SWITCHED NETWORKS

Circuit Switching & Packet Switching

PROBLEMS…

Permasalahan yang timbul jika jaringan memiliki banyak perangkat:

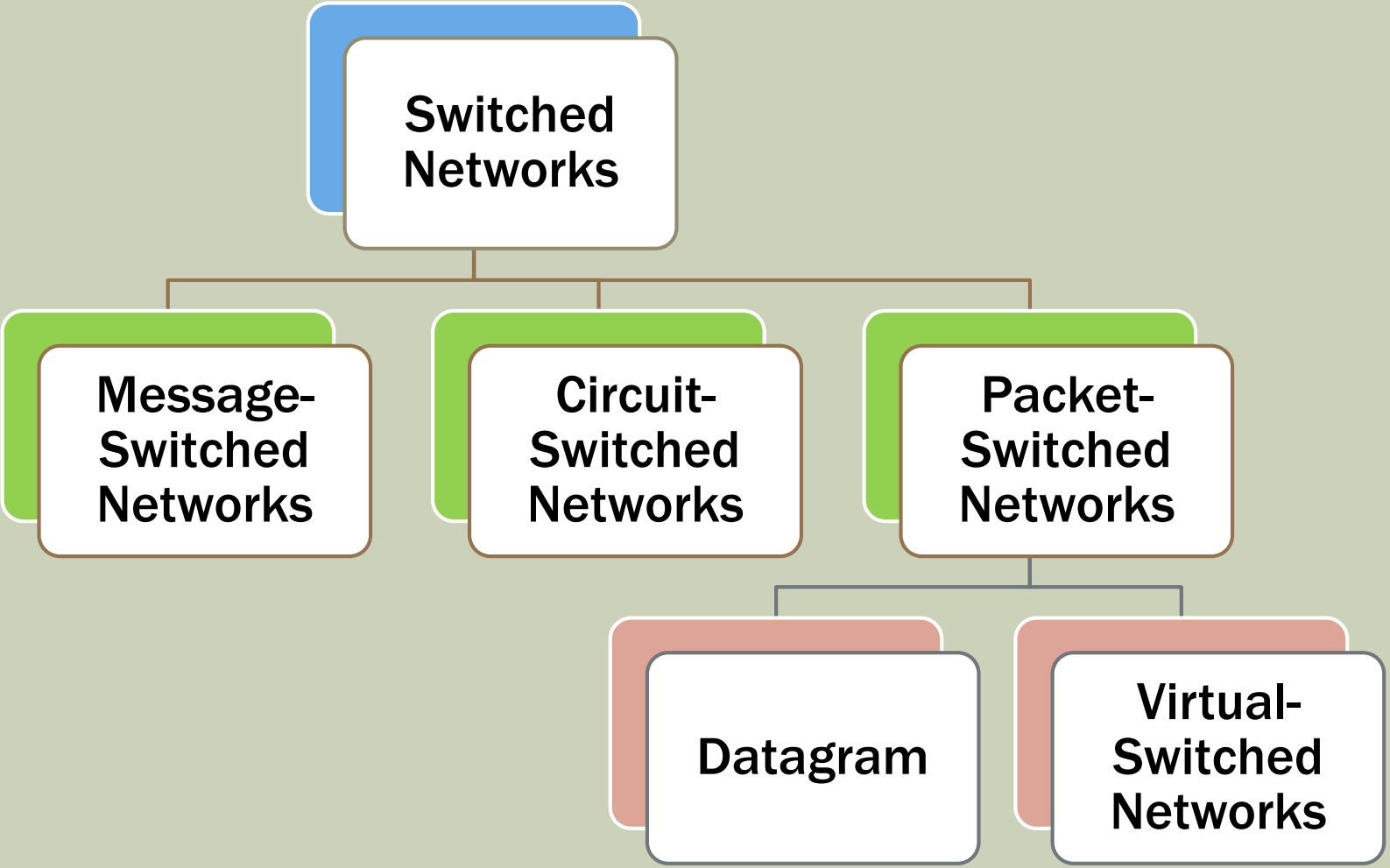
- Boros
- semakin banyak perangkat akan makin banyak dan makin panjang link → tidak efisien dalam cost
- Mayoritas link akan idle dalam suatu waktu

SOLUTION…

SWITCHING !

- Sebuah jaringan switching akan terdiri dari satu set node interlink yang disebut switch.
- Switch merupakan perangkat yang mampu menciptakan koneksi sementara (temporary connection) antara 2 atau lebih perangkat yang terhubung ke switch.

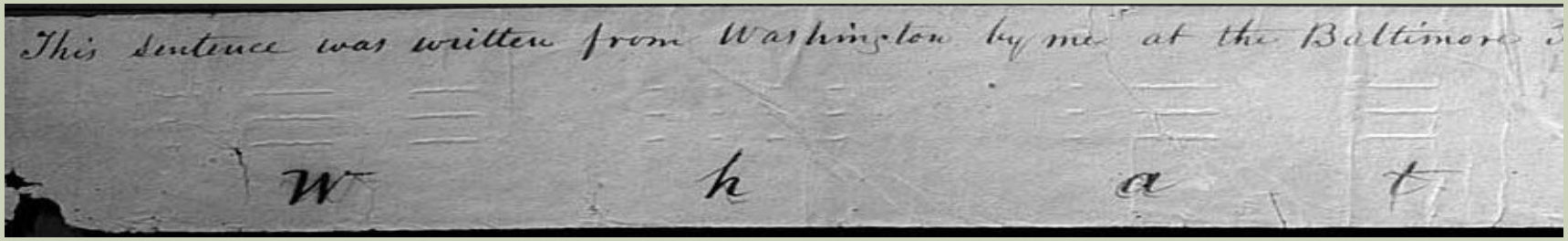
TAKSONOMI JARINGAN SWITCHING



1. MESSAGE SWITCHING

- Digunakan pada jaringan telegraph
  - Telegraphy : writing in distance
- Sinyal-sinyal morse dari suatu stasiun telegraph ditransfer ke stasiun yang lain (bisa jadi melalui beberapa perantara)

Samuel F.B. Morse
1791-1872
Copyrighted
A Short History of Telegraphy
AG Hobbs & SM Hallas



WHAT HATH GOD WROUGHT" The first telegraph message sent by Morse

- Stasiun perantara akan menerima keseluruhan message lalu memeriksa stasiun berikutnya yang harus dituju, kemudian meneruskan message ke stasiun berikutnya. Ini merupakan proses Store-and-Forward
- Proses Store-and-Forward ini diulangi sampai message tiba di tujuan
- Tidak ada proses pembentukan dan pemutusan koneksi

2. CIRCUIT SWITCHING

- Digunakan pada jaringan telepon
- Komunikasi berlangsung di dalam tiga tahap :
  1. Pembentukan koneksi antara dua pihak yang berkomunikasi
     - Proses ini ditujukan untuk mendefinisikan jalur yang harus ditempuh oleh informasi yang akan dikirimkan
     - Koneksi yang dibentuk (resource jaringan yang sudah dialokasikan bagi suatu panggilan) bersifat dedicated (tidak di-share bersama panggilan lain)
       - Baik ada maupun tidak ada informasi yang ditransfer, koneksi terhubung terus
  2. Transfer informasi
  3. Pemutusan koneksi

- Berdasarkan adanya keharusan pembentukan koneksi sebelum transfer informasi berlangsung maka teknik circuit switching disebut bersifat ***connection oriented***
- Teknik circuit switching cocok untuk mentransfer voice
  - Sifat koneksi yang dedicated dapat menjamin delay dan jitter yang disyaratkan untuk transfer voice

3. PACKET SWITCHING

- Digunakan pada jaringan untuk mentransfer informasi data
- Sebelum dikirimkan ke jaringan, message dipecah ke dalam beberapa message yang ukurannya lebih pendek
  - Message-message yang ukurannya pendek ini disebut paket
  - Di penerima, paket-paket itu akan disusun kembali membentuk message semula
- Resource jaringan di-share oleh user-user yang ada pada jaringan (tidak dedicated)
  - Bila suatu user tidak mentransfer informasi maka user tsb tidak akan menggunakan resource jaringan

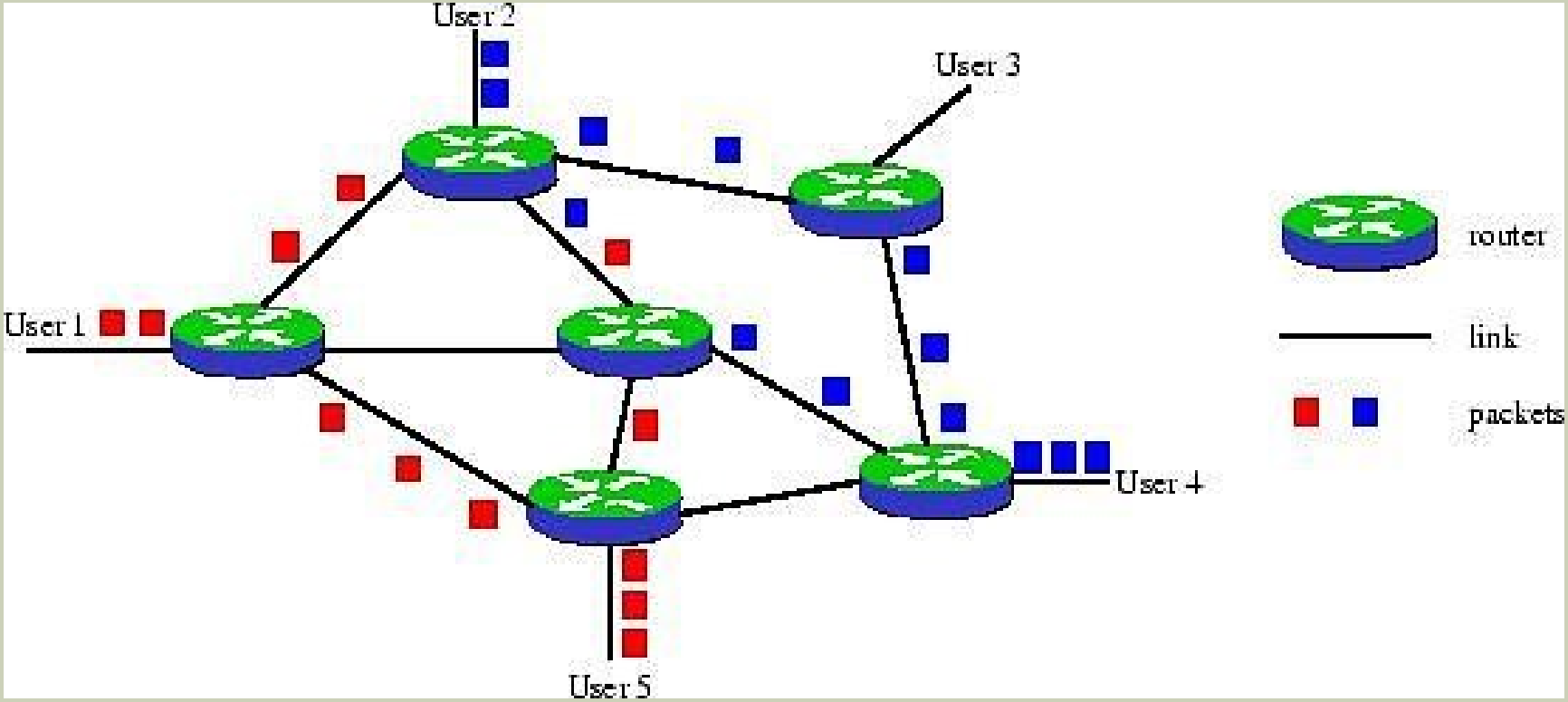
Ada dua macam teknik Packet Switching :

- Datagram Packet Switching
- Virtual-Circuit Packet Switching

3A. DATAGRAM PACKET SWITCHING

- Connectionless
  - Tidak ada pembentukan koneksi dahulu
- Paket-paket yang dikirimkan diberi identifier node pengirim dan tujuan
- Paket yang sampai di *intermediate node* akan diteruskan ke node berikutnya (bila memungkinkan)
  - Intermediate node tidak perlu menunggu sampainya semua paket yang berasal dari suatu message
  - Merupakan proses Store-and-Forward (seperti pada Message Switching)

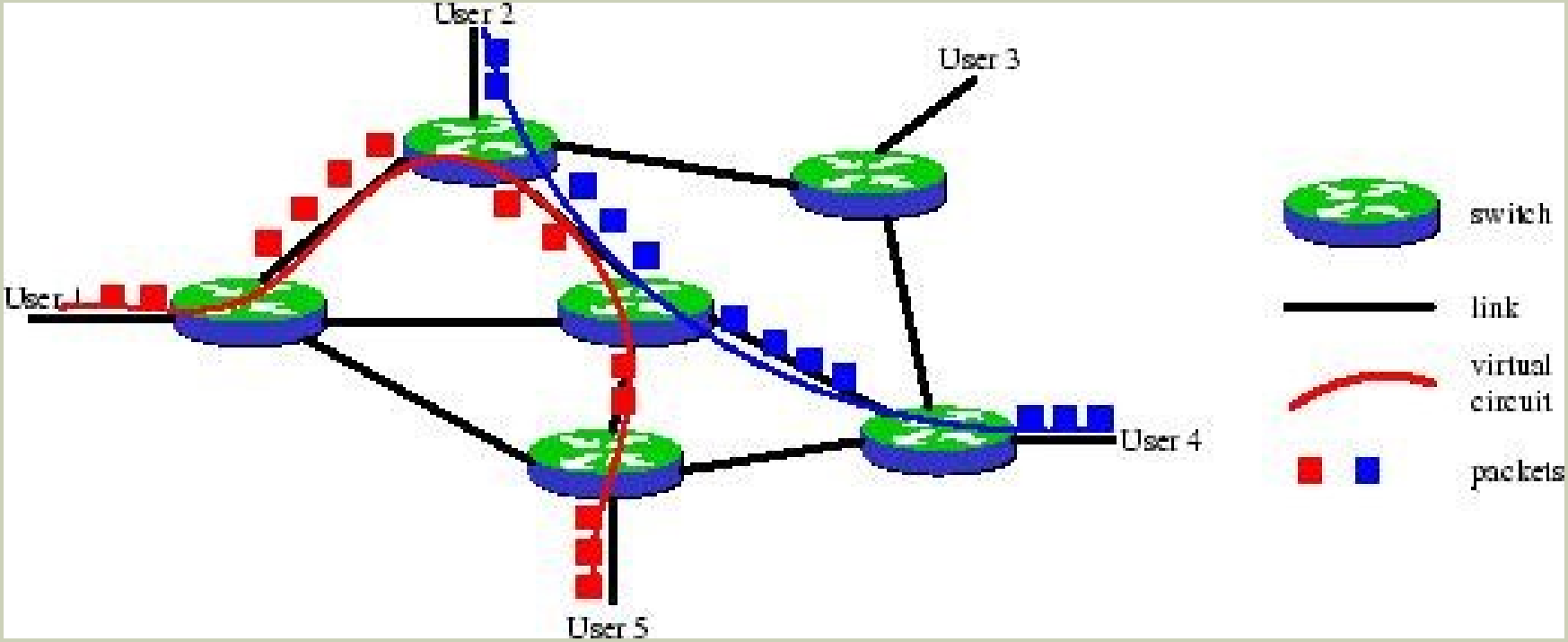
ILUSTRASI DATAGRAM PACKET SWITCHING



3B. VIRTUAL-CIRCUIT PACKET SWITCHING

- Memadukan keunggulan circuit switching dan datagram packet switching
  - Connection oriented ; komunikasi berlangsung di dalam tiga tahap seperti pada circuit switching
  - Pemakaian resource jaringan tidak dedicated
  - Store-and-forward process masih berlangsung
- Setelah koneksi terbentuk, paket-paket yang berasal dari suatu message yang sama akan dikirimkan melalui jalur yang sudah ditentukan ketika pembentukan koneksi
  - Paket-paket tiba di tujuan secara terurut

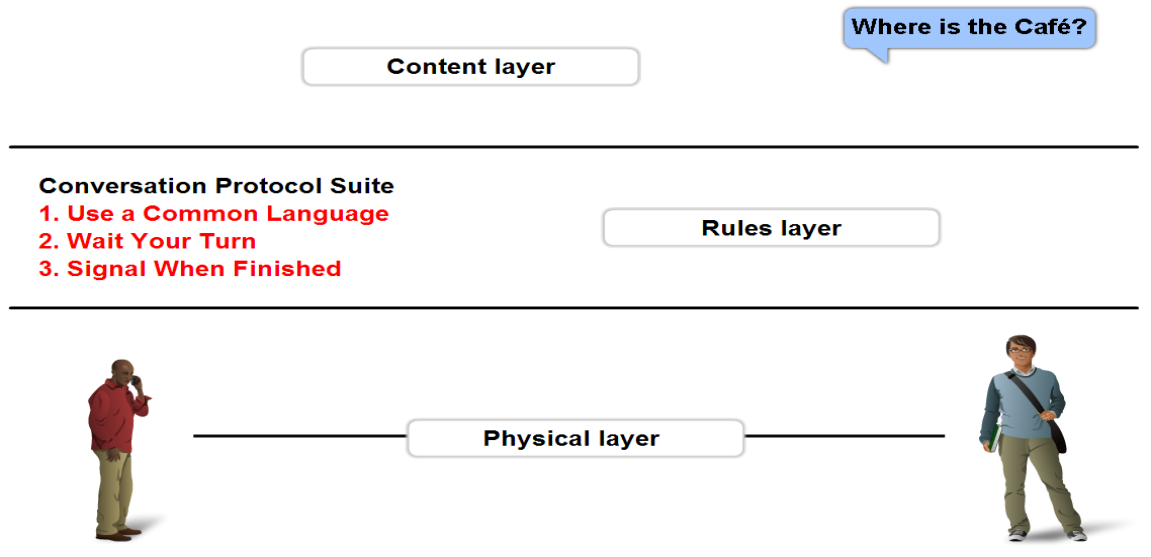
ILUSTRASI VIRTUAL-CIRCUIT PACKET SWITCHING



COMMUNICATION PROTOCOL

FUNCTION OF PROTOCOL IN NETWORK COMMUNICATION

- The importance of protocols and how they are used to facilitate communication over data networks
  - A protocol is a set of predetermined rules
  - A standard is a process or protocol that has been endorsed by the networking industry and ratified by a standards organization

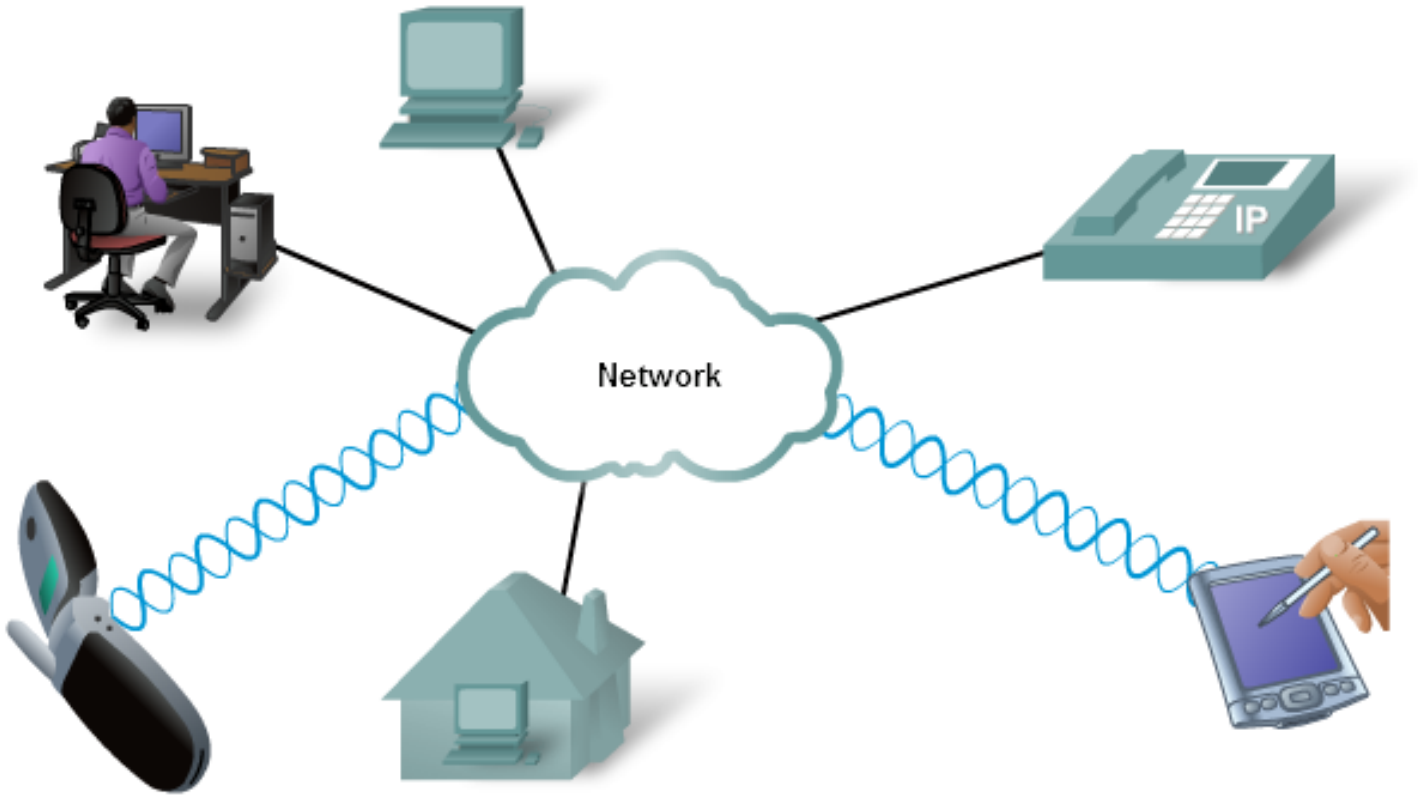


THE ROLE OF PROTOCOL

Networking protocols suites describe processes such as:

- The format or structure of the message
- The process by which networking devices share information about pathways with other networks
- How and when error and system messages are passed between devices
- The setup and termination of data transfer sessions

Many diverse types of devices can communicate using the same sets of protocols. This is because protocols specify network functionality, not the underlying technology to support this functionality.



BENEFIT OF USING LAYERED MODEL

- To visualize the interaction between various protocols, it is common to use a layered model.
- There are benefits to using a layered model to describe network protocols and operations. Using a layered model:
  - Assists in protocol design, because protocols that operate at a specific layer have defined information that they act upon and a defined interface to the layers above and below.
  - Fosters competition because products from different vendors can work together.
  - Prevents technology or capability changes in one layer from affecting other layers above and below.
  - Provides a common language to describe networking functions and capabilities.

PROTOCOL AND REFERENCE MODEL

- There are two basic types of networking models:
  - protocol models
  - reference models.

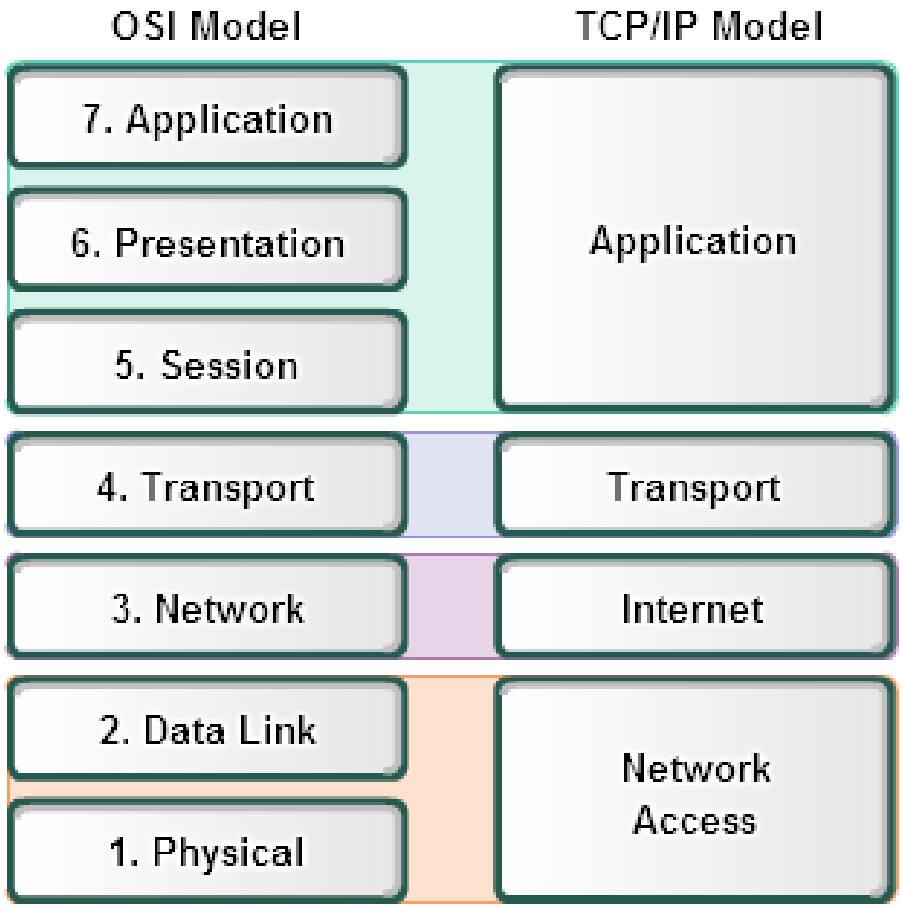
PROTOCOL MODEL

- A protocol model provides a model that closely matches the structure of a particular protocol suite.
- The hierarchical set of related protocols in a suite typically represents all the functionality required to interface the human network with the data network.
- The TCP/IP model is a protocol model because it describes the functions that occur at each layer of protocols within the TCP/IP suite.

REFERENCE MODEL

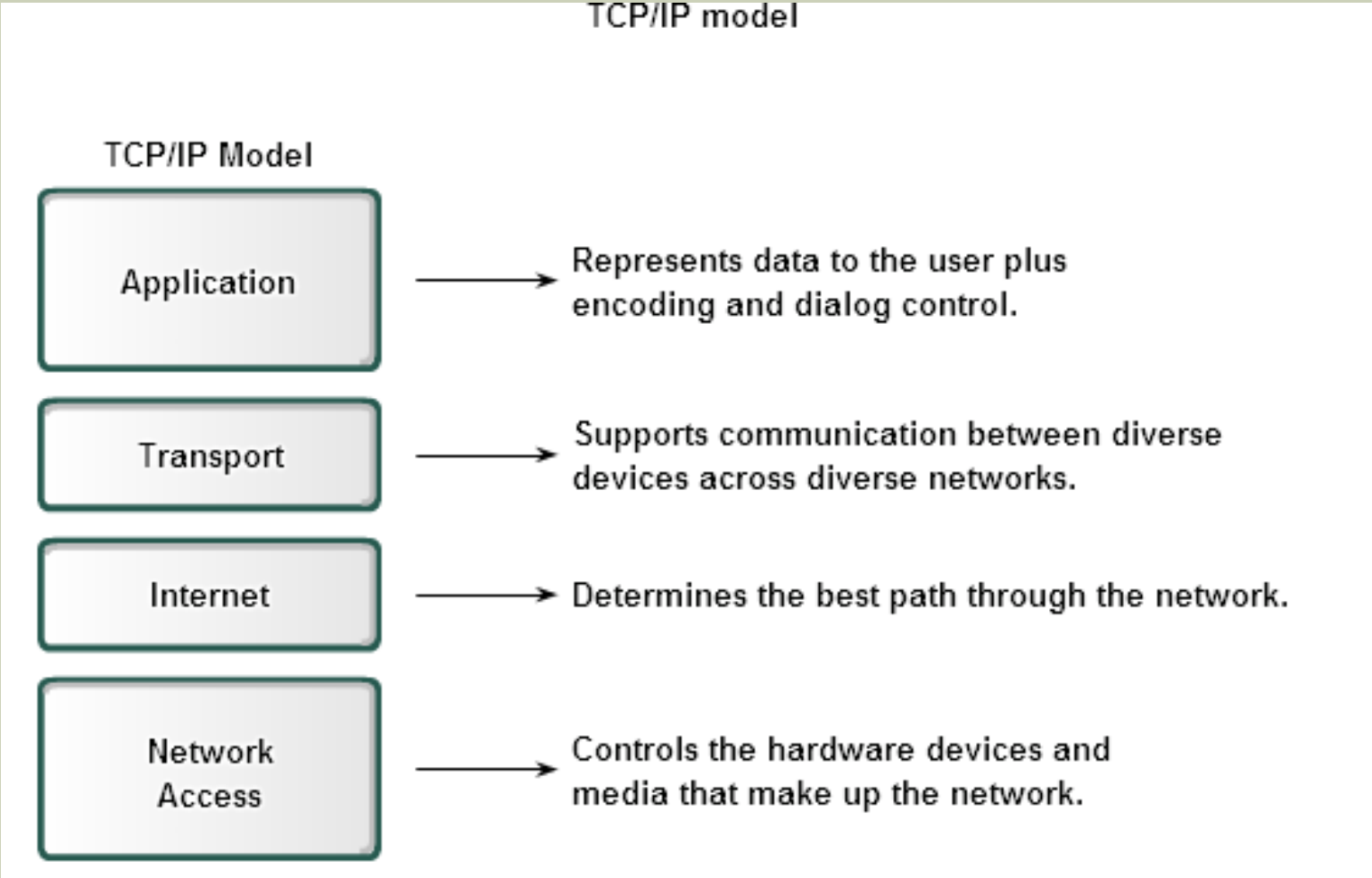
- A reference model provides a common reference for maintaining consistency within all types of network protocols and services.
- A reference model is not intended to be an implementation specification or to provide a sufficient level of detail to define precisely the services of the network architecture.
- The primary purpose of a reference model is to aid in clearer understanding of the functions and process involved.
- The Open Systems Interconnection (OSI) model is the most widely known internetwork reference model. It is used for data network design, operation specifications, and troubleshooting.

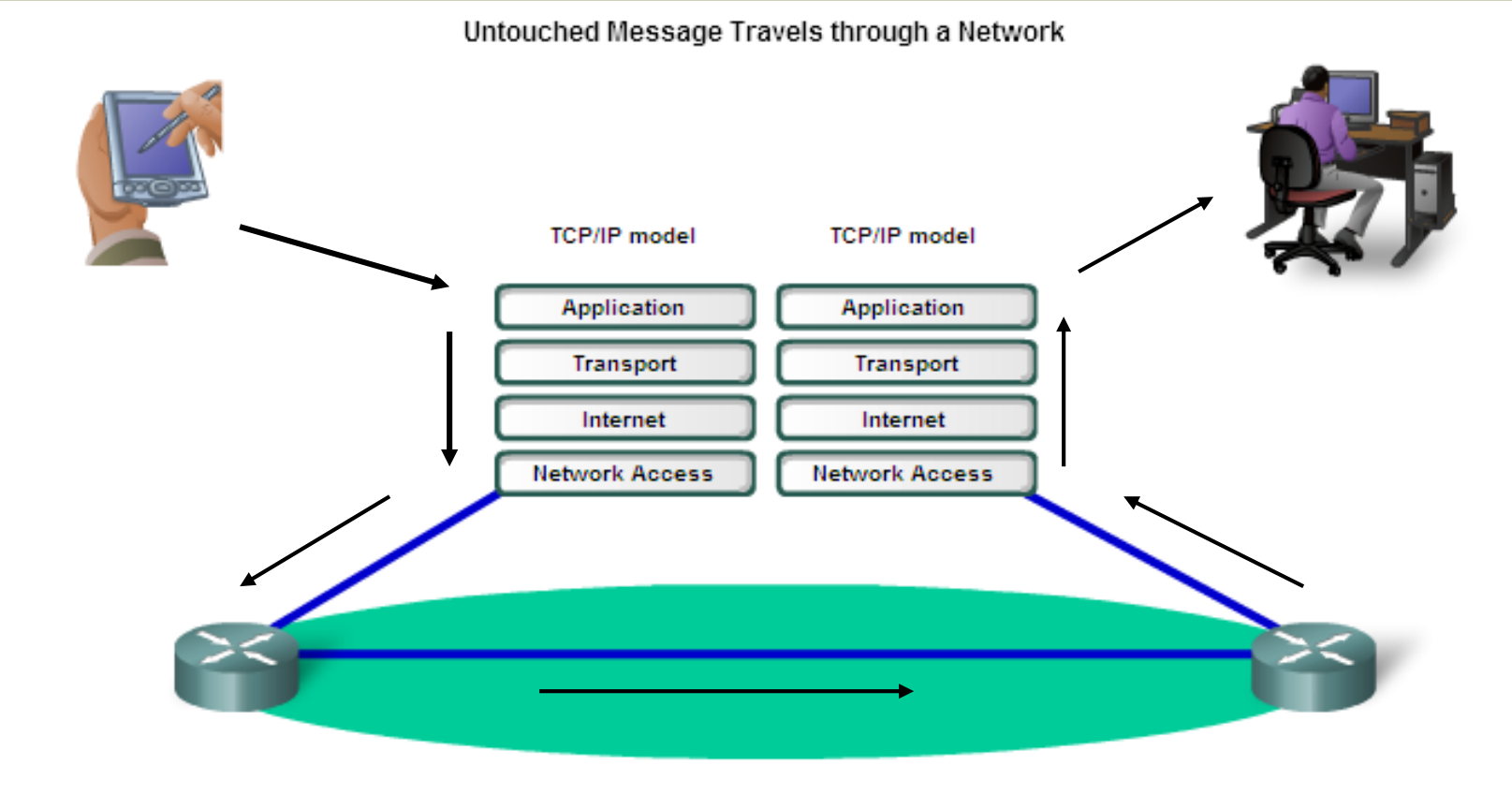
COMPARING THE OSI AND TCP/IP MODELS

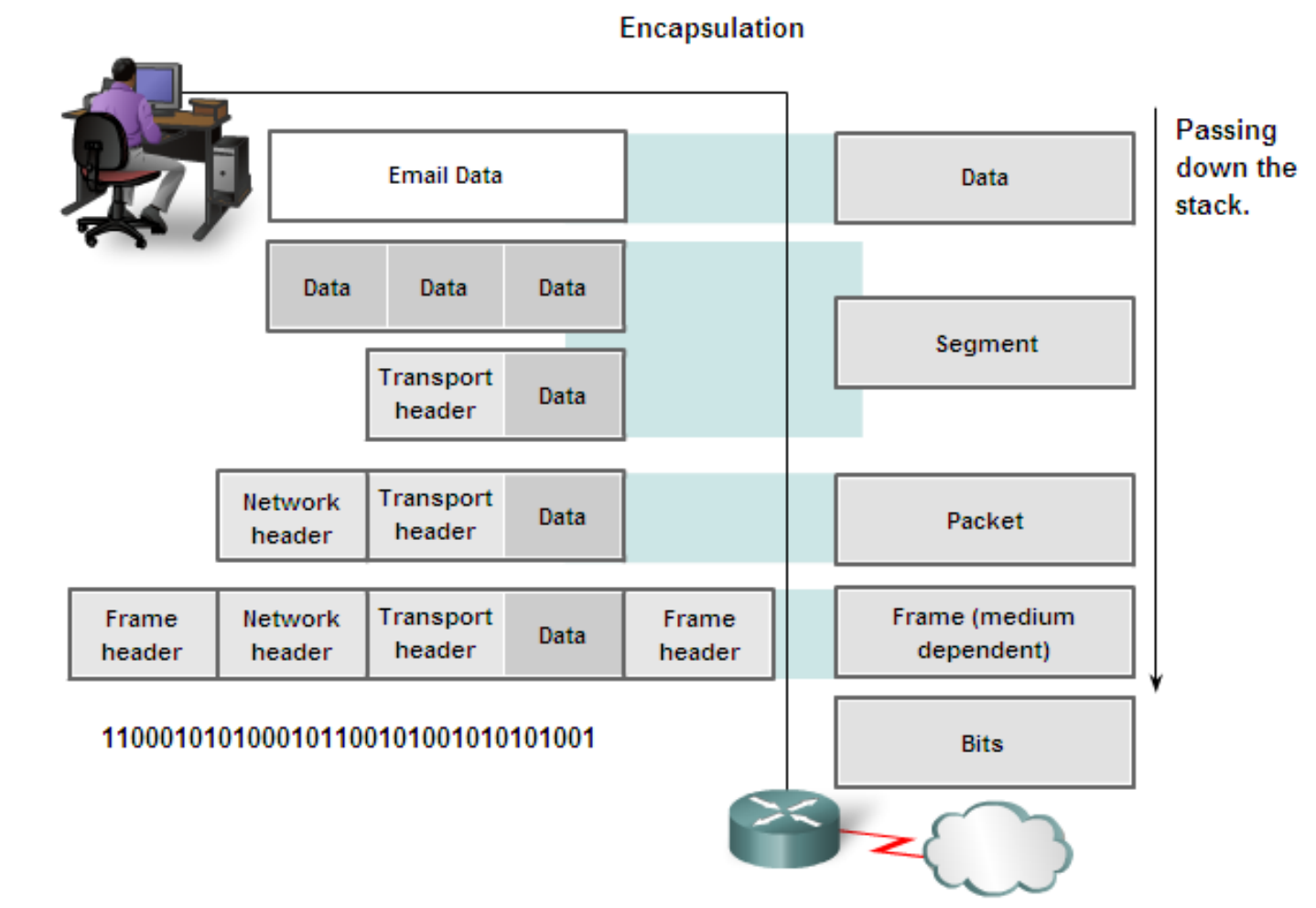


The key parallels are in the Transport and Network layers.

TCP/IP MODEL


TCP/IP model
TCP/IP Model
Application
Represents data to the user plus encoding and dialog control.
Transport
Supports communication between diverse devices across diverse networks.
Internet
Determines the best path through the network.
Network Access
Controls the hardware devices and media that make up the network.

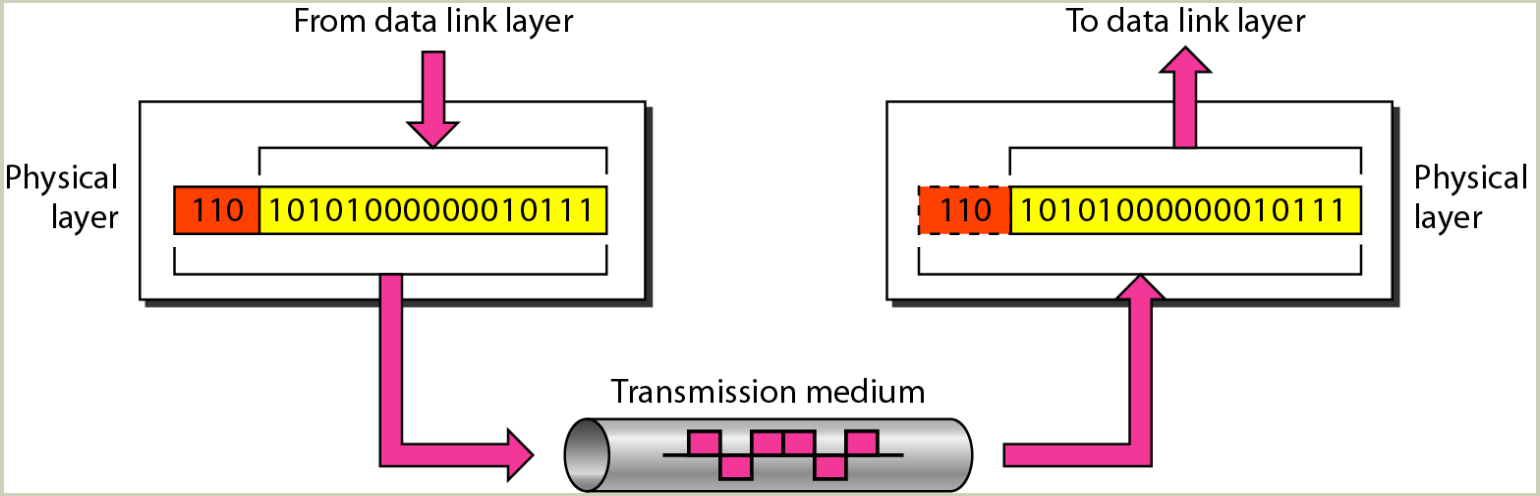

Untouched Message Travels through a Network
TCP/IP model
TCP/IP model
Application
Transport
Internet
Network Access
Application
Transport
Internet
Network Access


Encapsulation
Email Data
Data
Data
Data
Transport header
Data
Network header
Transport header
Data
Frame header
Network header
Transport header
Data
Frame header
1100010101000101100101001010101001
Data
Segment
Packet
Frame (medium dependent)
Bits
Passing down the stack.

OSI MODEL

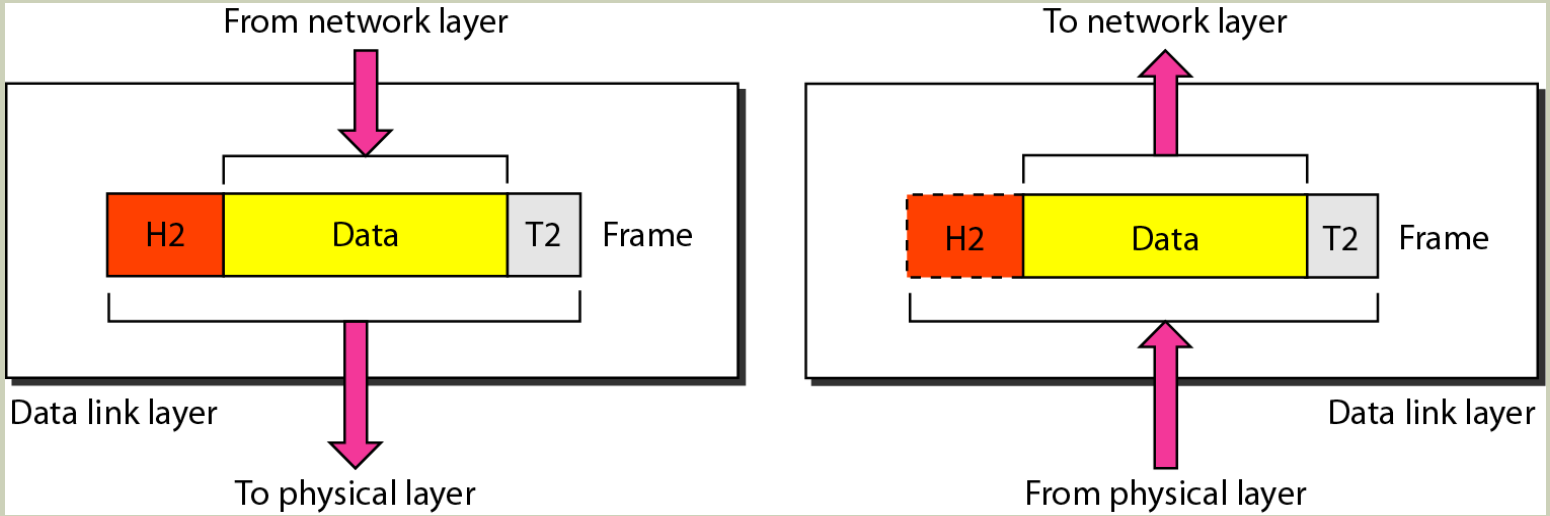
- Initially the OSI model was designed by the International Organization for Standardization (ISO) to provide a framework on which to build a suite of open systems protocols.
- The vision was that this set of protocols would be used to develop an international network that would not be dependent on proprietary systems.

PHYSICAL LAYER

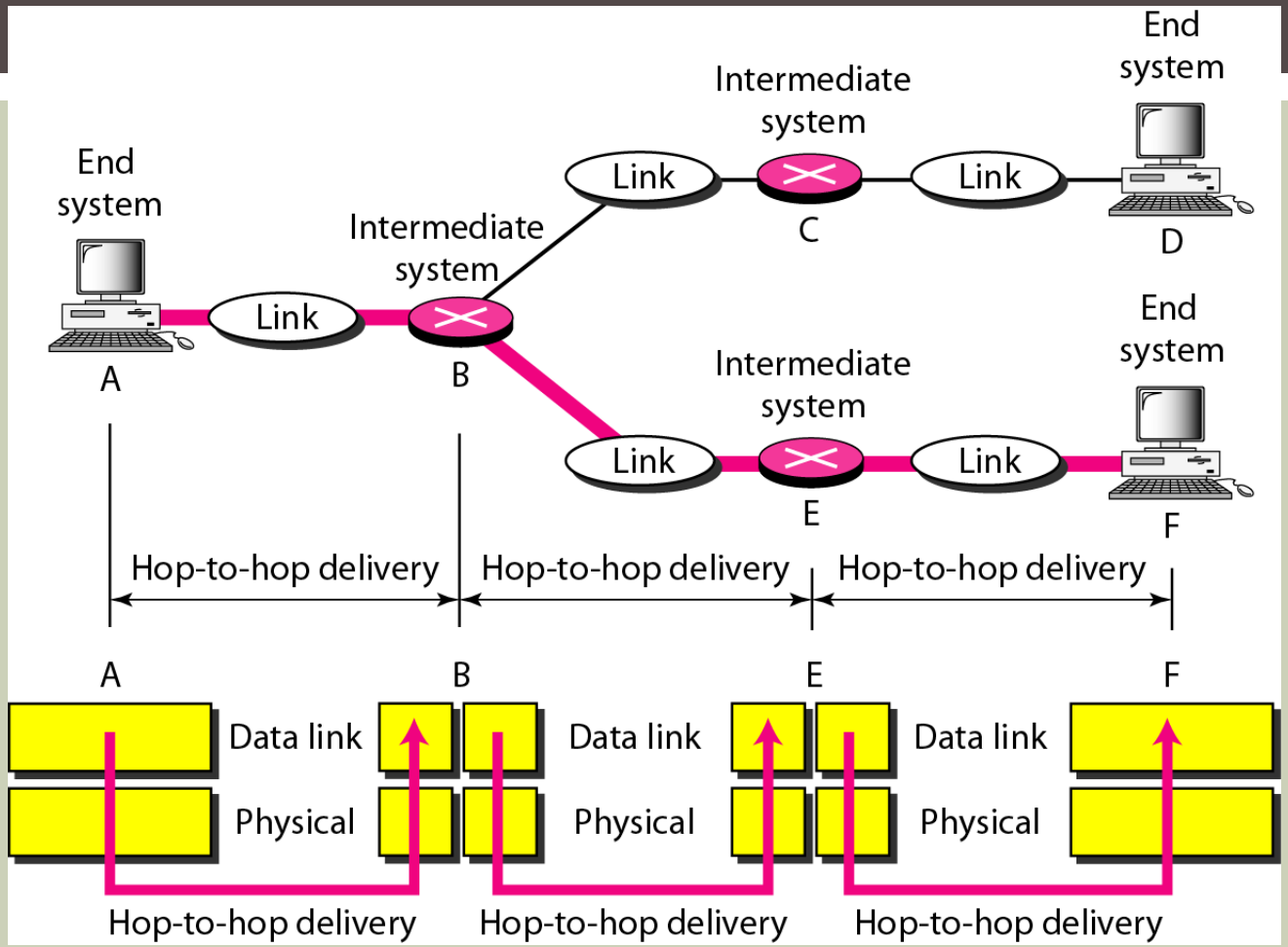


The physical layer is responsible for movements of individual bits from one hop (node) to the next.

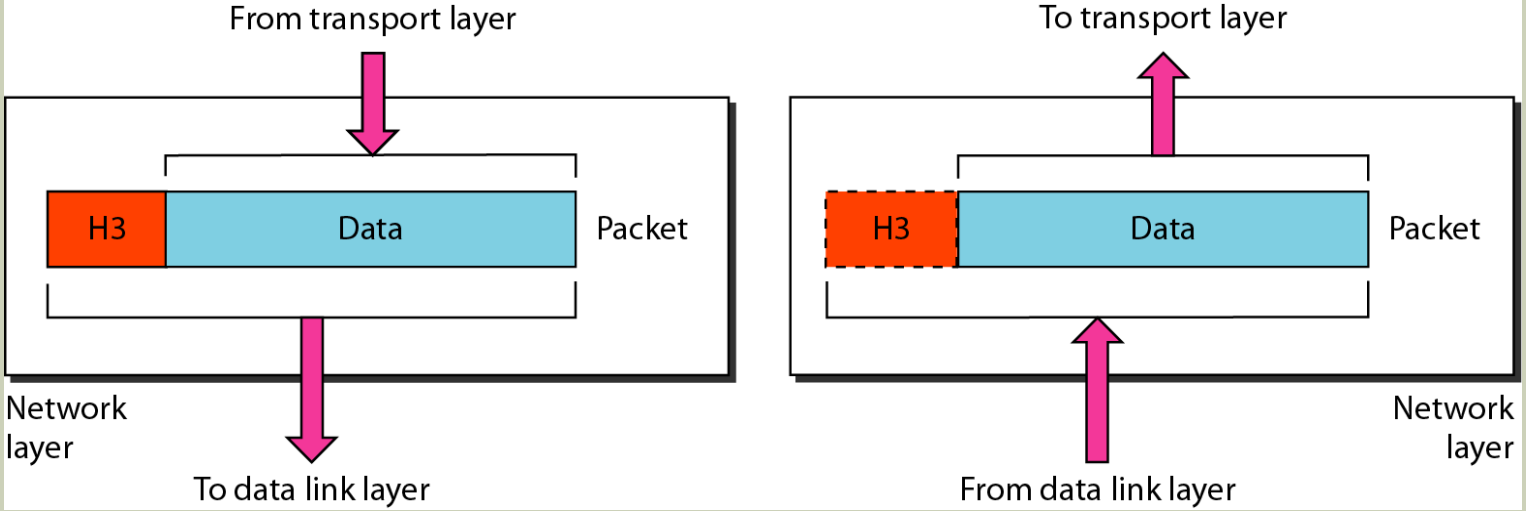
DATA LINK LAYER



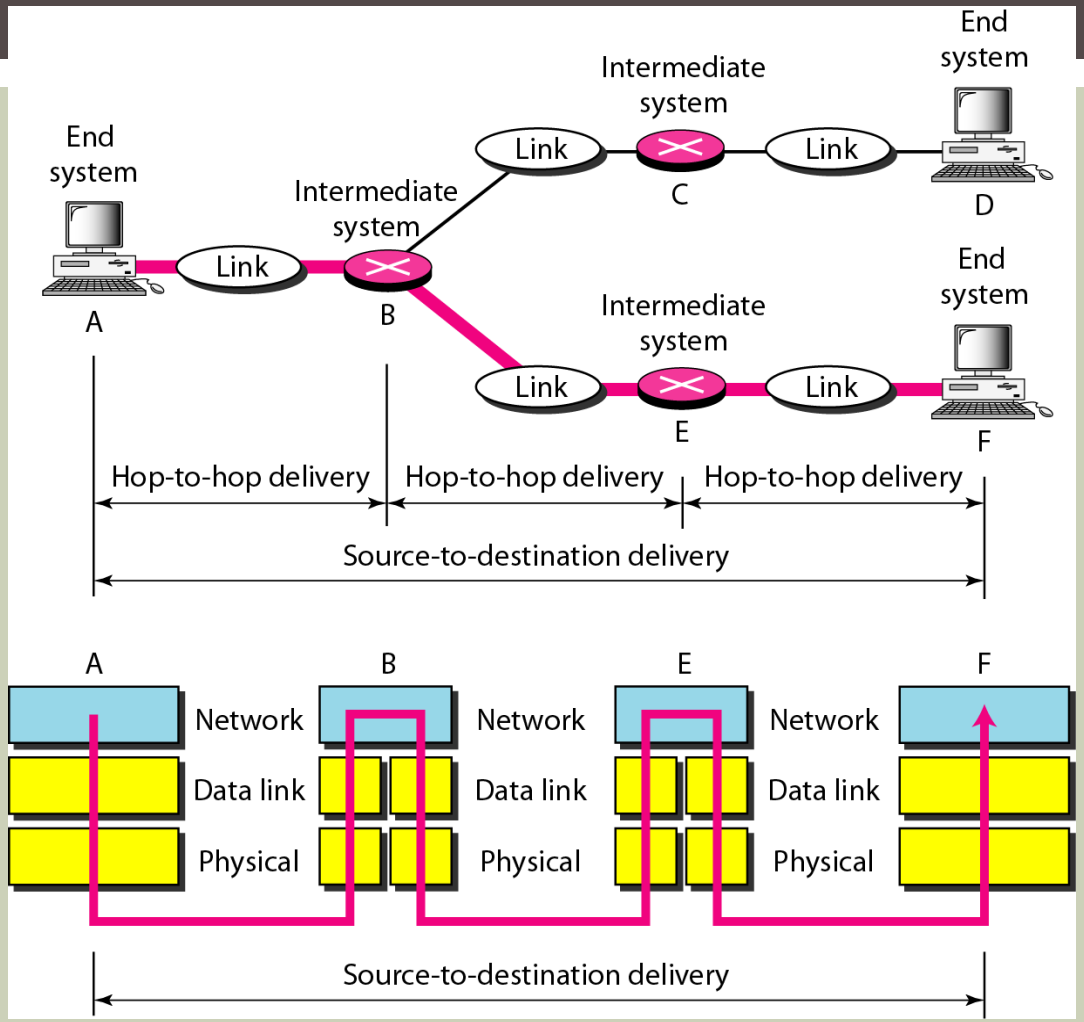
The data link layer is responsible for moving frames from one hop (node) to the next.


End system
Intermediate system
End system
Link
Link
C
D
End system
Intermediate system
Link
A
B
Intermediate system
End system
Link
Link
E
F
Hop-to-hop delivery
Hop-to-hop delivery
Hop-to-hop delivery
A
B
E
F
Data link
Data link
Data link
Physical
Physical
Physical
Hop-to-hop delivery
Hop-to-hop delivery
Hop-to-hop delivery

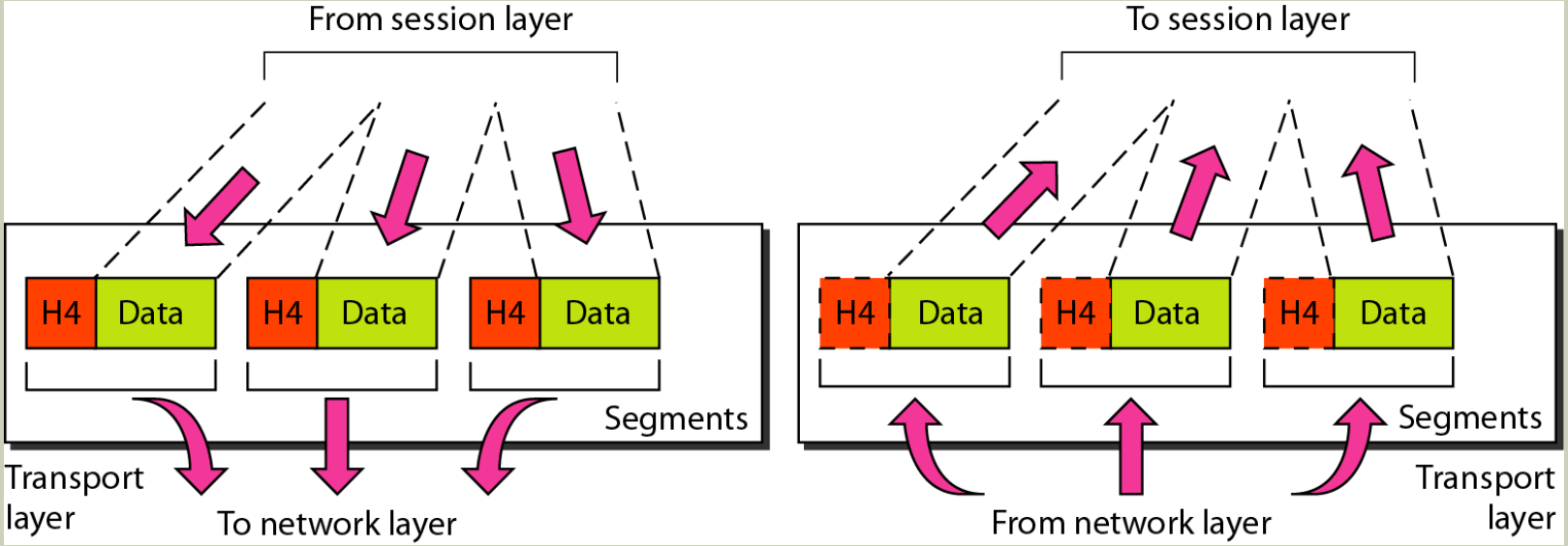
NETWORK LAYER



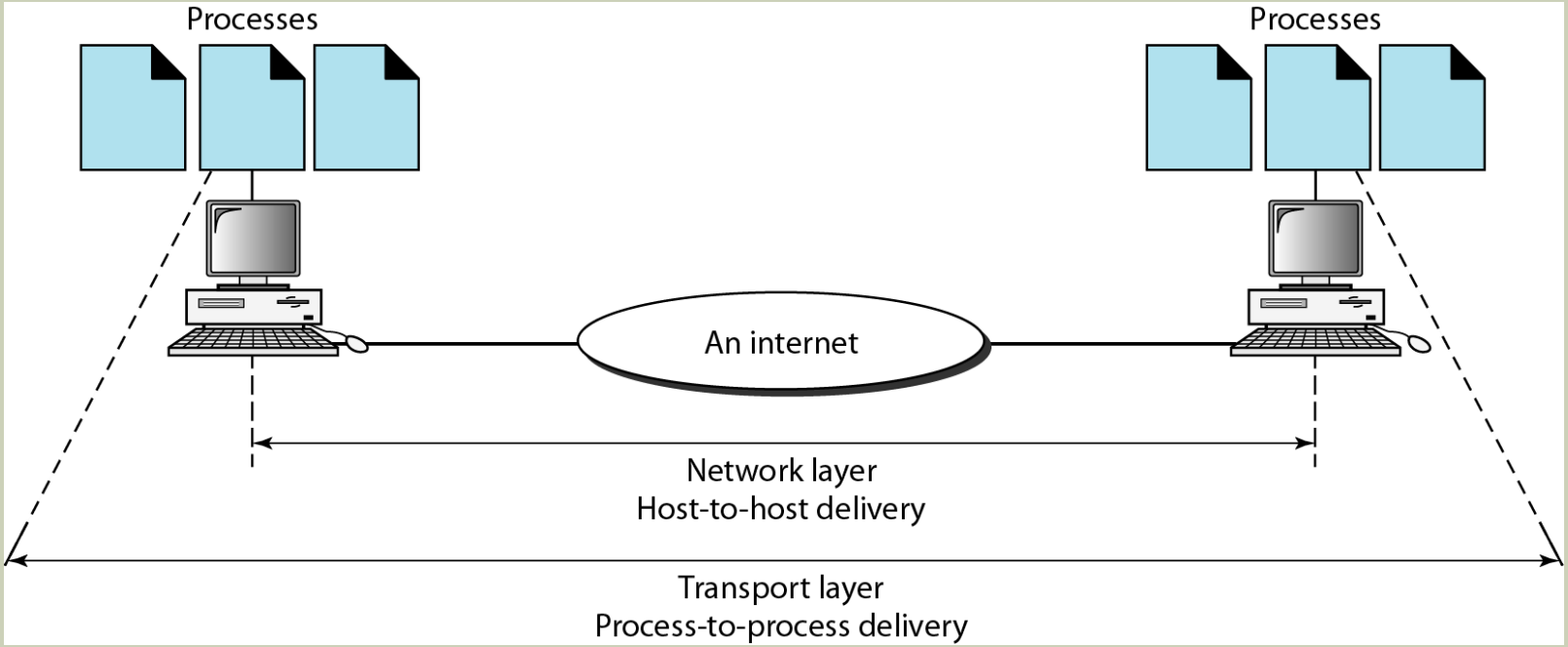
The network layer is responsible for the delivery of individual packets from the source host to the destination host.


End system
Intermediate system
End system
Link
Link
Link
C
D
A
B
Intermediate system
End system
Link
Link
E
F
Hop-to-hop delivery
Hop-to-hop delivery
Hop-to-hop delivery
Source-to-destination delivery
A
B
E
F
Network
Network
Network
Data link
Data link
Data link
Physical
Physical
Physical
Source-to-destination delivery

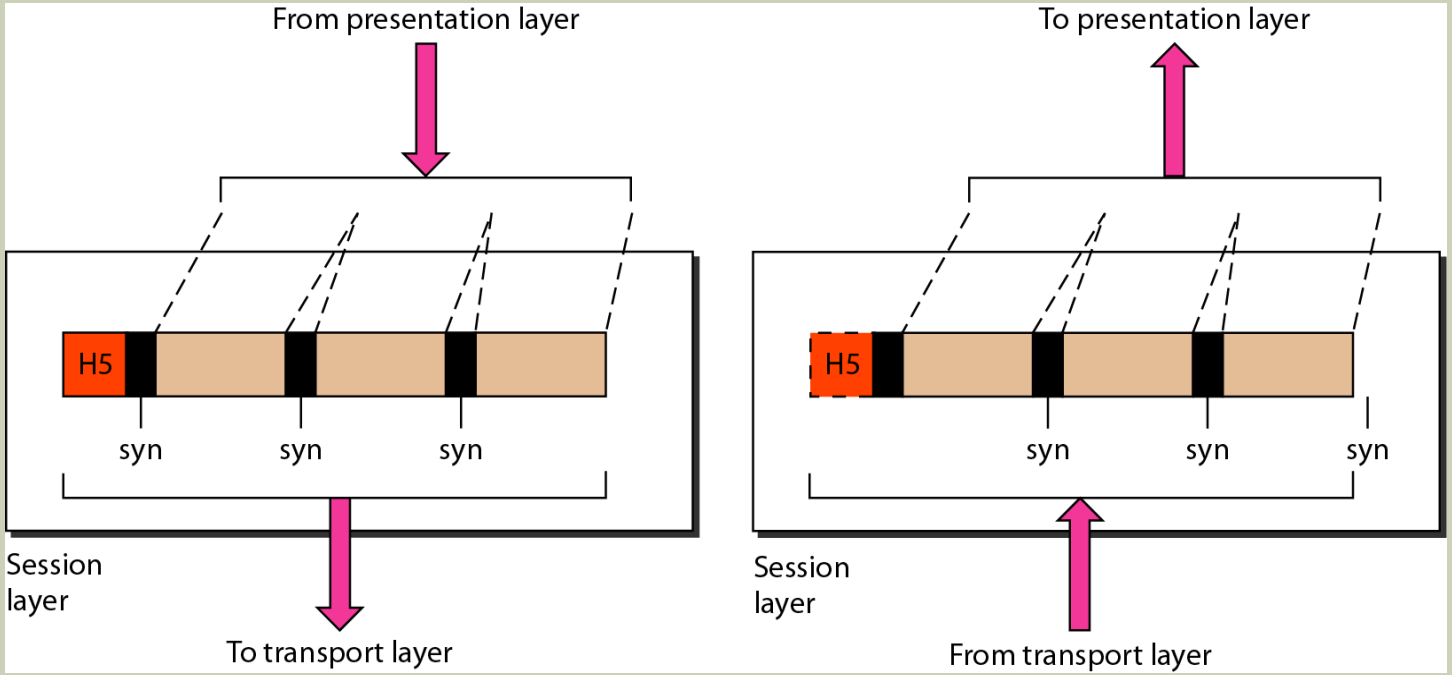
TRANSPORT LAYER



The transport layer is responsible for the delivery of a message from one process to another.

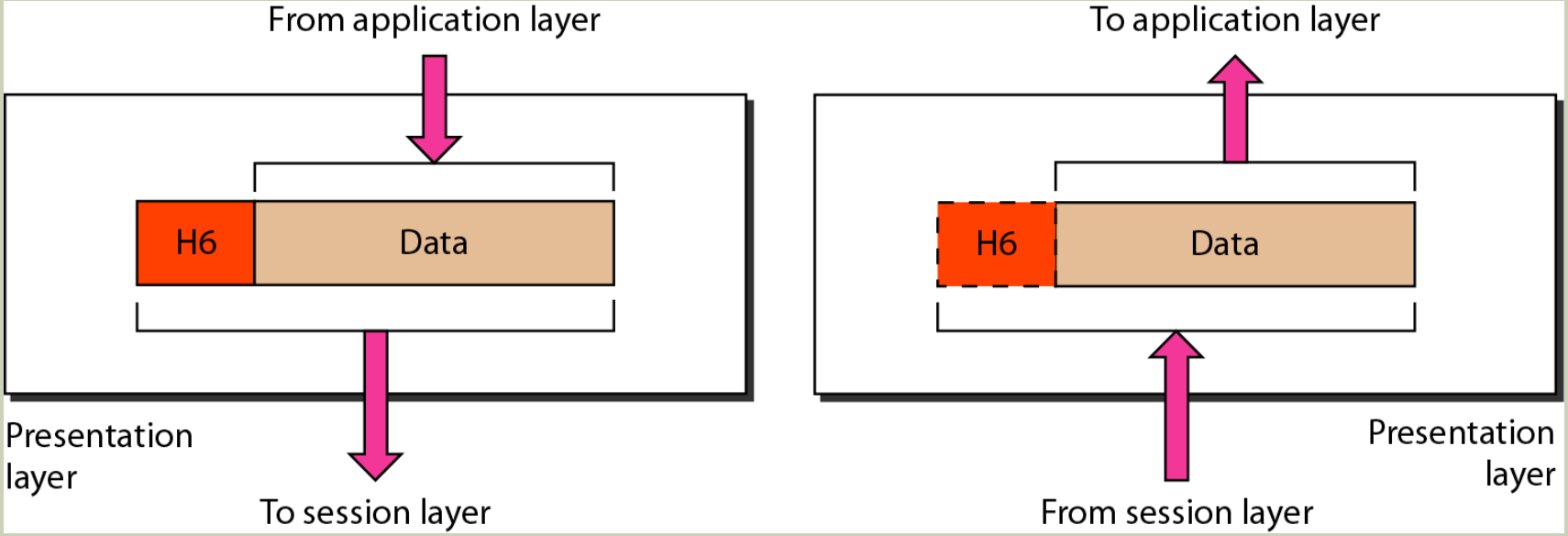

Processes
Processes
An internet
Network layer
Host-to-host delivery
Transport layer
Process-to-process delivery

SESSION LAYER



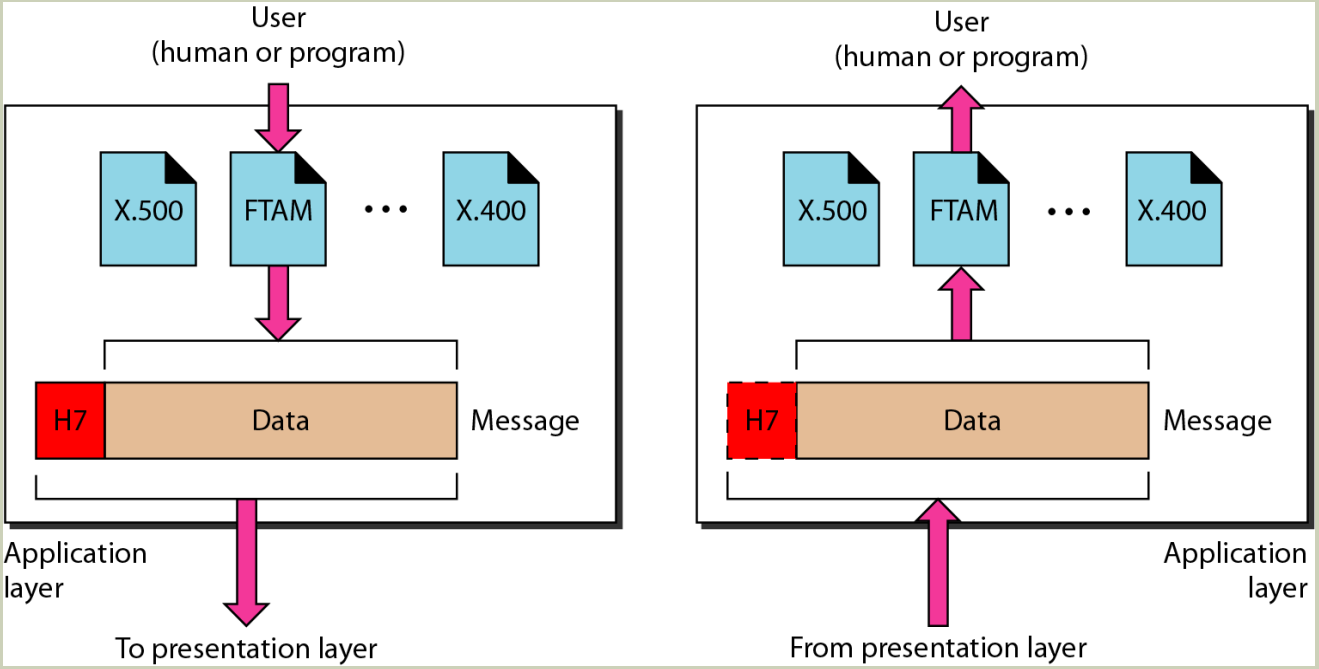
The session layer is responsible for dialog control and synchronization.

PRESENTATION LAYER



The presentation layer is responsible for translation, compression, and encryption.

APPLICATION LAYER



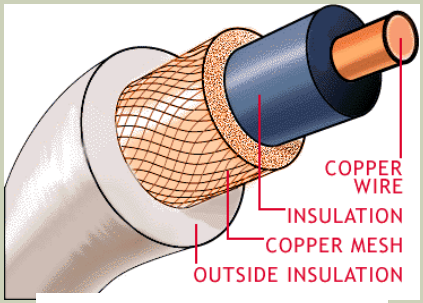
The application layer is responsible for providing services to the user.

PHYSICAL LAYER

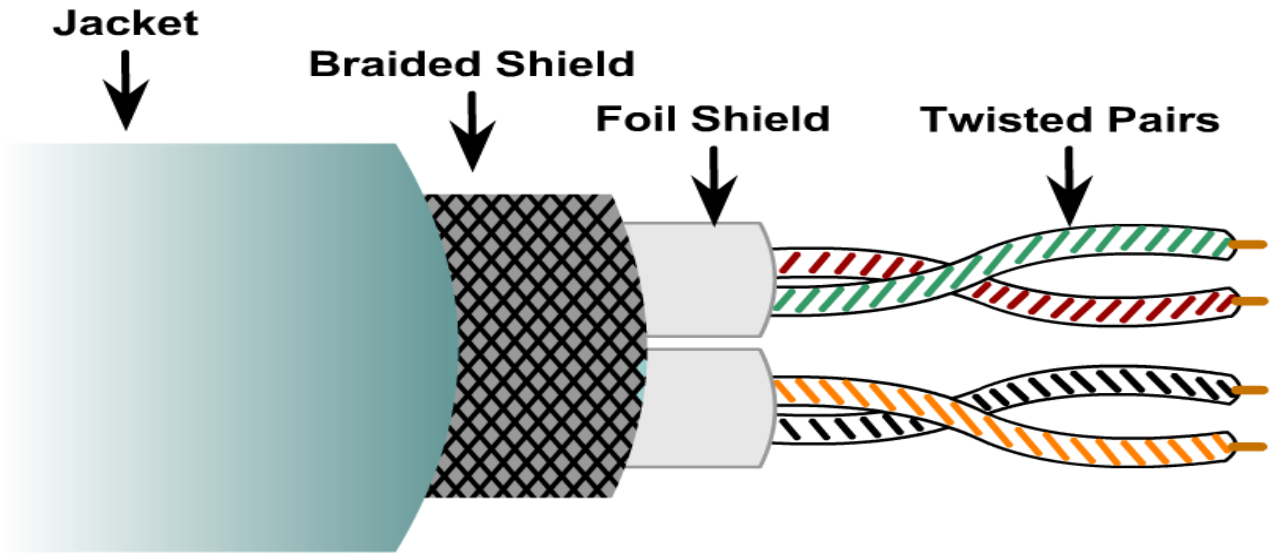
CONNECTOR AND CABLING

MEDIUM TYPE

- Terdapat beberapa media yang sering digunakan dalam mentransmisikan data dari node-1 ke node yang lain, diantaranya :
  - Twisted Pair
  - Coaxial Cabel
  - Optic Fiber
  - Wireless

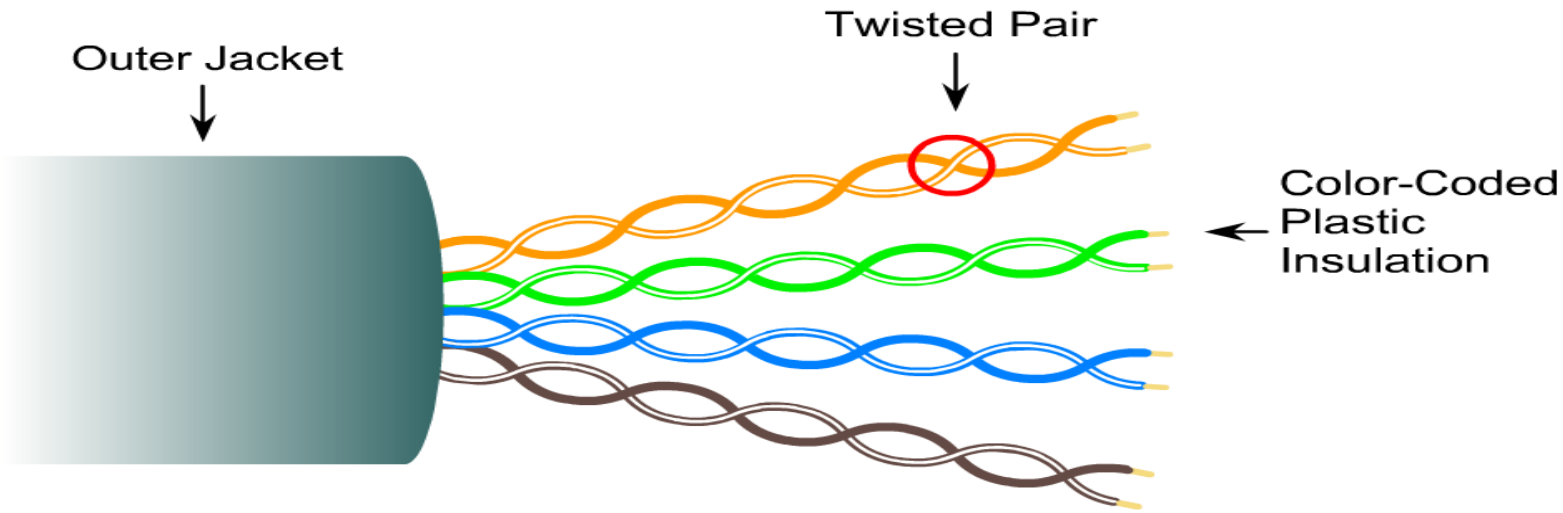


SHIELDED TWISTED PAIR (STP)



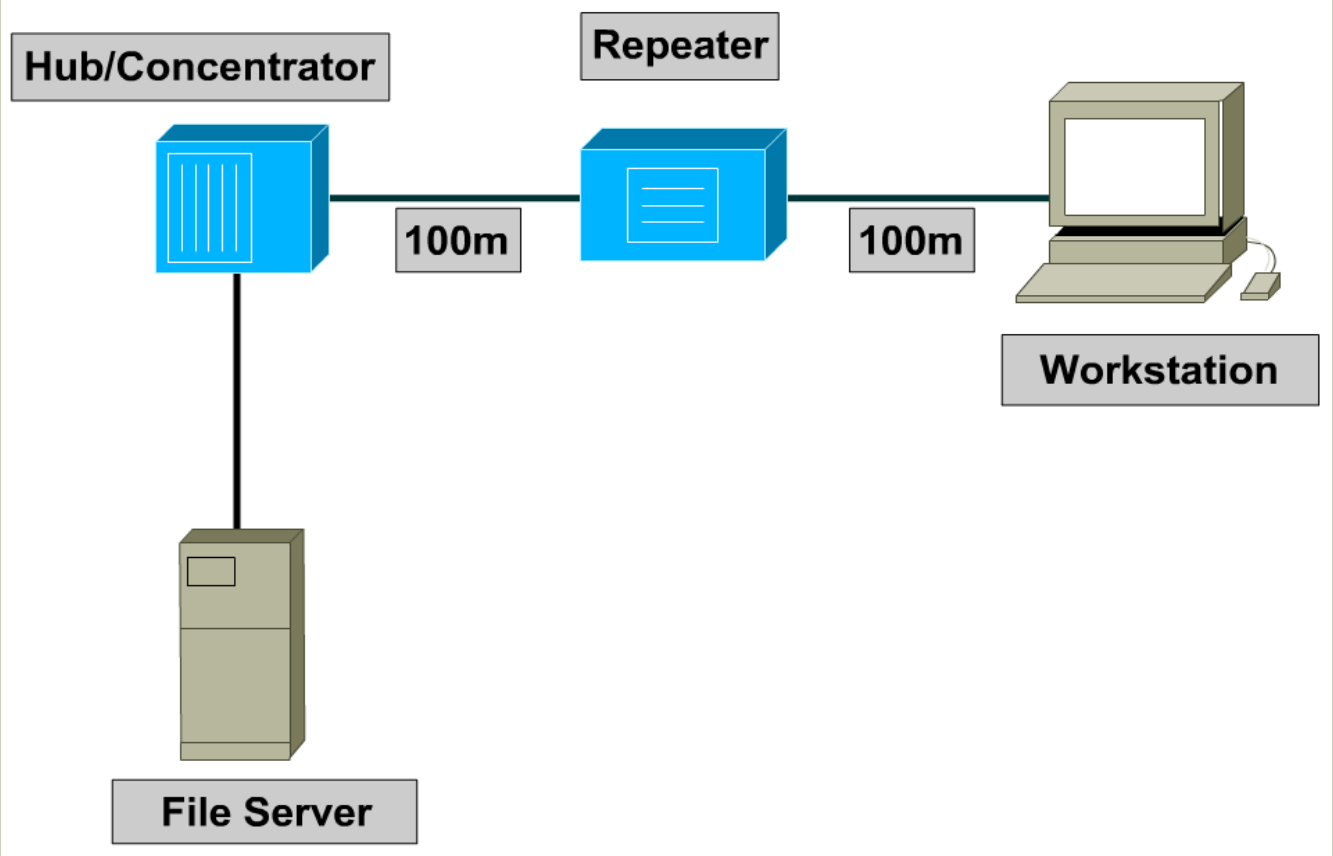
- Speed and throughput: 0 - 100 Mbps
- Cost: Moderate
- Media and connector size: Medium to Large
- Maximum cable length: 100m

UNSHIELDED TWISTED PAIR (UTP)

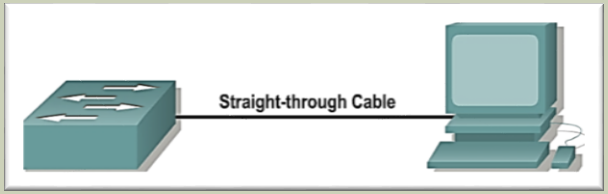


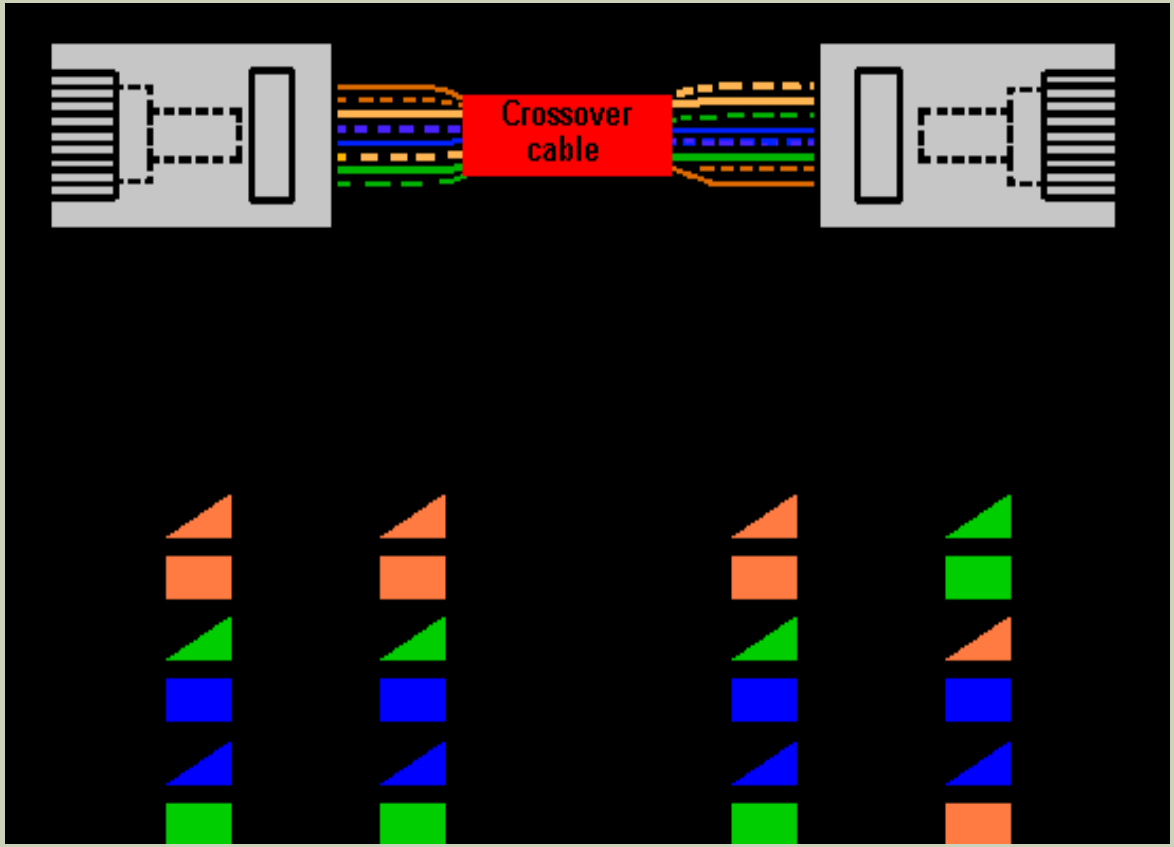
- Speed and throughput: 10 - 100 - 1000 Mbps (depending on the quality/category of cable)
- Cost: Least Expensive
- Media and connector size: Small
- Maximum cable length: 100m

UTP CABLING

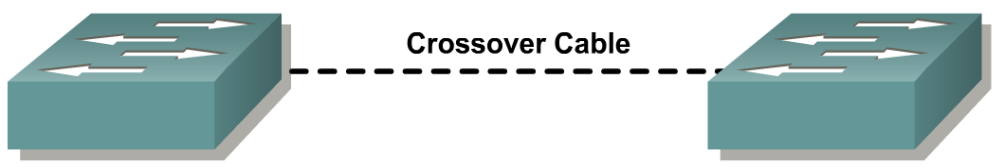

Hub/Concentrator
Repeater
100m
100m
Workstation
File Server

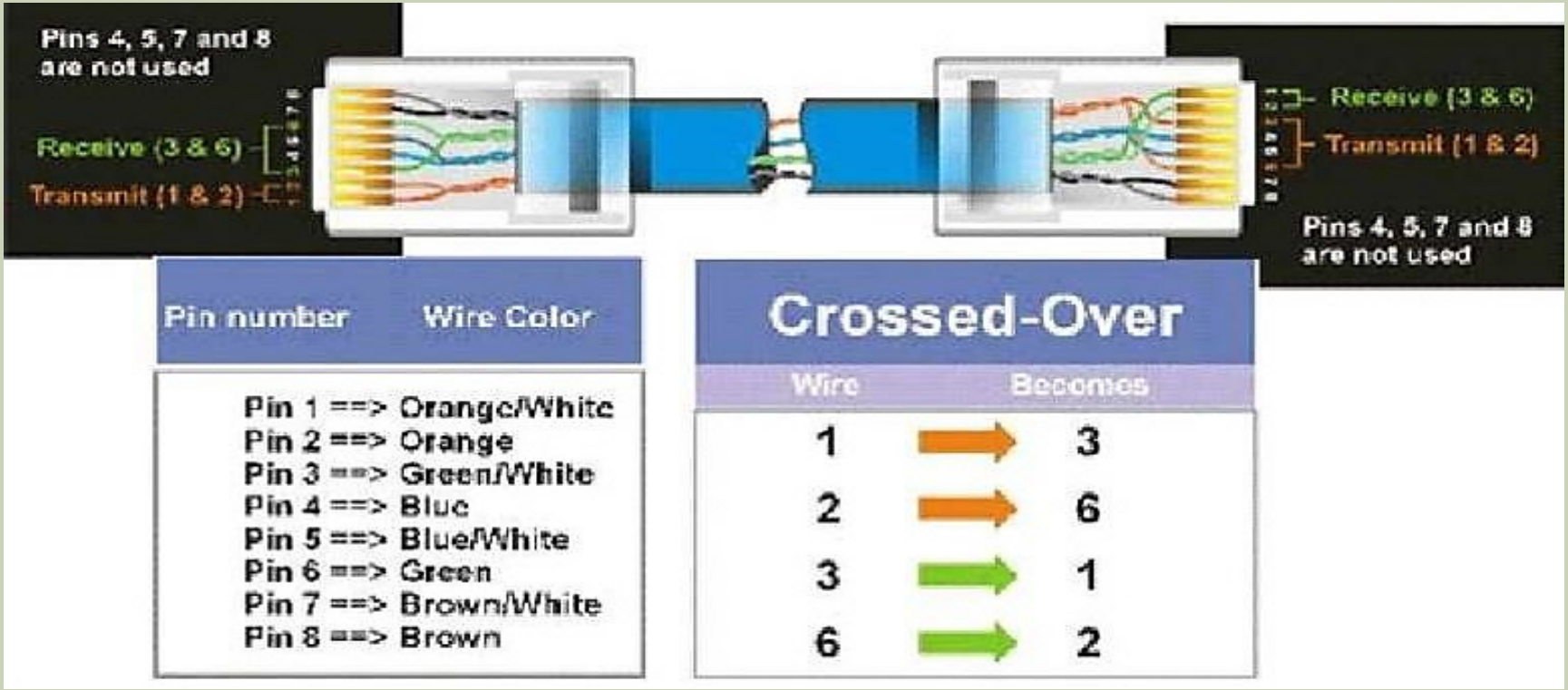
STRAIGHT CABLING



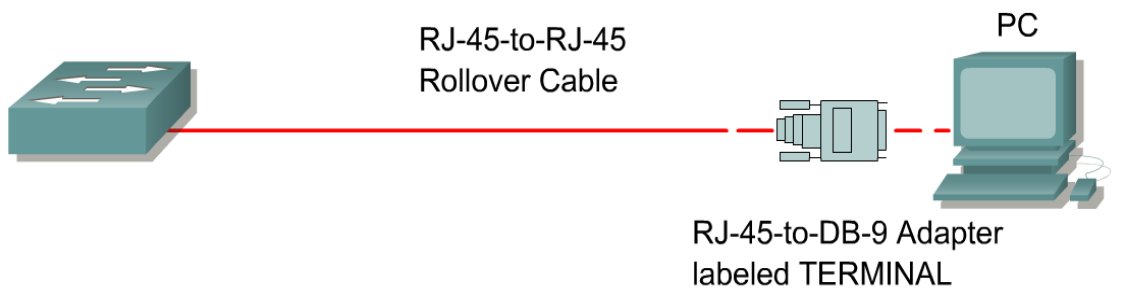


CROSS CABLING

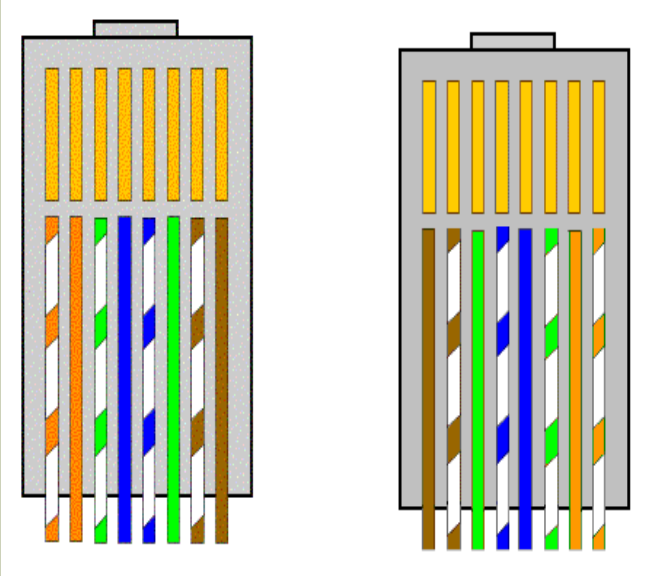




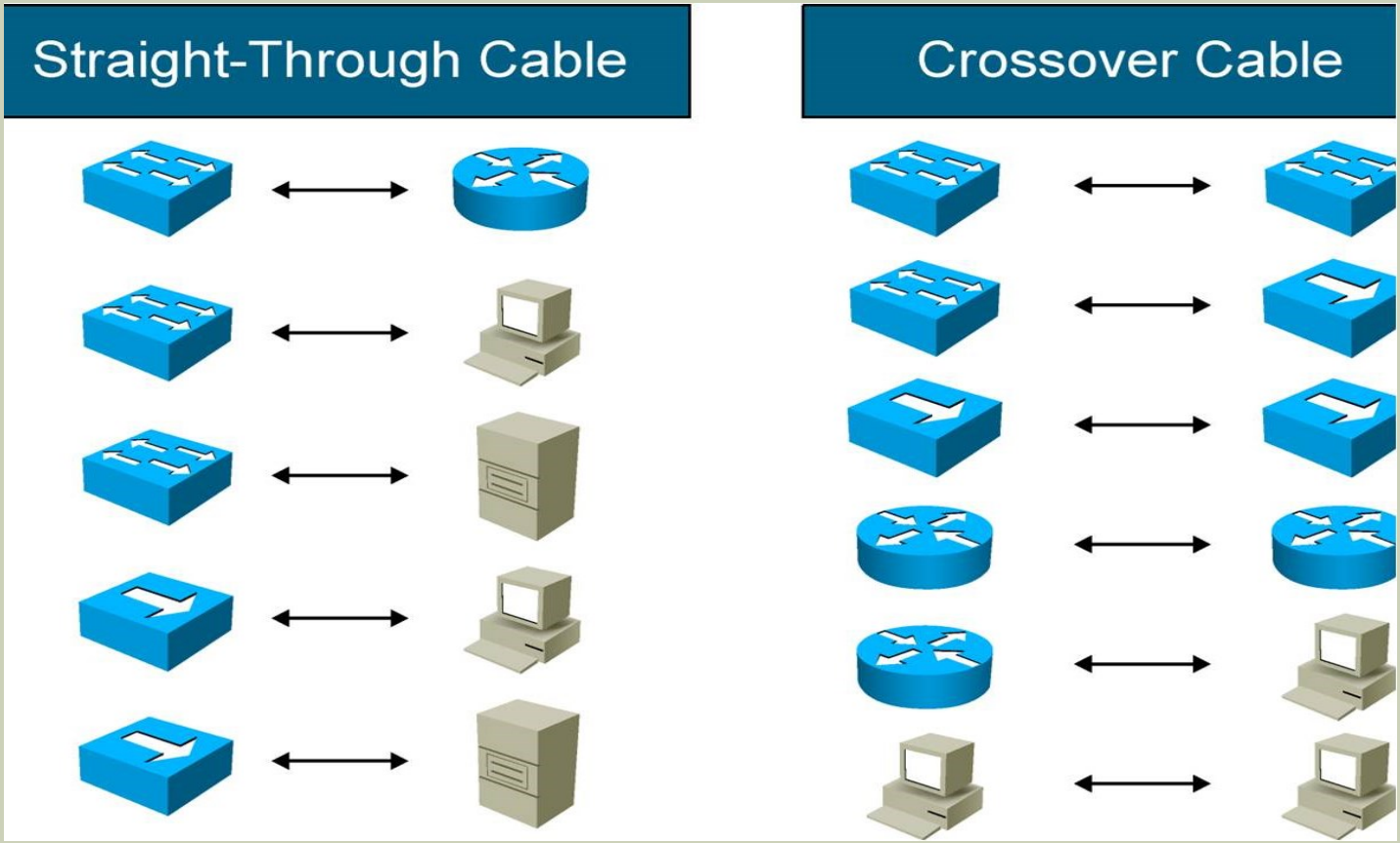
ROLL-OVER CABLING



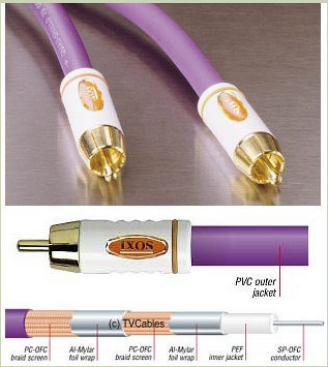
- PCs require an RJ-45 to DB-9 or RJ-45 to DB-25 adapter.
- COM port settings are 9600 bps, 8 data bits, no parity, 1 stop bit, no flow control.
- This provides out-of-band console access.
- AUX switch port may be used for a modem-connected console.

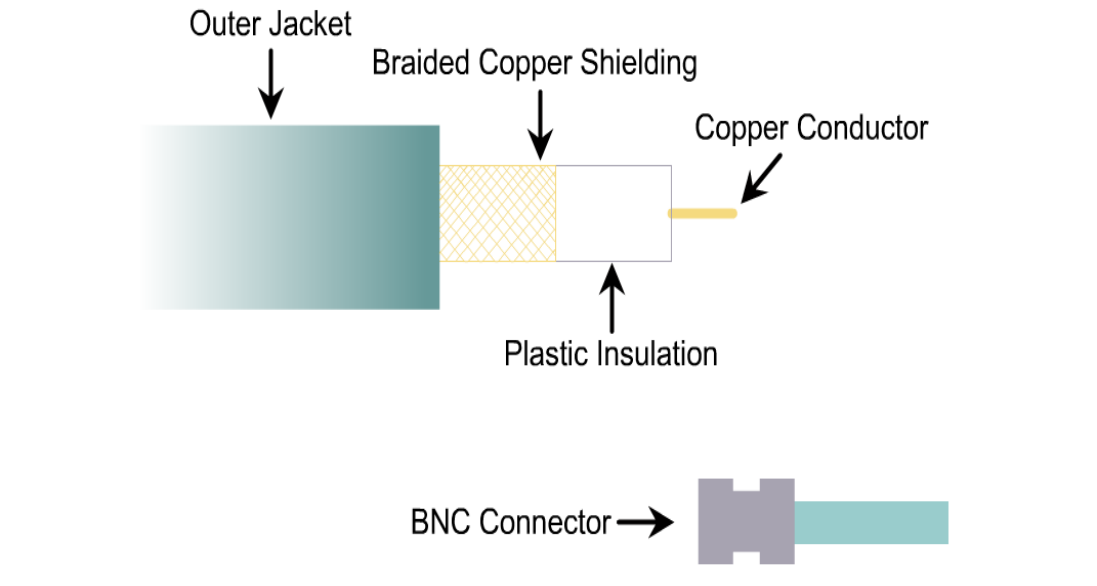


PENGGUNAAN KABEL UTP



COAXIAL CABLE

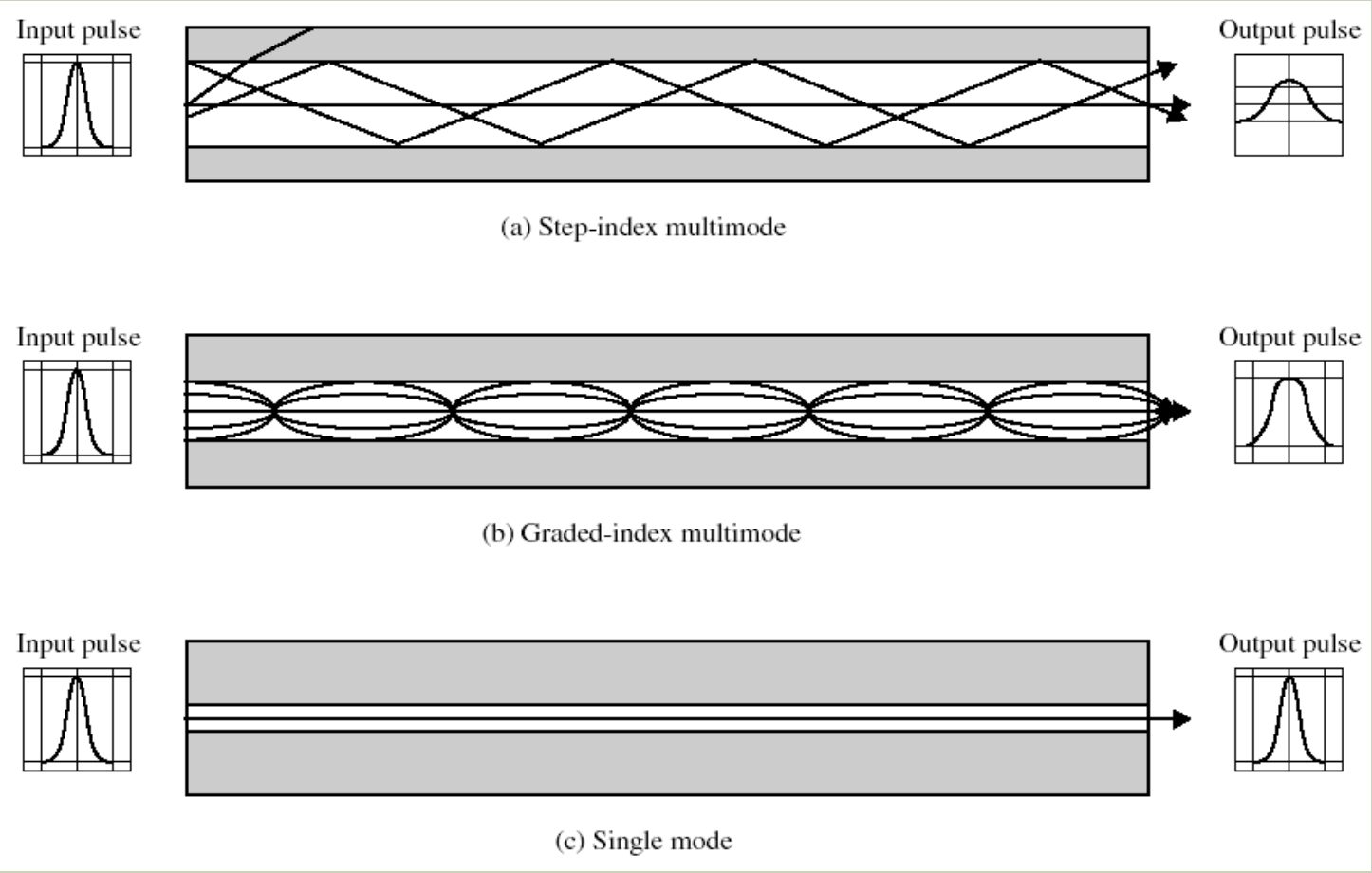




- Speed and throughput: 10 - 100 Mbps
- Cost: Inexpensive
- Media and connector size: Medium
- Maximum cable length: 500m

FIBER OPTIC

MODE TRANSMISI

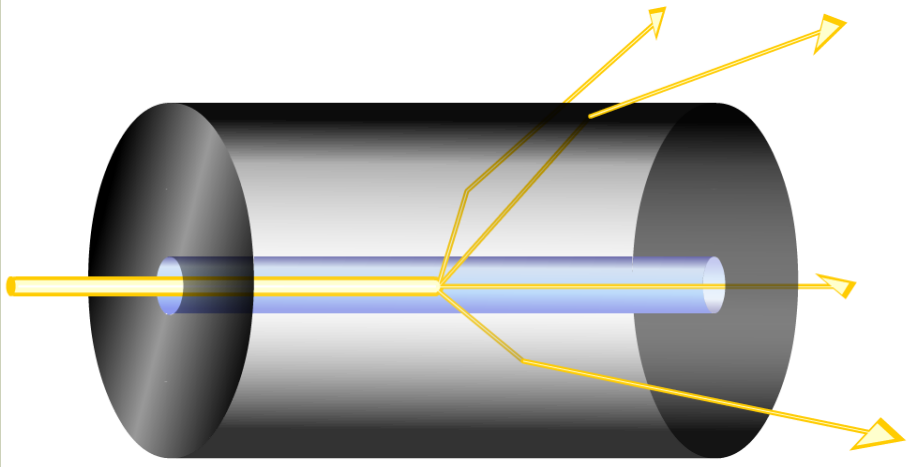


FIBER OPTIC

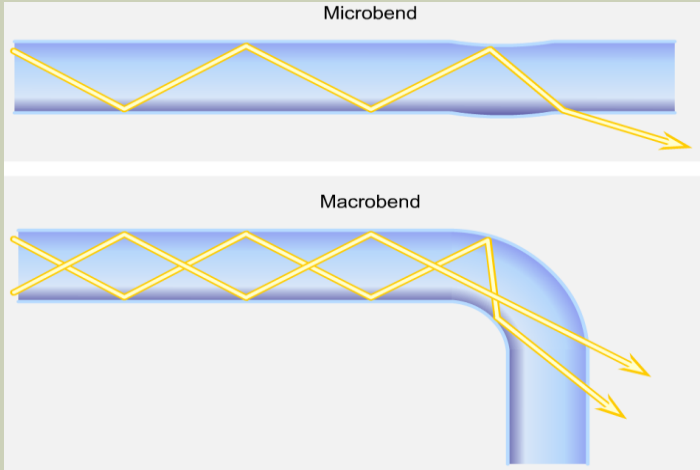
- Beberapa hal yang dapat menurunkan kualitas Optik :
  1. Scattering
  2. Bending
  3. Splicing

FIBER OPTIC

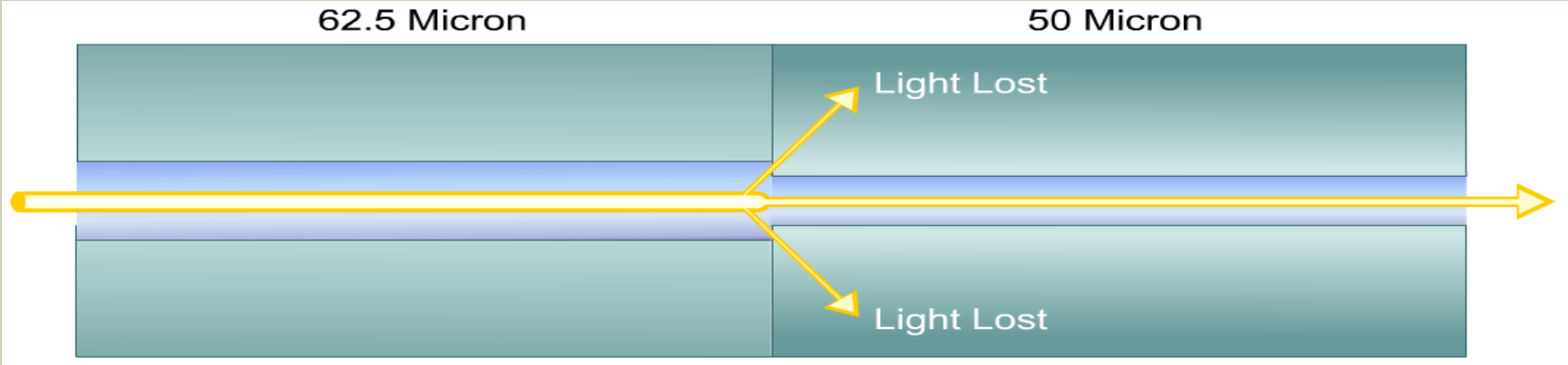
1. SCATTERING



2. BENDING



3. SPLICING



WIRELESS

- **Transmisi Wireless :**
  1. Pengiriman dan penerimaan sinyal dilakukan dengan antena
  2. Frekuensi
     - ✓ Gelombang mikro: 2 - 40 GHz
     - ✓ Radio broadcast: 30 MHz - 1 GHz
     - ✓ Infra merah: 3.10^{11} – 2.10^{14} Hz

WIRELESS

Band	Frequency Range	Free-Space Wavelength Range	Propagation Characteristics	Typical Use
ELF (extremely low frequency)	30 to 300 Hz	10,000 to 1000 km	GW	Power line frequencies; used by some home control systems.
VF (voice frequency)	300 to 3000 Hz	1000 to 100 km	GW	Used by the telephone system for analog subscriber lines.
VLF (very low frequency)	3 to 30 kHz	100 to 10 km	GW; low attenuation day and night; high atmospheric noise level	Long-range navigation; submarine communication
LF (low frequency)	30 to 300 kHz	10 to 1 km	GW; slightly less reliable than VLF; absorption in daytime	Long-range navigation; marine communication radio beacons
MF (medium frequency)	300 to 3000 kHz	1,000 to 100 m	GW and night SW; attenuation low at night, high in day; atmospheric noise	Maritime radio; direction finding; AM broadcasting.
HF (high frequency)	3 to 30 MHz	100 to 10 m	SW; quality varies with time of day, season, and frequency.	Amateur radio; international broadcasting, military communication; long-distance aircraft and ship communication
VHF (very high frequency)	30 to 300 MHz	10 to 1 m	LOS; scattering because of temperature inversion; cosmic noise	VHF television; FM broadcast and two-way radio, AM aircraft communication; aircraft navigational aids
UHF (ultra high frequency)	300 to 3000 MHz	100 to 10 cm	LOS; cosmic noise	UHF television; cellular telephone; radar; microwave links; personal communications systems
SHF (super high frequency)	3 to 30 GHz	10 to 1 cm	LOS; rainfall attenuation above 10 GHz; atmospheric attenuation due to oxygen and water vapor	Satellite communication; radar; terrestrial microwave links; wireless local loop
EHF (extremely high frequency)	30 to 300 GHz	10 to 1 mm	LOS; atmospheric attenuation due to oxygen and water vapor	Experimental; wireless local loop
Infrared	300 GHz to 400 THz	1 mm to 770 nm	LOS	Infrared LANs; consumer electronic applications
Visible light	400 THz to 900 THz	770 nm to 330 nm	LOS	Optical communication

PERANGKAT LAN

1. Repeater
2. Hub
3. Switch
4. Bridge
5. Router

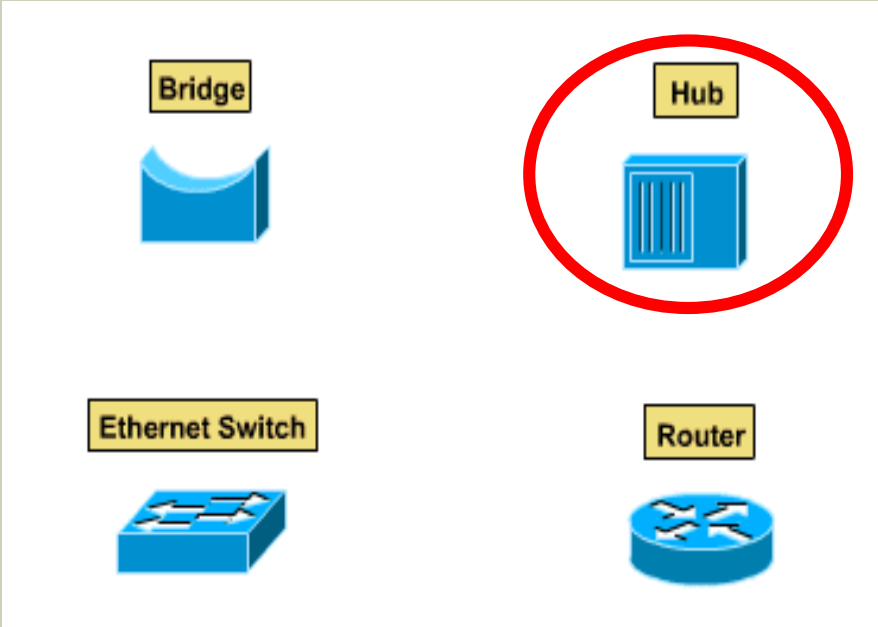
REPEATER

- Fungsi utama *repeater* : menerima sinyal dari satu segmen kabel LAN dan memancarkannya kembali dengan kekuatan yang sama dengan sinyal asli pada segmen (satu atau lebih) kabel LAN yang lain.
- Repeater beroperasi pada *Physical layer* dalam model jaringan OSI.

HUB

Hub melakukan fungsi :

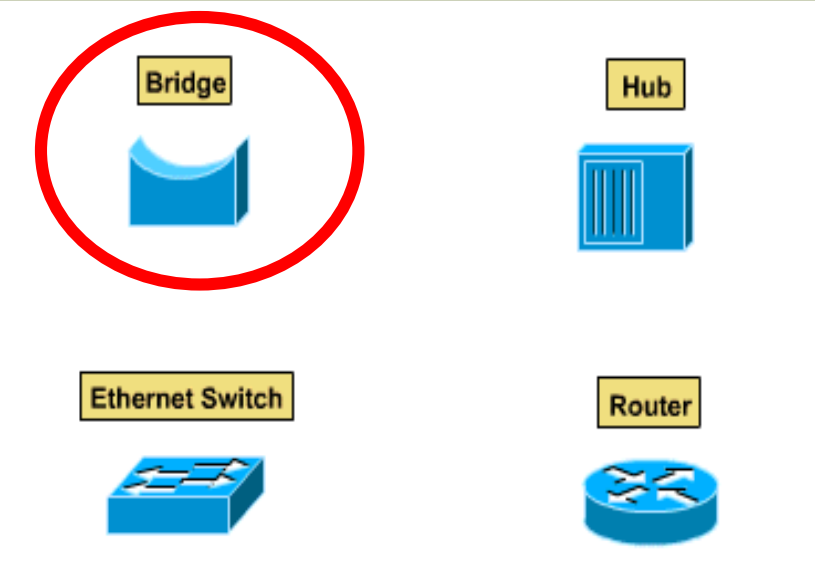
1. Sebagai konsentrator
2. Pada aktif hub dapat menjadi multiport repeater
3. Bekerja pada layer 1 model OSI (melihat sinyal pada level bit)



BRIDGE

Kemampuan Bridge antara lain:

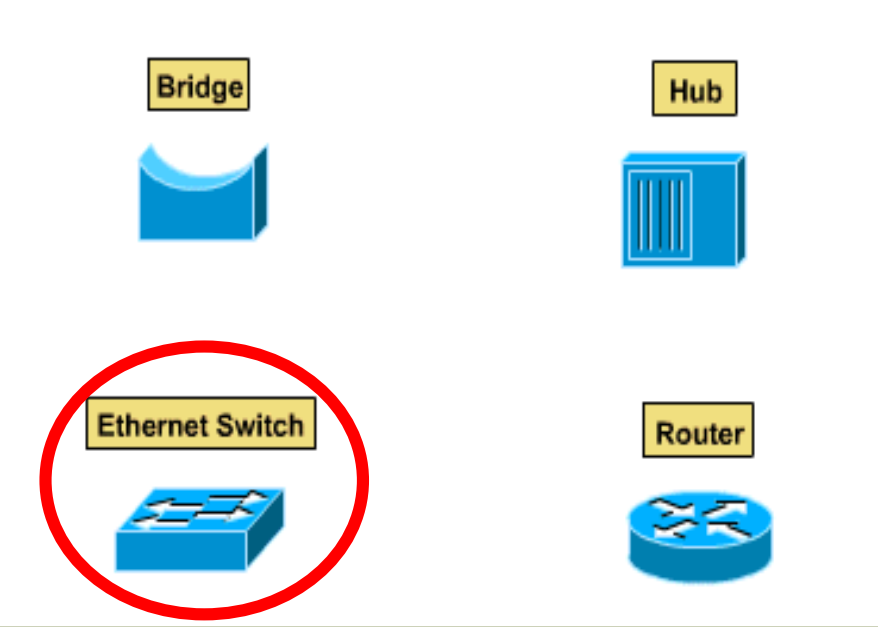
1. Semua kemampuan repeater terdapat pada Bridge.
2. Menghubungkan dua segmen dan regenerate signal pada level paket
3. Berfungsi pada Data Link Layer (melihat sinyal melalui MAC Addressnya)
4. Menghubungkan media fisik berbeda seperti twisted pair dengan coaxial ethernet.
5. Menghubungkan antar segmen jaringan berbeda seperti ethernet dan token ring.



SWITCH

Fungsi Switch :

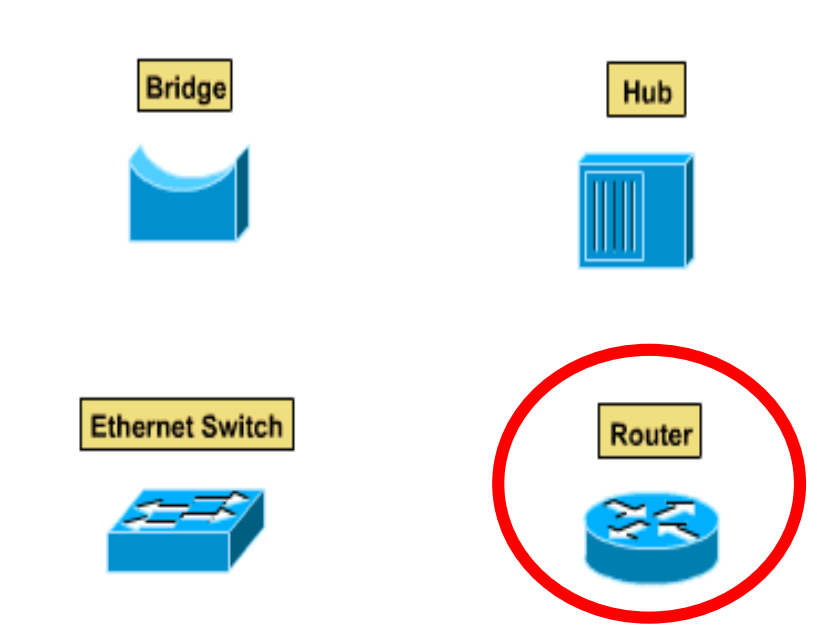
1. Sebagai konsentrator
2. Sebagai multiport bridge
3. Bekerja pada layer 2 OSI (melihat sinyal melalui MAC Address)



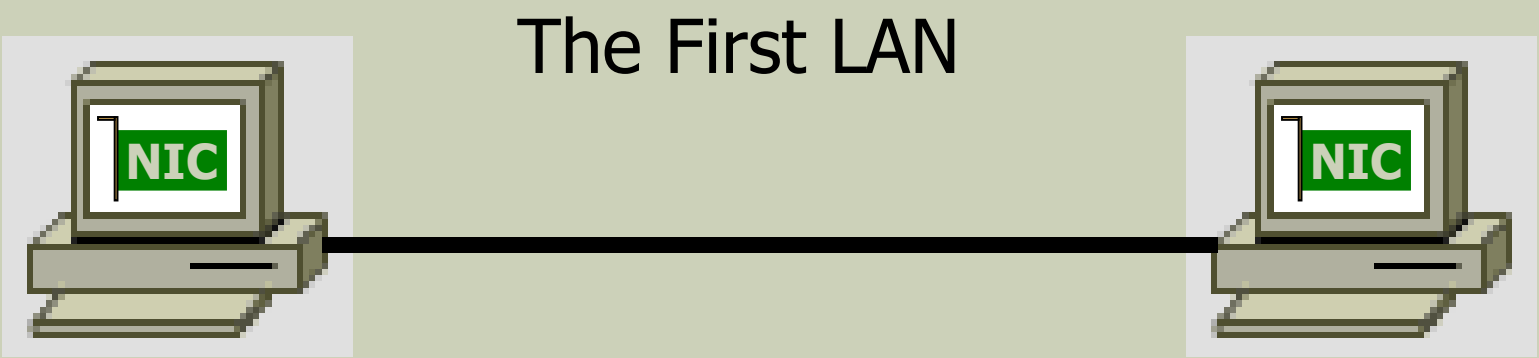
ROUTER

Kemampuan router antara lain :

1. Membagi segmen jaringan yang besar menjadi segmen yang kecil-kecil.
2. Memfilter dan mengisolasi trafik.
3. Menghubungkan segman jaringan yang berbeda topologi dan metode akses.
4. Dapat melalukan routing paket dengan shorthest path, dari banyak pilihan jalur.



NIC, REPEATER, & HUB



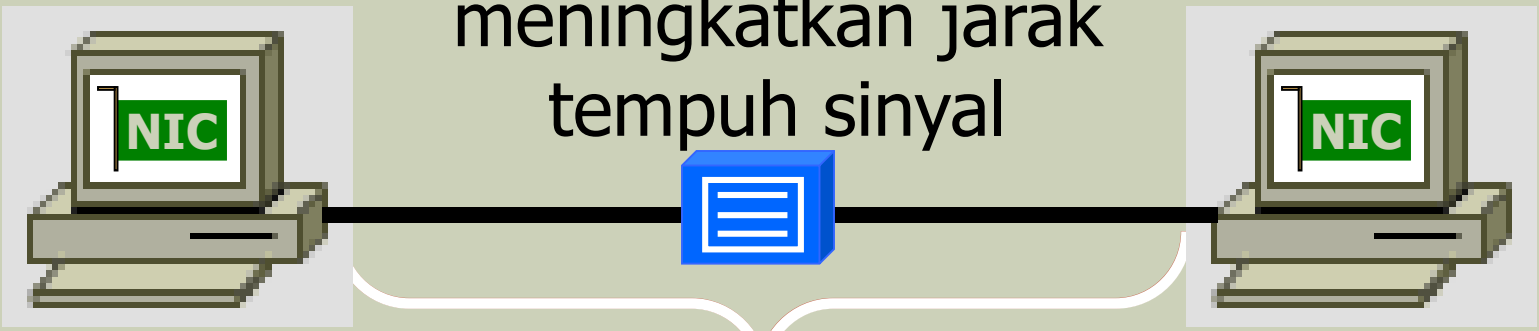
Untuk menghubungkan dua komputer, harus

- Install sebuah NIC pada setiap komputer.

- Hubungkan komputer dengan kabel crossover (Tx pengirim → Rx penerima)

NICS, REPEATERS, & HUBS

Repeaters dapat digunakan untuk meningkatkan jarak tempuh sinyal



Jadi apa yang digunakan untuk

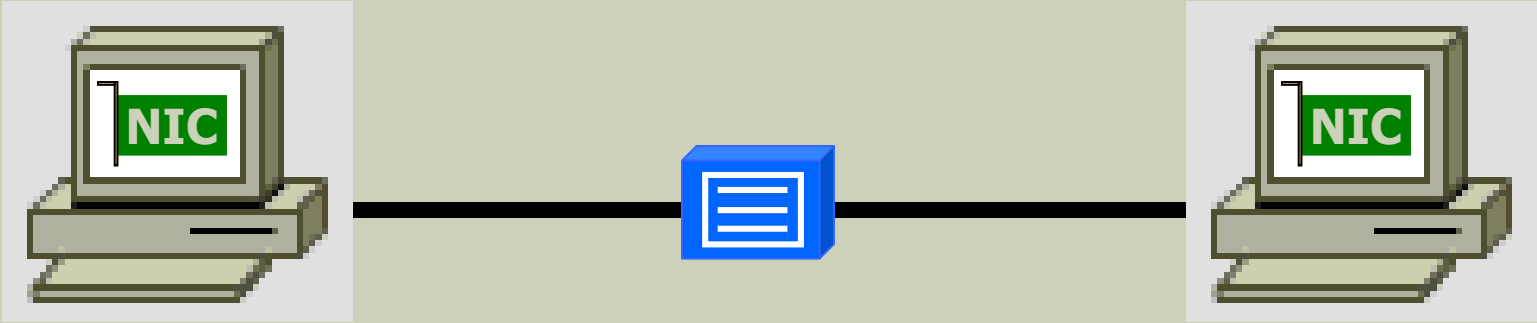
Repeaters menerima sinyal kembali

Berapa jarak maksimum ?

100 meters atau 300 feet

100 meters atau 300 feet

NICS, REPEATERS, & HUBS



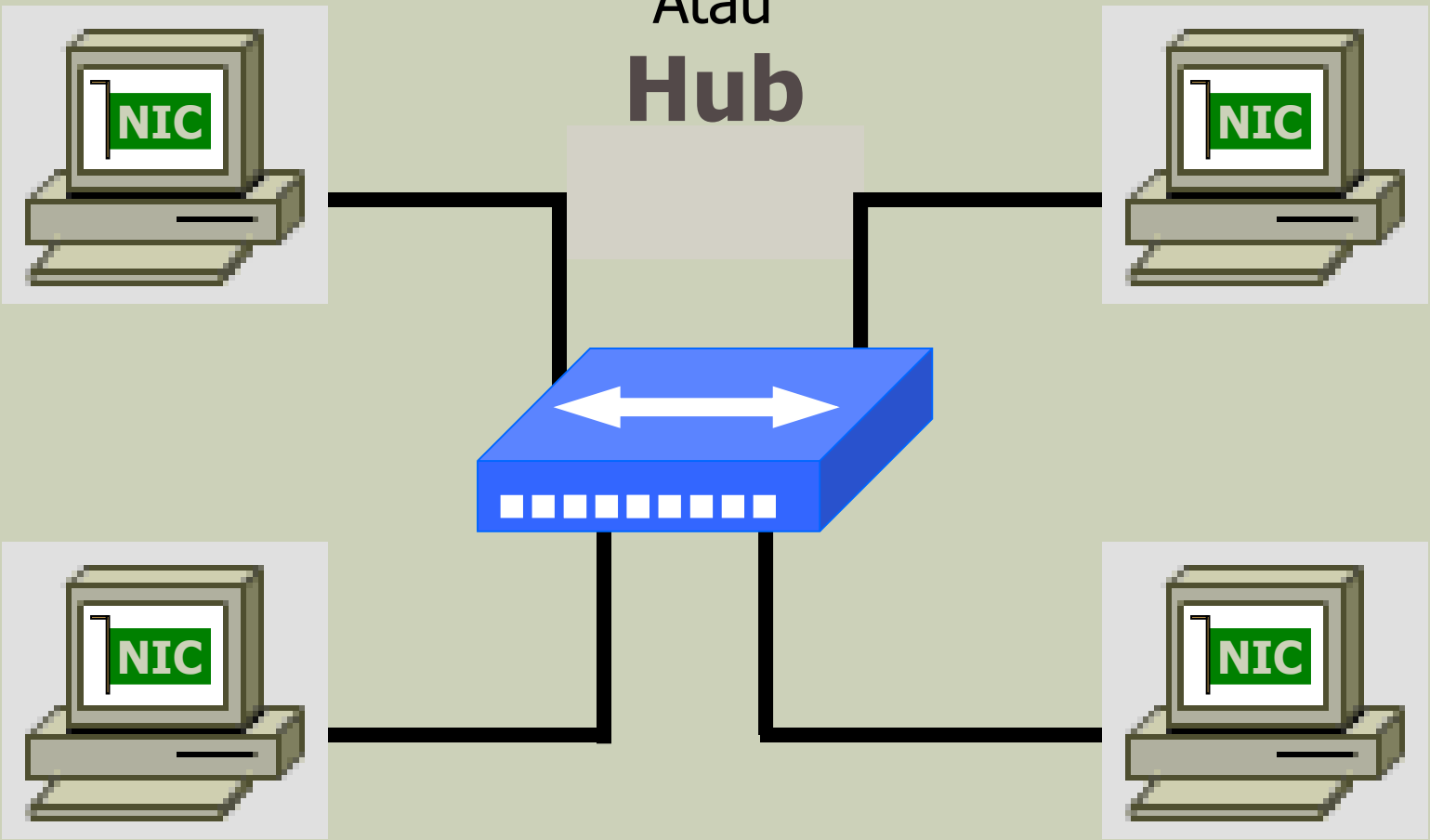
Penggunaan repeater hanya terbatas untuk 2 komputer

Bagaimana jika ingin menghubungkan 3 atau lebih komputer dalam jaringan ?

Perangkat apa yang dibutuhkan ?

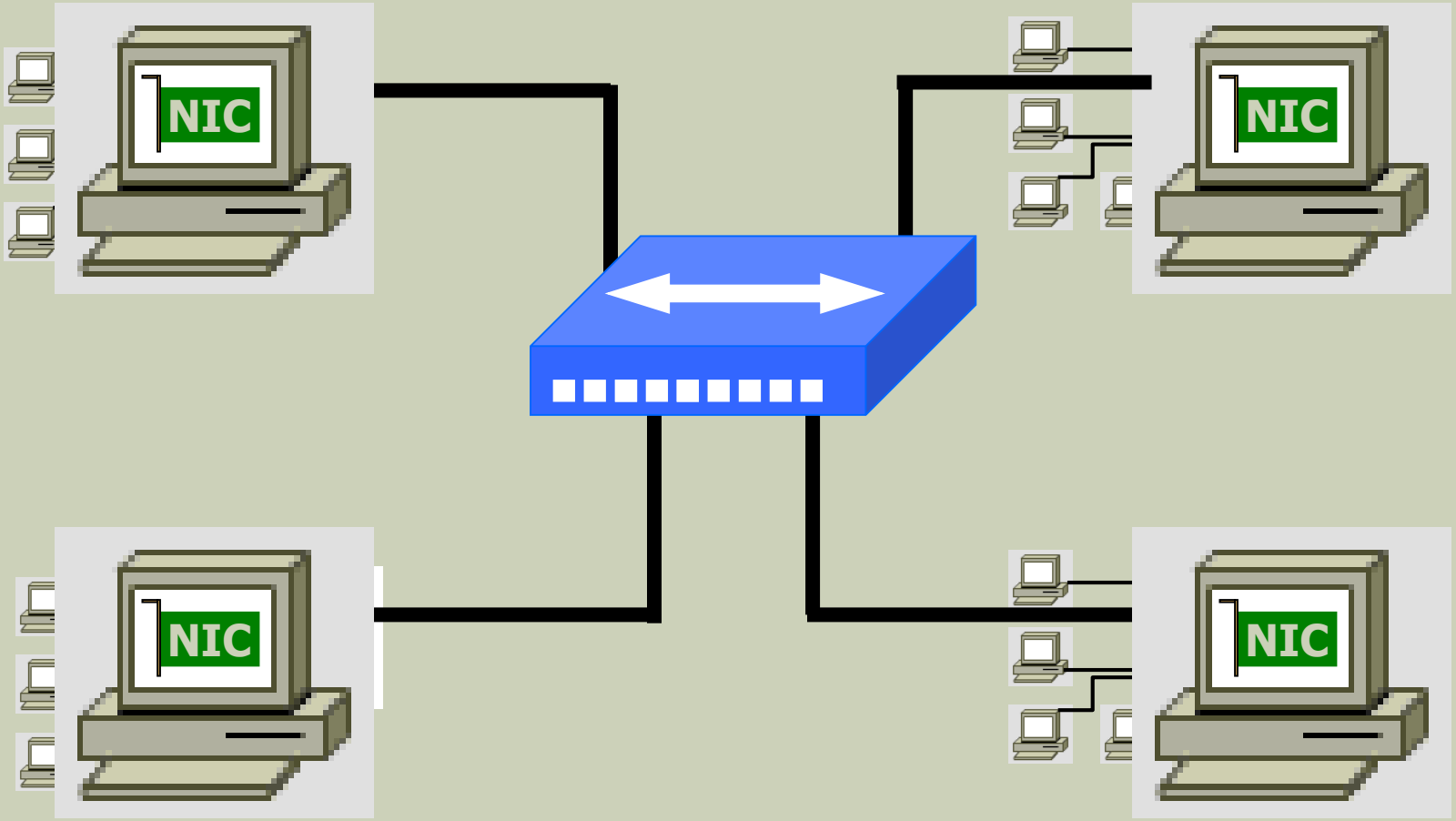
NICS, REPEATERS, & HUBS

A multi-port repeater!
Atau
Hub



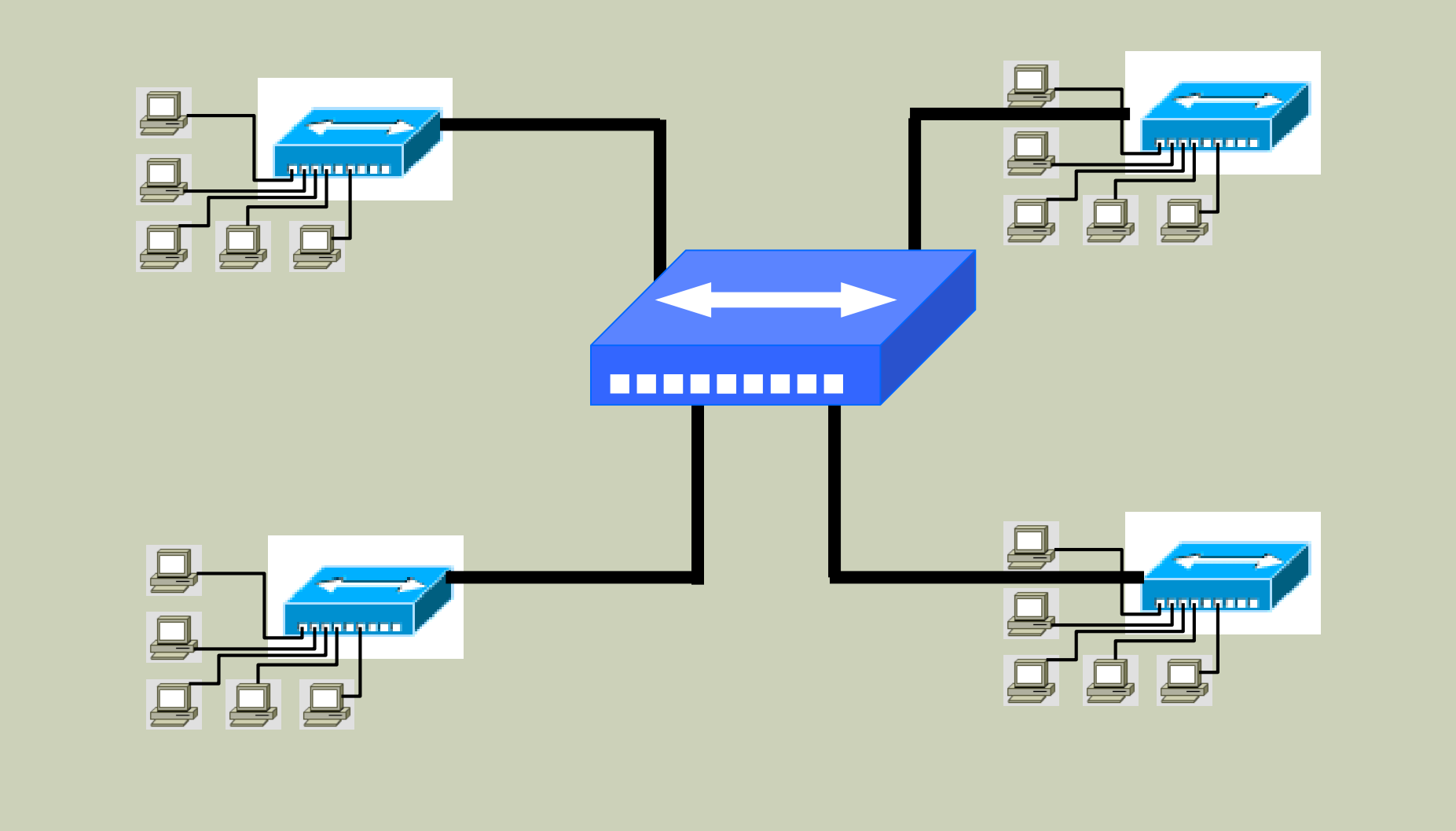
PROBLEM

Saat jaringan diperluas, akan terbentuk cascade hubs.



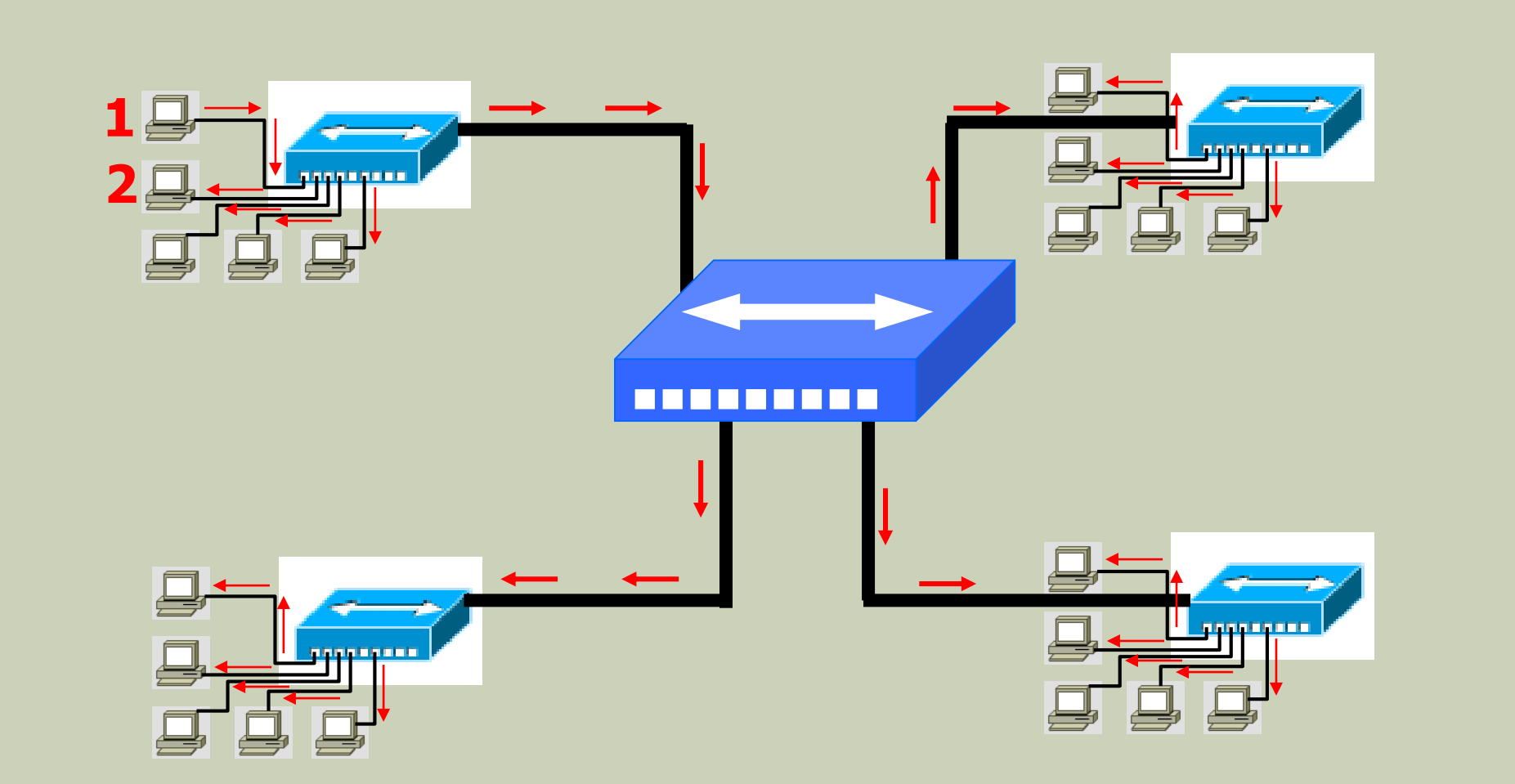
BROADCASTS

Semua hub meneruskan semua traffic ke semua perangkat



BROADCASTS

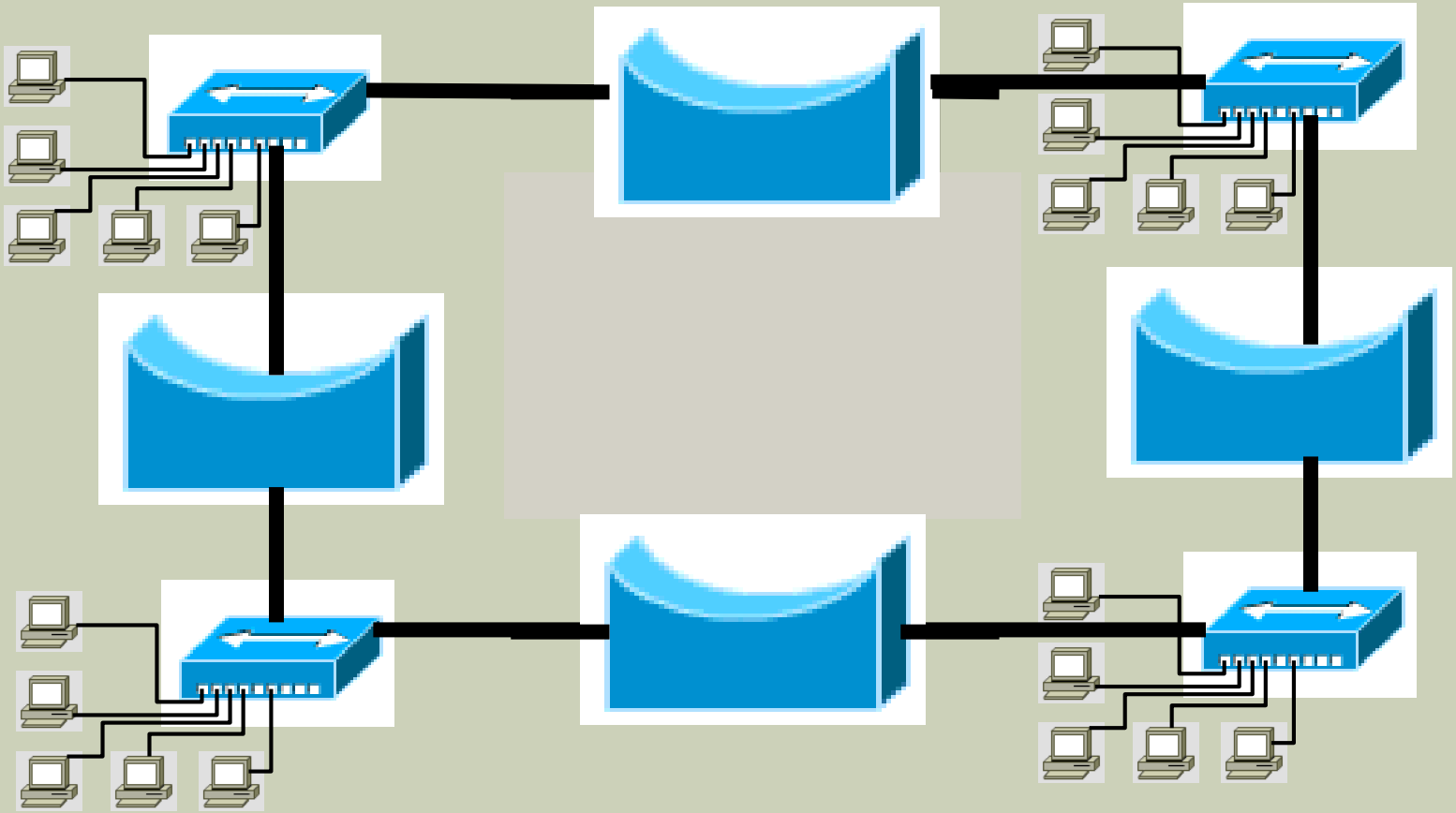
Jadi jika Host 1 ingin melakukan ping Host 2, semua perangkat akan melihat paket ping yang dikirimkan.



Semua host akan menerima paket ping request dari host 1, tapi hanya host 2 yang akan menjawab

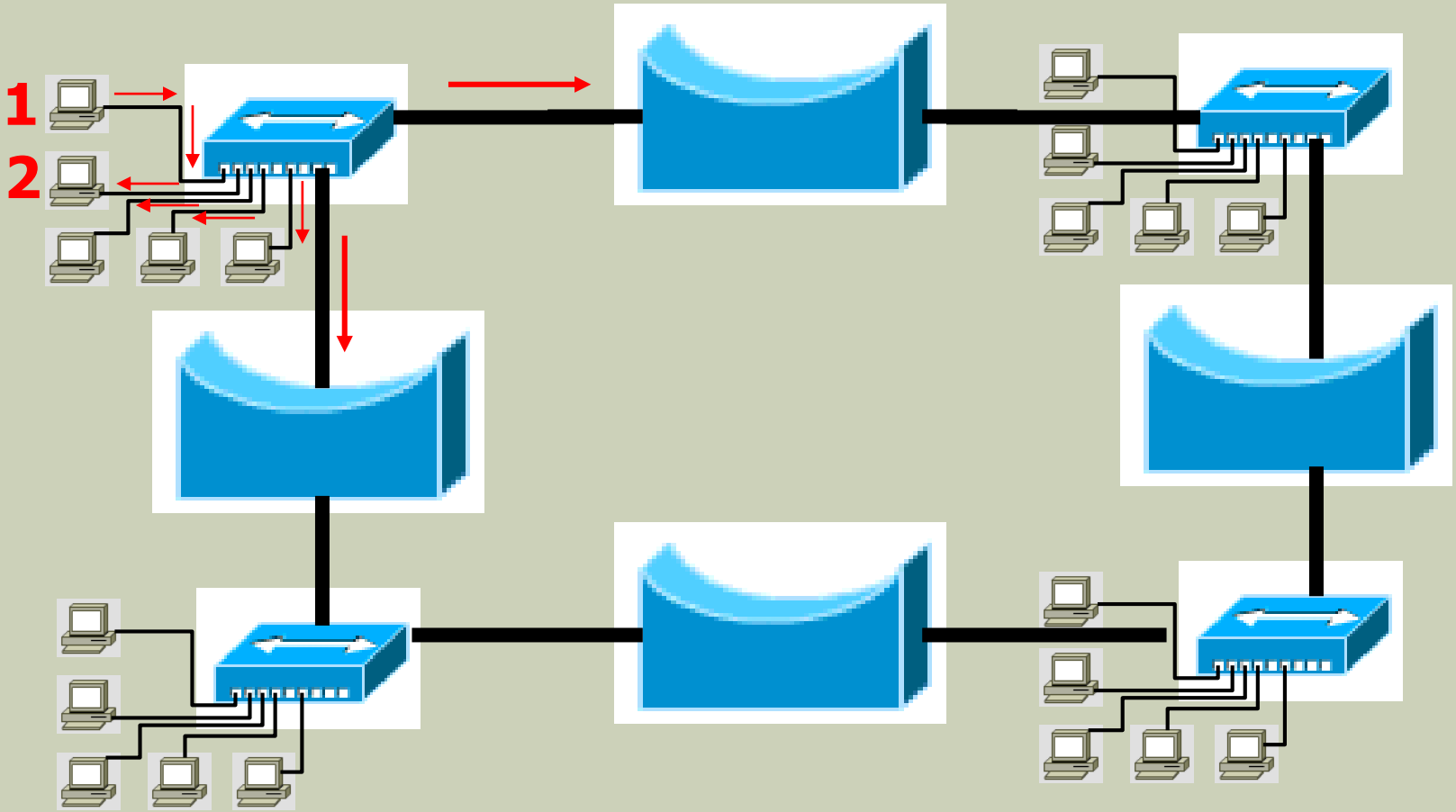
BRIDGE

Untuk mengurangi jumlah traffik, mulai digunakan bridges untuk menyaring paket berdasar alamat MAC



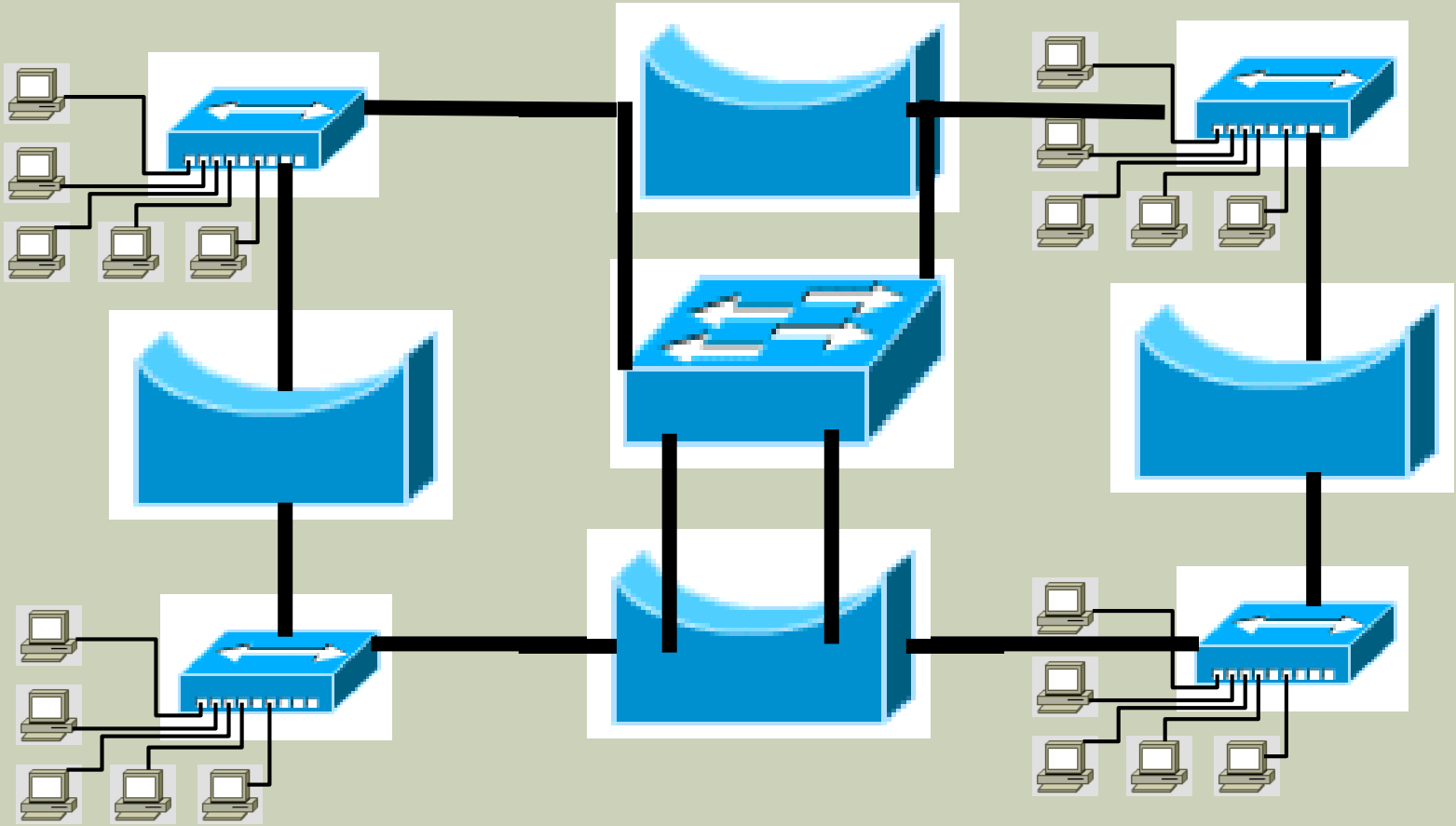
BRIDGE

Sekarang, jika Host 1 melakukan ping ke Host 2, maka hanya semua host dalam satu LAN segment yang melihat paket ping. *Bridges stop the ping*.



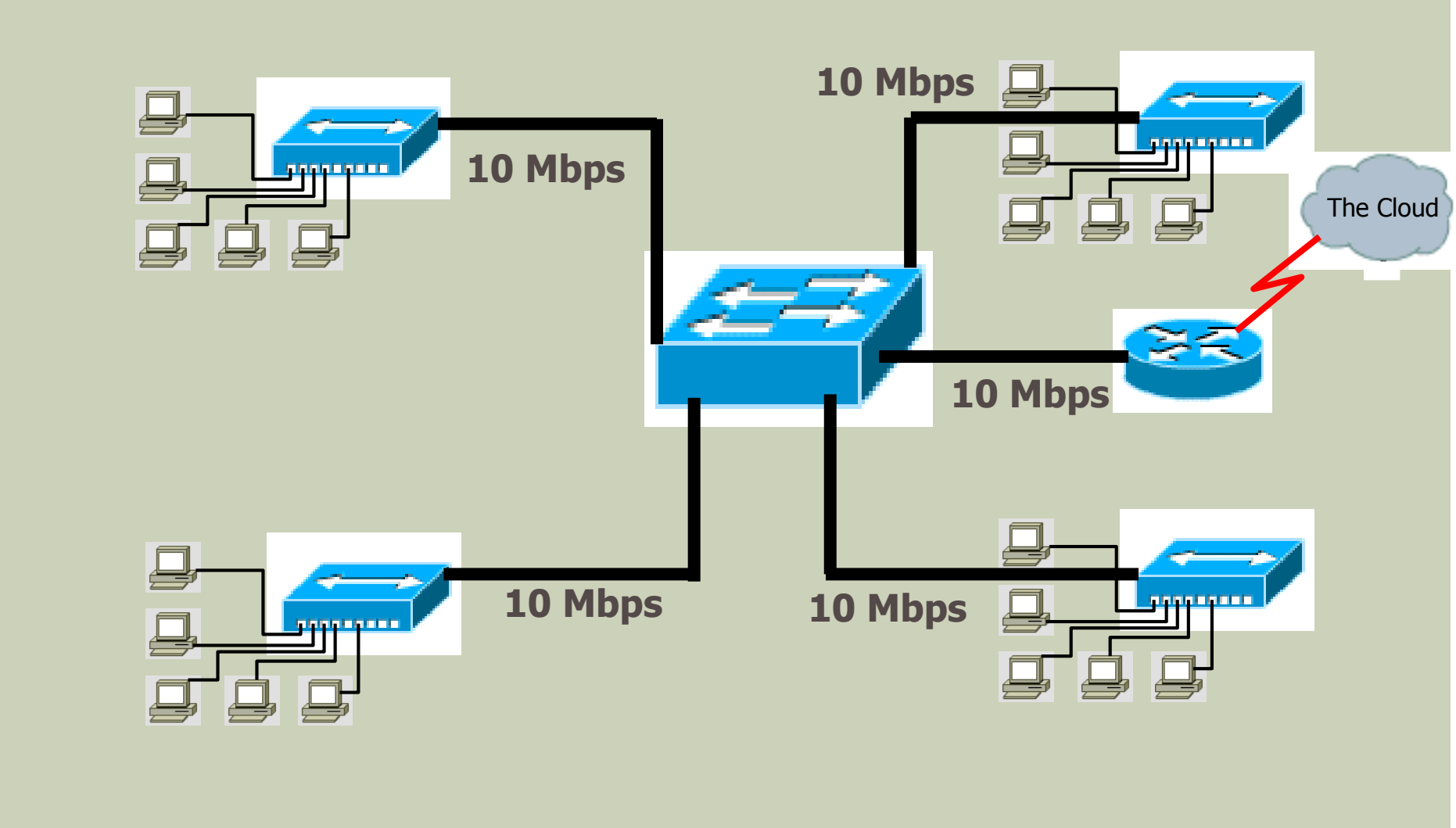
SWITCH

Sebuah switch (multi-port bridge), secara efektif menggantikan keempat bridge yang digunakan.



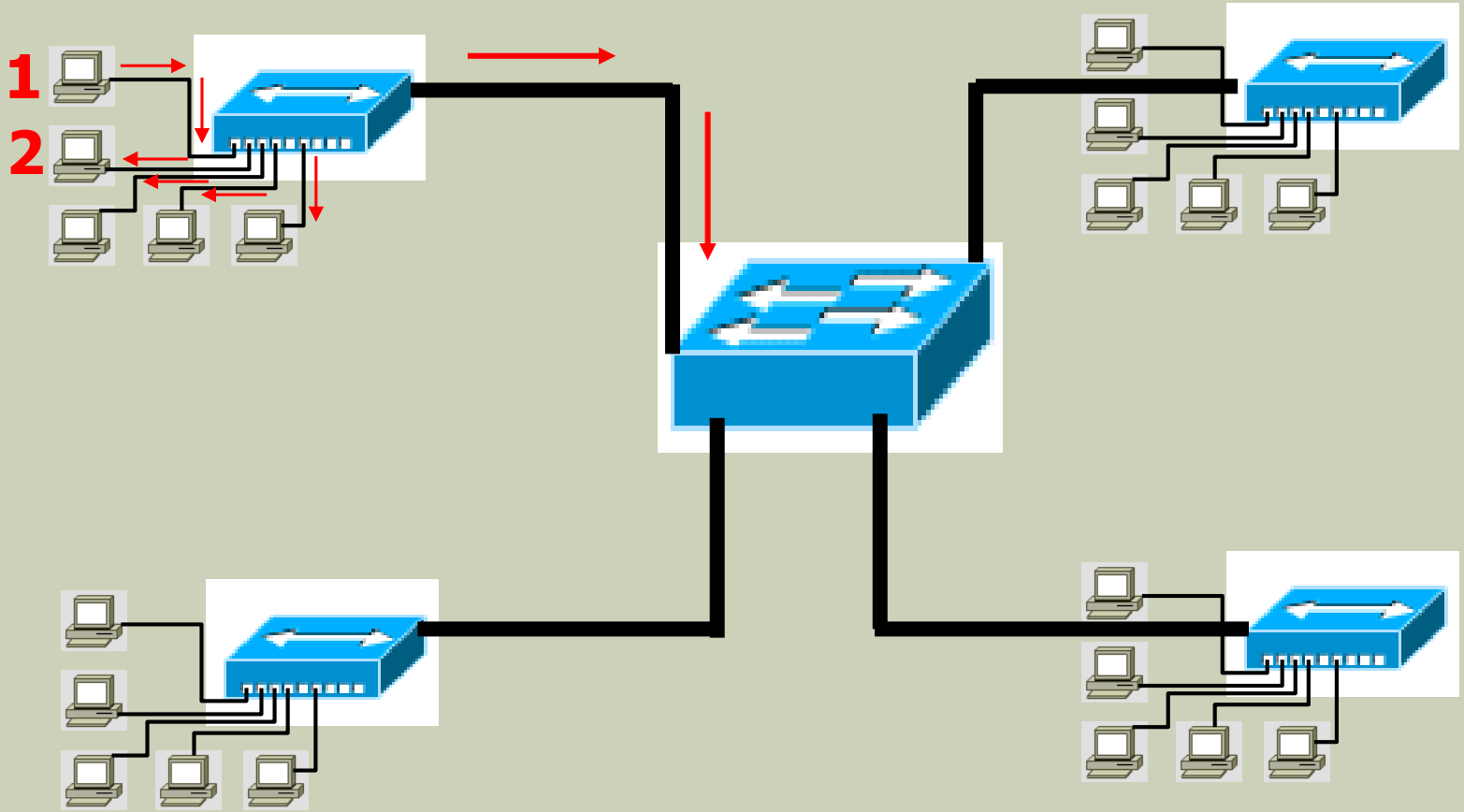
SWITCH

Keungungan lain : setiap LAN segment akan memperoleh dedicated bandwidth.



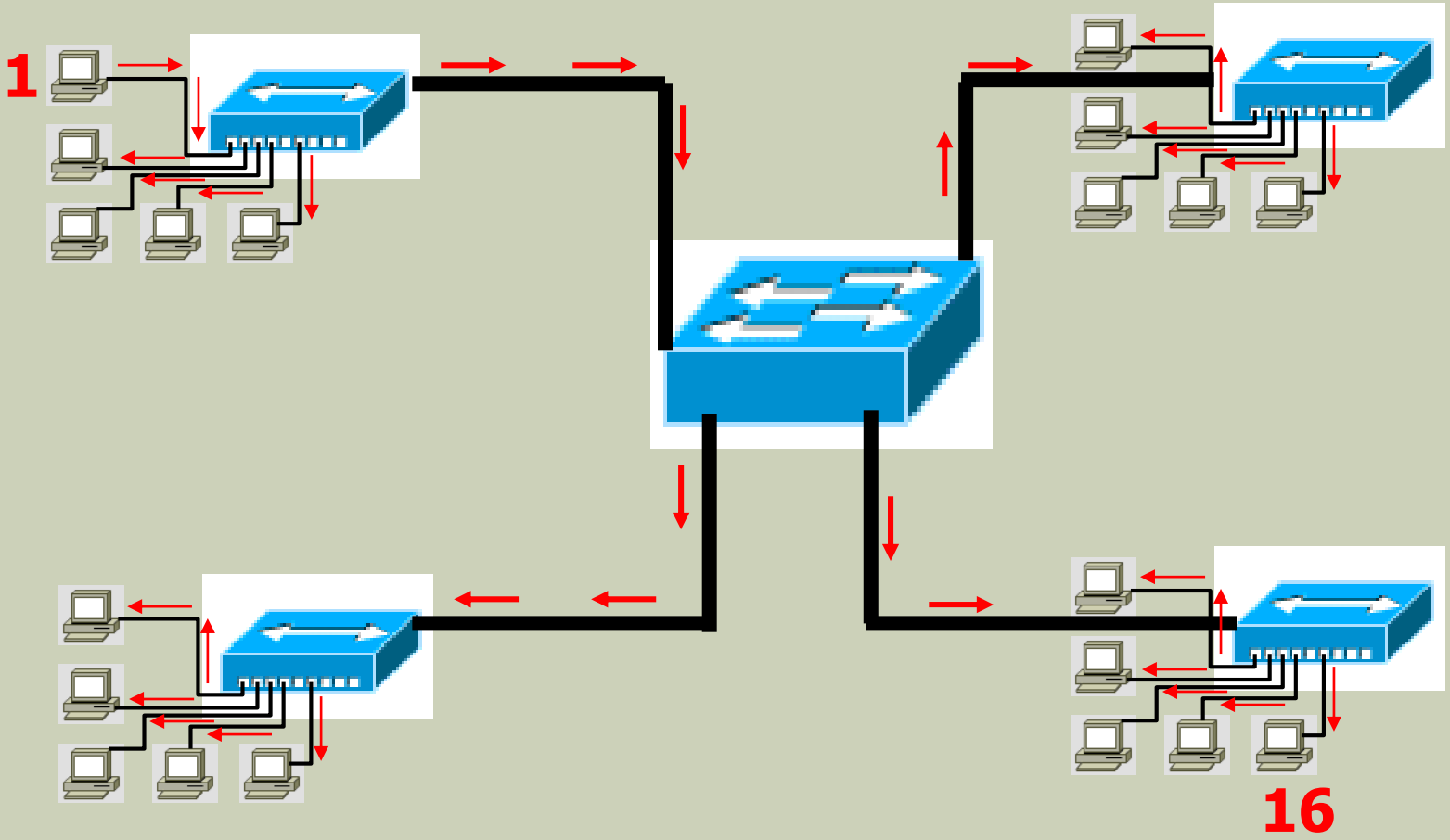
SWITCH

Sebuah switch tidak bisa menghentikan paket ping yang ditujukan pada LAN segment yang berbeda, sehingga ditujukan ke semua port dari switch.



SWITCH

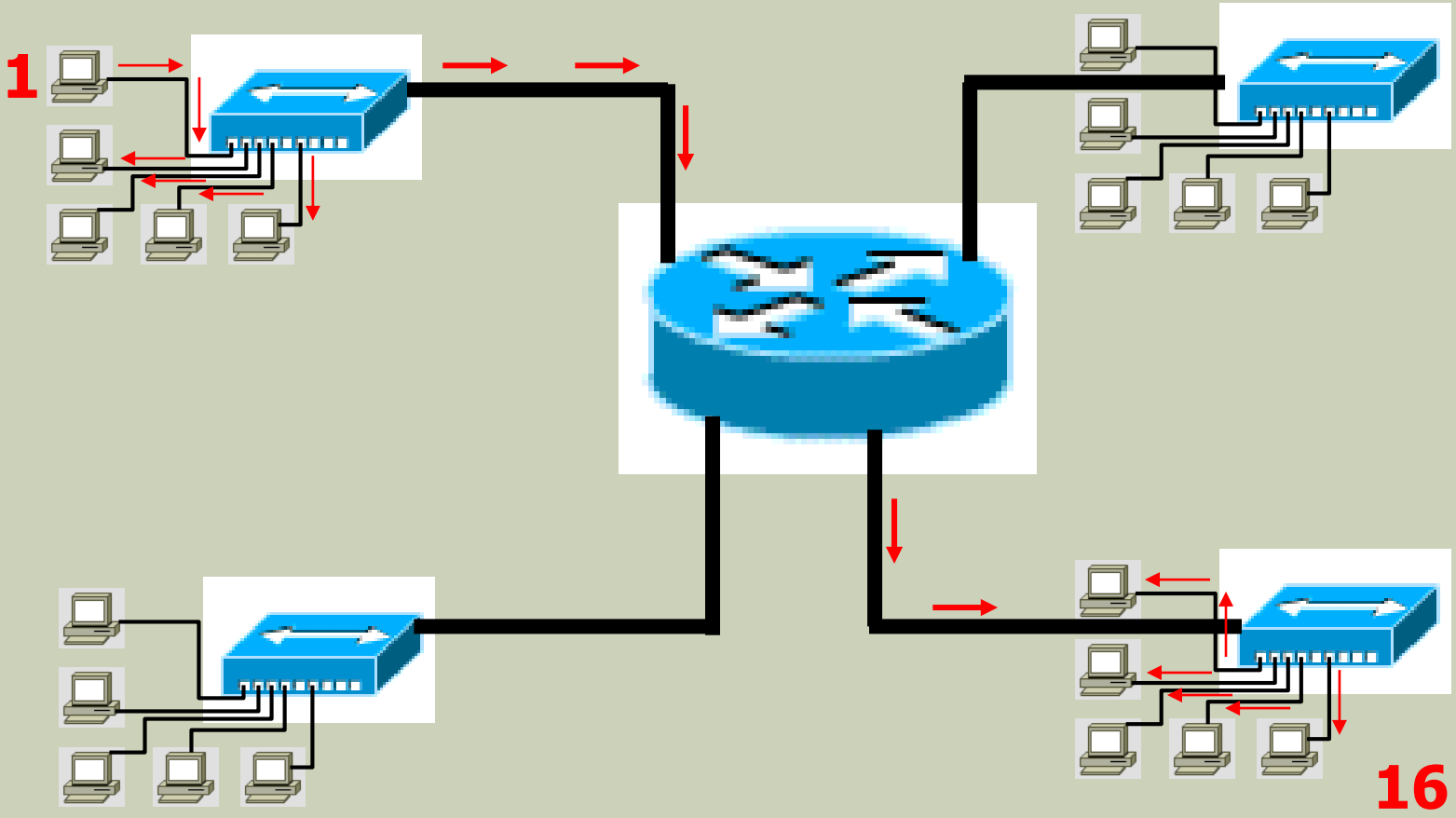
Misalnya Host 1 melakukan Ping ke Host 16. selama Host 16 terhubung dengan segmen LAN yang berbeda, maka Switch akan membanjiri Ping Request ke seluruh port



Perangkat apa yang bisa memperbaikinya?

ROUTER

Routers memnyaring trafik berdasarkan alamat IP, dimana alamat IP akan memberitahu router segment mana yang harus dituju oleh paket ping.



DEVICES FUNCTION AT LAYERS

- Jadi, dapat diambil kesimpulan, bahwa suatu perangkat tidak hanya bekerja pada layer itu sendiri, tapi juga bekerja pada layer yang terletak dibawahnya
- Sebagai contoh : sebuah router adalah perangkat pada layer 3 tetapi juga menggunakan MAC addresses (pada layer 2) dan melakukan repeat signal (pada layer 1)

SELAMAT BELAJAR