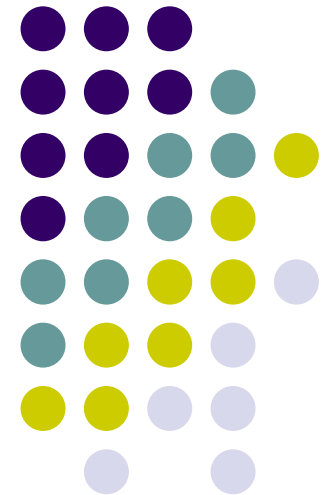


# Lecture 2:

## Basic concepts of computer networks

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# Last lecture

- Introduction of the course
- History of the Internet
- Concept of Computer Networks
- Some fundamental concepts: switching, connection oriented, connection less.

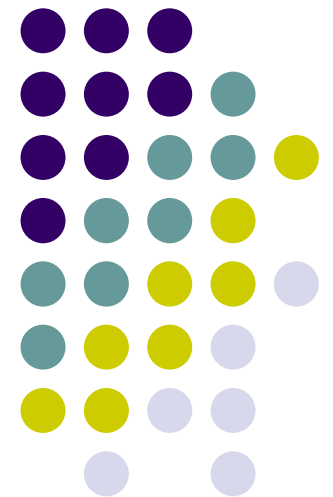


# Content of this lecture

- Layer architecture
- OSI & TCP/IP reference model
- Addressing
- Domain name and conversion/resolution of domain name

# Layer architecture

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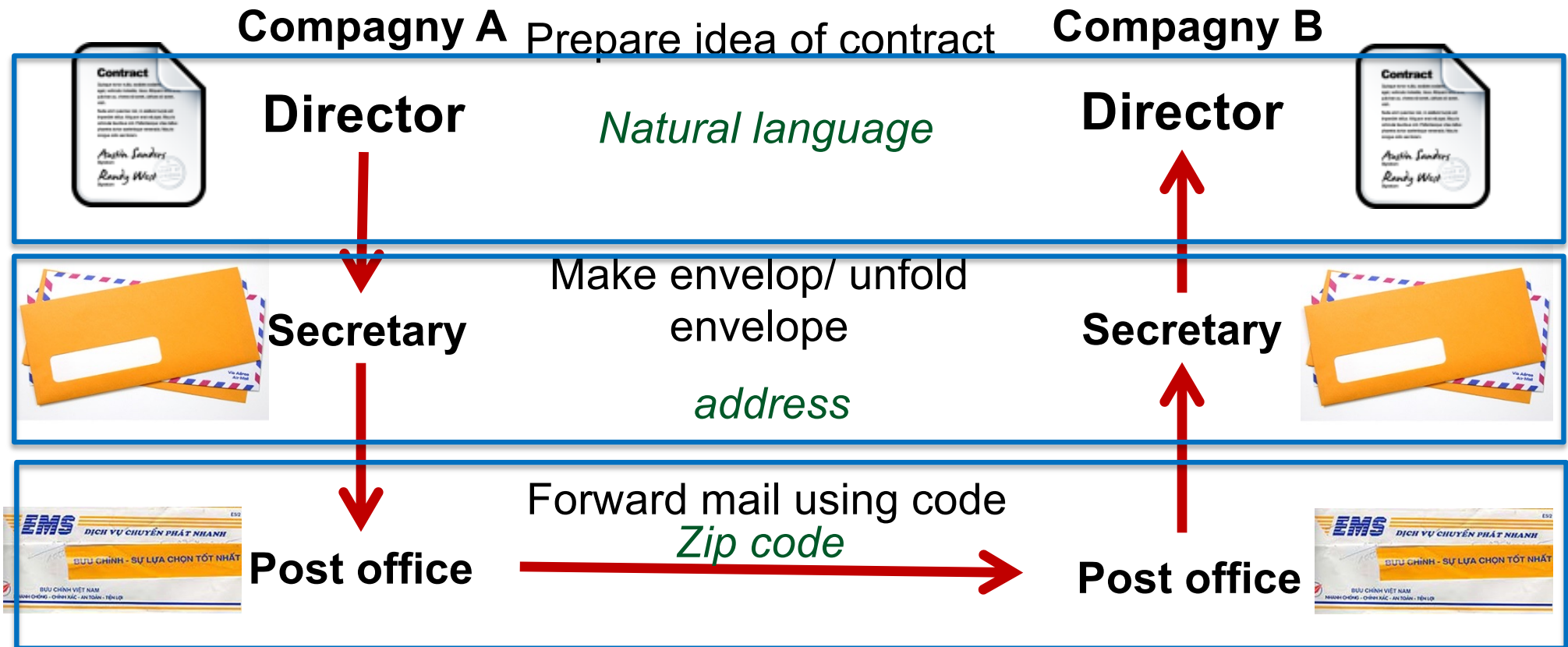
# Devide and conquer principle

- Big work is divided into small tasks
- Assign some tasks to individuals
- Ex: Compagny A & B needs to discuss about a contract
  - **Director of A,B:** Identify the main points of the contracts & ask secretary to write down the contract.
  - **Secretary:**
    - Format the contract, put contract to envelope, write down the address of company B
    - Ask post office (VNPT) to send to company B
  - **Post office:**
    - Forward the envelop through several hub of post then to B

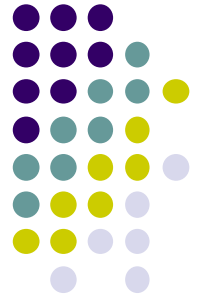
# Example



- Parties at the same level performs similar tasks and use the same information communication methods.



# Advantage of layering systems



- For the complex system: principle of “*devide and conquer*”
- Allow to determine the responsibility of each layer and the relationship amongst them
- Allow to maintain and upgrade easily the system
  - Changes in some parts do not influence the other parts.
  - Ex: upgrade a media lecture from CD lecture to DVD lecture without the need to change speakers.



## Example of layers

Architecture with  
layers



Sound system

Player  
Speaker  
Amplifier

Architecture  
without layers



Cassette

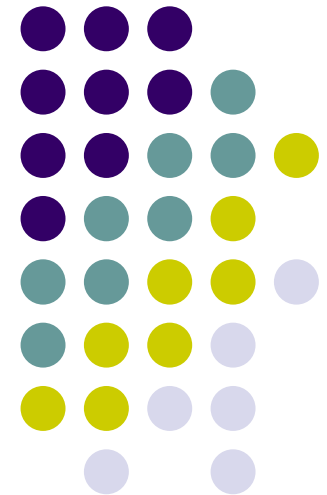
All functionalities are put  
on the same box  
When we want to upgrade:  
Upgrade the whole box



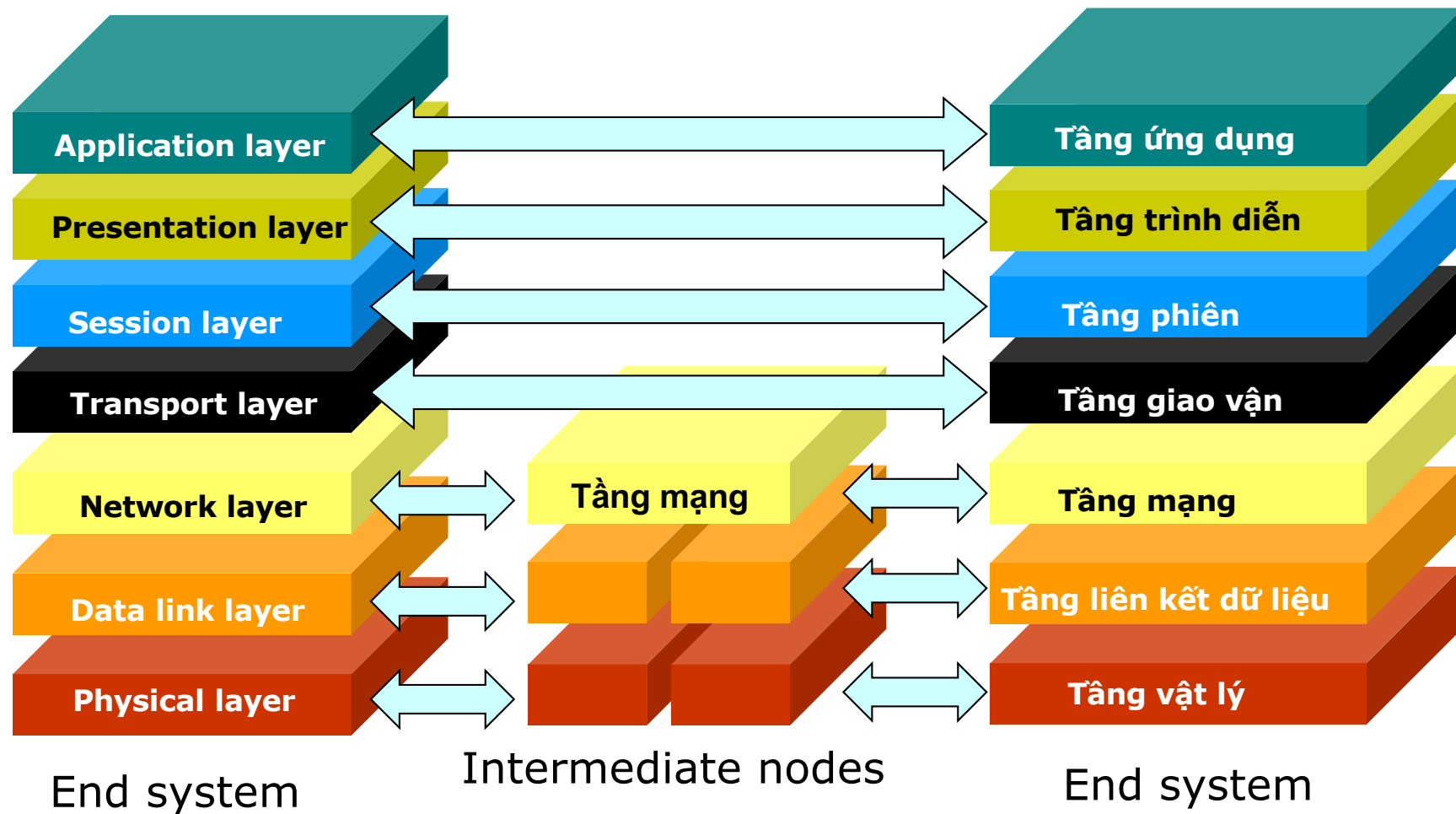
# Reference models

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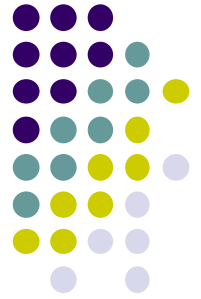
OSI  
TCP/IP



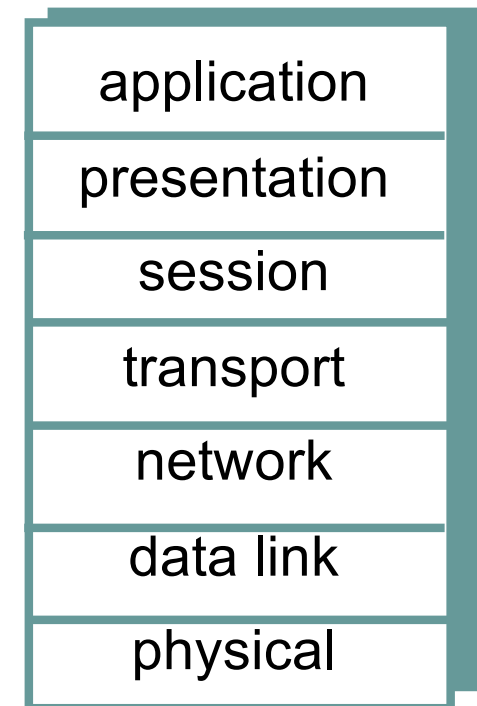
# OSI - Open System Interconnection: 7 layers



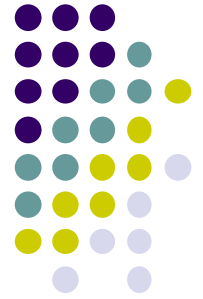
# The main functionality of each layers



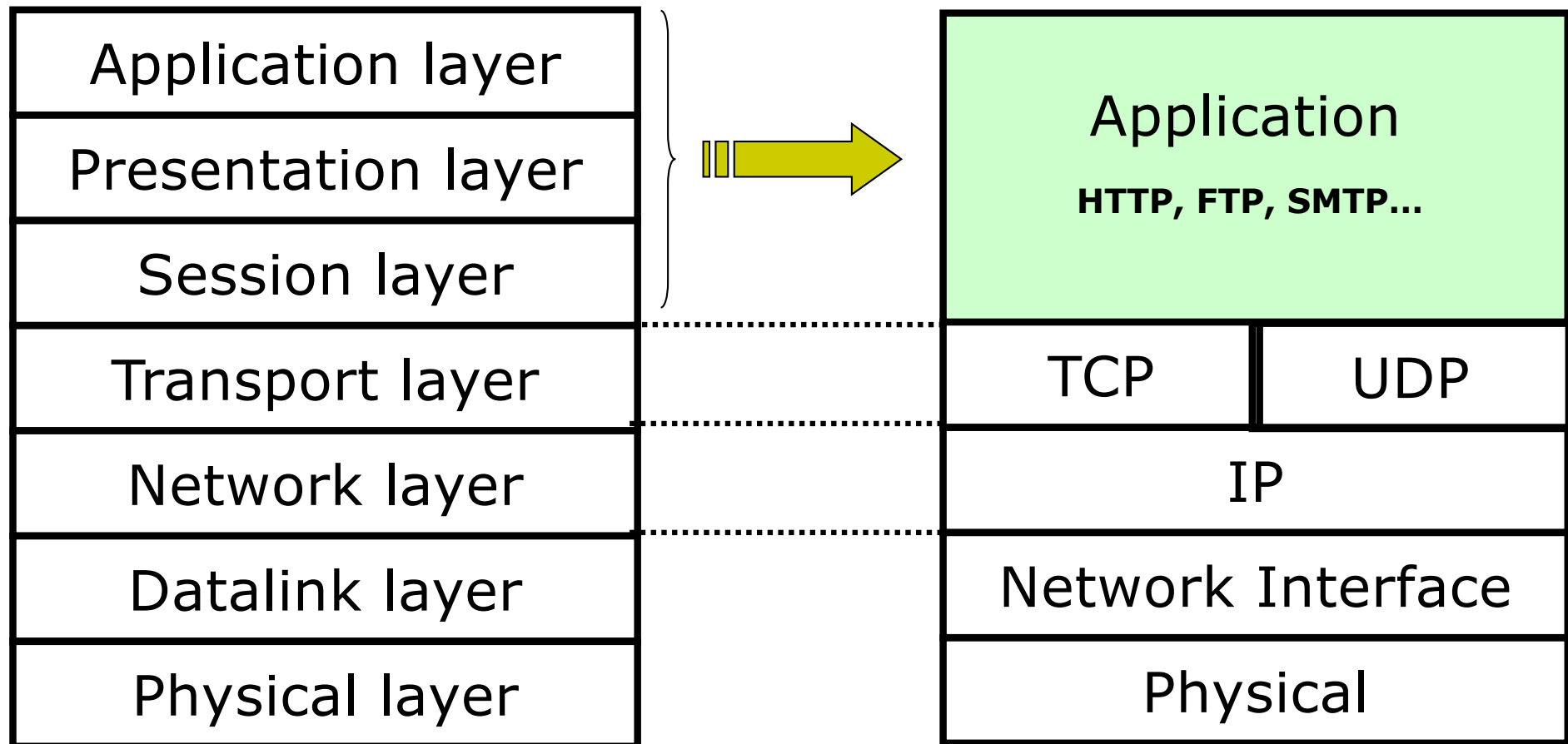
- **Physical layer:** Transferring bits “over medium”
- **Datalink layer:** Transferring data between direct connected elements in the networks.
- **Network layer:** Routing, forwarding data from the source to the distant destination
- **Transport:** Transmitting data between applications
- **Session :** synchronization, check-point, recovery of transmission process
- **Presentation:** data encoding, compression, data conversion...
- **Application:** Supporting communications between distant parts of an application.



# Models OSI and TCP/IP



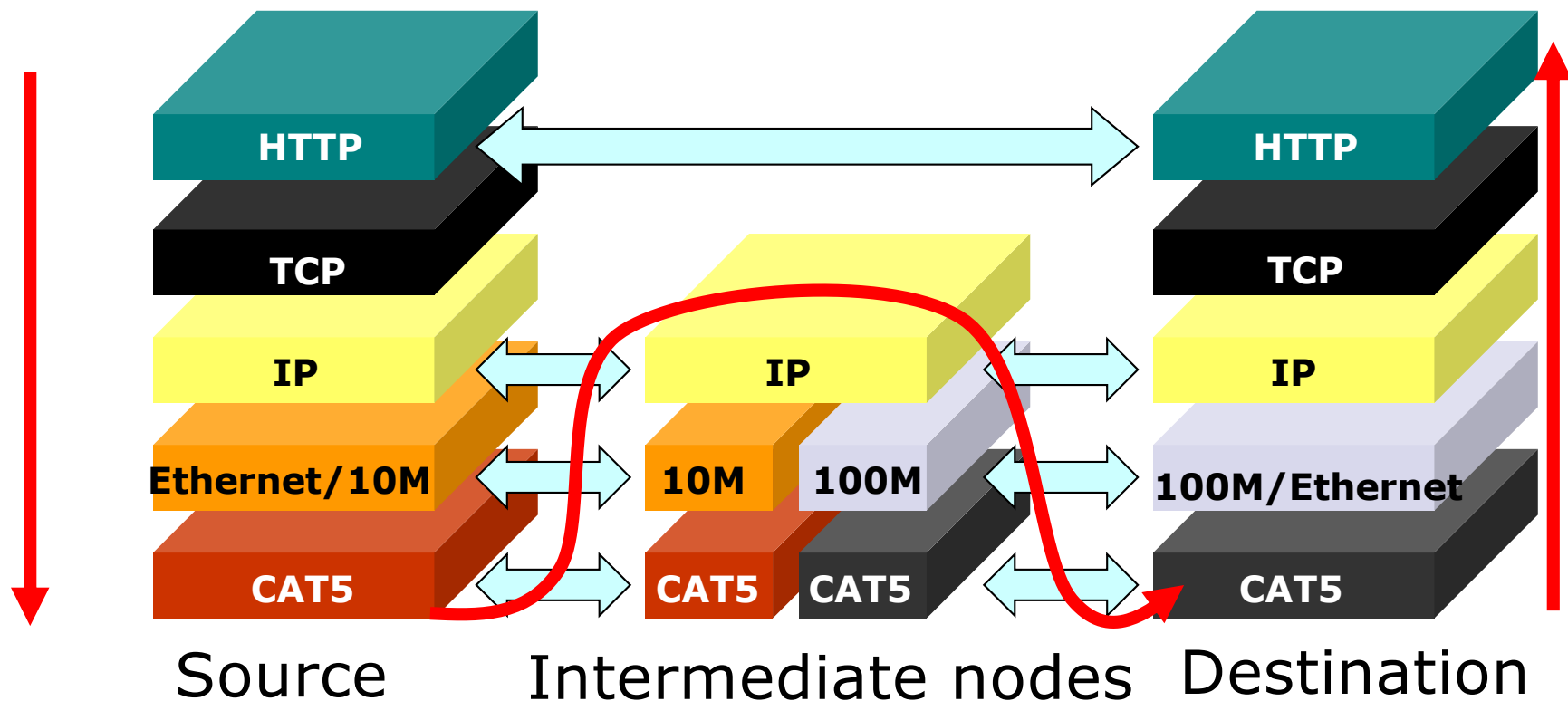
In the TCP/IP model of the Internet, the functionalities of 3 first layers are combined in a single layer.



# Layering model of the Internet



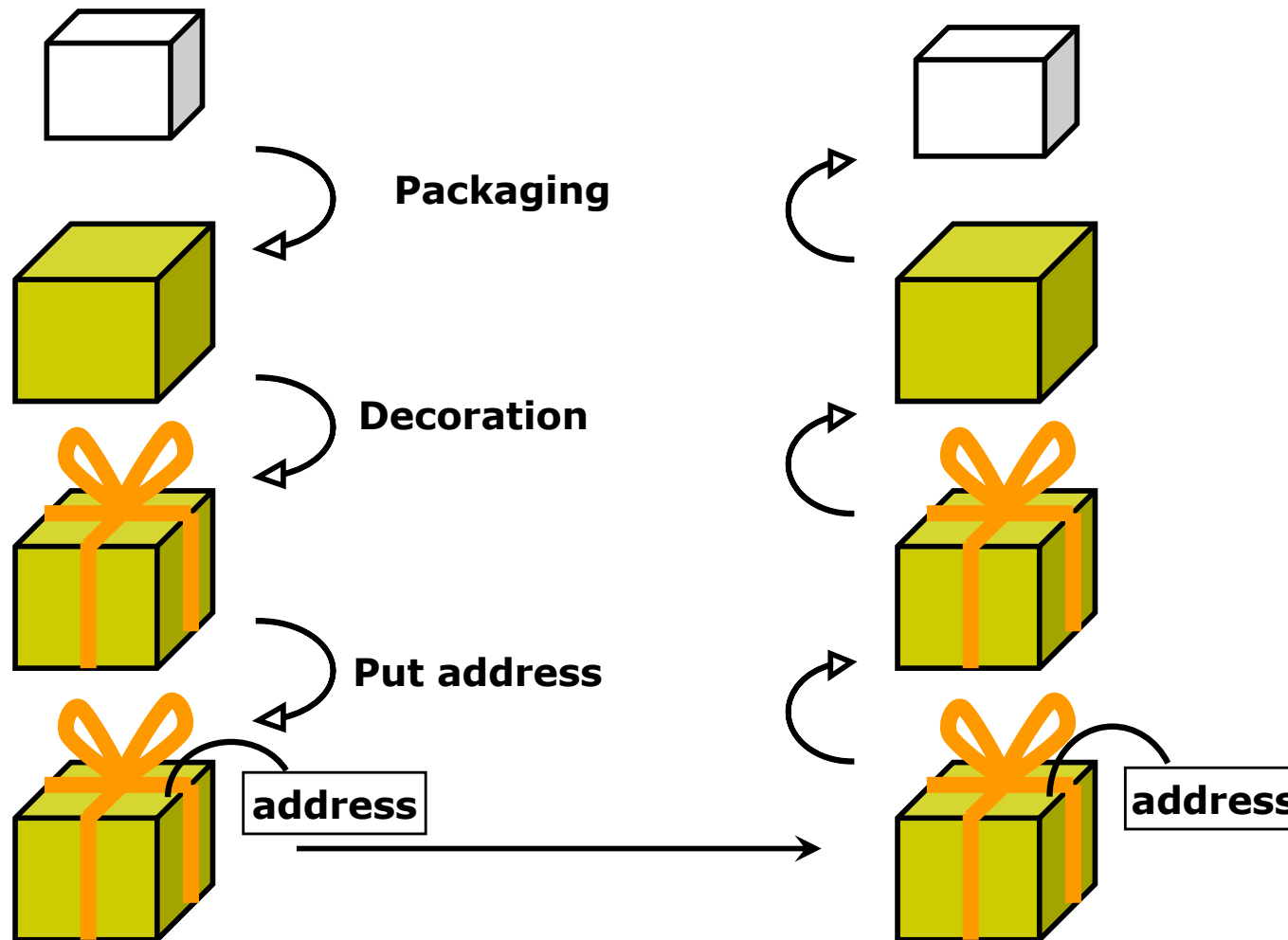
Example of data transmission from a source to a destination through intermediate nodes (router)



# Data Encapsulation



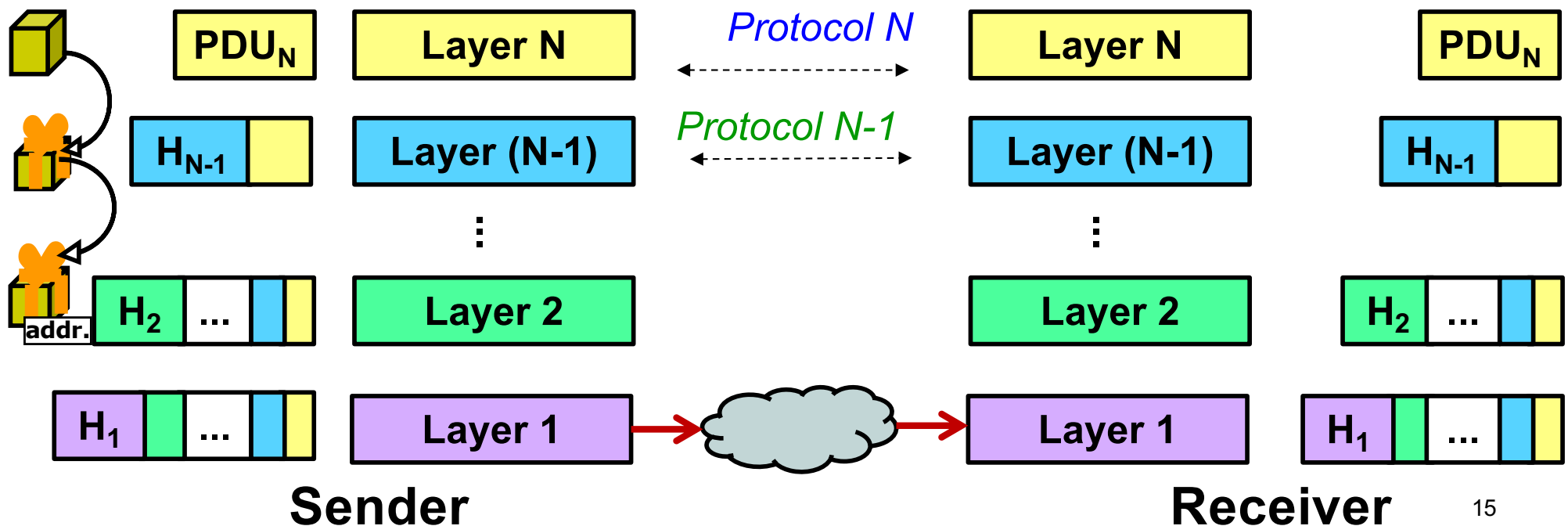
Data encapsulation is similar to a packaging process for a gift.



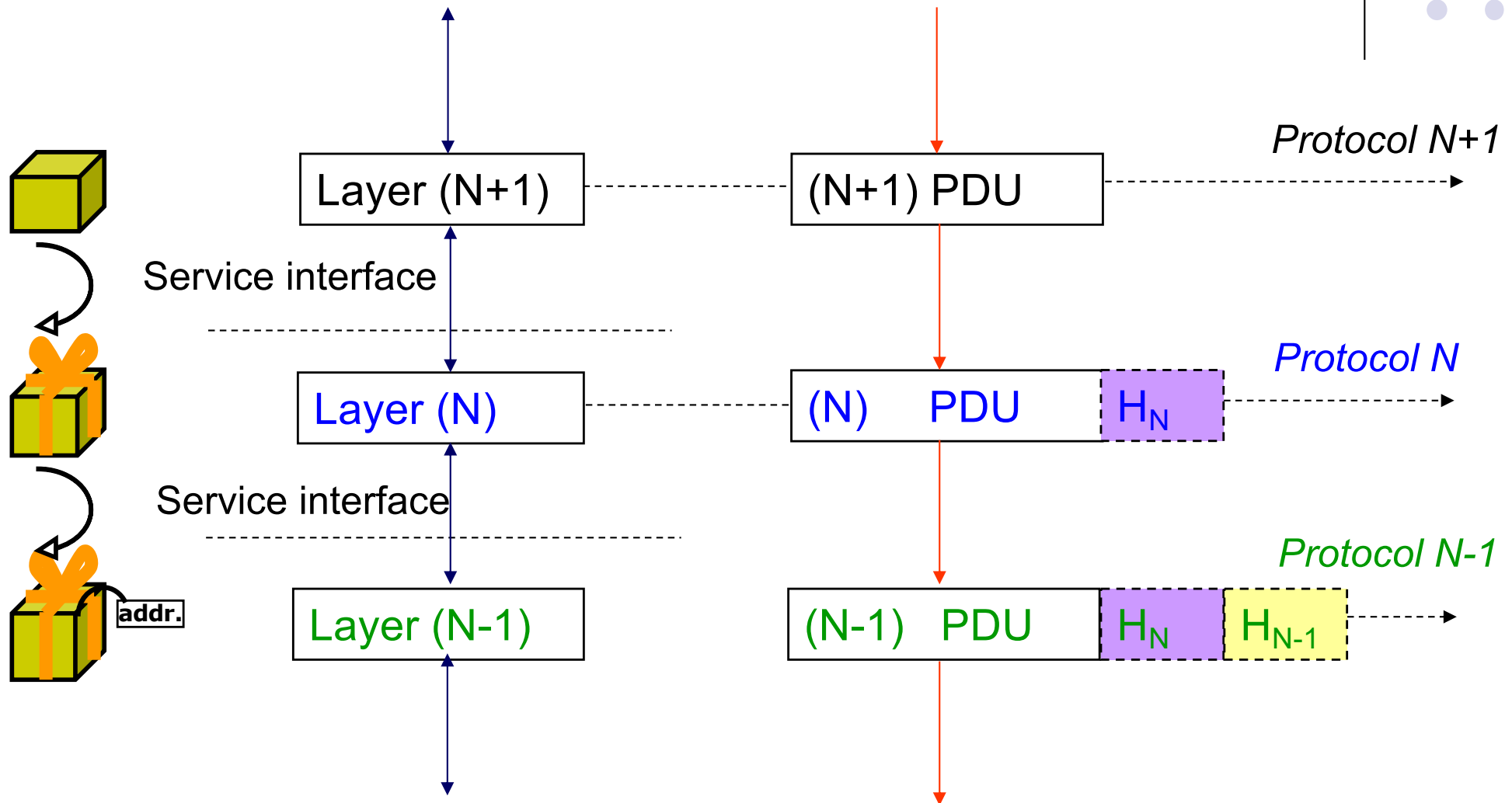


# Data Encapsulation

- Sender side: Add header containing the information necessary for package processing at that layer, then send packet to the lower layer.
- Receiver side: Process data in the package according to information in the header, remove the header and send data to the upper layer.



# PDU: Protocol Data Unit

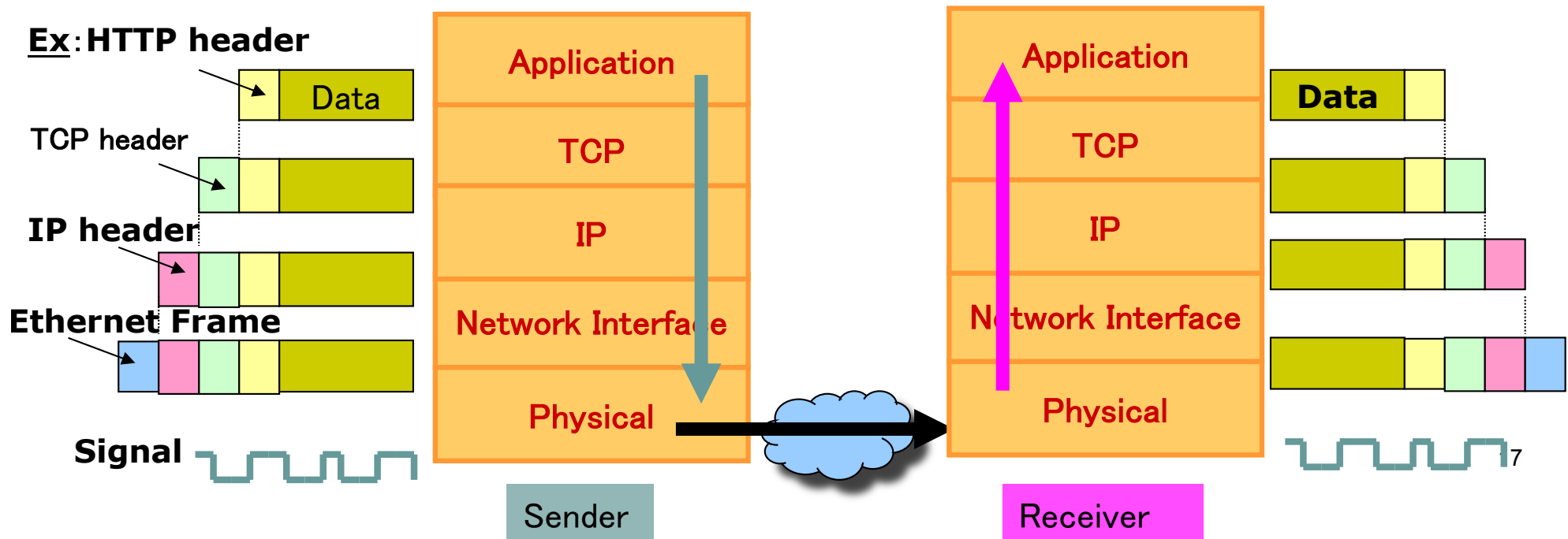




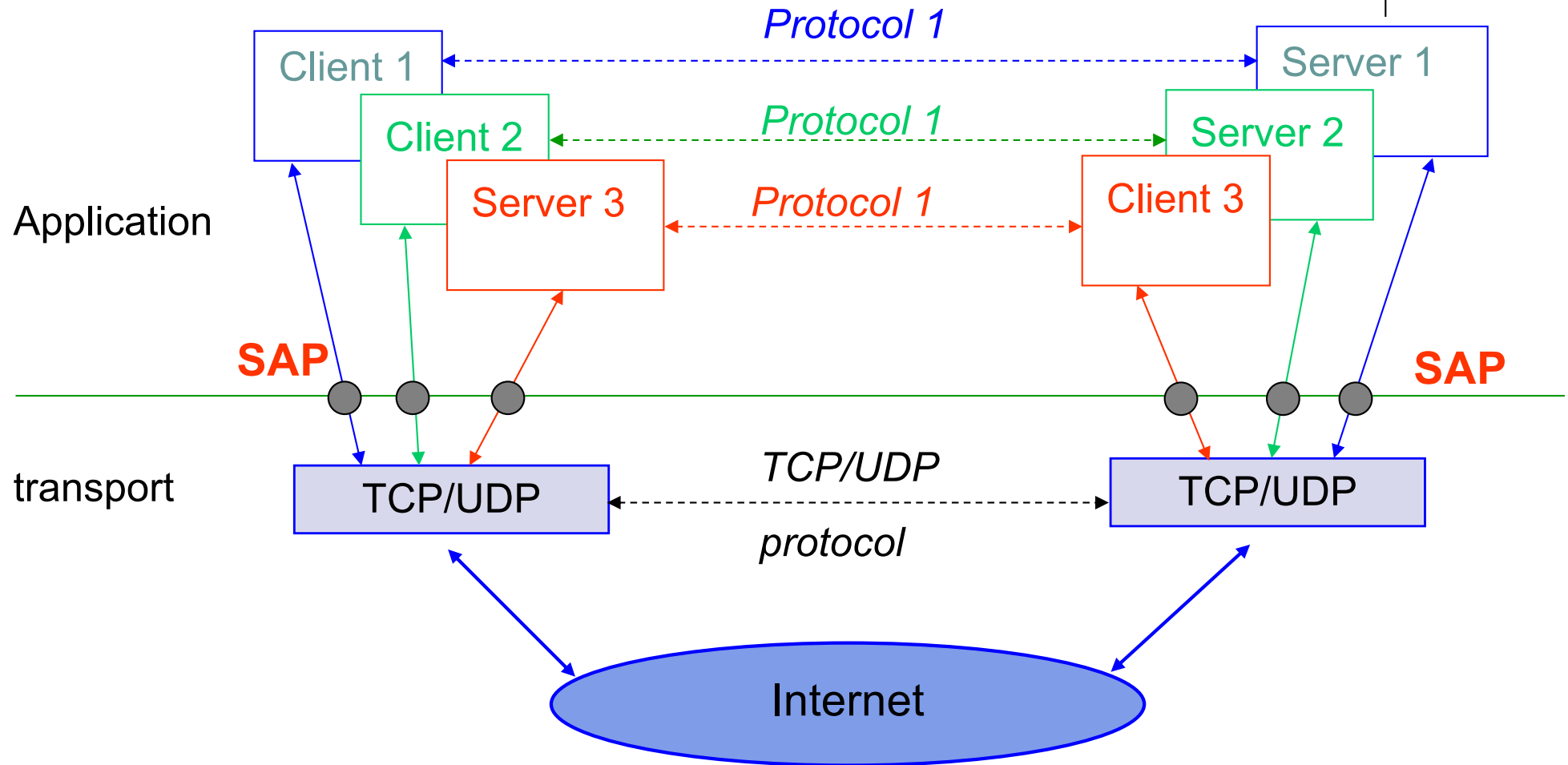
# The protocols TCP/IP and encapsulation process



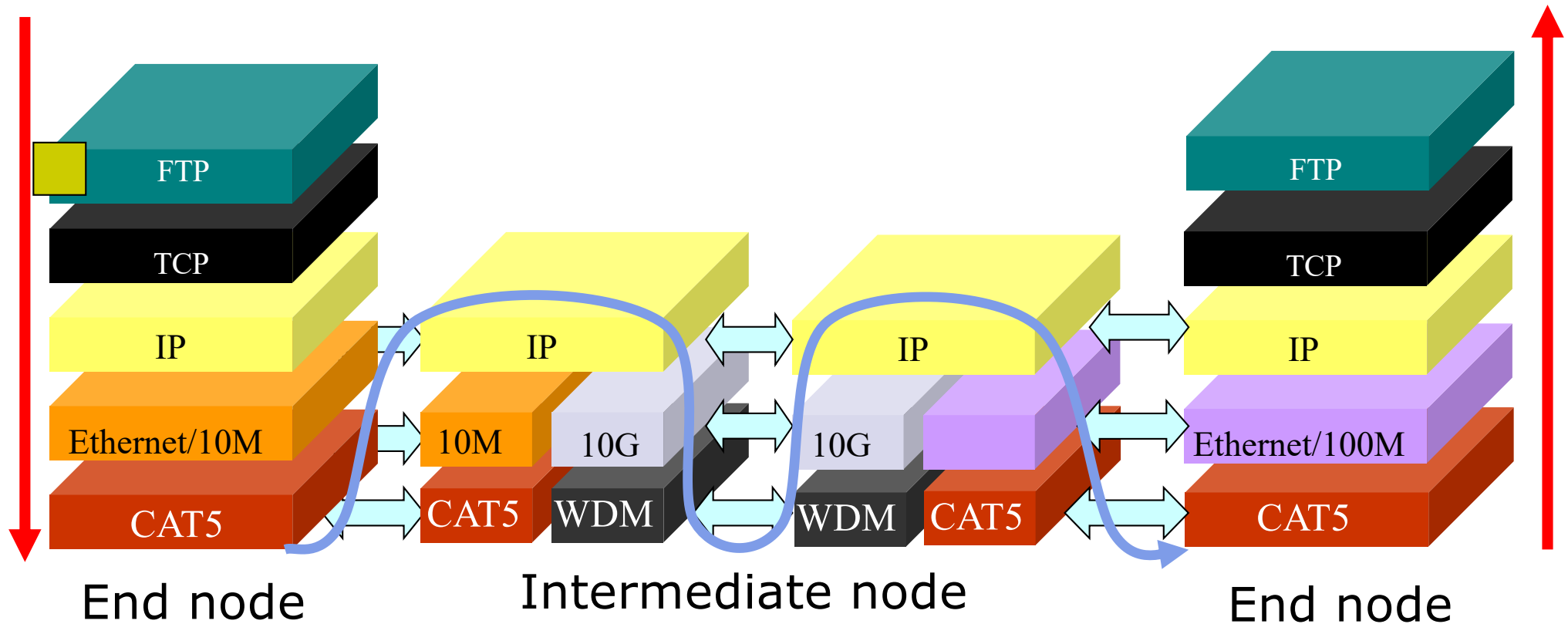
- At sender
  - Each layer add control information to the header of packet and transfer to the lower layer.
- At receiver
  - Each layer process packet according to the information of the header, then remove the corresponding header and deliver the remaining data to the upper layer.



# SAP: Service Access Point

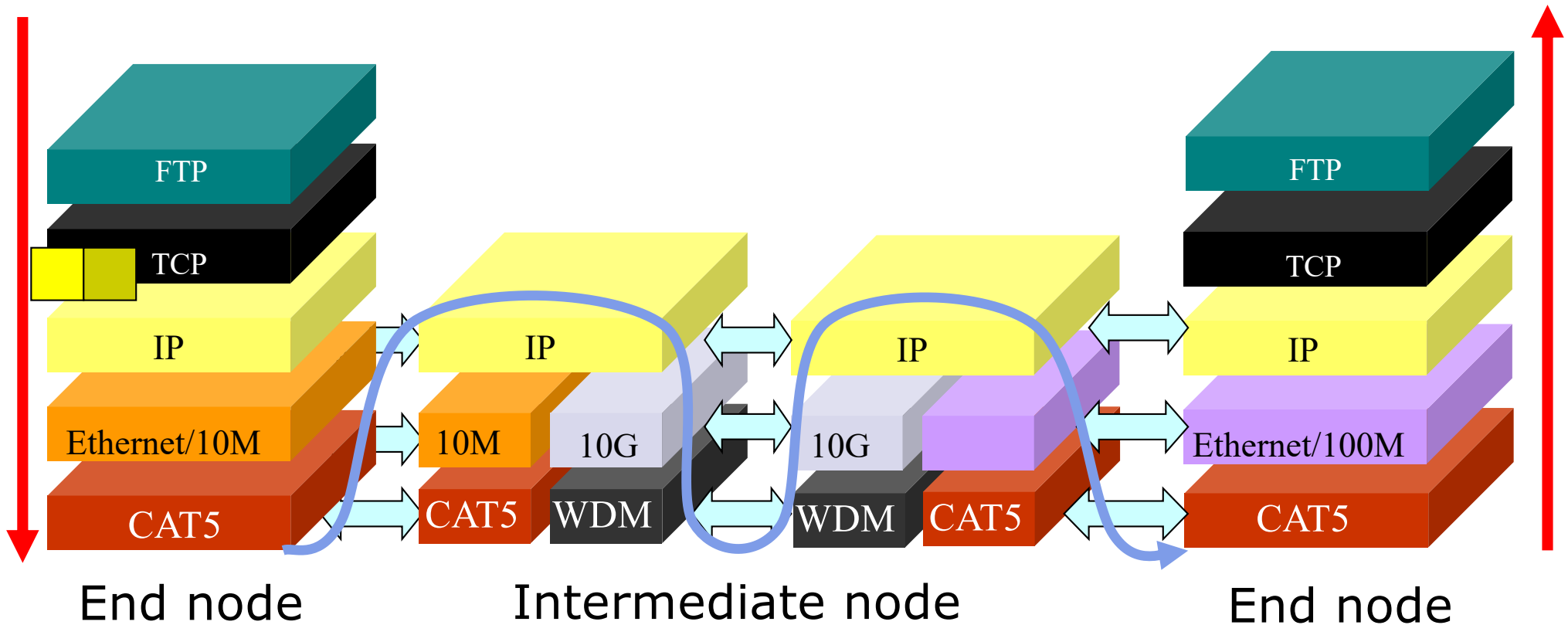


# Protocol stack and encapsulation



Dữ liệu - payload

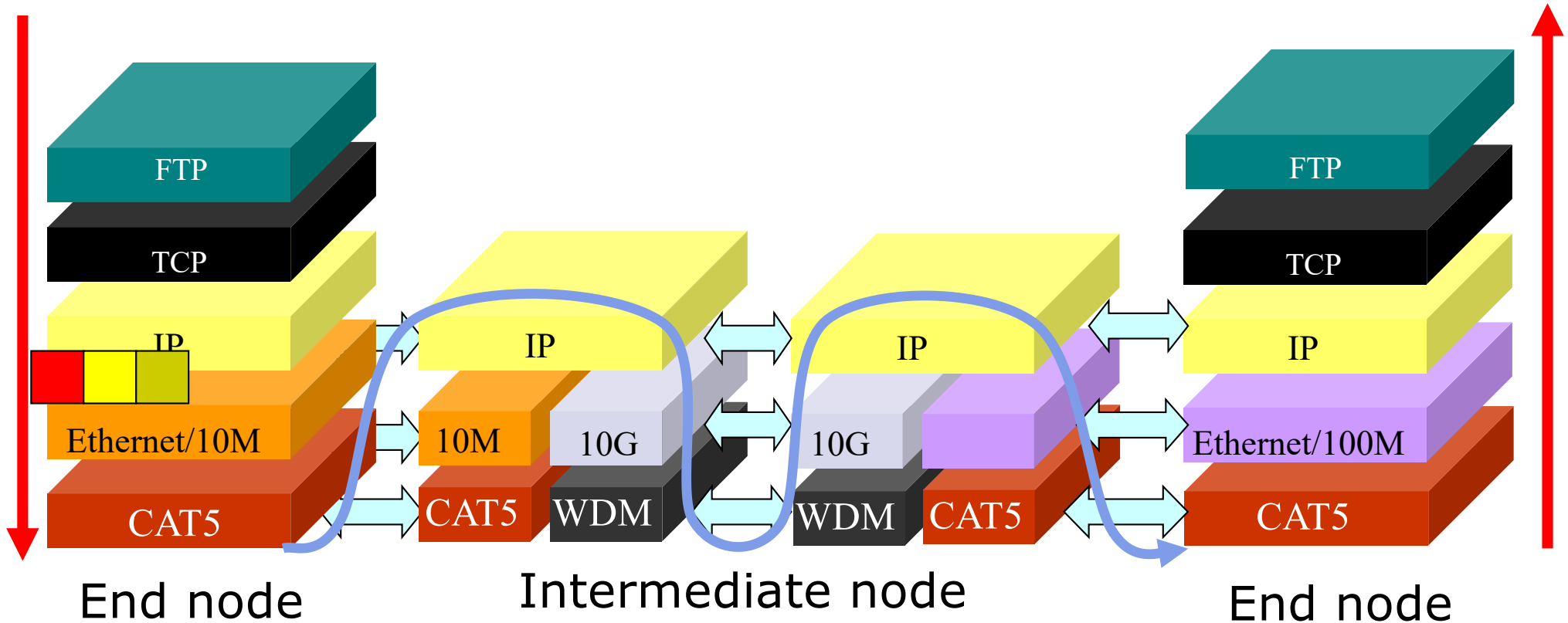
# Protocol stack and encapsulation



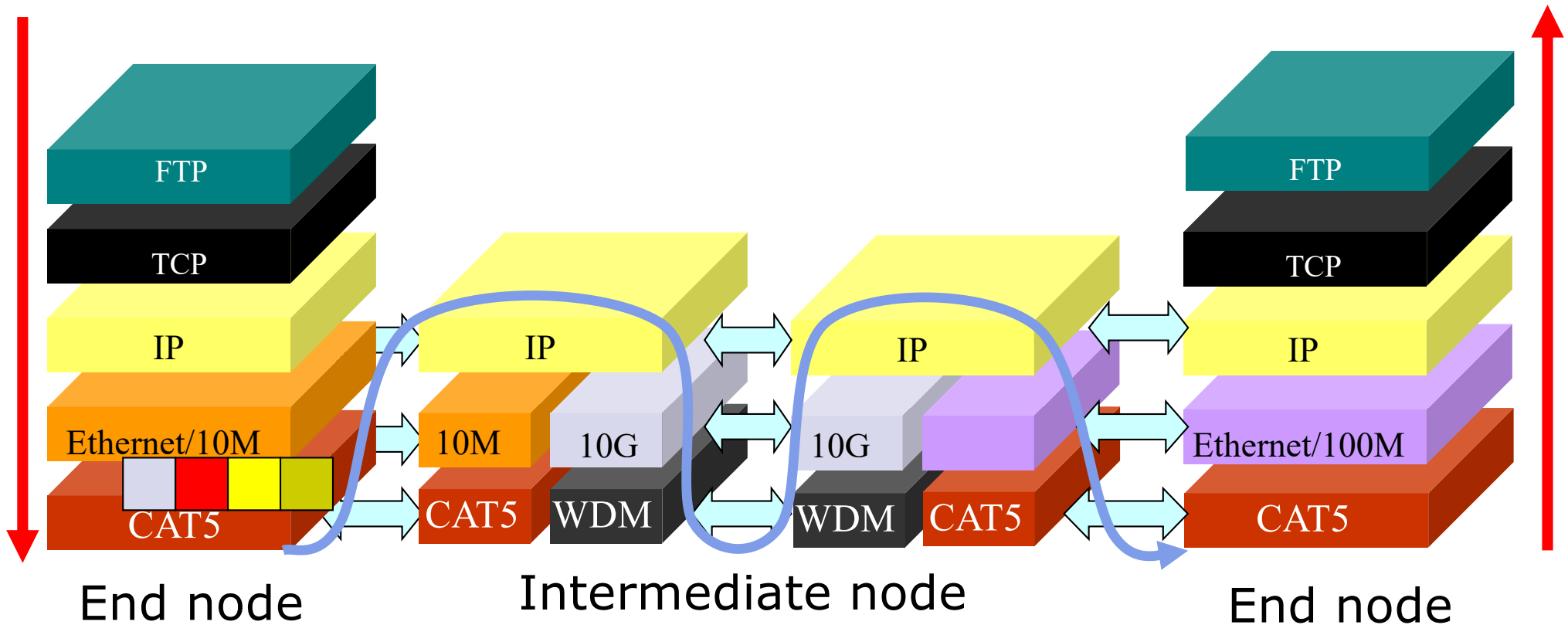
TCP header

Dữ liệu - payload

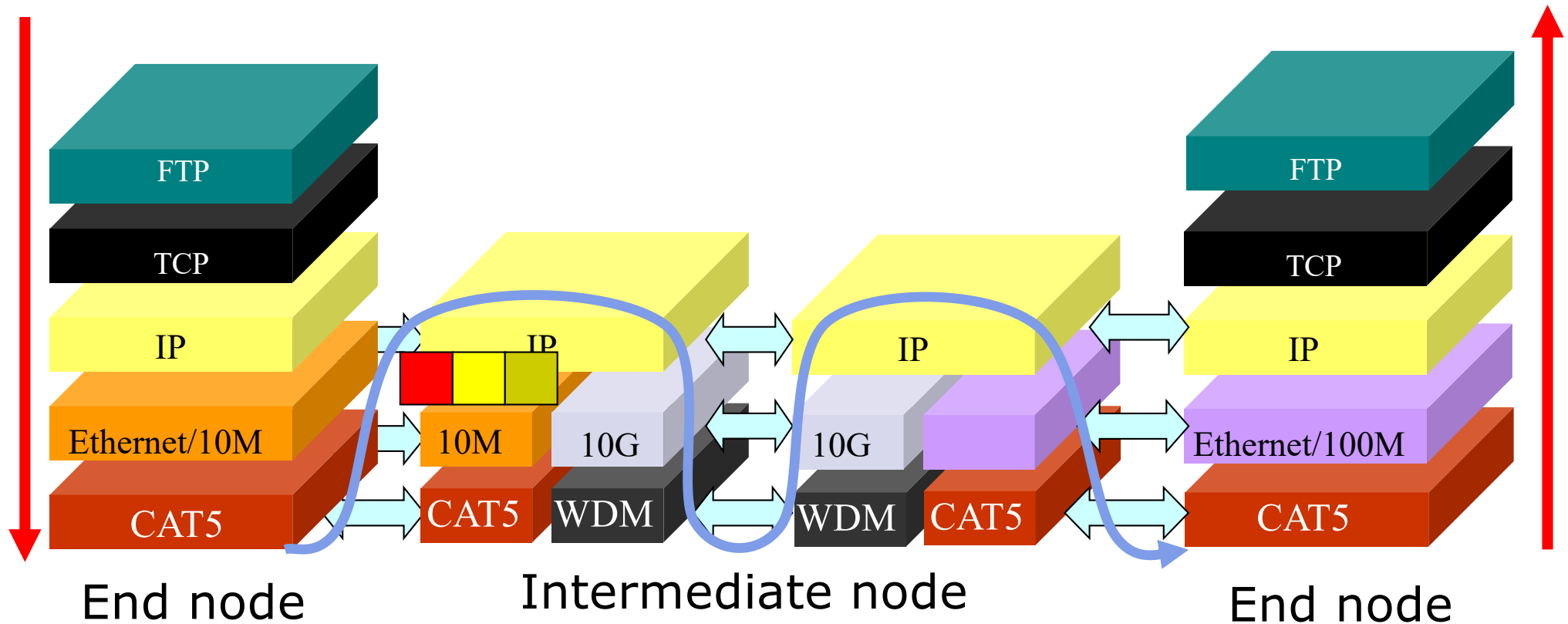
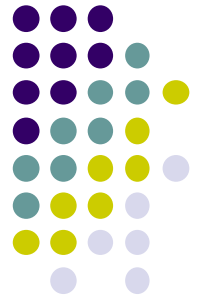
# Protocol stack and encapsulation



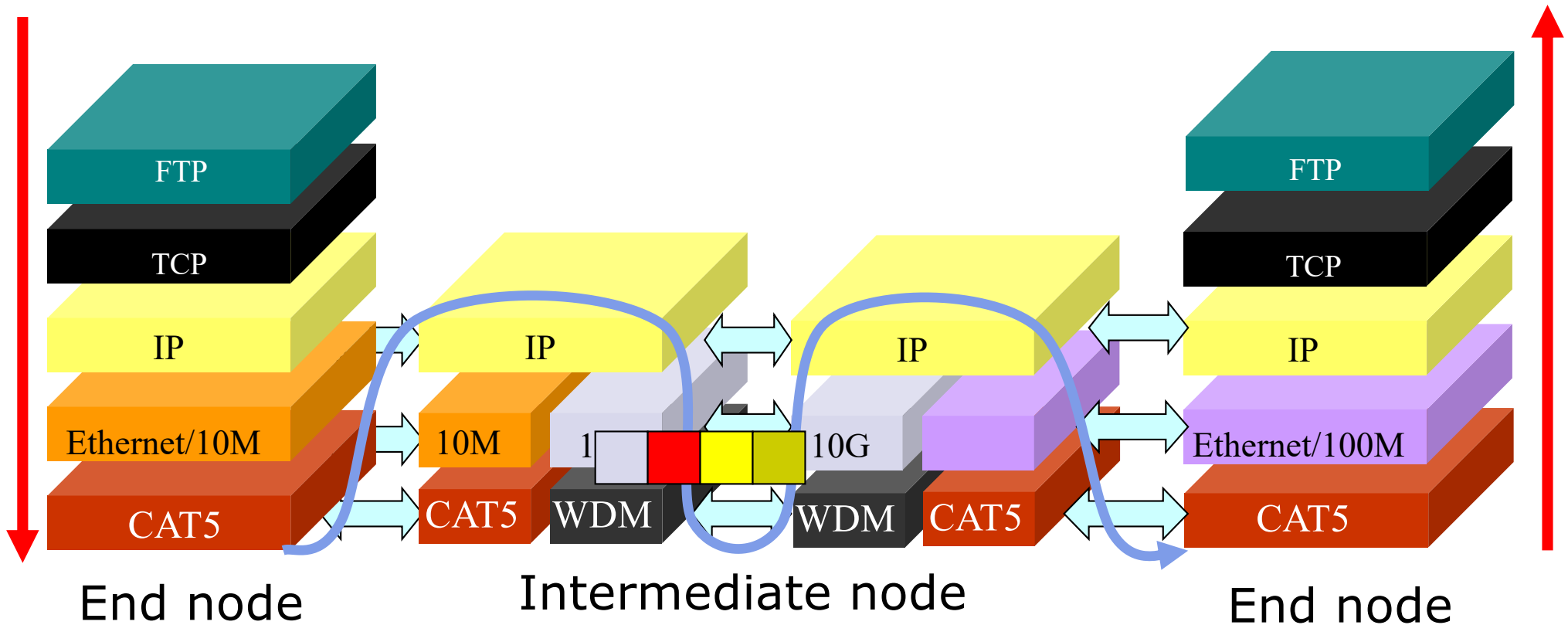
# Protocol stack and encapsulation



# Protocol stack and encapsulation

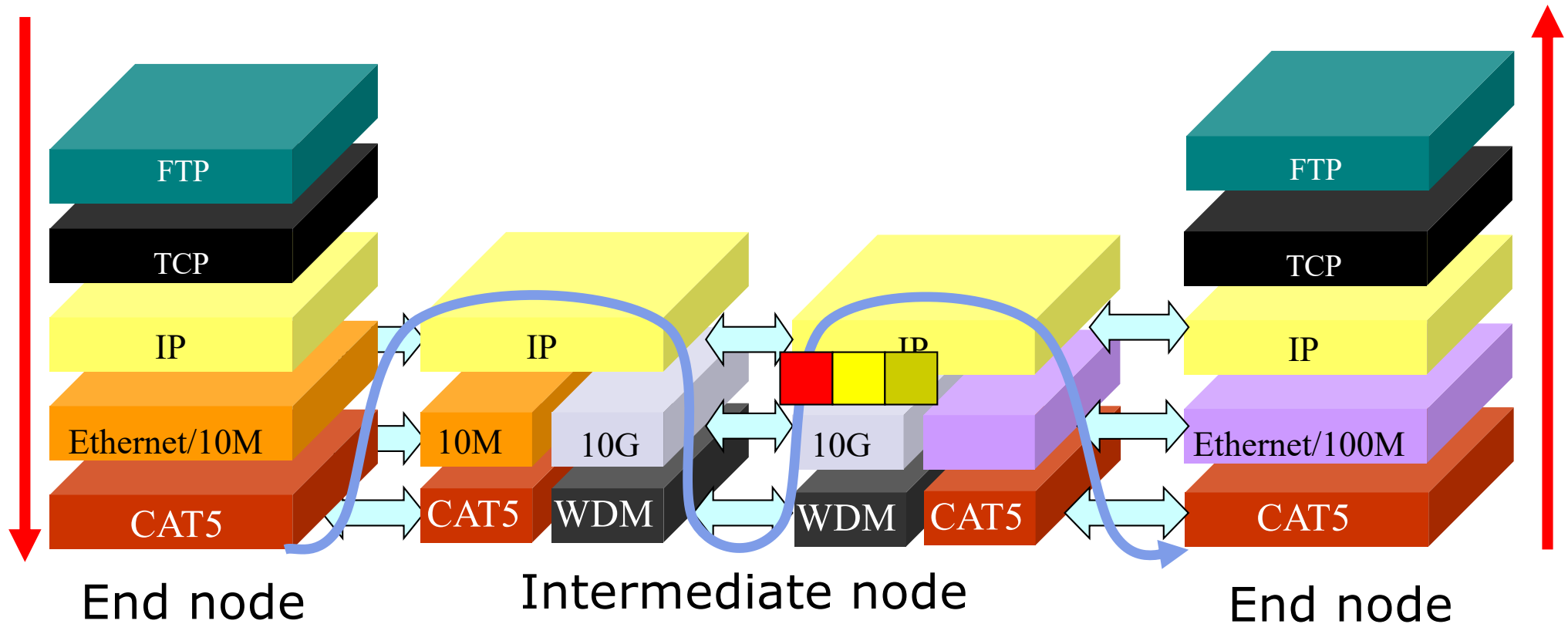


# Protocol stack and encapsulation

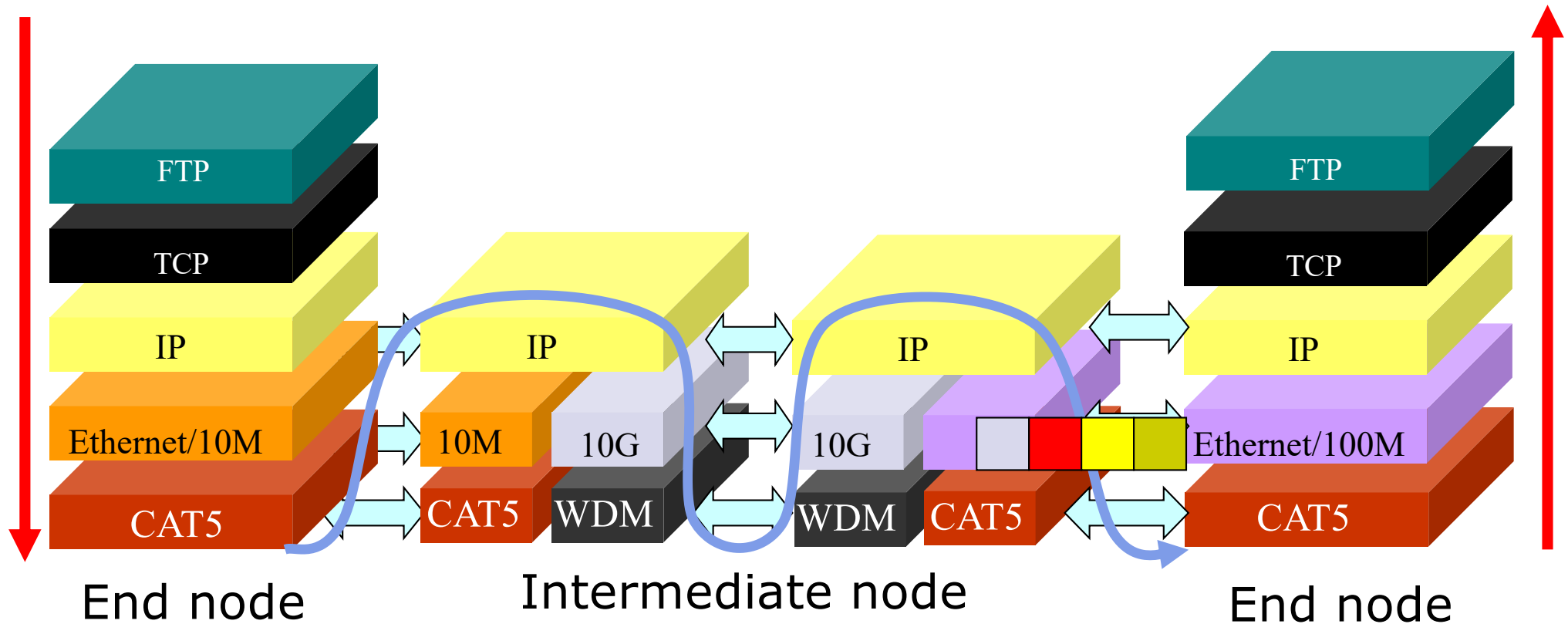




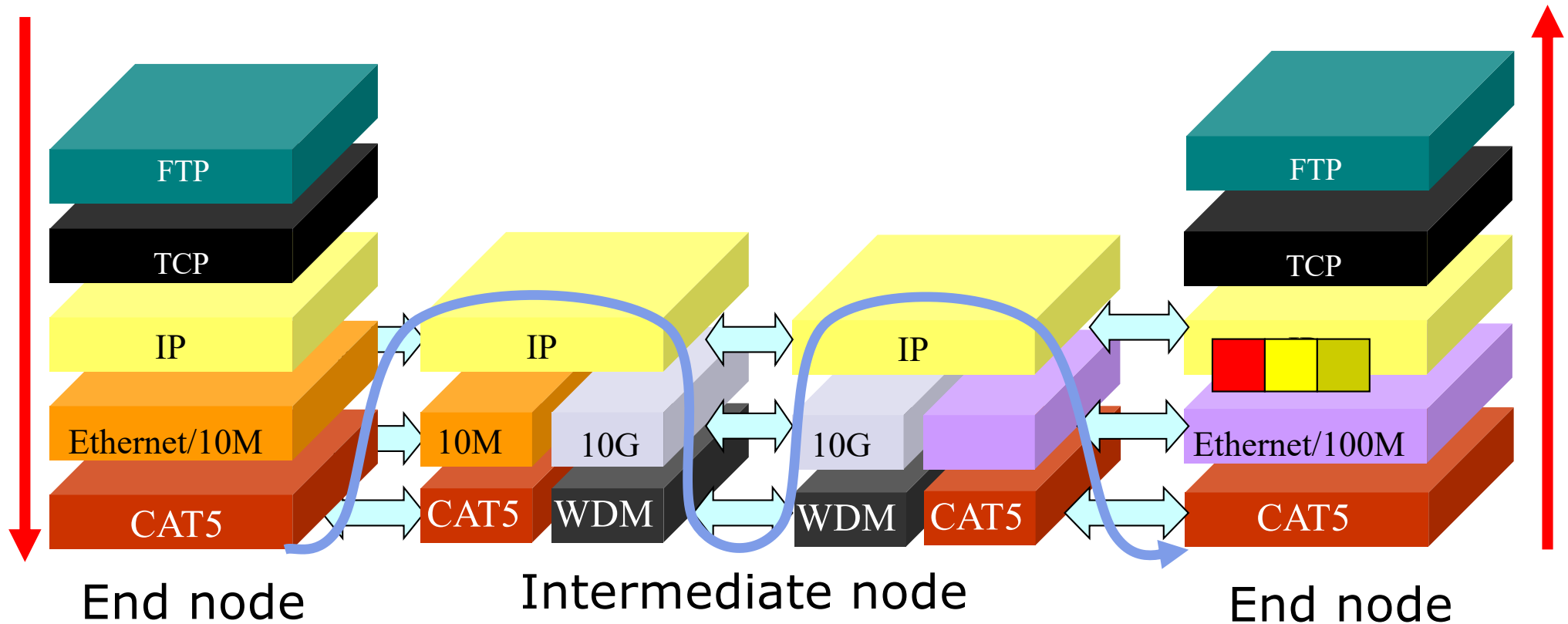
# Protocol stack and encapsulation



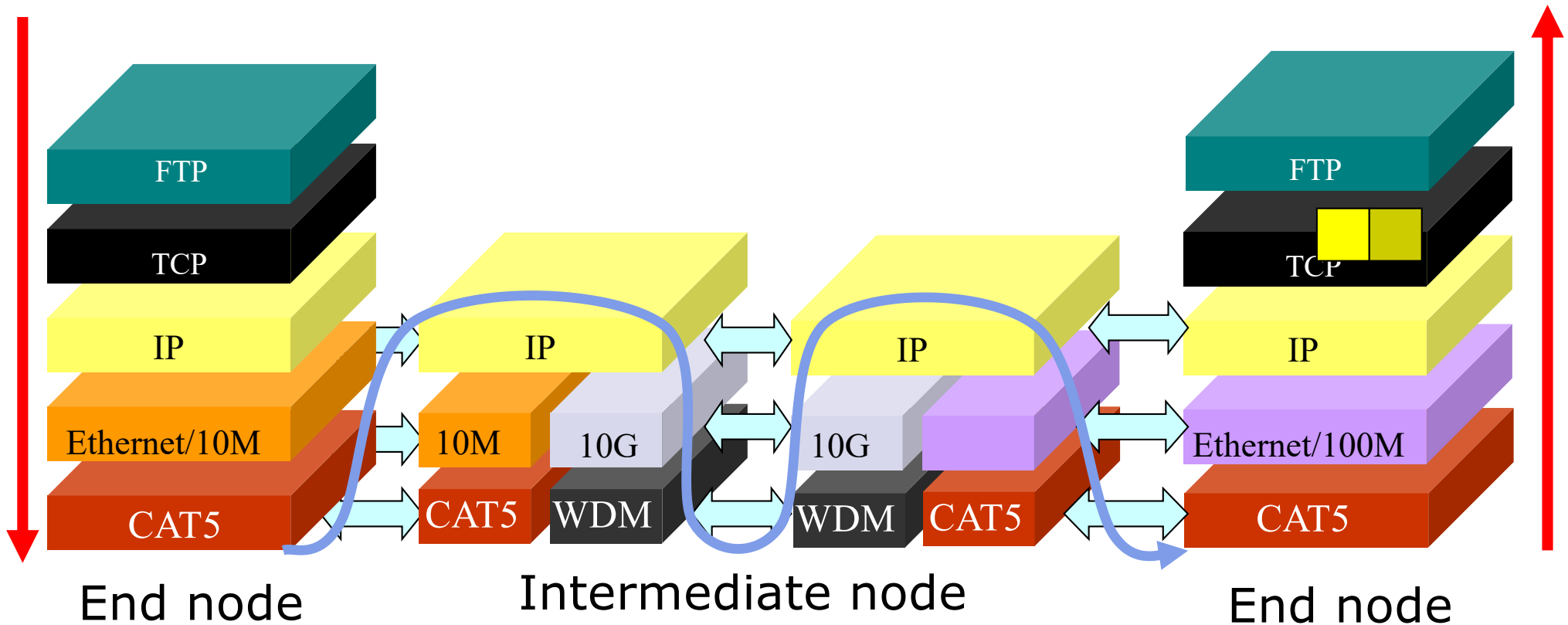
# Protocol stack and encapsulation



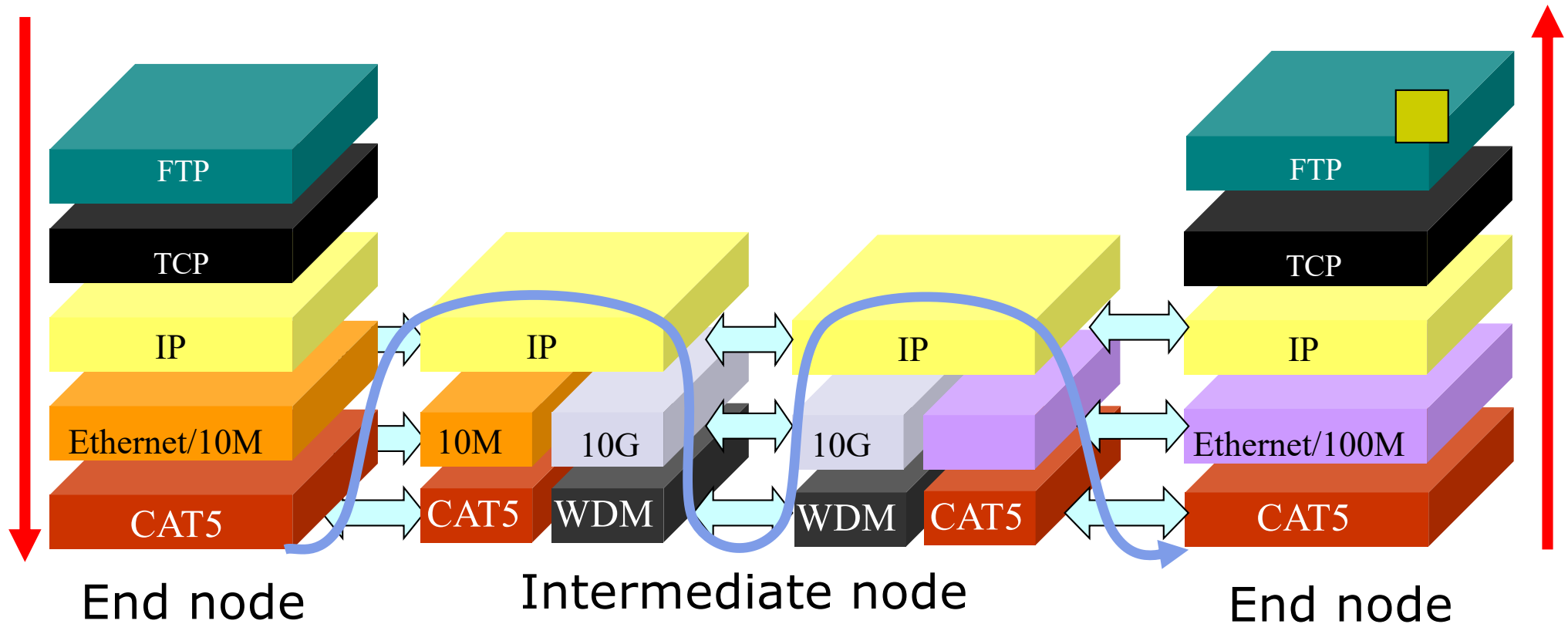
# Protocol stack and encapsulation



# Protocol stack and encapsulation



# Protocol stack and encapsulation



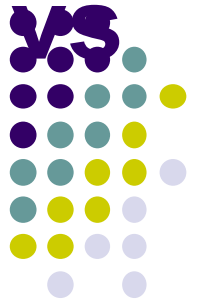
Dữ liệu - payload

# Summary: Advantage of layering architecture



- Layering architecture allows to divide the functionalities of networks into small components
- Layers are independent:
  - An upper layer makes use of the functionality of its right bellow layer but does not care about further layer.
- Extensibility/Scalability
- Flexible
  - It is possible to upgrade the communication system by upgrading the technology of some layers: Ex:
    - ADSL→FTTH
    - IPv4→IPv6
- Without layering:
  - Any change in the system requires changing the whole systems.

# Connection oriented communication vs Connectionless



- Connection oriented communication:
  - Data is transmitted over a connection already setup
  - 3 phase of communication
    - Setup connection
    - Data transmission
    - Tear down connection
  - Connection setup allows to make sur that receiver is ready for the communication → more reliable
  - More control mechanism can be performed before the data transmission to enhance it QoS
- Connectionless
  - No connection is setup, there is only data transmission phase
  - Not reliable
  - “Best effort” QoS, sending data as quick as possible.

# Unicast, Multicast, Broadcast protocols



- Unicast protocol: control data to send to one destination node
- Multicast protocol: control data to send to multiple destination nodes
- Broadcast protocol: control data to send to all nodes



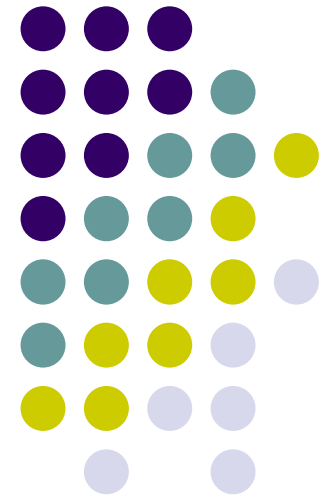
# Identification in the Internet

---

MAC Address

IP Address

Port number





# Identification

- Identification allows identify a person or an object
  - Name
    - Nguyen Thuc Hai
  - Address
    - 1 Dai Co Viet, Hai Ba Trung, Ha Noi
  - Telephone number
    - 8680896
  - Email
    - hai--xxx@it.hut.edu.vn

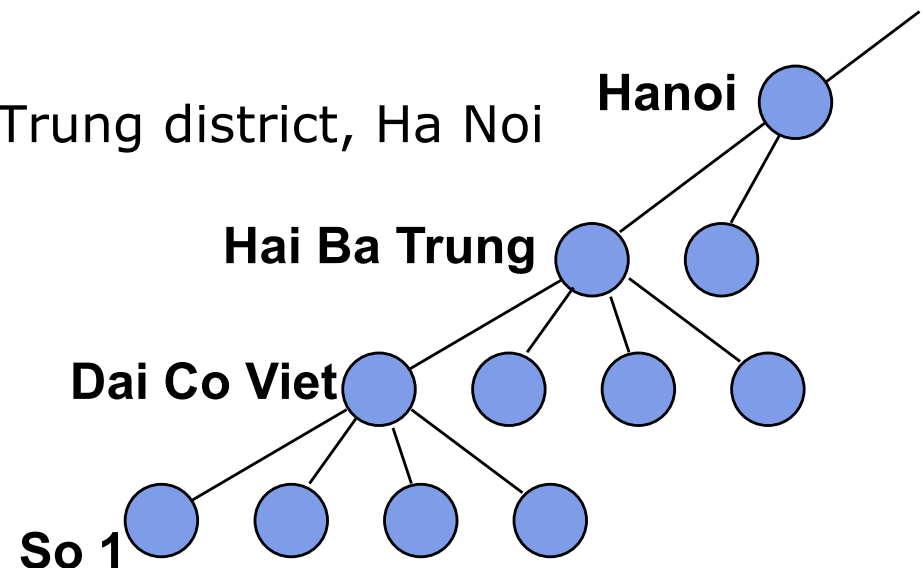


# Identification

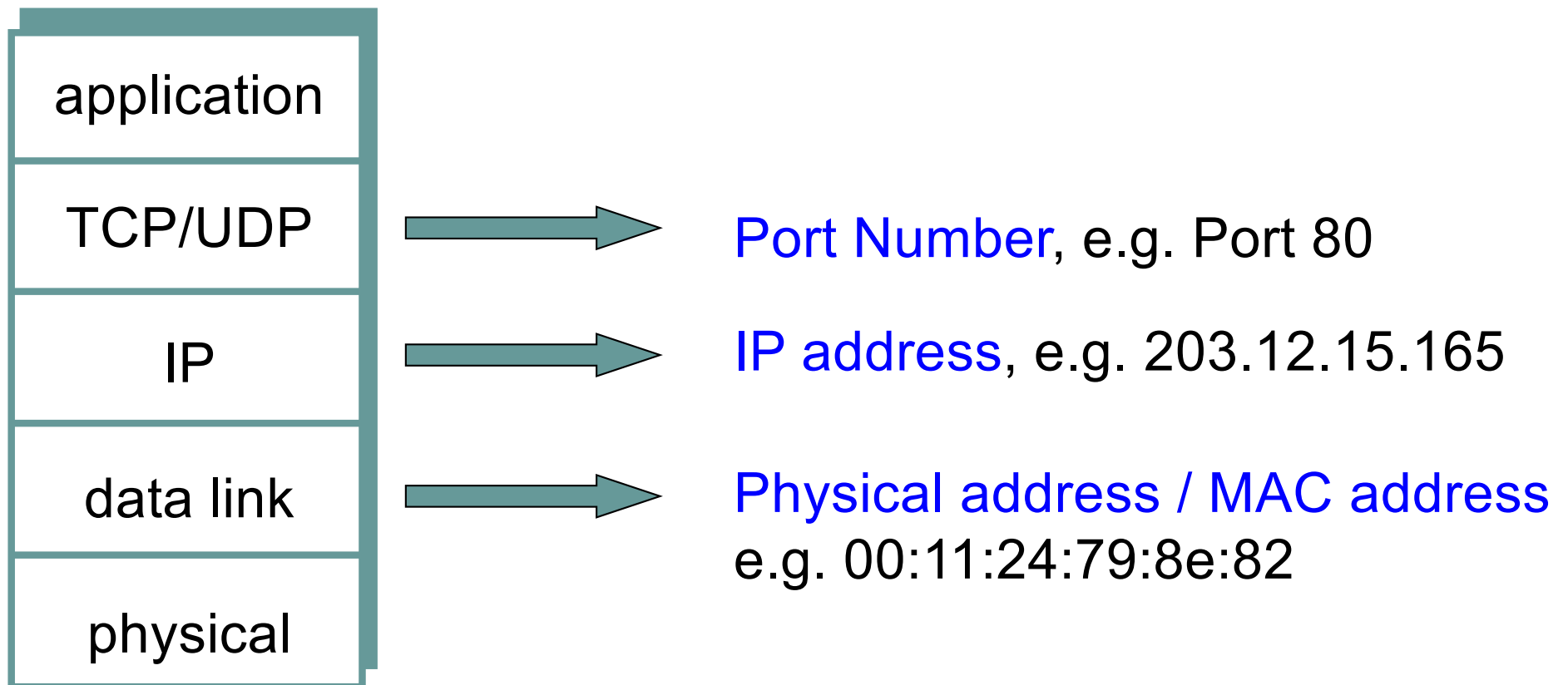
- Identification usually has hierarchical structure
  - Allow to manage efficiently a large addressing space
  - Scalability

- Example of hierarchy

- Address
  - 1 Dai Co Viet street, Hai Ba Trung district, Ha Noi
- Telephone number
  - +84-(4) 868-08-96



# Identification in the Internet and the relationship between layers





# Addressing in the Internet



- IP address
  - Used in IP-**Internet Protocol** (network layer)
  - Value depends on the networks. Each network interface card should be assigned an IP address.
  - Used for identifying a machine in an IP network, example:
    - 133.113.215.10 (ipv4)
    - 2001:200:0:8803::53 (ipv6)



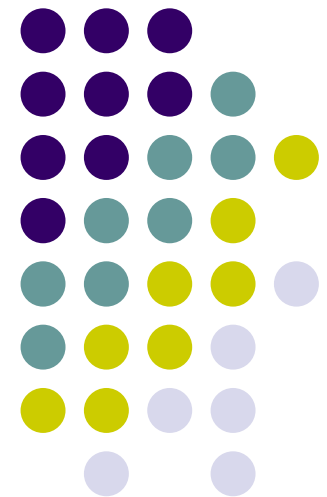
# Addressing in transport layer

- Port number
  - On each machine, there may be several applications running.
  - Applications of the same machine are distinguished by port number.
  - An application instance in the internet is identified by the IP address of the host and port number on which it runs
  - Similar to the address of a room in a building
    - Building address: B1 Building, 1 Dai Co Viet, Ha Noi => similar to IP address
    - Room number 325 => Similar to port number
- E.g. HTTP runs on port 80, FTP runs on ports 20, 21 ...

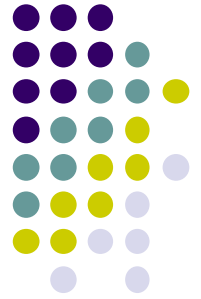
# Mapping to address

---

Domain name  
Domain name resolution  
nslookup  
arp



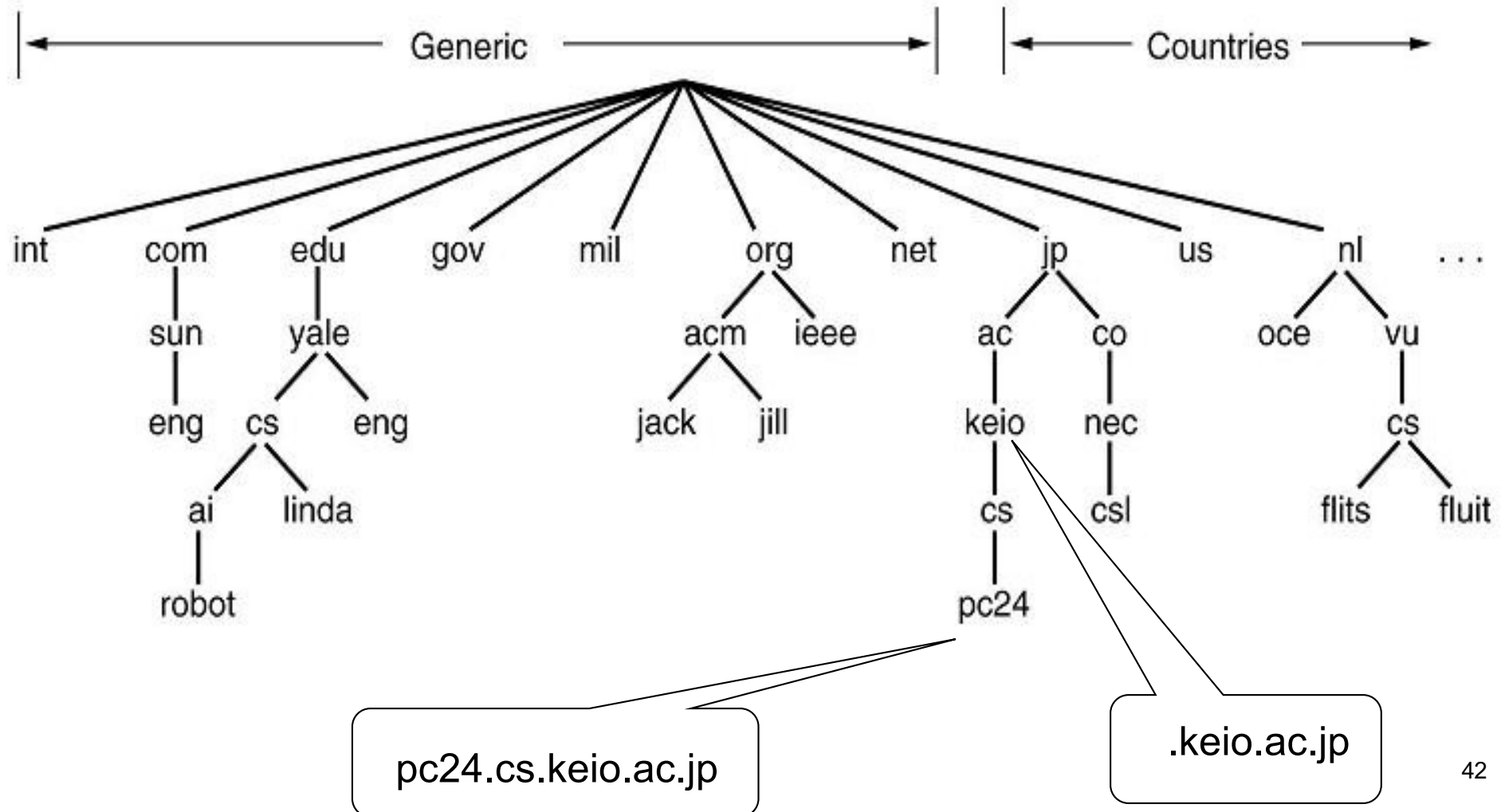




# Domain name

- Domain Name  
(FQDN: Fully Qualified Domain Name)
  - Domain name is the name of a computer or a network using alphabet and numbers
    - www.keio.ac.jp
    - www.hedspi.hut.edu.vn
    - .hut.edu.vn

# Domain name space



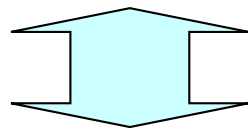


# Domain name and IP address

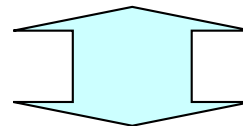
- For sending data to a host/machine, the host must be identified
  - By an IP address
  - By a domain name (easy to be memorized by human)
- name
  - Variable length
  - easy to be memorized by human
  - Nothing to do with the location of the host
- IP address
  - Fixed length (32 bits or 128 bits)
  - Computer process address more easily
  - Used for routing purpose

203.162.7.194

www.hedspi.hut.edu.vn



www.hust.edu.vn



202.47.142.40

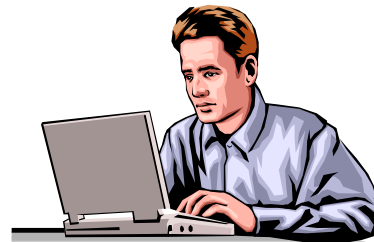
# Conversion/resolution of address



- Computer prefers numbers
- Human prefers names



Need address conversion



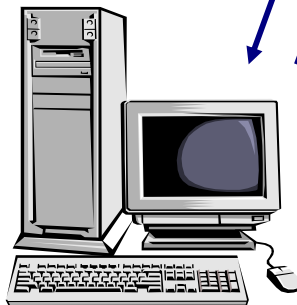
User

I want to see the webpage  
www.hust.edu.vn

Need to access to  
202.47.142.40



Domain name server



Webserver of  
www.hust.edu.vn  
202.47.142.40

*If user knows the IP address of  
the webserver, he can access  
via IP address from Browser*

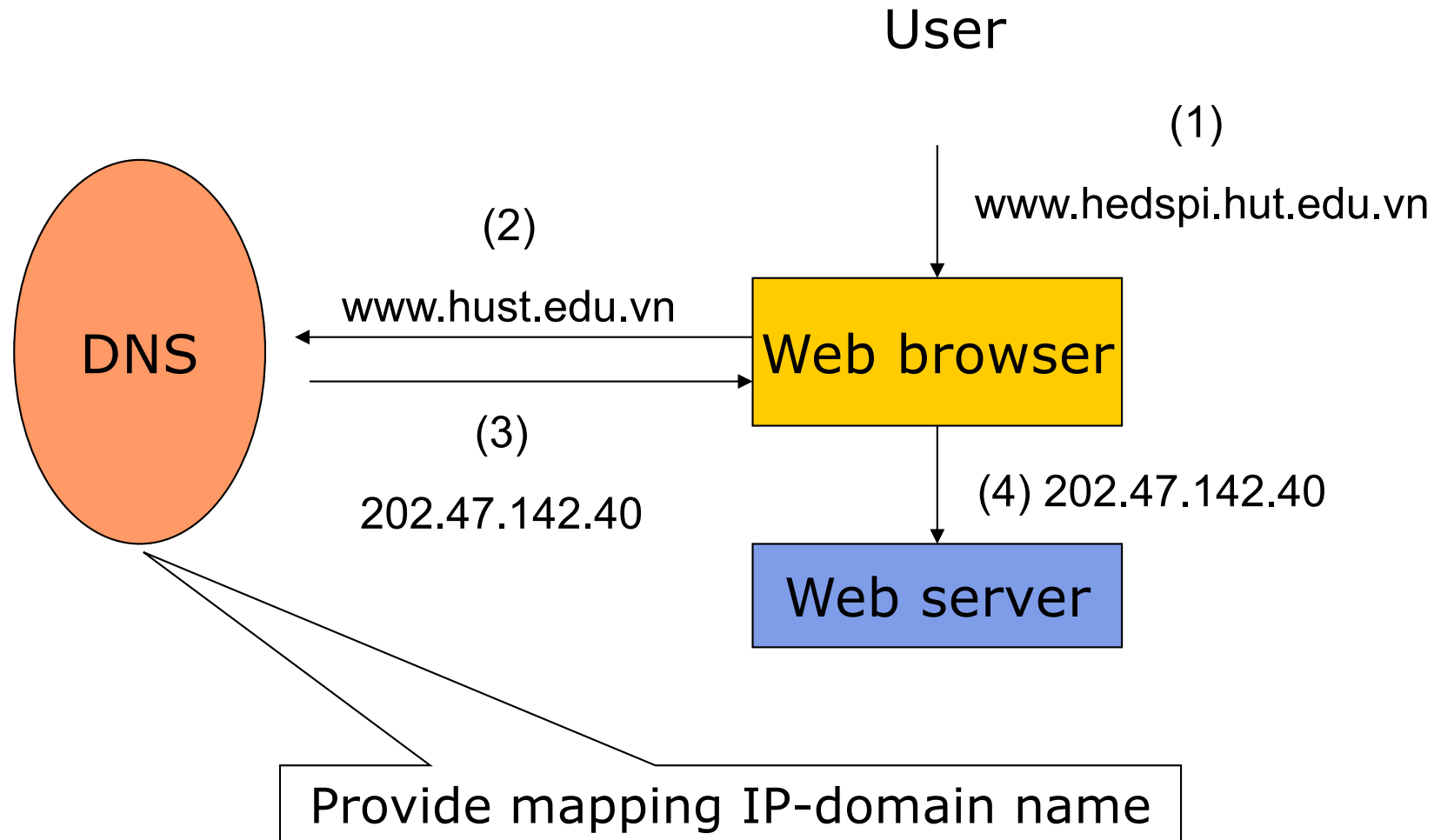


# Address resolution/conversion

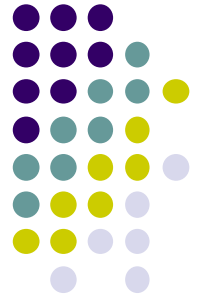
- Concept
  - Mechanism finding address IP from a domain name and vice versa.
  - There is no mathematical formula for this conversion.
- Domain name server (DNS)
  - Store the mapping of IP address and Domain name of the same host in a database
  - Answer requests of resolution of IP or domain name from users.
  - Widely used in the Internet



# Example



# Nslookup tool on Windows, Linux



- nslookup www.hedspi.hut.edu.vn
- Conversion "name $\Leftrightarrow$  IP address"

```
C:\Documents and Settings\hongson>nslookup www.hedspi.hut.edu.vn
```

```
Server:
```

```
Address: 192.168.1.1
```

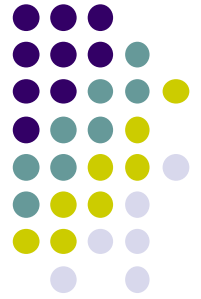
```
Non-authoritative answer:
```

```
Name: www.hedspi.hut.edu.vn
```

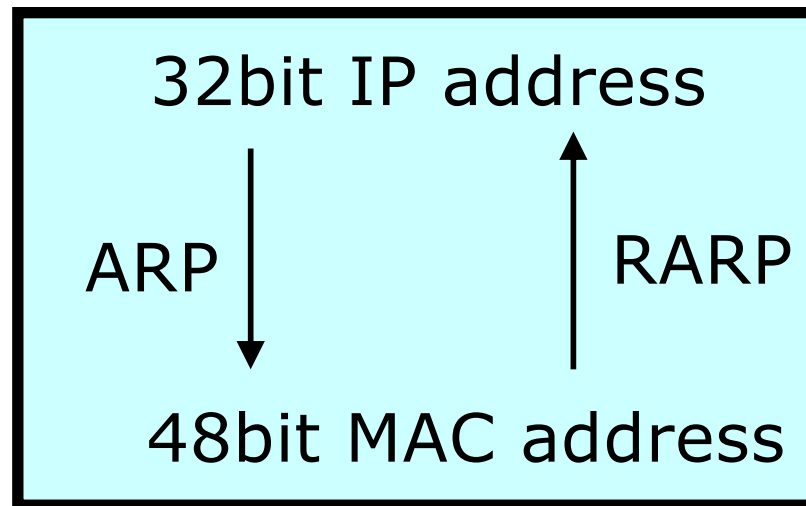
```
Address: 202.47.142.140
```

```
C:\Documents and Settings\hongson>
```

# ARP Conversion of Mac address and IP address



- Address Resolution Protocol
- MAC and IP are both used for identifying a NIC.
- ARP allows to find MAC address from IP address





# Example: ARP table (on Windows)



```
C:\Documents and Settings\hongson>arp -a
```

```
Interface: 192.168.1.34 --- 0x2
```

Internet Address	Physical Address	Type
192.168.1.1	00-02-cf-75-a1-68	dynamic
192.168.1.33	08-00-1F-B2-A1-A3	dynamic

**IP address**

```
C:\Documents and Settings\hongson>
```

**MAC address**



# Summary

- Layer architecture
  - Why layering
  - Model TCP/IP vs. Model OSI
  - Encapsulation, PDU. SAP
- Addressing on Internet
  - Address IP, MAC, domain name, port
  - Address conversion

# Quizz

