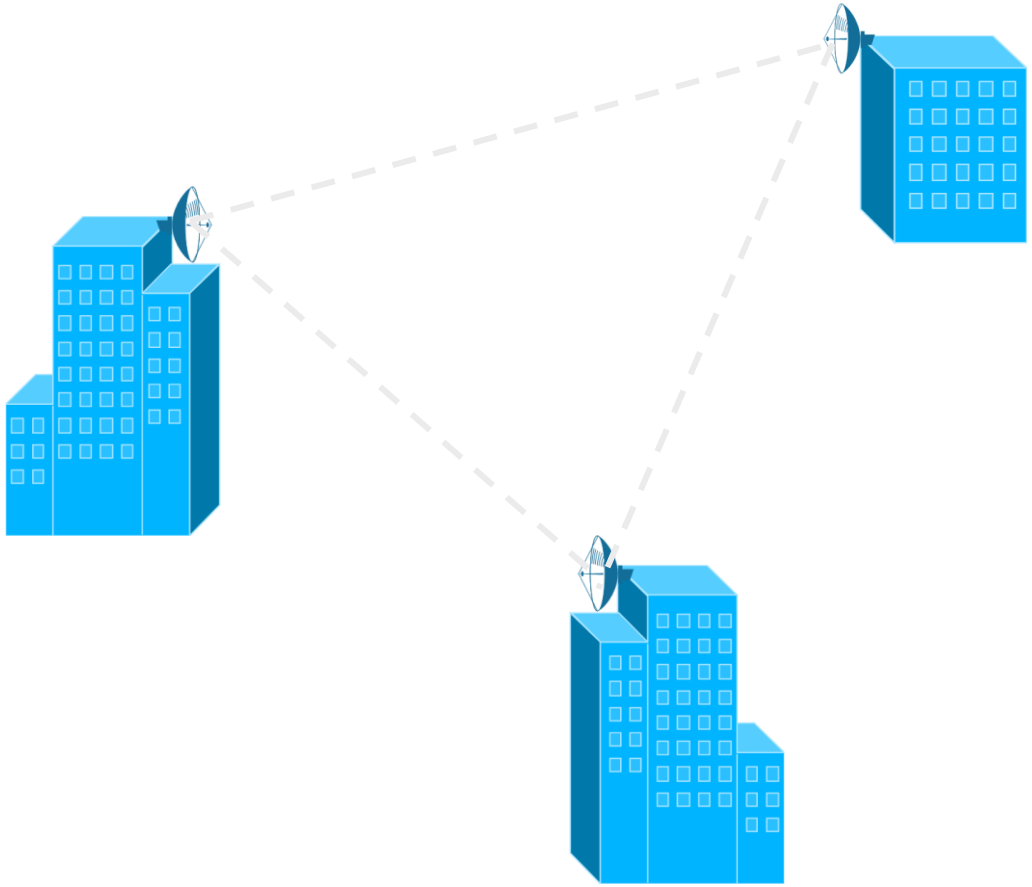
Example1



1.INTRODUCTION TO NETWORK TOPOLOGIES

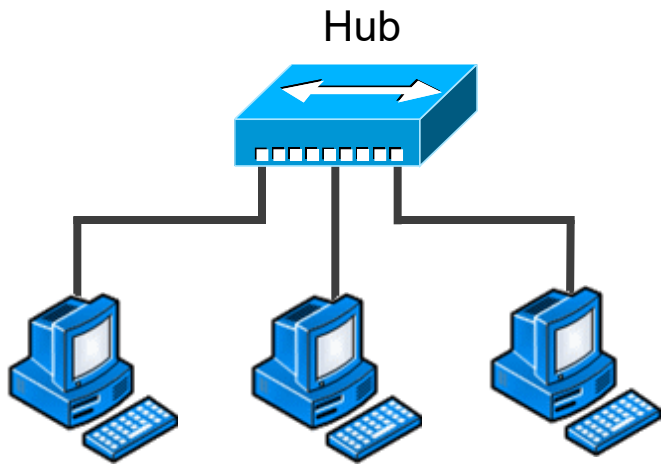
Physical Topologies : Point-to-Multipoint

Example2



1.INTRODUCTION TO NETWORK TOPOLOGIES

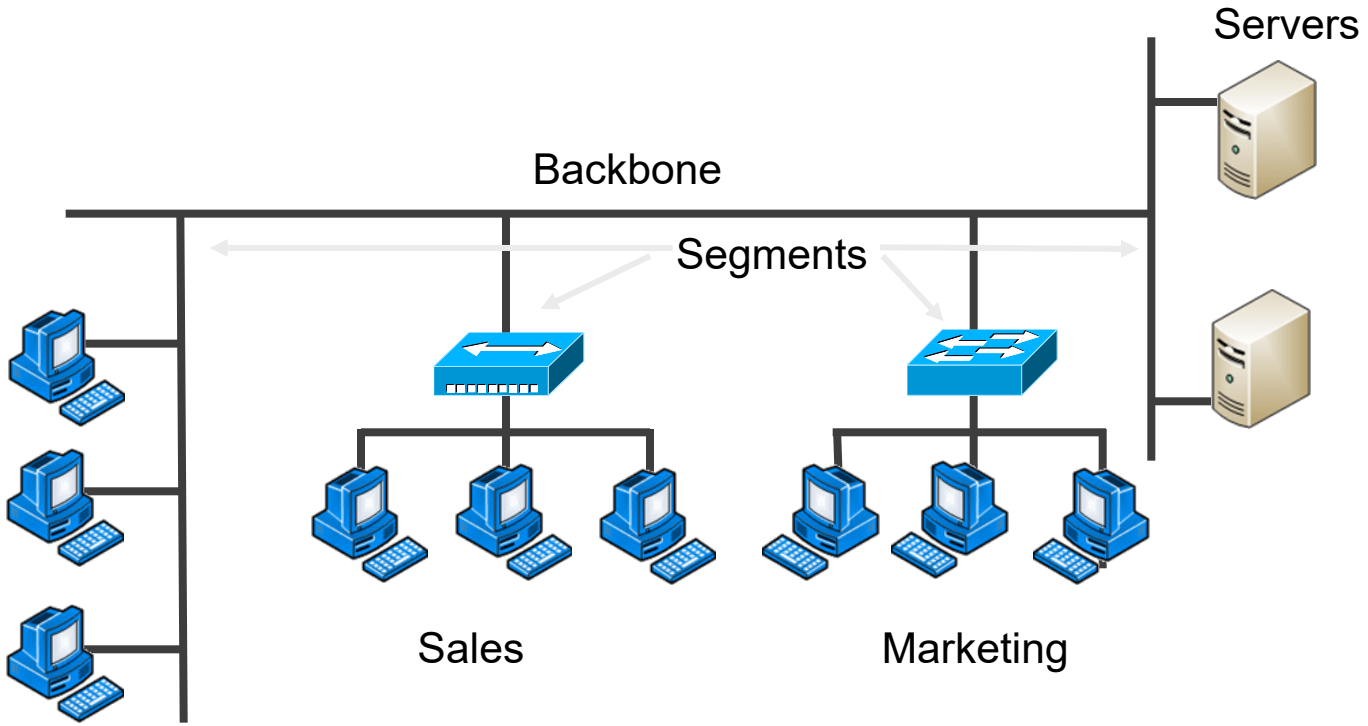
Physical Topologies : Hybrid



Physical Star, Logical Bus

1.INTRODUCTION TO NETWORK TOPOLOGIES

Backbones and Segments



1.INTRODUCTION TO NETWORK TOPOLOGIES

สรุป อุปกรณ์ที่ต่อในระบบ Network ที่ได้เรียนรู้ในบทนี้

- PC (Personal Computer) Client / Mac
- PC Server
- Network Printer
- Hub / Switch
- Router
- WiFi Access Point / WiFi Router
- Cloud

สรุป รูปแบบการเชื่อมต่อ ที่ได้เรียนรู้ในบทนี้ มีอะไรบ้าง

CHAPTER 2
OSI MODEL AND LAYERS

2. OSI MODEL AND LAYERS

- ในช่วงปลายทศวรรษ 1970 โมเดลอ้างอิง Open Systems Interconnection (OSI) ถูกสร้างขึ้นโดยองค์การระหว่างประเทศเพื่อการมาตรฐาน (ISO) เพื่อทำลายอุปสรรคนี้
- โมเดล OSI มีจุดมุ่งหมายเพื่อช่วยผู้จำหน่ายสร้างอุปกรณ์เครือข่ายและซอฟต์แวร์ที่ทำงานร่วมกันได้ในรูปแบบของโปรโตคอล เพื่อให้เครือข่ายผู้จำหน่ายที่แตกต่างกันสามารถทำงานร่วมกันได้
- โมเดล OSI เป็นโมเดลสถาปัตยกรรมหลักสำหรับเครือข่าย อธิบายวิธีการสื่อสารข้อมูลและข้อมูลเครือข่ายจากแอปพลิเคชันบนคอมพิวเตอร์เครื่องหนึ่งผ่านสื่อเครือข่ายไปยังแอปพลิเคชันบนคอมพิวเตอร์อีกเครื่องหนึ่ง โมเดลอ้างอิง OSI แบ่งแนวทางนี้ออกเป็นเลเยอร์ต่างๆ

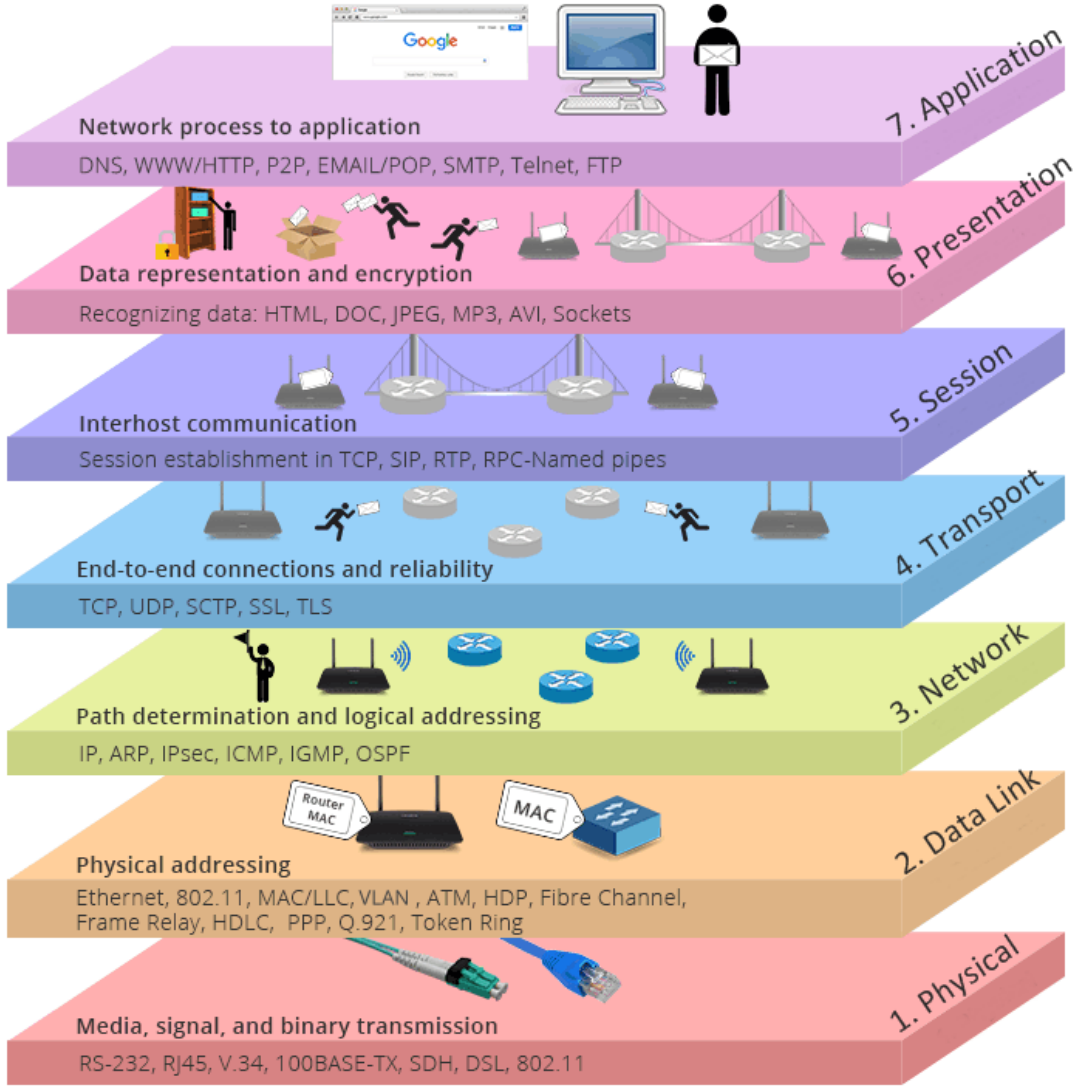
2. OSI MODEL AND LAYERS

ข้อดีของการใช้แบบจำลองแบบเลเยอร์ OSI

- แบ่งกระบวนการสื่อสารเครือข่ายออกเป็นส่วนประกอบที่เล็กลงและเรียบง่ายขึ้น ซึ่งช่วยในการพัฒนา การออกแบบ และการแก้ไขปัญหาส่วนประกอบ
- ช่วยให้สามารถพัฒนาผู้จำหน่ายหลายรายผ่านการกำหนดมาตรฐานของส่วนประกอบเครือข่าย
- สนับสนุนการสร้างมาตรฐานอุตสาหกรรมโดยการกำหนดฟังก์ชันที่เกิดขึ้นในแต่ละเลเยอร์ของโมเดล
- ช่วยให้ฮาร์ดแวร์และซอฟต์แวร์เครือข่ายประเภทต่างๆ สามารถสื่อสารได้
- โดยจะป้องกันการเปลี่ยนแปลงในเลเยอร์หนึ่งไม่ให้ส่งผลกระทบต่อเลเยอร์อื่นๆ ดังนั้นจึงไม่ขัดขวางการพัฒนาและทำให้การเขียนโปรแกรมแอปพลิเคชันง่ายขึ้น

2. OSI MODEL AND LAYERS

OSI Layer Functions



2. OSI MODEL AND LAYERS

OSI Layer Functions

Application	• File, print, message, database, and application services
Presentation	• Data encryption, compression, and translation services
Session	• Dialog control
Transport	• End-to-end connection
Network	• Routing
Data Link	• Framing
Physical	• Physical topology

2. OSI MODEL AND LAYERS

The Upper Layers

Application	• Provides a user interface
Presentation	• Presents data • Handles processing such as encryption
Session	• Keeps different applications' data separate
Transport	
Network	
Data Link	
Physical	

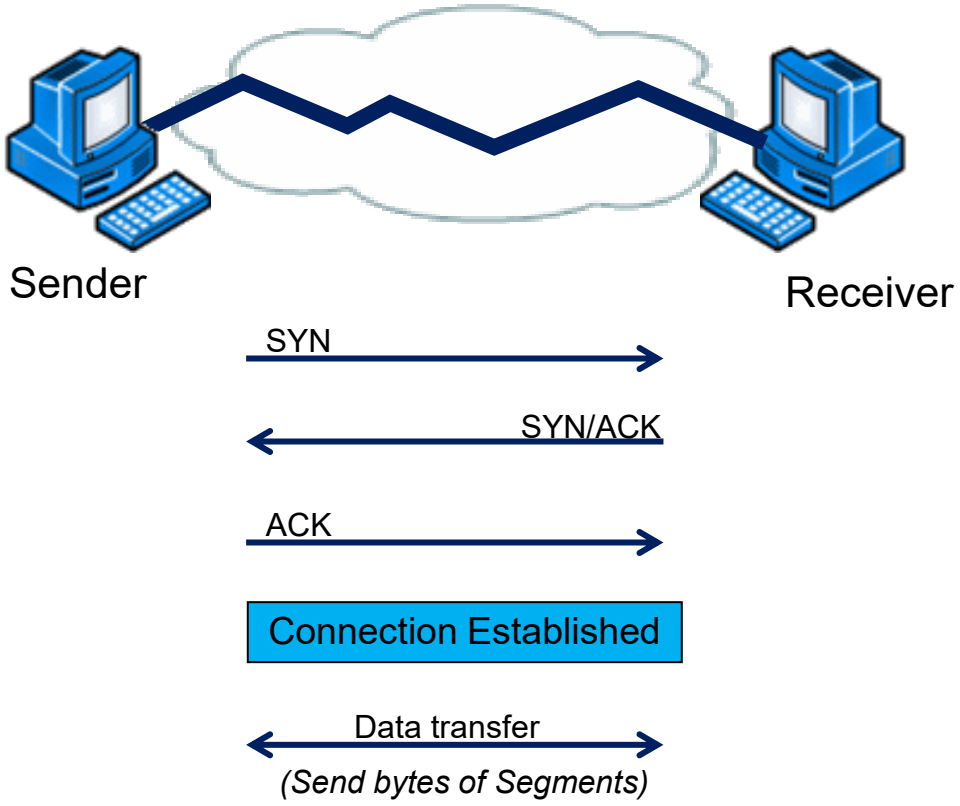
2. OSI MODEL AND LAYERS

The Lower Layers

Application	
Presentation	
Session	
Transport	• Provides reliable or unreliable delivery • Performs error correction before retransmit
Network	• Provides logical addressing which routers use for path determination
Data Link	• Combines packets into bytes and bytes into frames • Provides access to media using MAC address • Performs error detection not correction
Physical	• Moves bits between devices • Specifies voltage, wire speed, and pin-out of cables

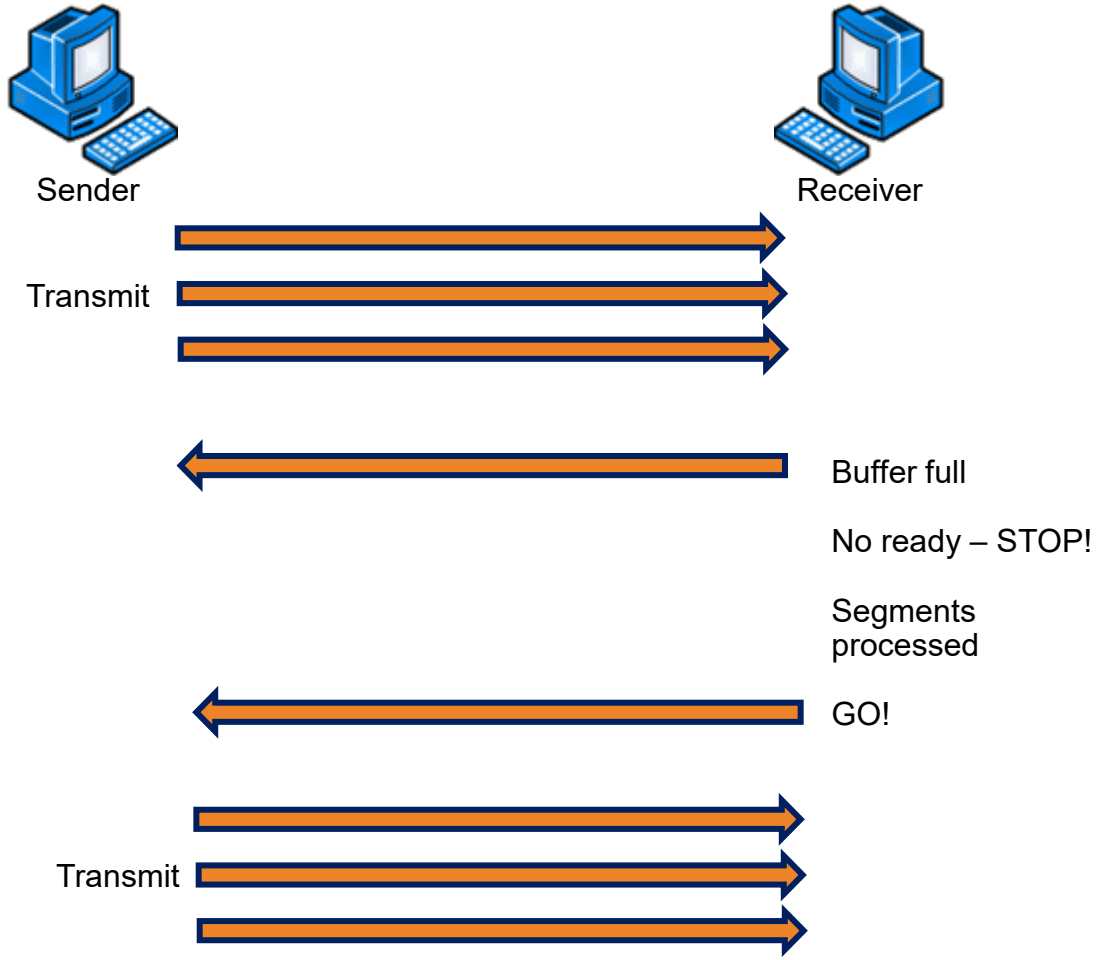
2. OSI MODEL AND LAYERS

The Upper Layers : A Connection Oriented Session



2. OSI MODEL AND LAYERS

The Upper Layers : Flow Control



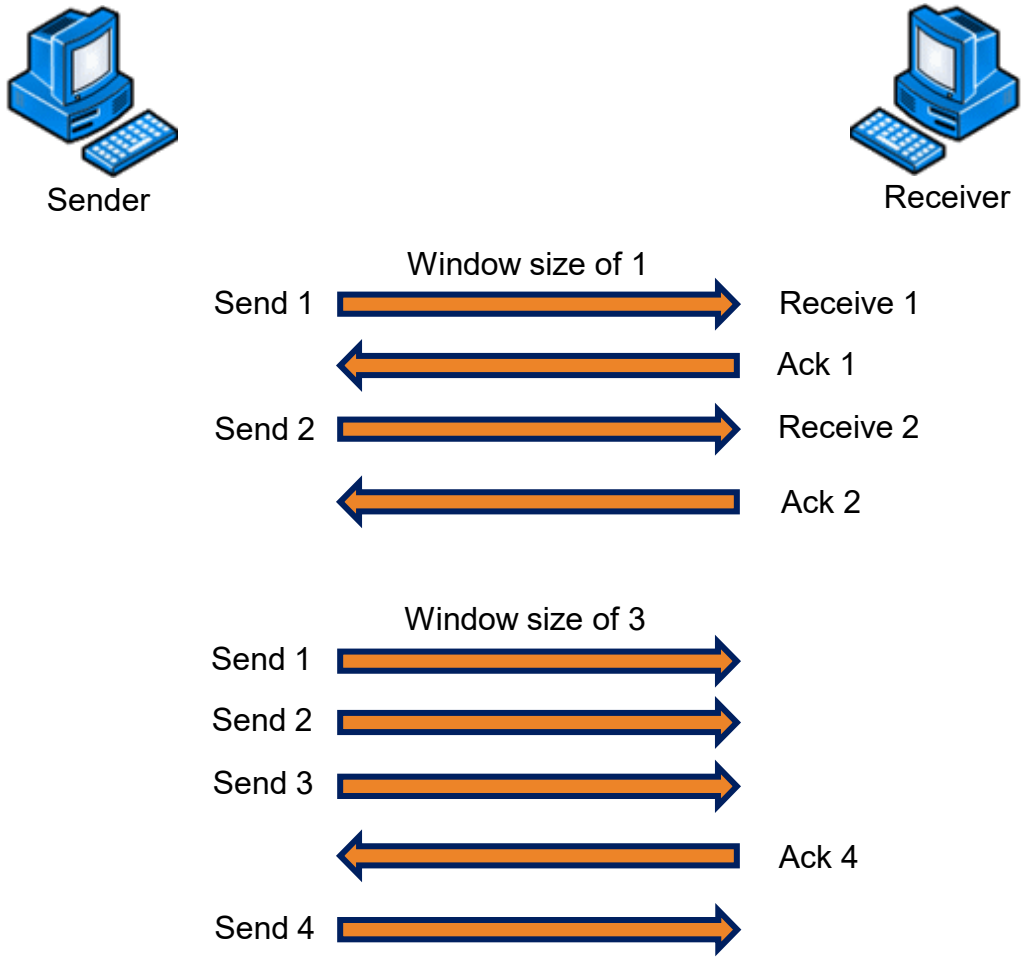
2. OSI MODEL AND LAYERS

The Upper Layers : Connection Oriented Session

- Virtual circuit is setup (three-way handshake).
- Uses sequencing.
- Uses acknowledgments.
- Uses flow control.

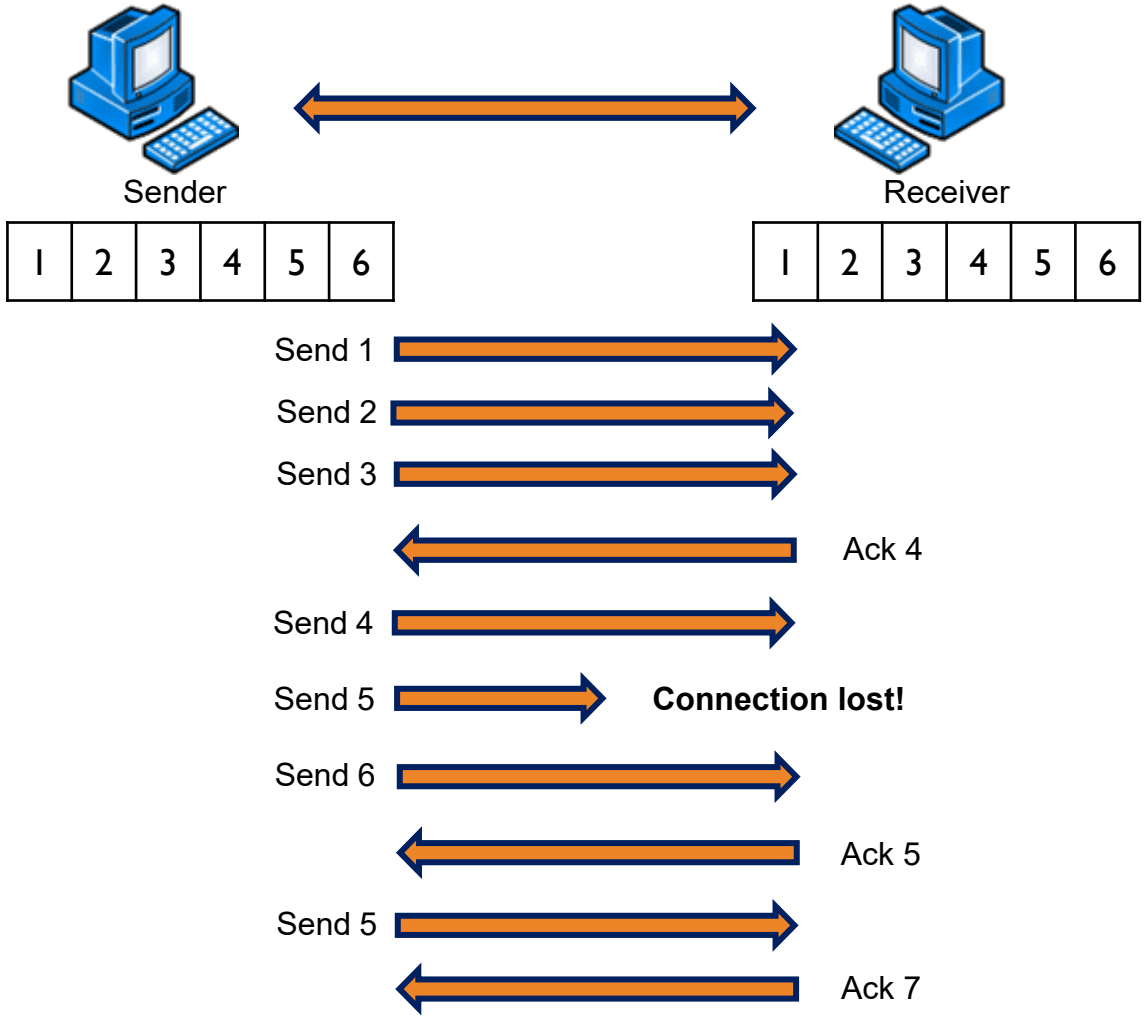
2. OSI MODEL AND LAYERS

The Upper Layers : Windowing Flow Control



2. OSI MODEL AND LAYERS

The Upper Layers : Acknowledgements



2. OSI MODEL AND LAYERS

The Lower Layers

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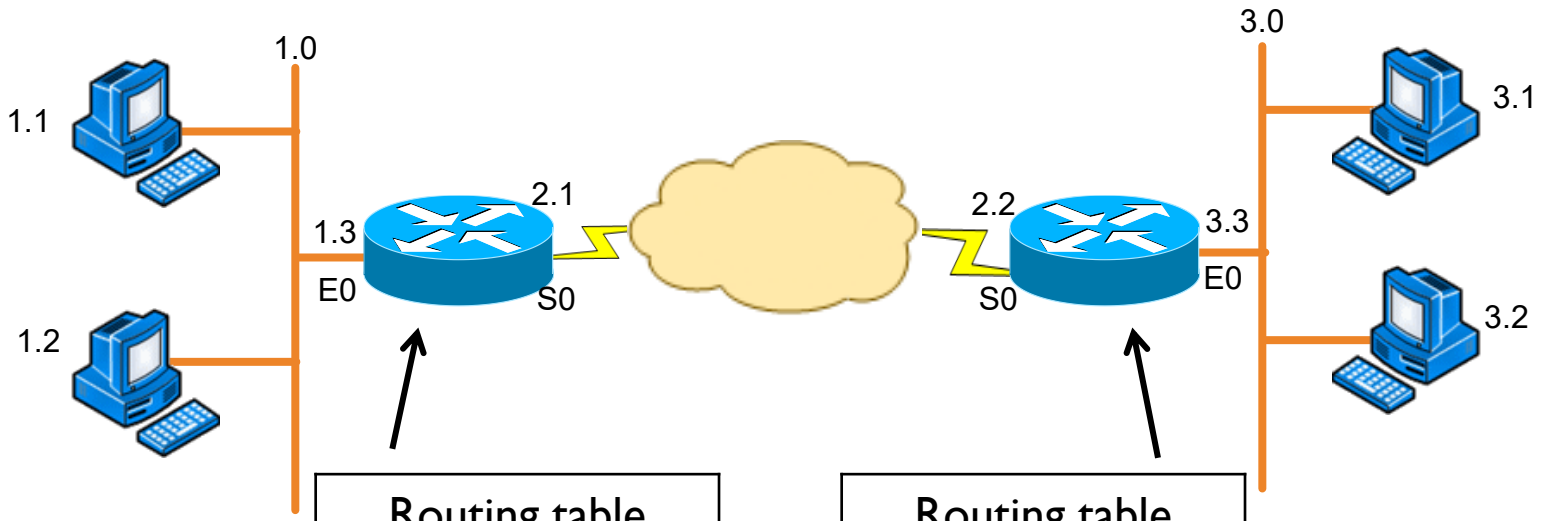
2. OSI MODEL AND LAYERS

The Lower Layers : Routing at Layer 3



Routing table

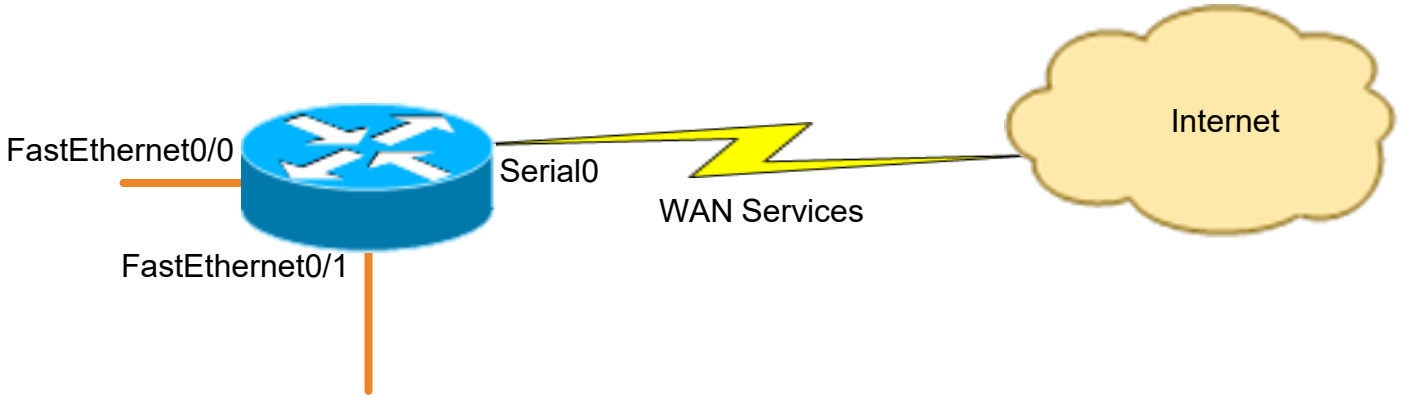
NET	INT	Metric
1	E0	0
2	S0	0
3	S0	1

Routing table

NET	INT	Metric
1	S0	1
2	S0	0
3	E0	0

2. OSI MODEL AND LAYERS

The Lower Layers : Routing at Layer 3



2. OSI MODEL AND LAYERS

The Lower Layers

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Transport	• Provides reliable or unreliable delivery • Performs error correction before retransmit
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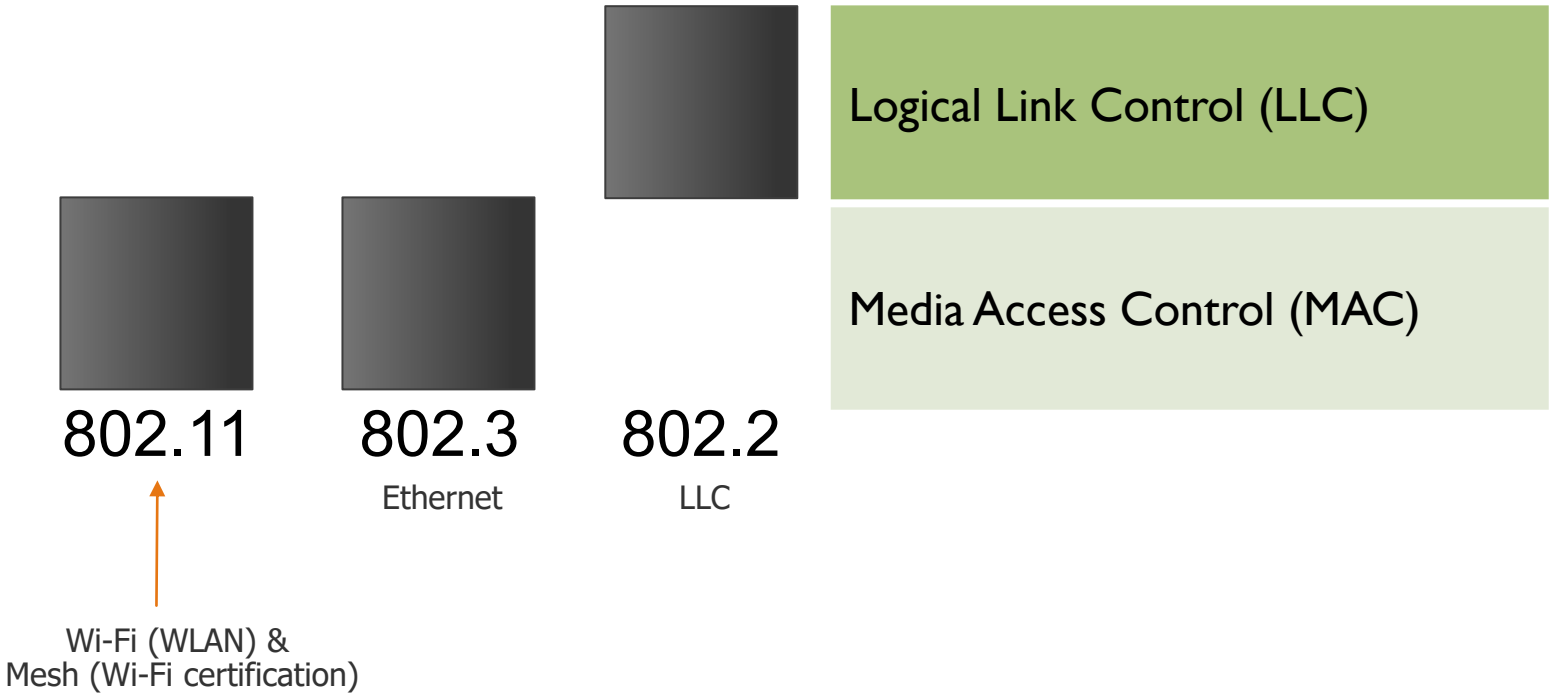
2. OSI MODEL AND LAYERS

The Lower Layers : Data Link Layer (Layer 2)



2. OSI MODEL AND LAYERS

The Lower Layers

Application	
Presentation	
Session	
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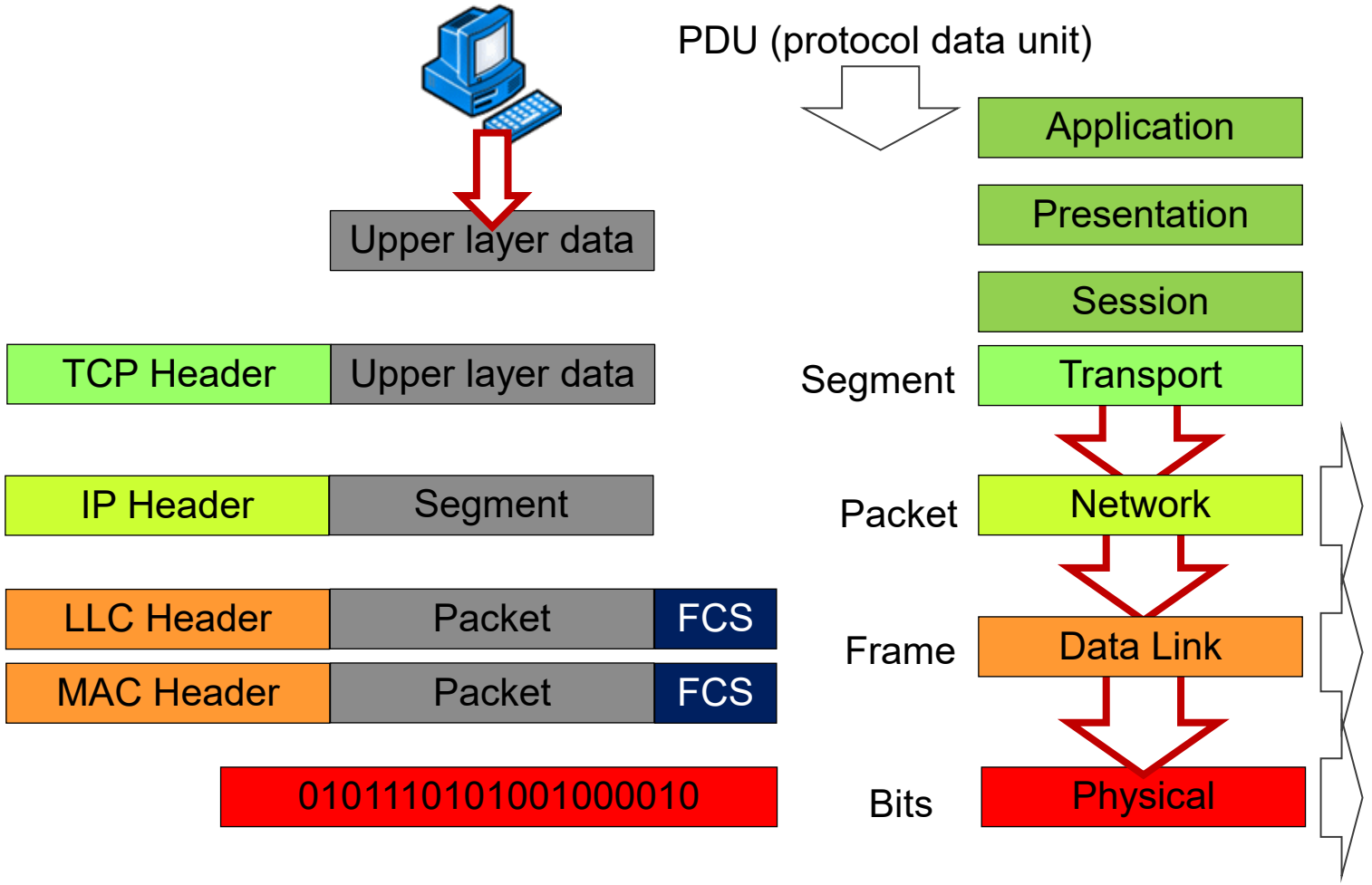
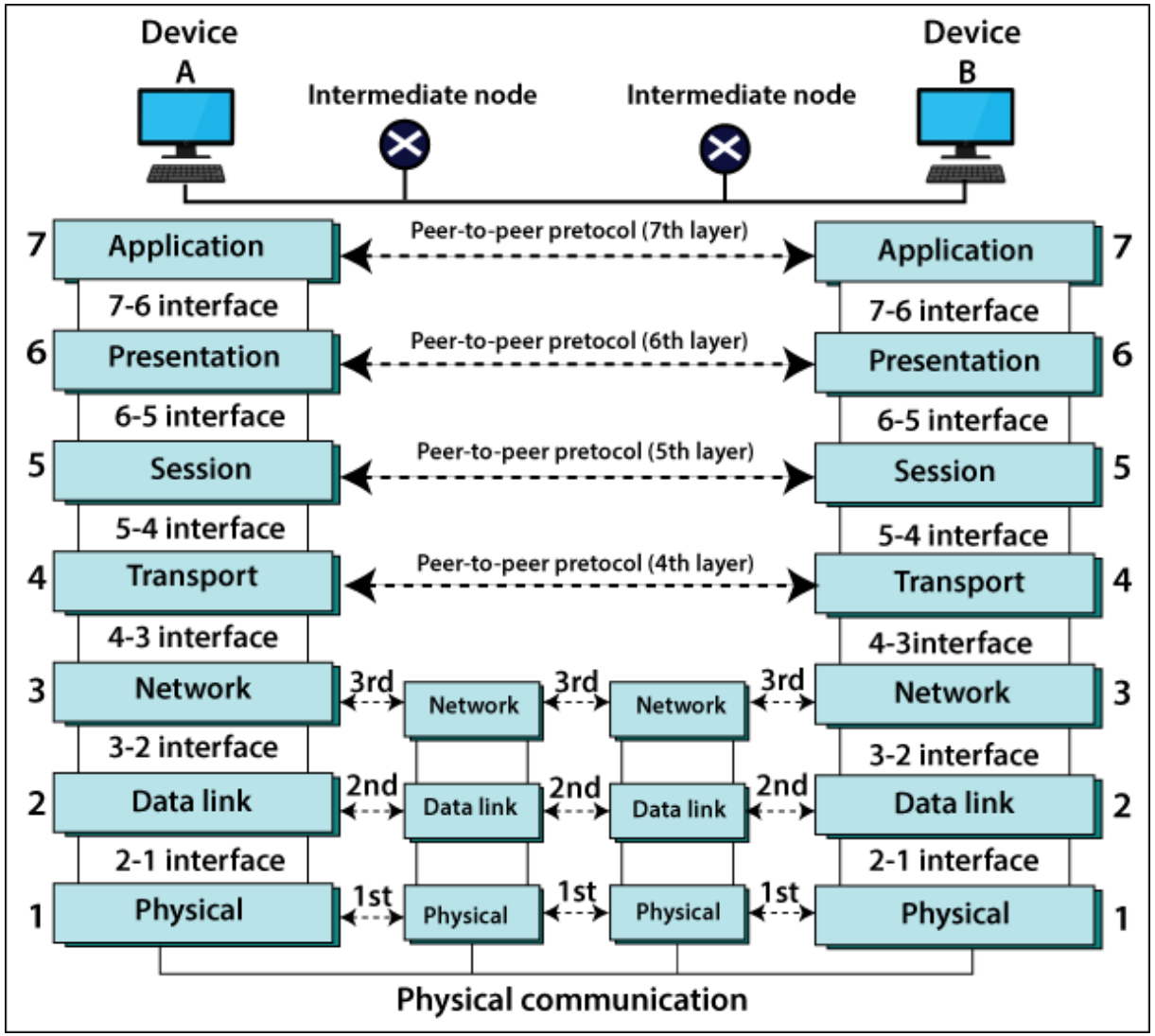
2. OSI MODEL AND LAYERS

The Lower Layers : Data Encapsulation



2. OSI MODEL AND LAYERS



2. OSI MODEL AND LAYERS

Modulation Technique

Modulation เป็นกระบวนการเปลี่ยนแปลงคุณสมบัติของรูปคลื่นหนึ่งอย่างหรือมากกว่านั้นที่เรียกว่าสัญญาณพาหะ

ในเครือข่ายปัจจุบัน การ Modulate จะรับ Digital Signal หรือ Analog Signal แล้วใส่ Signal อื่นที่สามารถส่งทางกายภาพได้

- Modem : Modulation / Demodulation
- FDM : Frequency Division Multiplexing
- TDM : Time Division Multiplexing
- Ethernet : uses digital baseband modulation or line coding to transfer digital bit stream

2. OSI MODEL AND LAYERS

Modulation Technique

Ethernet (CSMA/CD) Carrier-sense multiple access with collision detection.

Standard	Transmission Medium	Data Rate (bps)	Length (meters)
10Base5	Coaxial RG-8 or RG-11	10Mbps	500m
10Base2	Coaxial RG-58	10Mbps	185m
10Base-T	Category 3 UTP or better UTP	10Mbps	100m
100Base-T	Category 5 UTP/STP	100Mbps	100m
100Base-TX	Category 5 UTP/STP	100Mbps	100m
100Base-FX	OM1 (62.5um) ; 850nm Wavelength	100Mbps	2,000m (2km)
1000Base-T	4-Pair Category 5e UTP/STP or better UTP/STP	1000Mbps	100m
1000Base-SX	OM1(62.5um)/OM2(50um) ; 850nm Wavelength	1000Mbps	270m/550m
1000Base-LX	OS1(9um) ; 1310nm Wavelength	1000Mbps	20,000m (20km)

2. OSI MODEL AND LAYERS

สรุป

- OSI Model มีความสำคัญอย่างไรบ้าง?
- OSI Upper Layer ทำหน้าหลักด้านใด?
- OSI Lower Layer ทำหน้าหลักด้านใด?
- การ Modulation มีประโยชน์อย่างไร?

CHAPTER 3
NETWORK CONNECTORS AND WIRING STANDARDS

3. NETWORK CONNECTORS AND WIRING STANDARDS

- Copper Connectors
- Copper Cables
- Fiber Connectors
- Fiber Cables
- Media Converters
- Customer premise equipment
- Wiring Standards

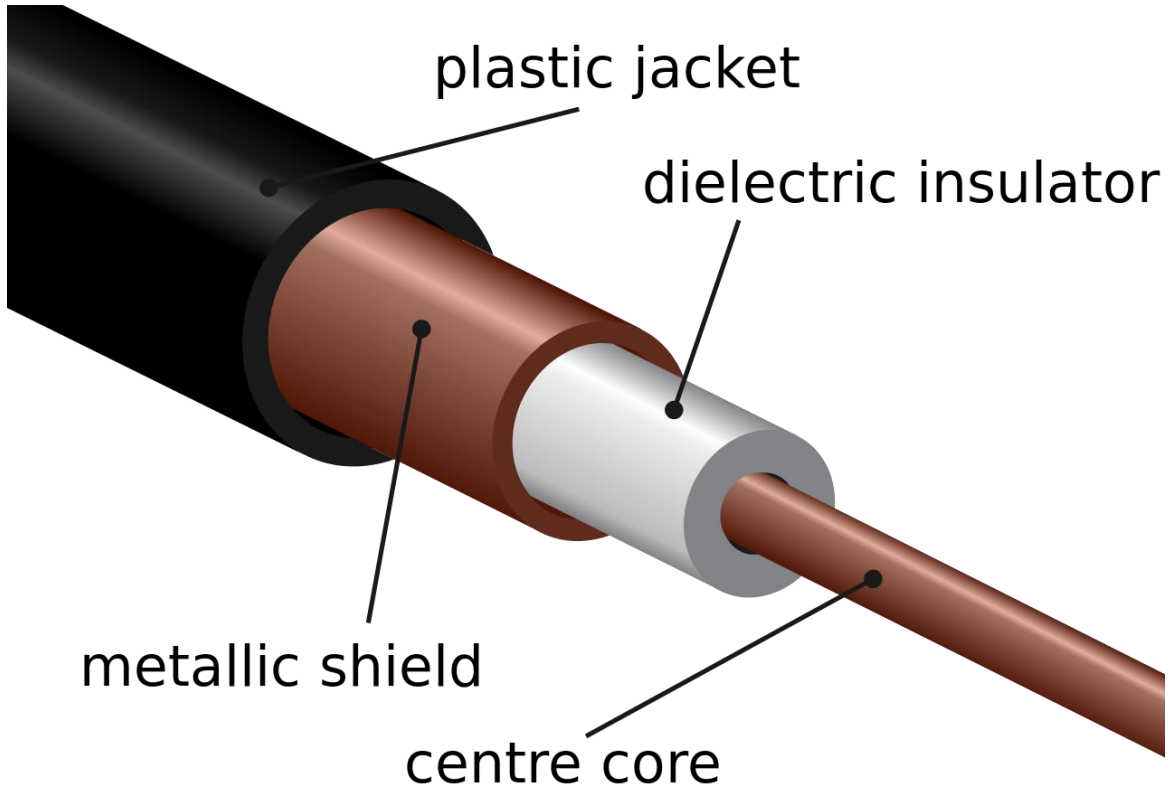
3. NETWORK CONNECTORS AND WIRING STANDARDS

Physical Media

- Coaxial
- Twisted pair
- Fiber optic

3. NETWORK CONNECTORS AND WIRING STANDARDS

Physical Media : Thin net Coaxial



3. NETWORK CONNECTORS AND WIRING STANDARDS

Physical Media : Thin net Coaxial -> BNC Connectors

3. NETWORK CONNECTORS AND WIRING STANDARDS

Physical Media : Twisted pair

UTP (Unshielded Twisted Pairs) / STP (Shielded Twisted Pairs)

- Catergory1
- Catergory2
- Catergory3
- Catergory4
- Catergory5
- Catergory5e
- Catergory6
- Catergory7

3. NETWORK CONNECTORS AND WIRING STANDARDS

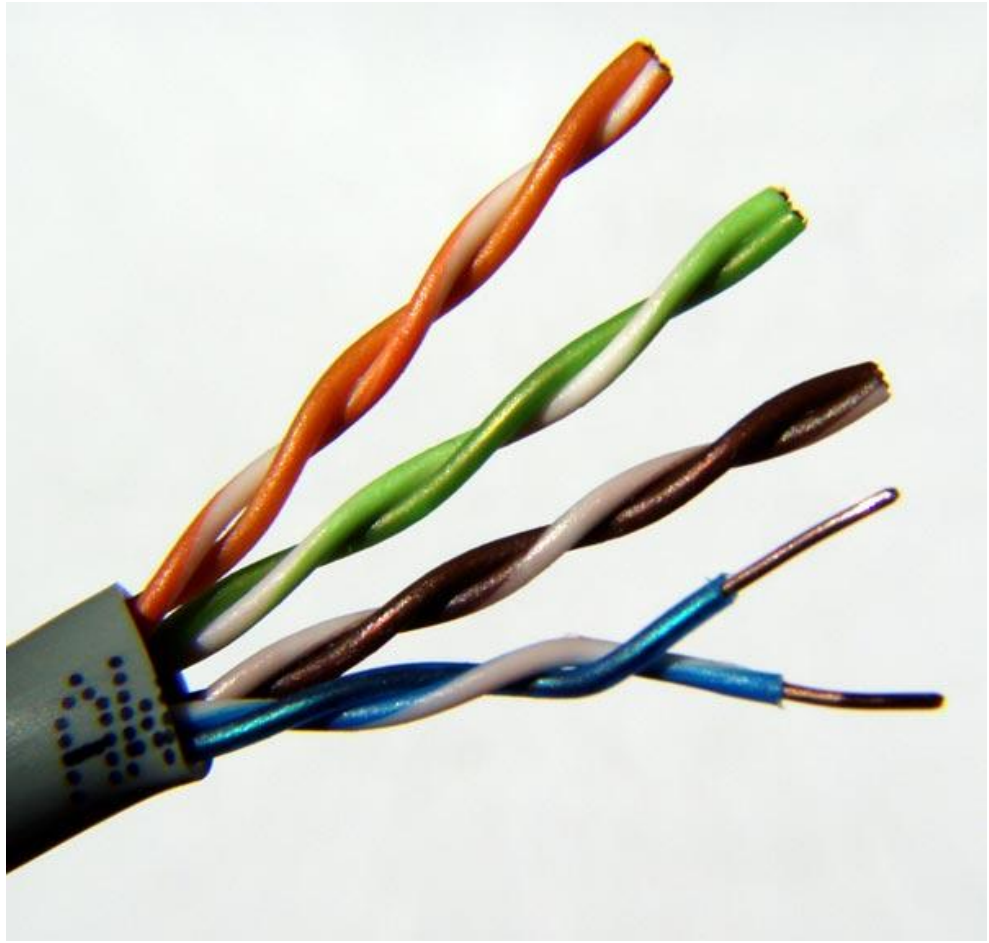
Physical Media : Twisted pair

UTP Categories - Copper Cable				
UTP Category	**Data Rate**	**Max. Length**	**Cable Type**	**Application**
CAT1	Up to 1Mbps	-	Twisted Pair	Old Telephone Cable
CAT2	Up to 4Mbps	-	Twisted Pair	Token Ring Networks
CAT3	Up to 10Mbps	100m	Twisted Pair	Token Rink & 10BASE-T Ethernet
CAT4	Up to 16Mbps	100m	Twisted Pair	Token Ring Networks
CAT5	Up to 100Mbps	100m	Twisted Pair	Ethernet, FastEthernet, Token Ring
CAT5e	Up to 1 Gbps	100m	Twisted Pair	Ethernet, FastEthernet, Gigabit Ethernet
CAT6	Up to 10Gbps	100m	Twisted Pair	GigabitEthernet, 10G Ethernet (55 meters)
CAT6a	Up to 10Gbps	100m	Twisted Pair	GigabitEthernet, 10G Ethernet (55 meters)
CAT7	Up to 10Gbps	100m	Twisted Pair	GigabitEthernet, 10G Ethernet (100 meters)

ข้อมูลจาก Firewall.cx

3. NETWORK CONNECTORS AND WIRING STANDARDS

Physical Media : Twisted pair –> CAT5e UTP Cable



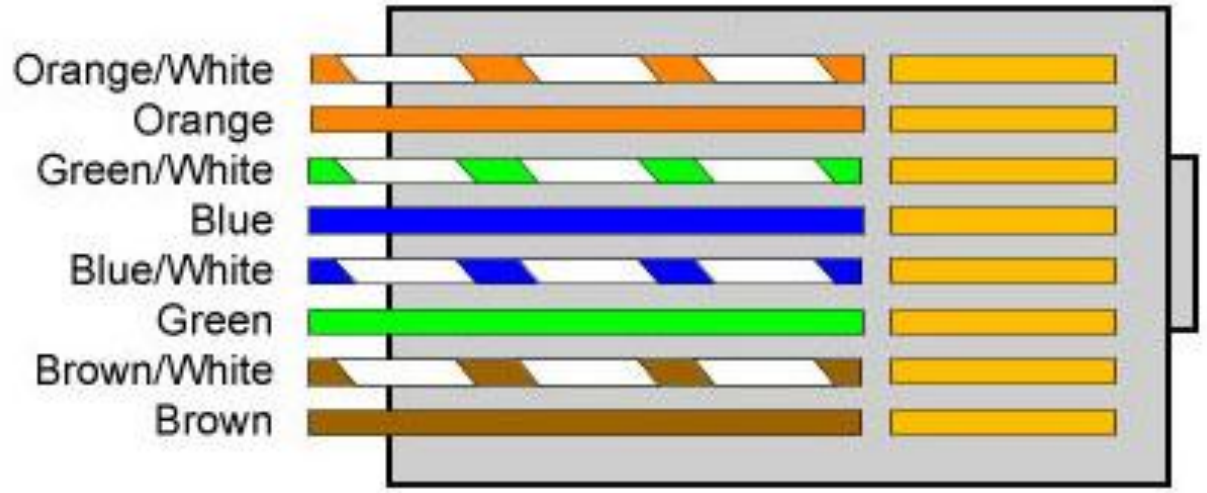
3. NETWORK CONNECTORS AND WIRING STANDARDS

Physical Media : Twisted pair –> RJ Connectors

RJ-11	RJ-45
6 pin 	8 pin 

3. NETWORK CONNECTORS AND WIRING STANDARDS

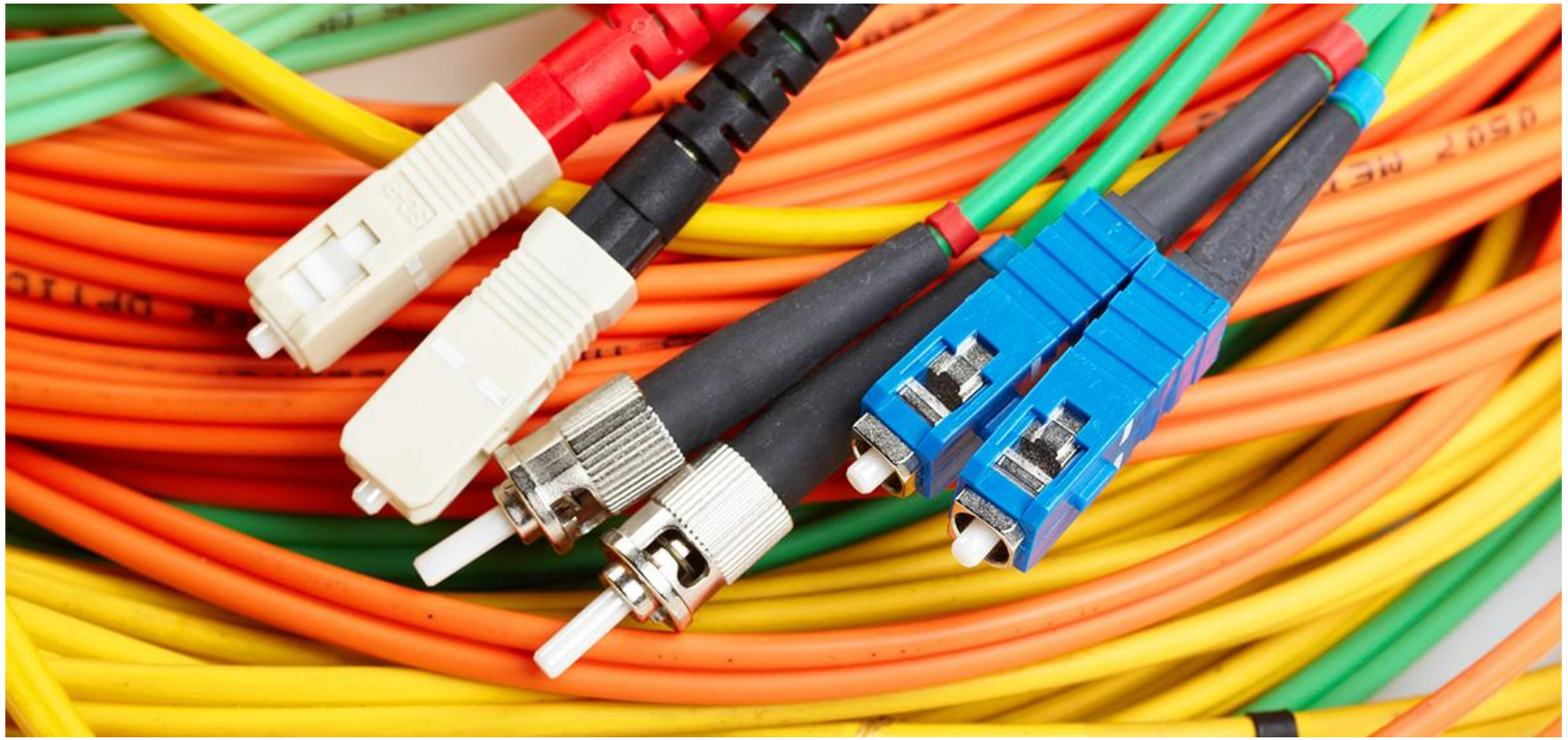
Physical Media : Twisted pair –> RJ45 Connectors



ข้อมูลจาก Firewall.cx

3. NETWORK CONNECTORS AND WIRING STANDARDS

Physical Media : Fiber Optic Cable

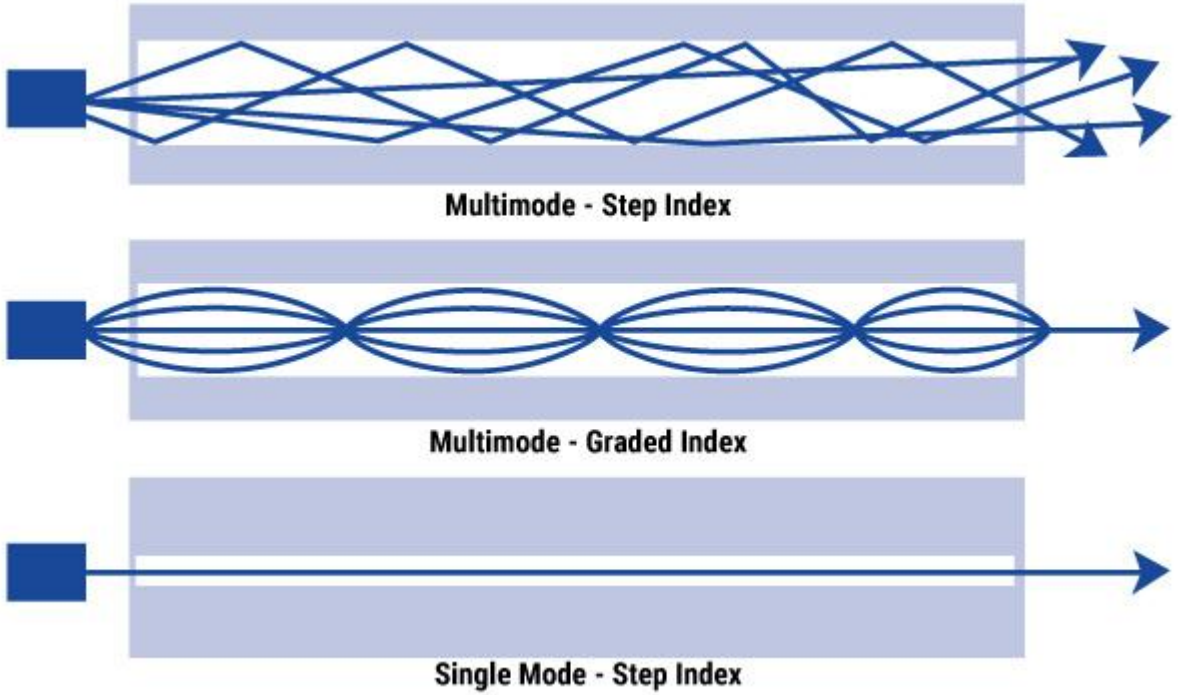


ข้อมูลจาก rfindustries.com

3. NETWORK CONNECTORS AND WIRING STANDARDS

Physical Media : Fiber Optic Cable

- Multimode Fiber Core Size: 50um and 62.5um
- Single Mode Fiber Core Size: 8 – 9um



ข้อมูลจาก rfindustries.com

3. NETWORK CONNECTORS AND WIRING STANDARDS

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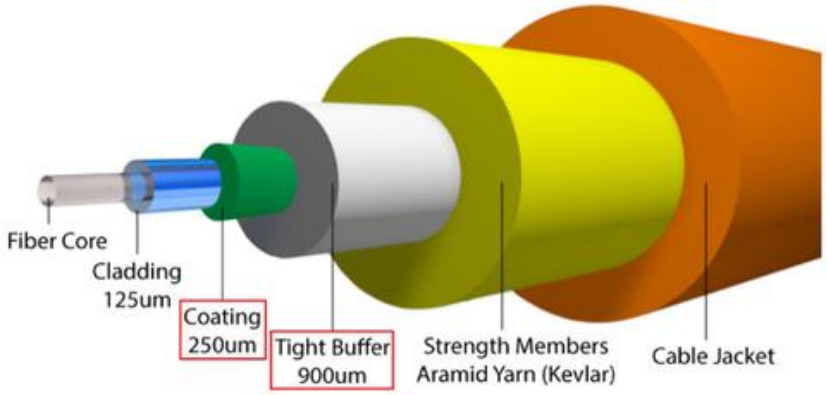

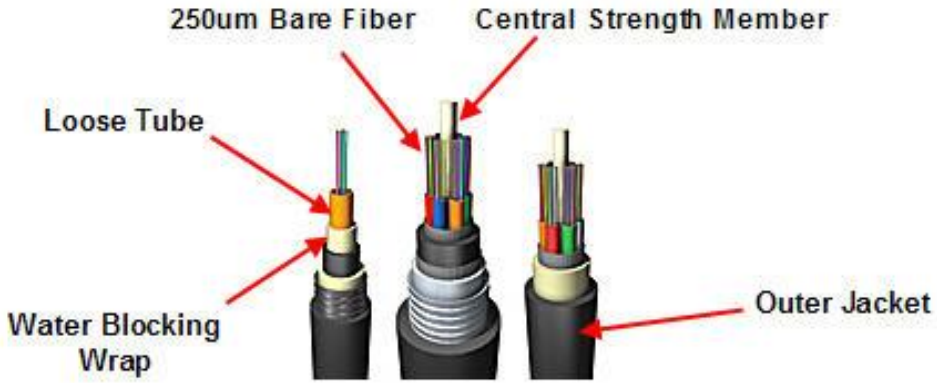

3. NETWORK CONNECTORS AND WIRING STANDARDS

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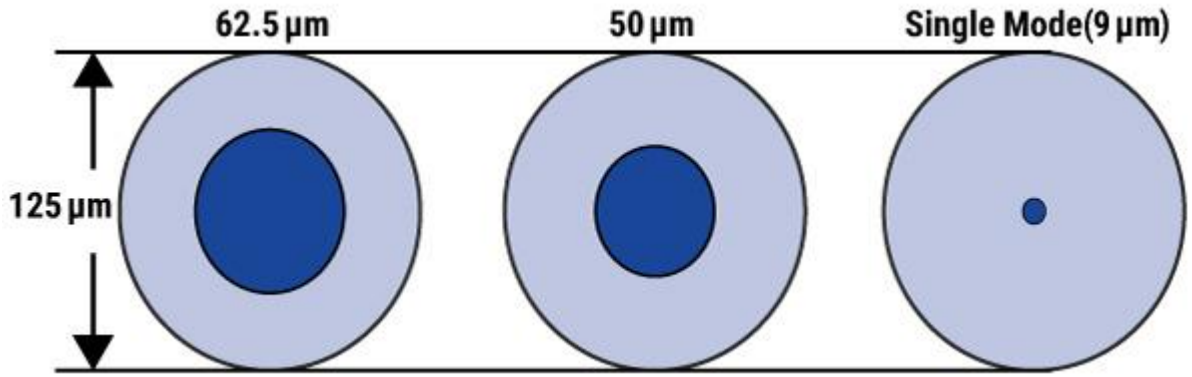


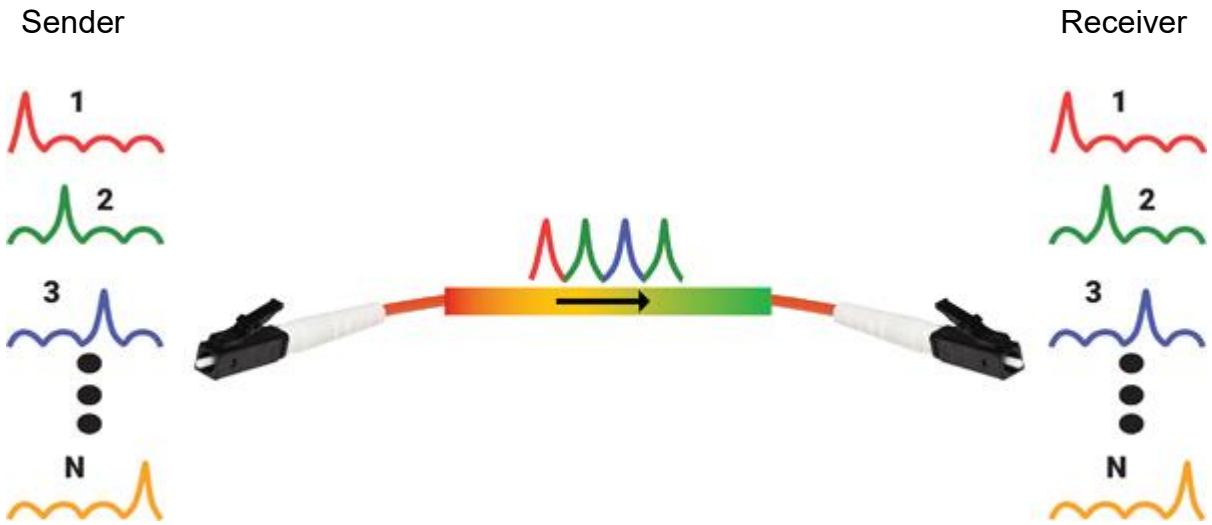
ข้อมูลจาก rfindustries.com

3. NETWORK CONNECTORS AND WIRING STANDARDS

Physical Media : Fiber Optic Cable

Standard Fiber Wavelengths

- Multimode Fiber: 850nm and 1300nm
- Single Mode Fiber: 1310nm and 1550nm



ข้อมูลจาก rfindustries.com

3. NETWORK CONNECTORS AND WIRING STANDARDS

Physical Media : Fiber Optic Cable

Multimode Fibers – OM1

- Jacket Color – Orange
- Core Size – 62.5um
- Data Rate – 1Gb @ 850nm wavelength
- Distance – Up to 300 meters
- Application – Short-haul networks, Local Area Networks(LANs) & private networks

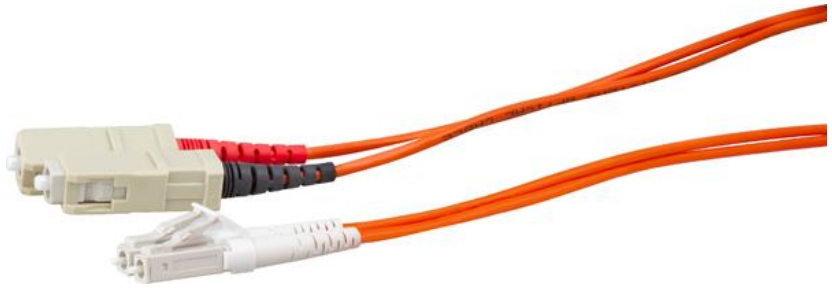
ข้อมูลจาก rfindustries.com

3. NETWORK CONNECTORS AND WIRING STANDARDS

Physical Media : Fiber Optic Cable

Multimode Fibers – OM2

- Jacket Color – Orange
- Core Size – 50um
- Data Rate – 1Gb @ 850nm wavelength
- Distance – Up to 600 meters
- Application – Short-haul networks, Local Area Networks(LANs) & private networks
- Generally used for shorter distances. Has twice the distance capacity has OM1



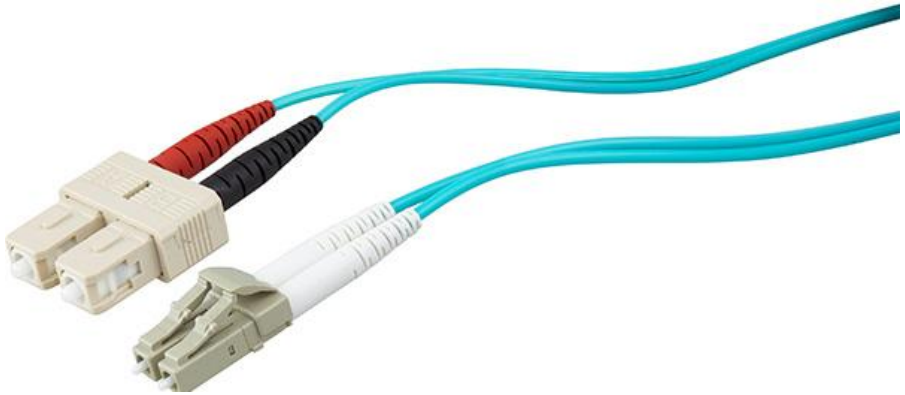
ข้อมูลจาก rfindustries.com

3. NETWORK CONNECTORS AND WIRING STANDARDS

Physical Media : Fiber Optic Cable

Multimode Fibers – OM3 (Laser Optimized Multimode)

- Jacket Color – Aqua
- Core Size – 50um
- Data Rate – 10Gb @ 850nm wavelength
- Distance – Up to 300 meters
- Uses fewer modes of light, enabling increased speeds
- Able to run 40GB or 100GB up to 100 meters utilizing an MPO connector
- Application – Larger Private Networks



ข้อมูลจาก rfindustries.com

3. NETWORK CONNECTORS AND WIRING STANDARDS

Physical Media : Fiber Optic Cable

Multimode Fibers – OM4 (Laser Optimized Multimode)

- Jacket Color – Aqua
- Core Size – 50um
- Data Rate – 10G @ 850nm wavelength
- Distance – Up to 550 meters
- Able to run 100GB up to 150 meters utilizing an MPO connector
- Application – High-Speed Networks, Data Centers, Financial Centers and Corporate Campuses

ข้อมูลจาก rfindustries.com

3. NETWORK CONNECTORS AND WIRING STANDARDS

Physical Media : Fiber Optic Cable

Multimode Fibers – OM5 (The latest and greatest in Multimode Fiber)

- Jacket Color – Lime Green
- Fully compatible and can mate with OM3 and OM4 cabling
- Utilizes a wider range of wavelengths between 850nm and 953nm
- Designed to support Short Wavelength Division Multiplexing (SWDM)
- Can Transmit 40 Gb/s and 100 Gb/s
- Application – High-speed Networks and Data Centers that require greater link distances and higher speeds.

ข้อมูลจาก rfindustries.com

3. NETWORK CONNECTORS AND WIRING STANDARDS

Physical Media : Fiber Optic Cable

Single Mode Fibers (9um) – OS1 and OS2

- Tight Buffered Cable
- Loose Tube Cable

Tight Buffered 12 Core

Loose Tube 12 Core

ข้อมูลจาก rfindustries.com

3. NETWORK CONNECTORS AND WIRING STANDARDS

Media Converters

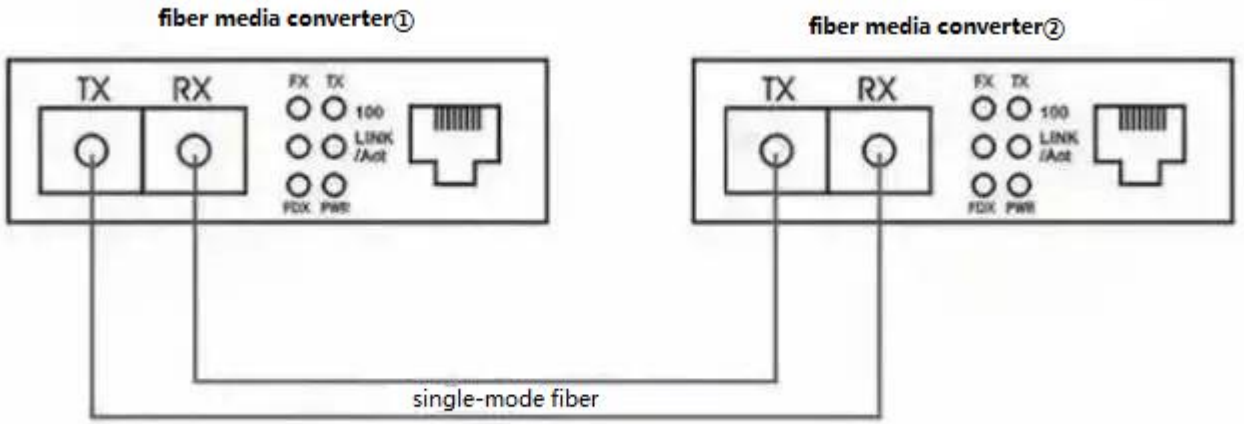
Fiber Optic to UTP/STP
SC – RJ45

Fiber Optic to UTP/STP
with SFP Module
LC – RJ45

ข้อมูลจาก electrep.com

3. NETWORK CONNECTORS AND WIRING STANDARDS

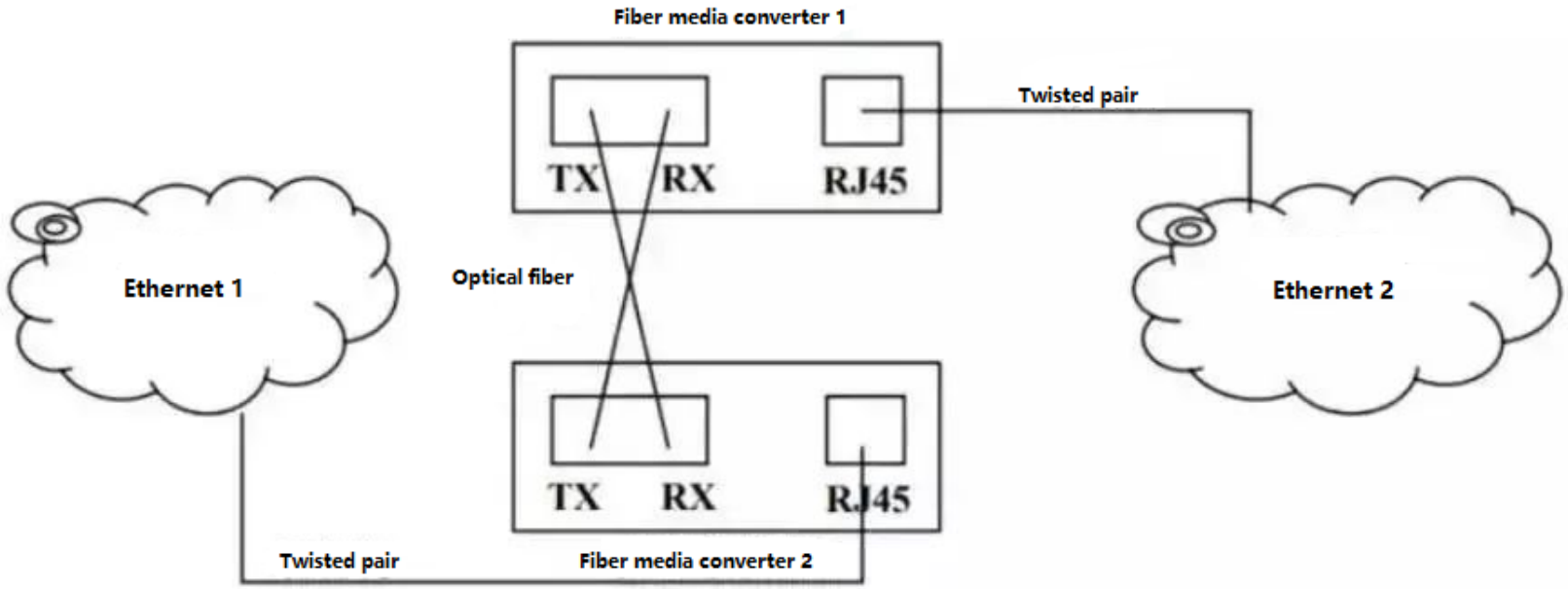
Media Converters



ข้อมูลจาก fibermall.com

3. NETWORK CONNECTORS AND WIRING STANDARDS

Media Converters



ข้อมูลจาก fibermall.com

3. NETWORK CONNECTORS AND WIRING STANDARDS

Media Converters

Peer-to-peer application

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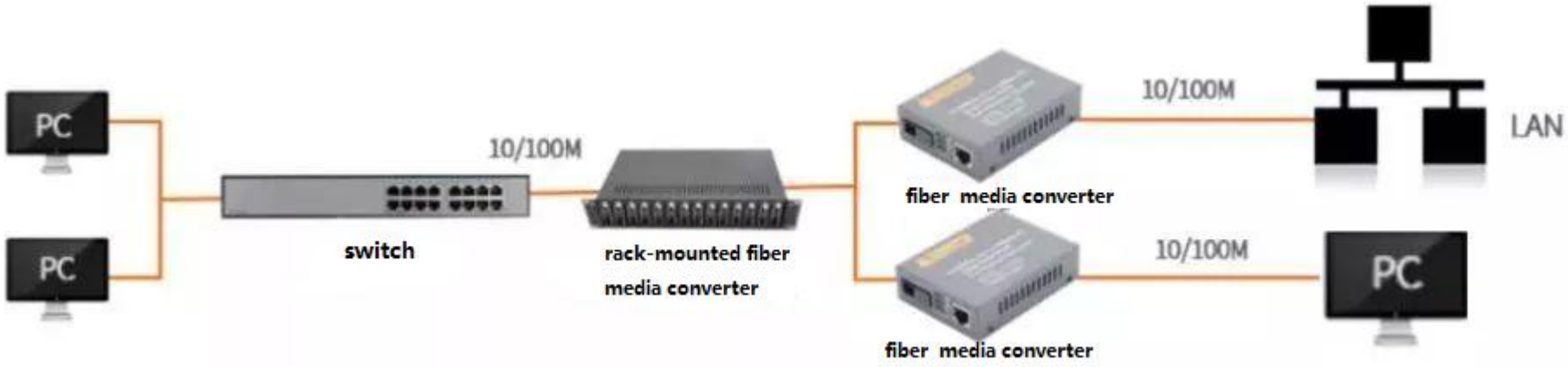
3. NETWORK CONNECTORS AND WIRING STANDARDS

Media Converters



Center to remote multipoint applications

ข้อมูลจาก fibermall.com

3. NETWORK CONNECTORS AND WIRING STANDARDS

Media Converters

Dual-fiber media converter vs. single-fiber media converter

ข้อมูลจาก fibermall.com

3. NETWORK CONNECTORS AND WIRING STANDARDS

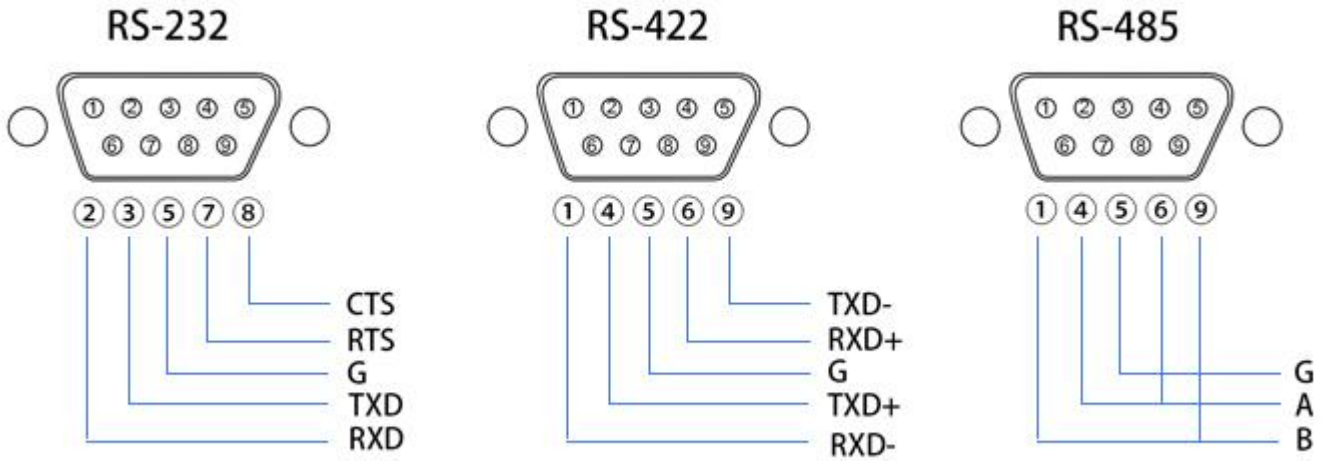
Media Converters

Dual-fiber media converter vs. single-fiber media converter

ข้อมูลจาก fibermall.com

3. NETWORK CONNECTORS AND WIRING STANDARDS

Serial Cable : RS-232/RS-422/RS-485



3. NETWORK CONNECTORS AND WIRING STANDARDS

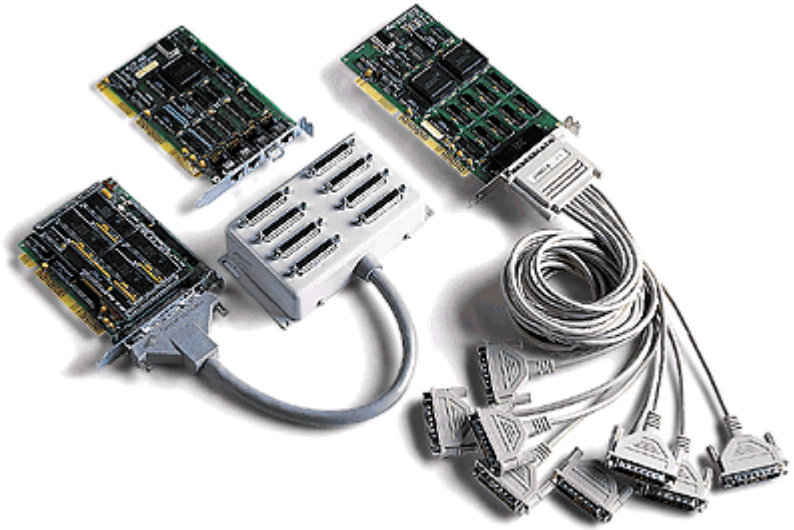
Serial Cable : RS-232/RS-422/RS-485

	RS-232	RS-485	RS-422
Network Topology	Point-to-Point	Point-to-Point or Multidrop	Point-to-Point or Multidrop
Duplex Type	Full Duplex	Full Duplex Half Duplex	Full Duplex Half Duplex
Number of Devices	1 controller 1 receiver	32 unit loads (controllers or receivers)	1 controller 10 receivers
Signaling	Unbalanced	Balanced (differential signaling)	Balanced (differential signaling)
Max Distance	50 feet at 19.2 Kbps	4000 feet at 100 Kbps	4000 feet at 100 Kbps
Mark (data 1)	-15 to -3 V	1.5 V to 5 V (B > A)	2 V to 6 V (B > A)
Space (data 0)	+3 to +15V	1.5 V to 5 V (A > B)	2 V to 6 V (A > B)

ข้อมูลจาก blog.mensor.com

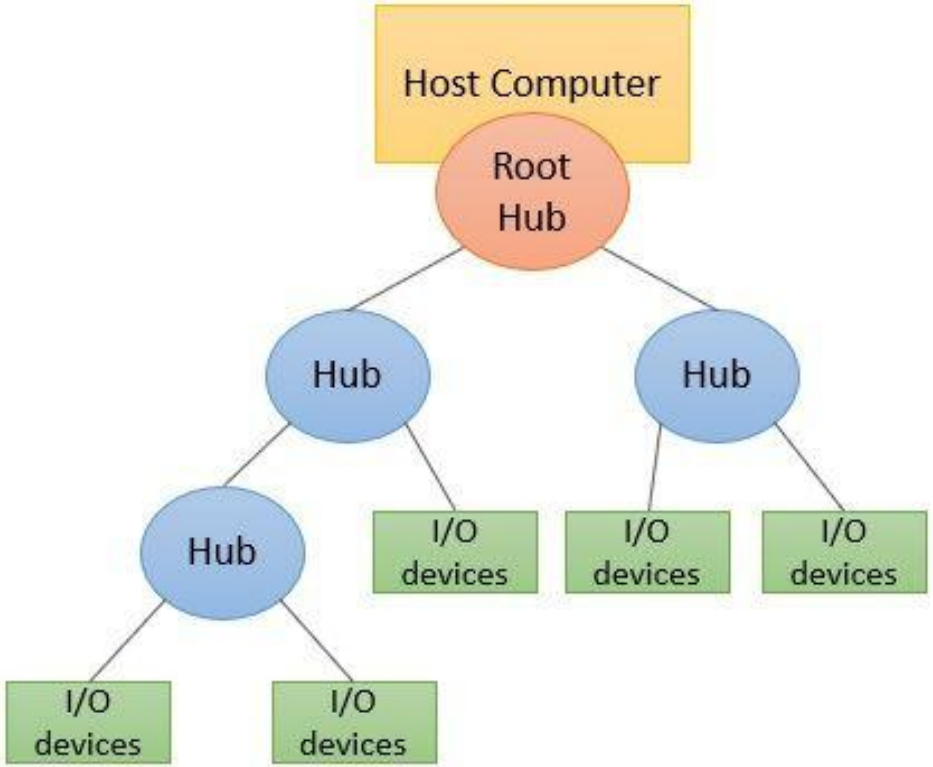
3. NETWORK CONNECTORS AND WIRING STANDARDS

Serial Cable : RS-232/RS-422/RS-485



3. NETWORK CONNECTORS AND WIRING STANDARDS

Universal Serial Bus (USB)

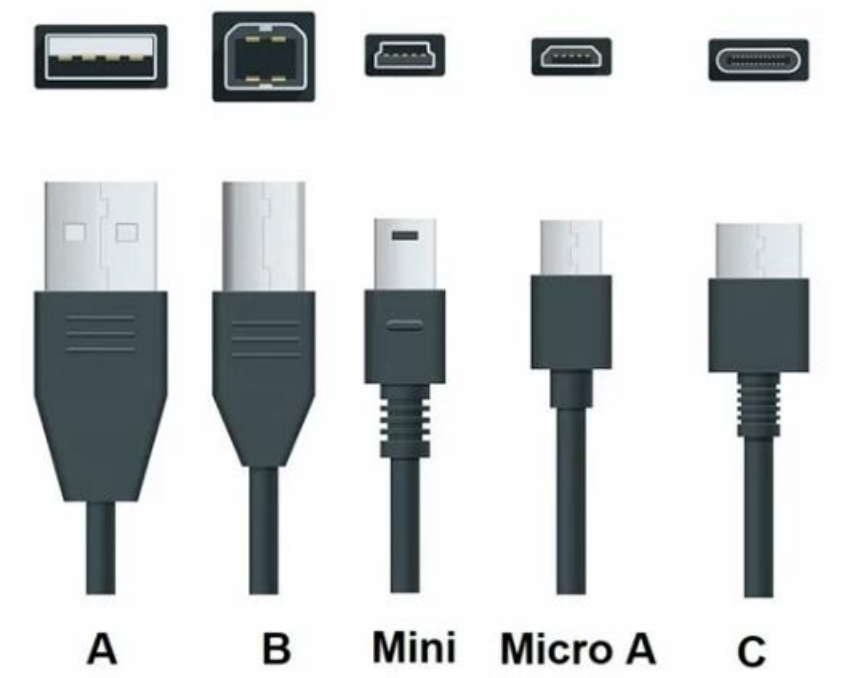


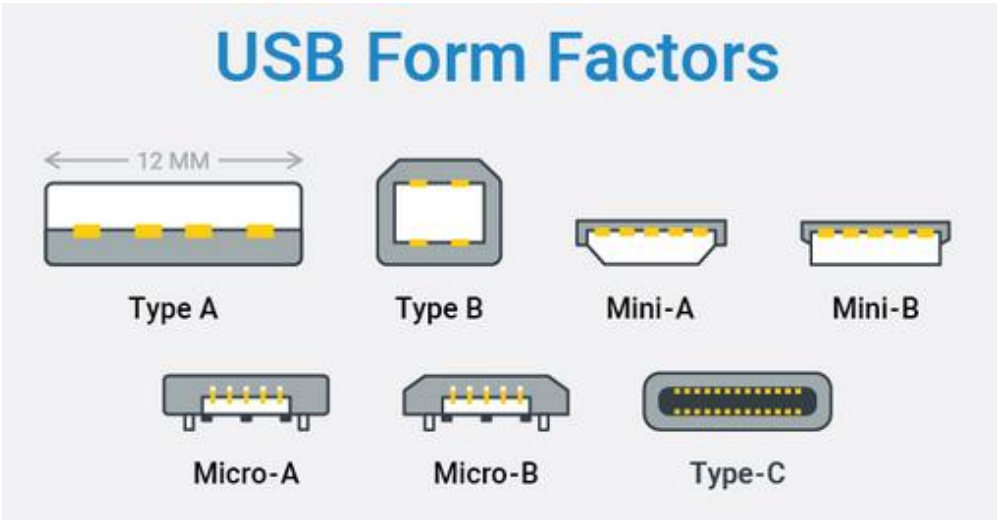
Universal Serial Bus Tree Structure

ข้อมูลจาก binaryterms.com

3. NETWORK CONNECTORS AND WIRING STANDARDS

Universal Serial Bus (USB)





ข้อมูลจาก columbiaisa.50webs.com

3. NETWORK CONNECTORS AND WIRING STANDARDS

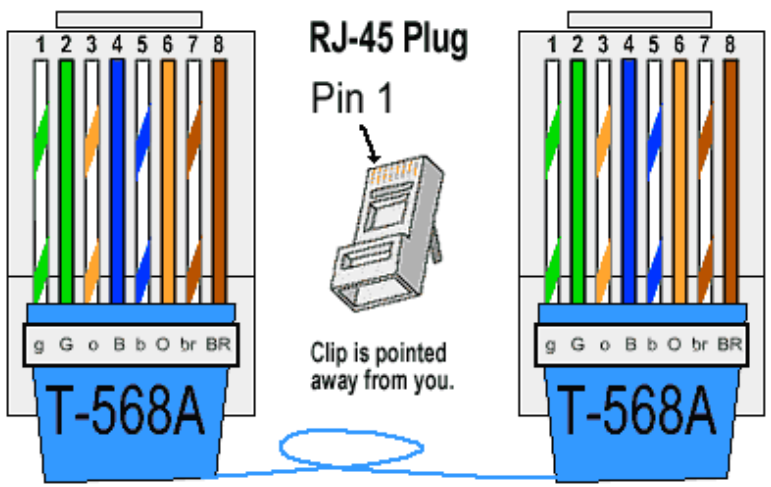
Universal Serial Bus (USB)

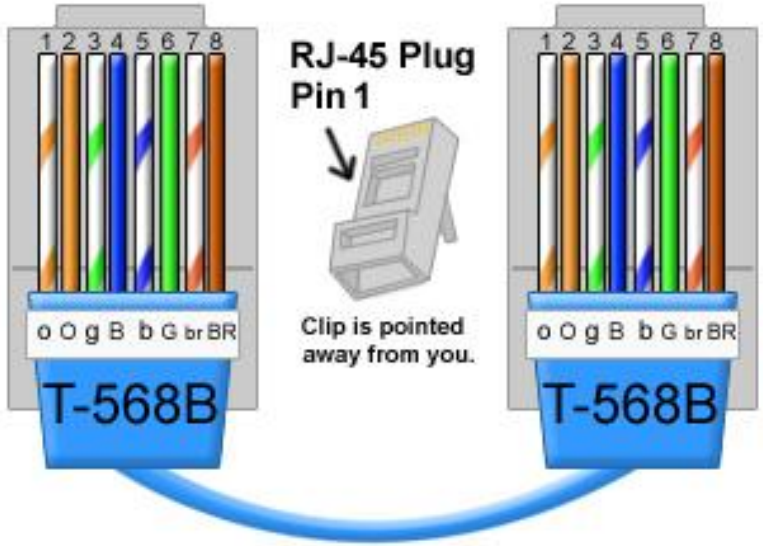
Version	Speed	Bits/sec	Notes
USB 1.x	Low Speed (LS) Full Speed (FS)	1.5 Mbps 12 Mbps	
USB 2.0	High Speed (HS)	480 Mbps	
USB 3.0	SuperSpeed (SS)	5 Gbps	Also called USB 3.1 Gen1
USB 3.1	SuperSpeed+ (SSP)	10 Gbps	Also called USB 3.1 Gen2

ข้อมูลจาก www.quora.com

3. NETWORK CONNECTORS AND WIRING STANDARDS

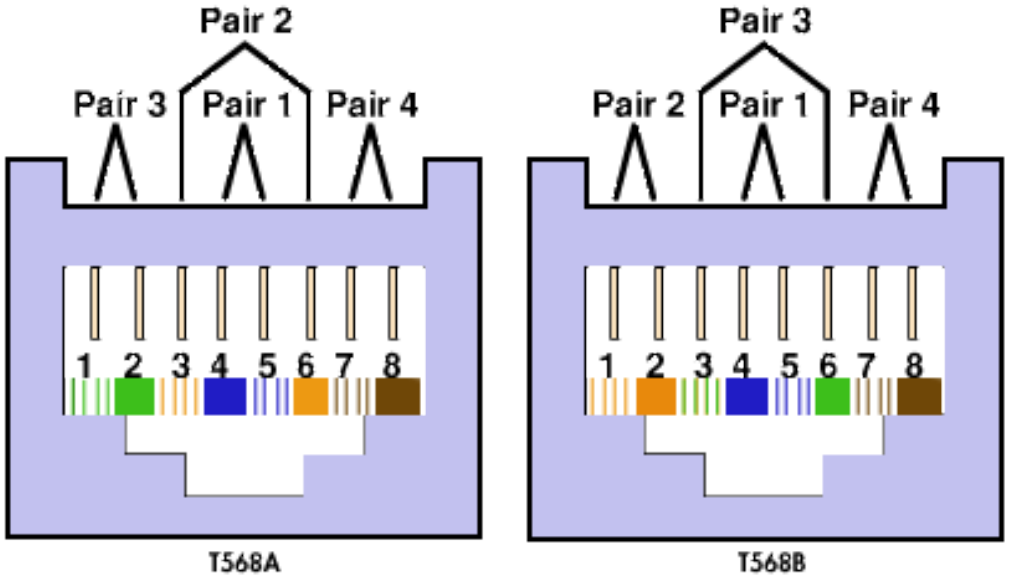
TIA/EIA 568A and 568B Wired Standard





3. NETWORK CONNECTORS AND WIRING STANDARDS

TIA/EIA 568A and 568B Wired Standard

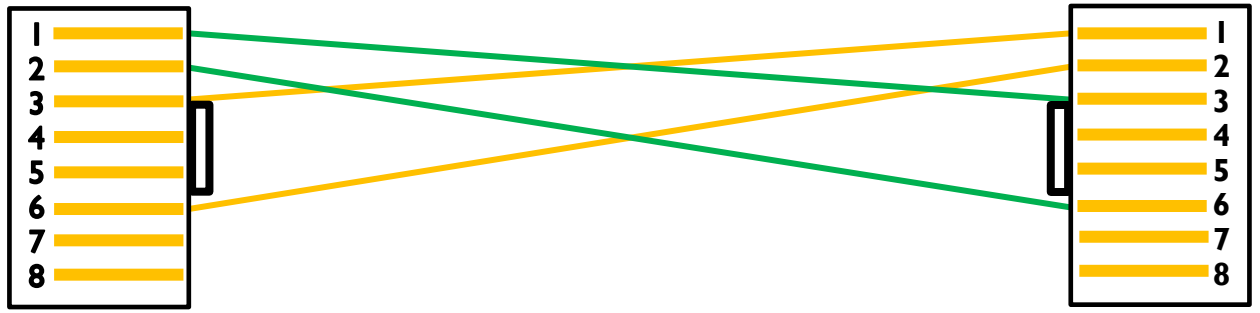


ข้อมูลจาก superuser.com

3. NETWORK CONNECTORS AND WIRING STANDARDS

Crossover Cable : TIA/EIA 568A to 568B

Fast Ethernet (100Mbps) 2Pair crossover cable



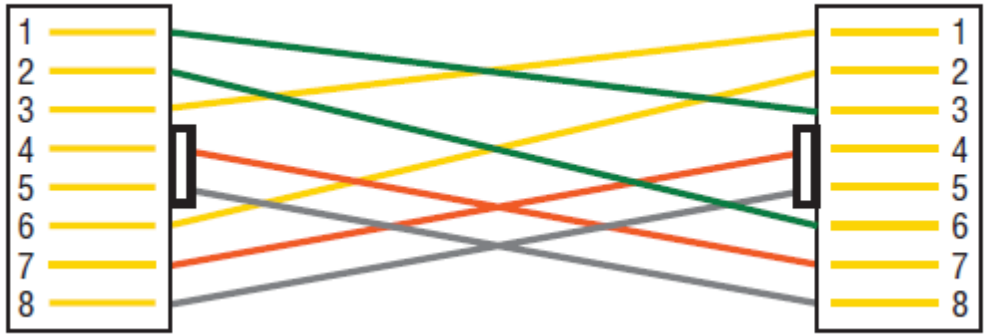
TIA/EIA568A

TIA/EIA568B

3. NETWORK CONNECTORS AND WIRING STANDARDS

Crossover Cable : TIA/EIA 568A to 568B

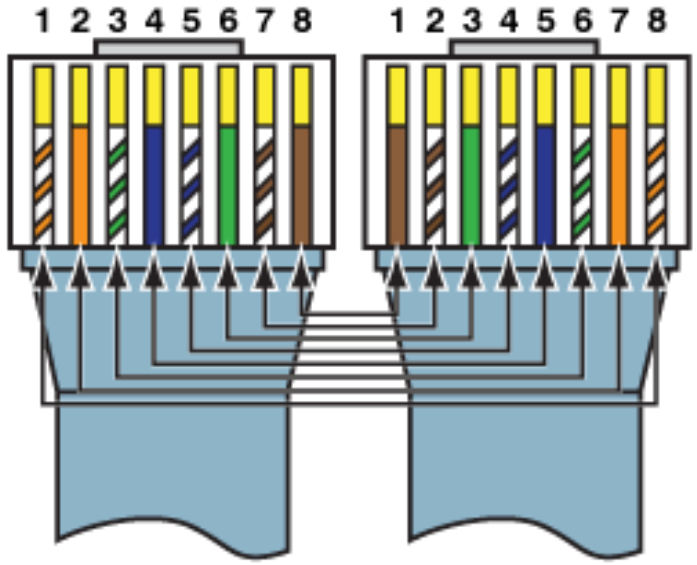
Gigabit Ethernet (1000Mbps) 4Pair crossover cable



TIA/EIA568A TIA/EIA568B

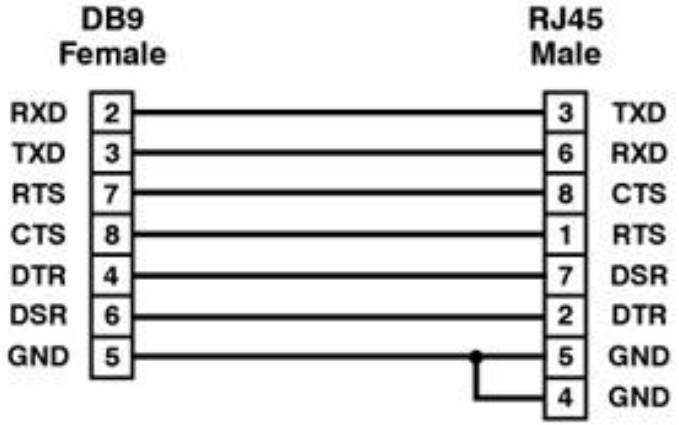
3. NETWORK CONNECTORS AND WIRING STANDARDS

Rollover/Rolled Cable : Console Cable



3. NETWORK CONNECTORS AND WIRING STANDARDS

Rollover/Rolled Cable : Console Cable



3. NETWORK CONNECTORS AND WIRING STANDARDS

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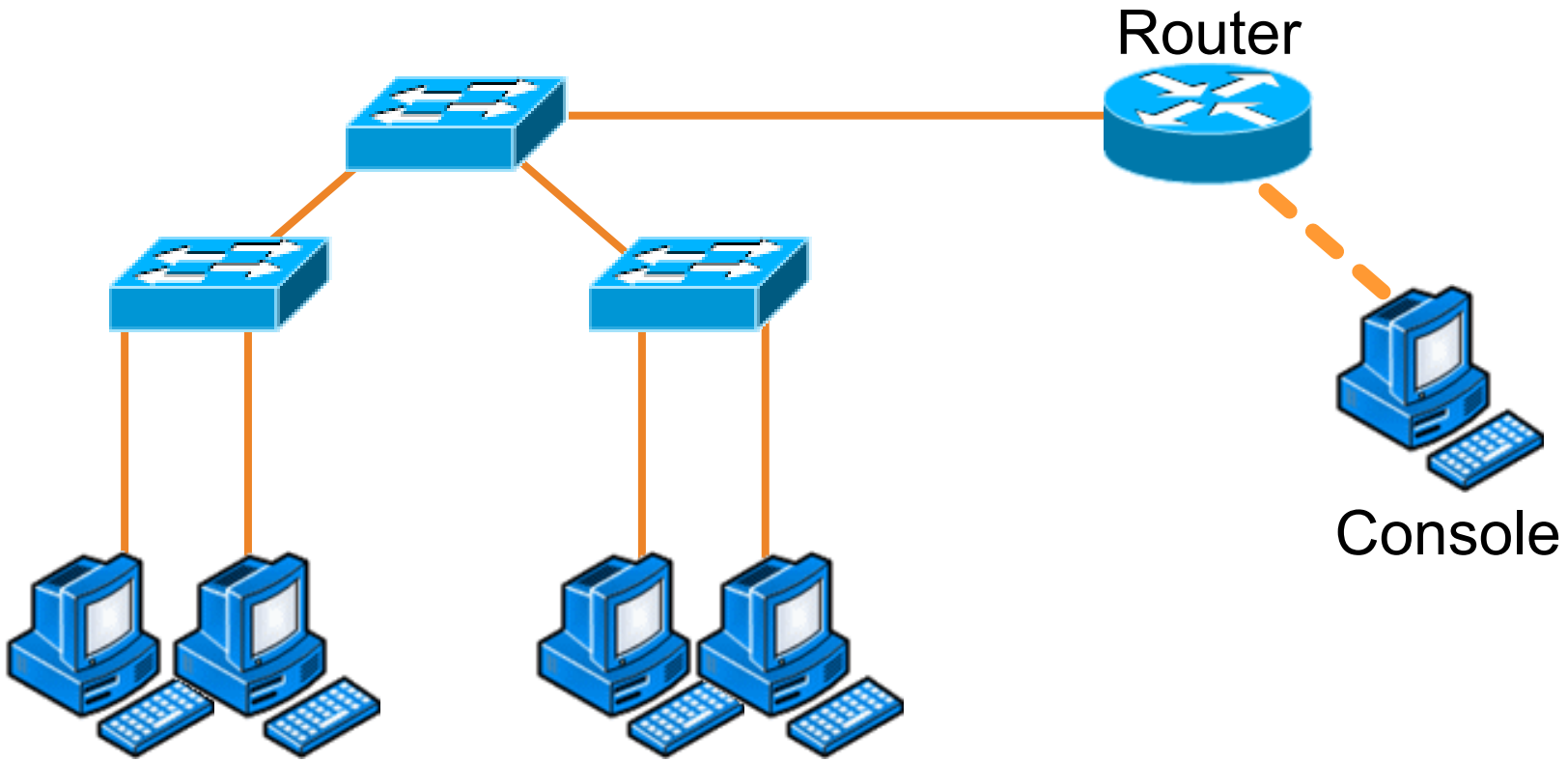

3. NETWORK CONNECTORS AND WIRING STANDARDS

UTP Cable Tester : Wired map tester

3. NETWORK CONNECTORS AND WIRING STANDARDS

UTP Cable Tester : Cable Analyzer

- Wired map
- TDX / TDR
- Attenuation
- NEXT (Near End Crosstalk)
- Attenuation Crosstalk Ratio (ACR)
- Power sum NEXT
- FEXT (Far End Crosstalk)
- Power sum FEXT
- RL (Return Loss)
- Tone Probe

3. NETWORK CONNECTORS AND WIRING STANDARDS

สรุป

- สาย Cable ในระบบ Network แบ่งออกเป็นกี่ประเภท?
- สายทองแดง ที่ใช้เชื่อมต่อ Network มีกี่ประเภท?
- สายใยแก้วนำแสง ที่ใช้เชื่อมต่อ Network มีกี่ประเภท?
- สาย Cable แต่ละประเภทใช้ Connectors ชนิดใดบ้าง?
- สายสำหรับเชื่อมต่ออุปกรณ์ต่อพ่วงคอมพิวเตอร์มีกี่ประเภท?
- หากต้องการปรับแต่ง Configuration อุปกรณ์ Switch , Router , Firewall etc. ที่ยังไม่ได้เชื่อมต่อ Network ใช้สายประเภทใด
- อุปกรณ์ทดสอบสายสัญญาณระบบเครือข่ายมีอะไรบ้าง?

Thank you for attention

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