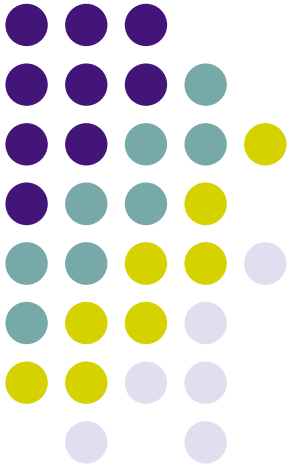
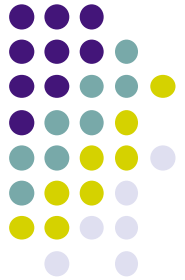
# Lecture 2: Basic concepts of computer networks

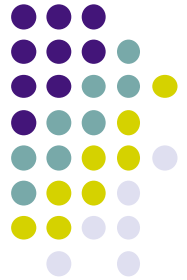


# Last lecture



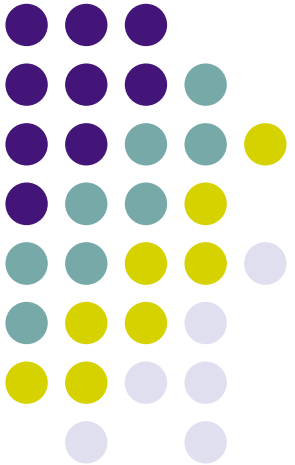
- Introduction of the course
- History of the Internet
- Concept of Computer Networks
- Some fundamental concepts: switching, connection oriented, connection less.

# Content of this lecture

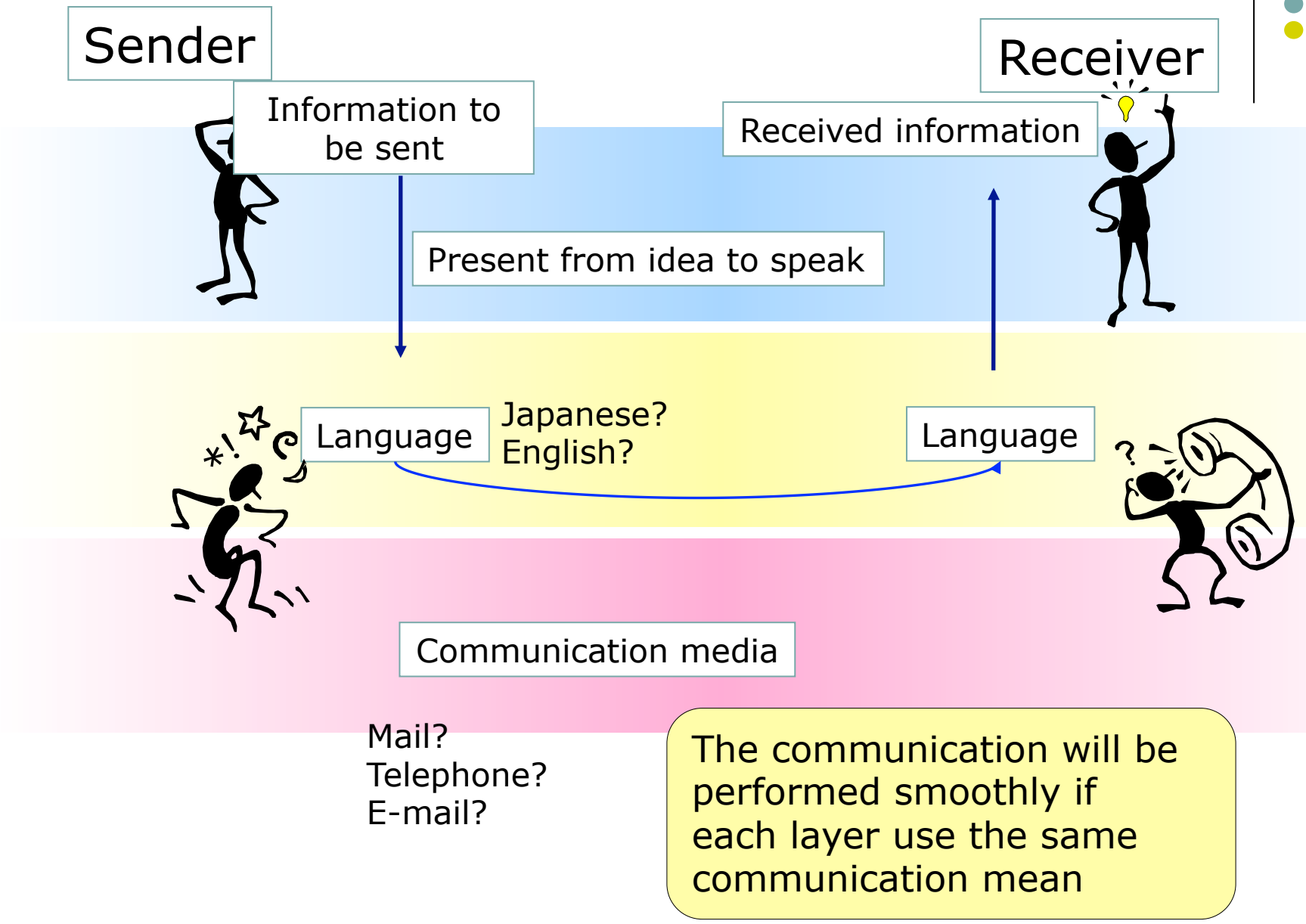


- Layer architecture
- OSI & TCP/IP reference model
- Addressing
- Domain name and conversion/resolution of domain name

# Layer architecture



# Example of different functionalities in human communication



# Example of layers

Architecture with layers

Sound system

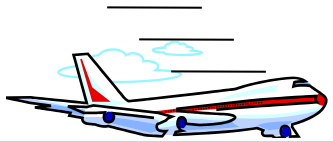
Player
Speaker
Amplifier

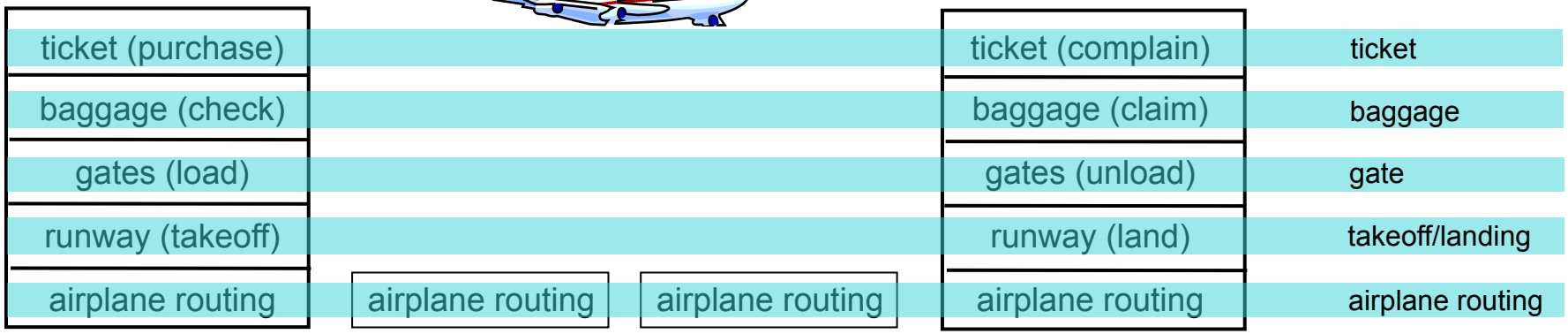
Architecture without layers

Cassette

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

# Layering in airlines

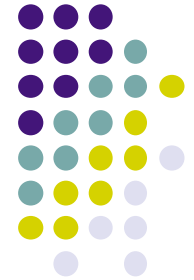





Tầng: Each layer provide 1 service.

- Based on the functionality of that layer
- Using the service of the lower layer.

# Why we need layering systems?

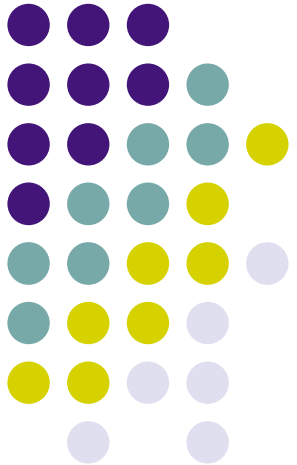


- For the complex system: principle of *" devide and conquer"*
- Allow to determine the responsibility of each layer and the relationship amongst them
- Allow to maintain and upgrade easily the system
  - Changes in some parts do not influence the other parts.
  - Ex: upgrade a media lecture from CD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

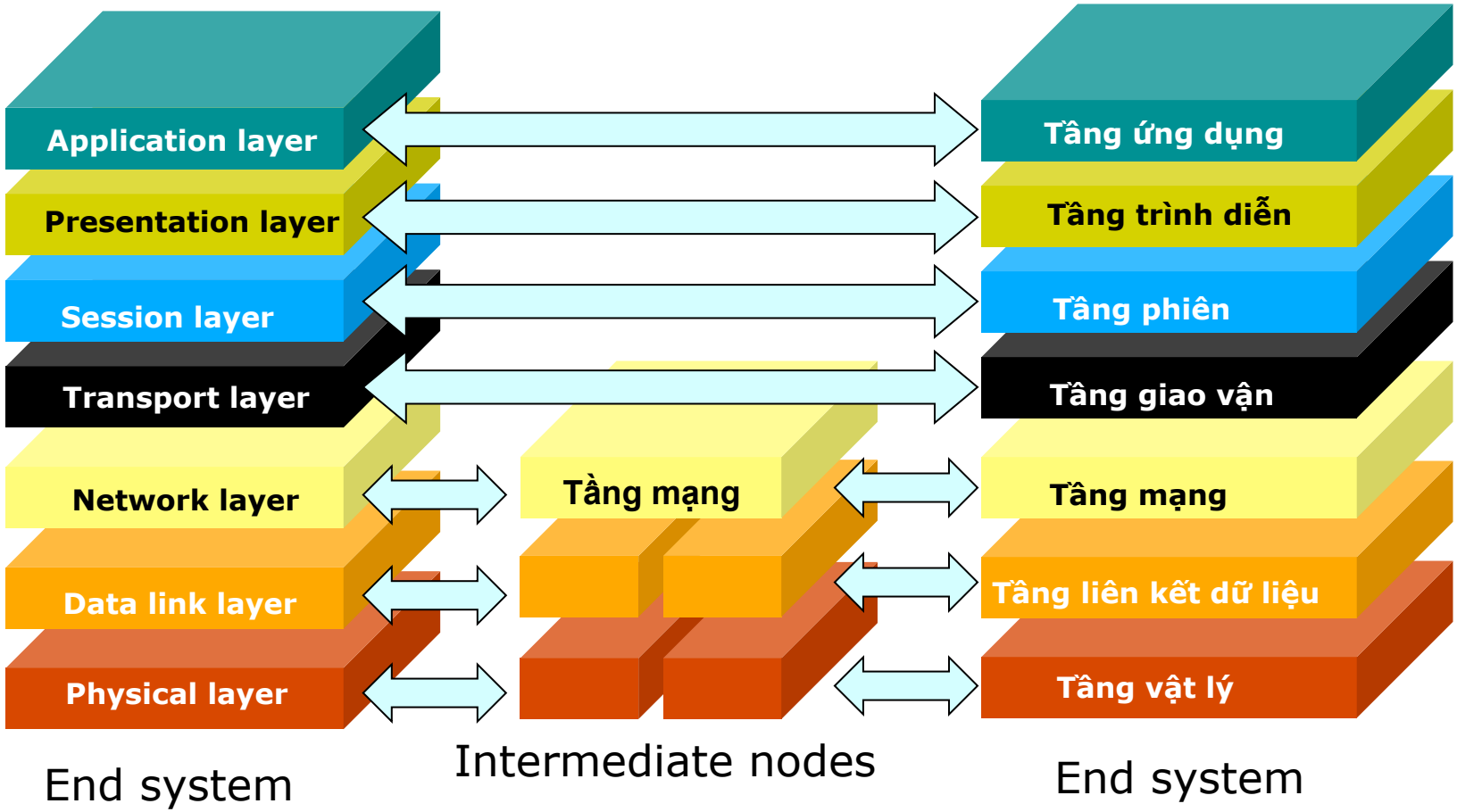
# Reference models

OSI

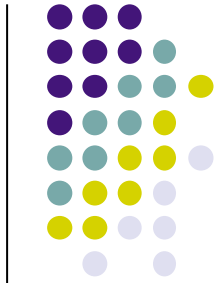
TCP/IP



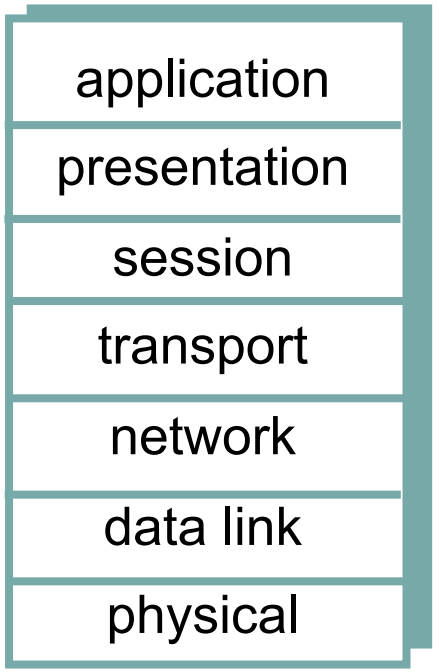
# OSI - Open System Interconnection: 7 layers



# The main functionality of each layers

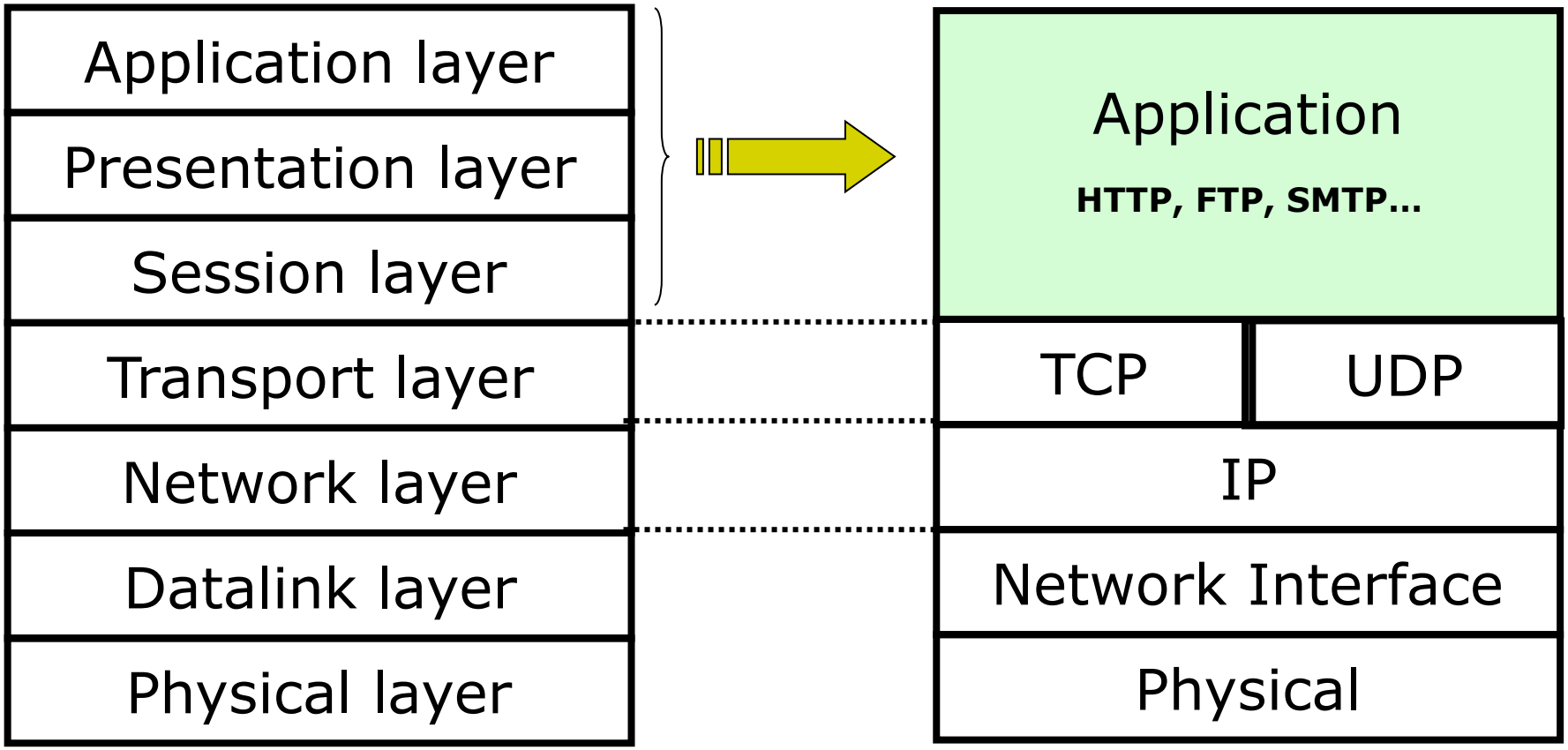


- Physical layer: Transfering bits “over medium”
- Datalink layer: Transfering data between direct connected elements in the networks.
- Network layer: Routing, forwarding data from the source to the distant destination
- Transport: Transmitting data between applications
- Session : synchronization,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



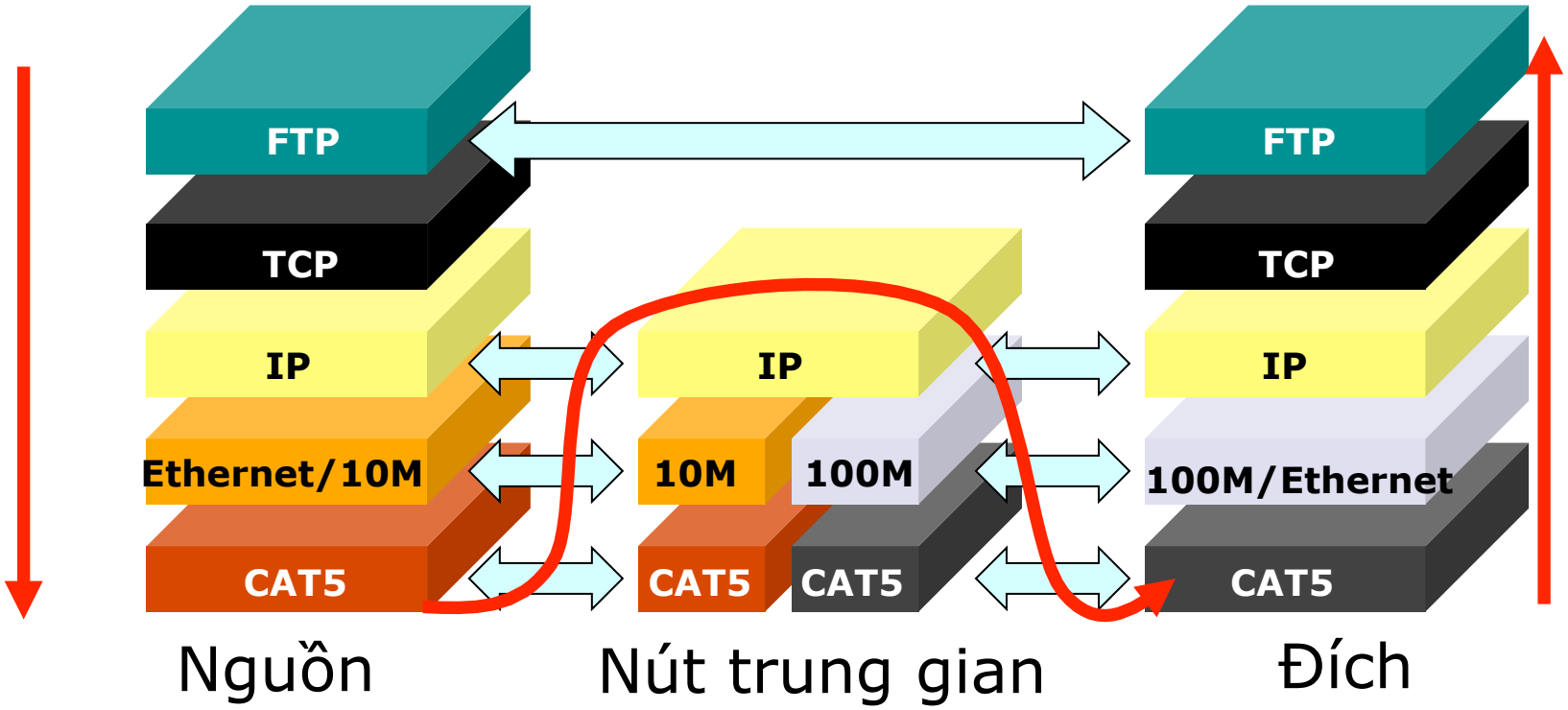
# Models OSI and TCP/IP

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



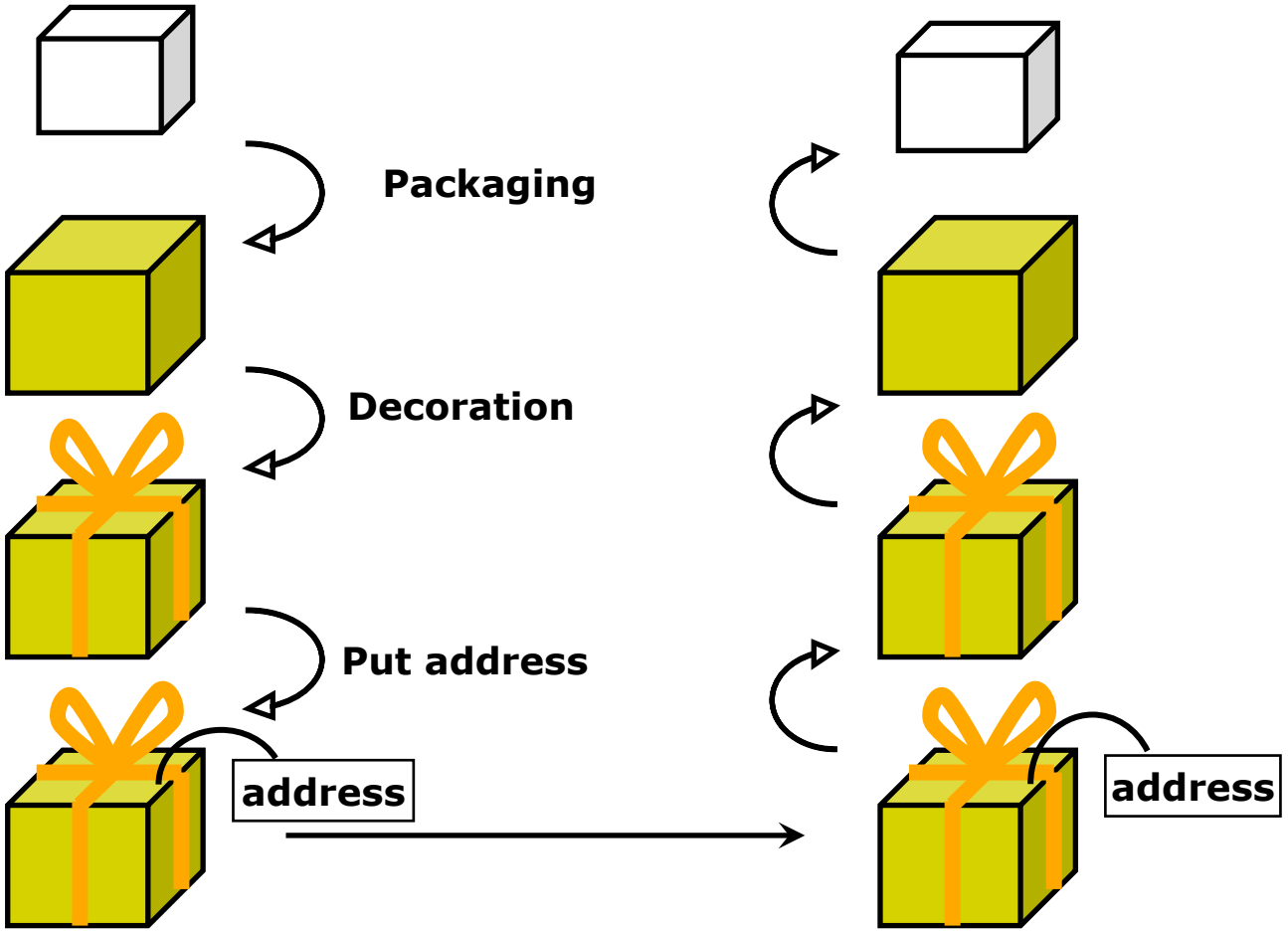
# Layering model of the Internet

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

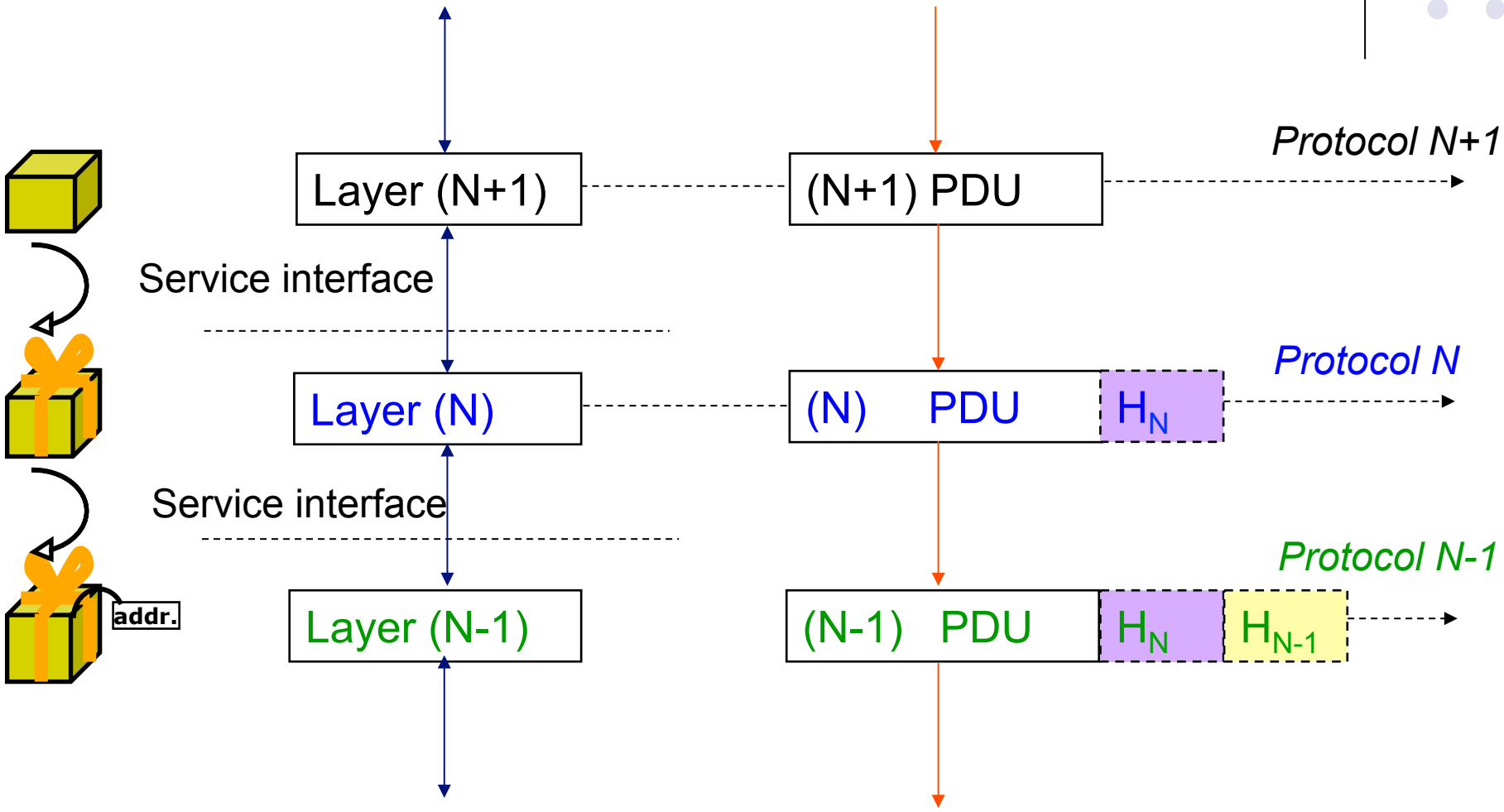


# Data Encapsulation

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

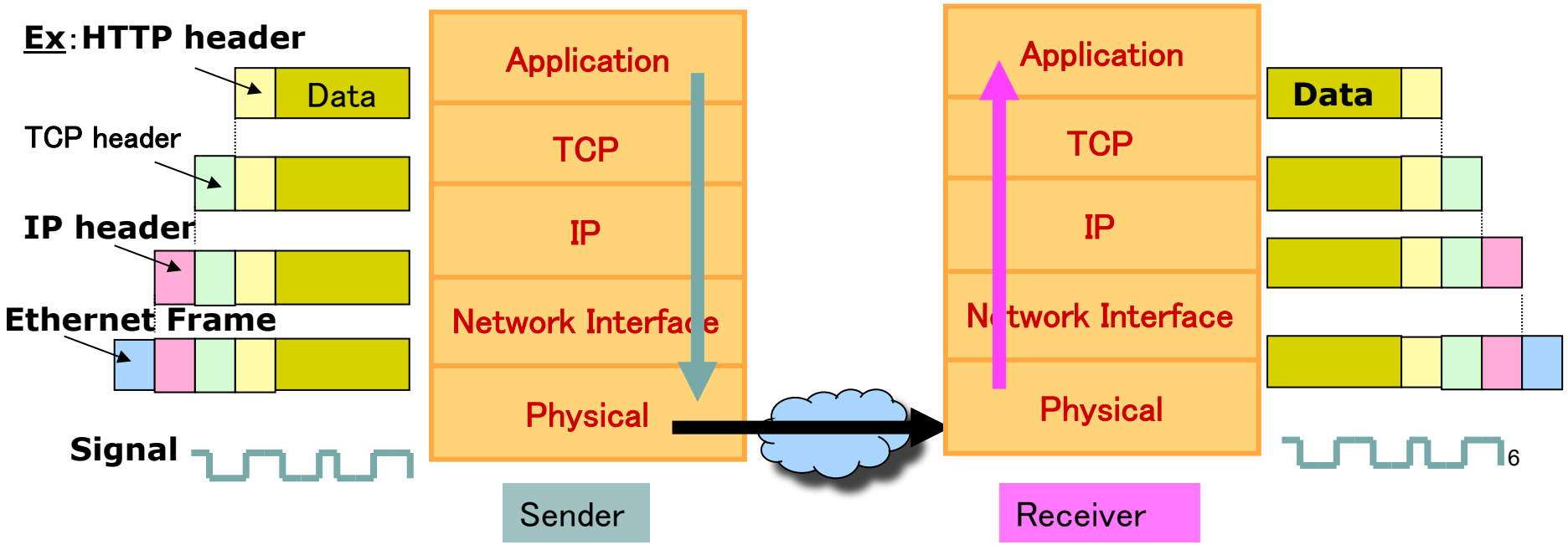


# PDU: Protocol Data Unit

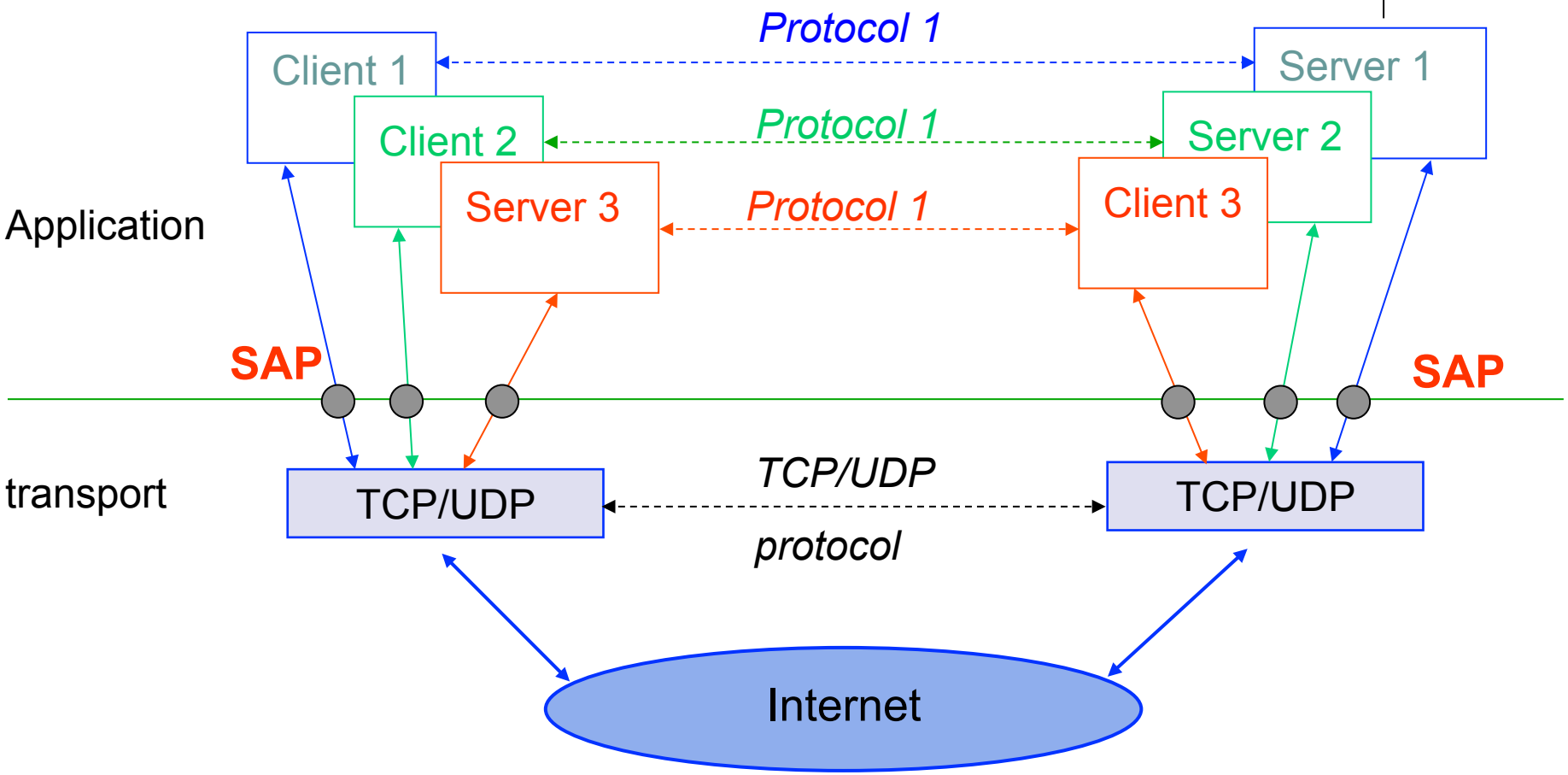


# The protocols TCP/IP and encapsulation process

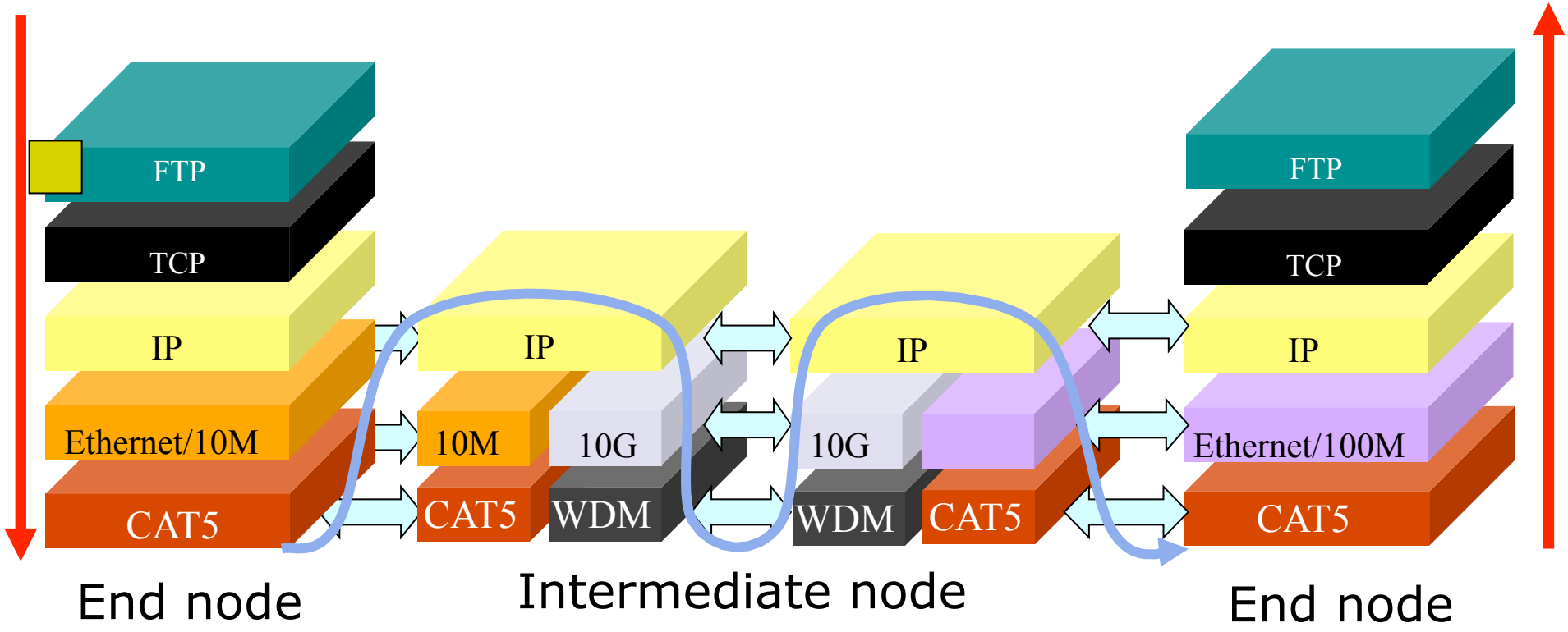
- At sender
  - Each layer add control information to the header of packet and transfer to the lower layer.
- At receiver
  - Each layer process packet according to the information of the header, then remove the corresponding header and deliver the remaining data to the upper layer.



# SAP: Service Access Point

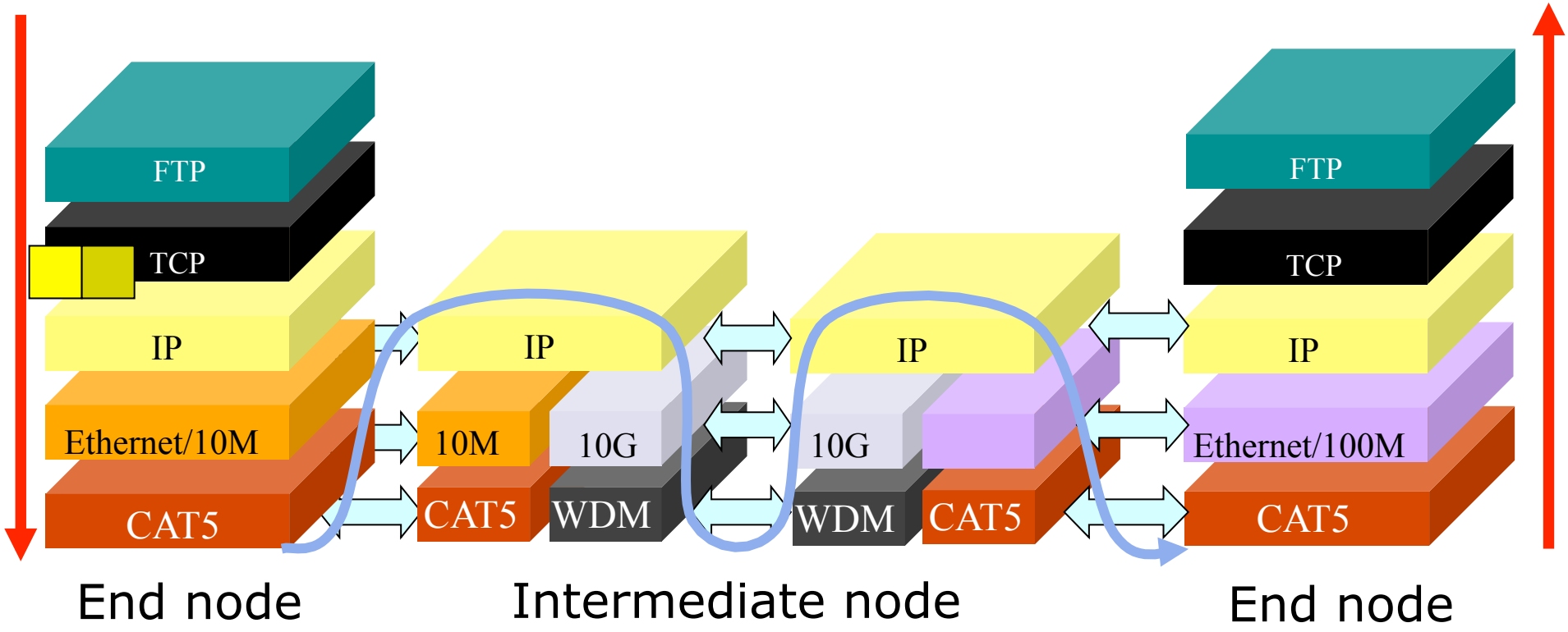


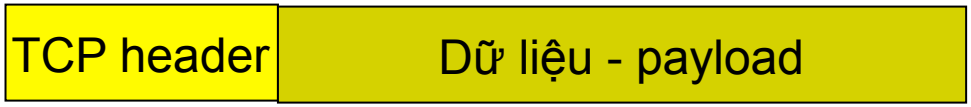
# Protocol stack and encapsulation



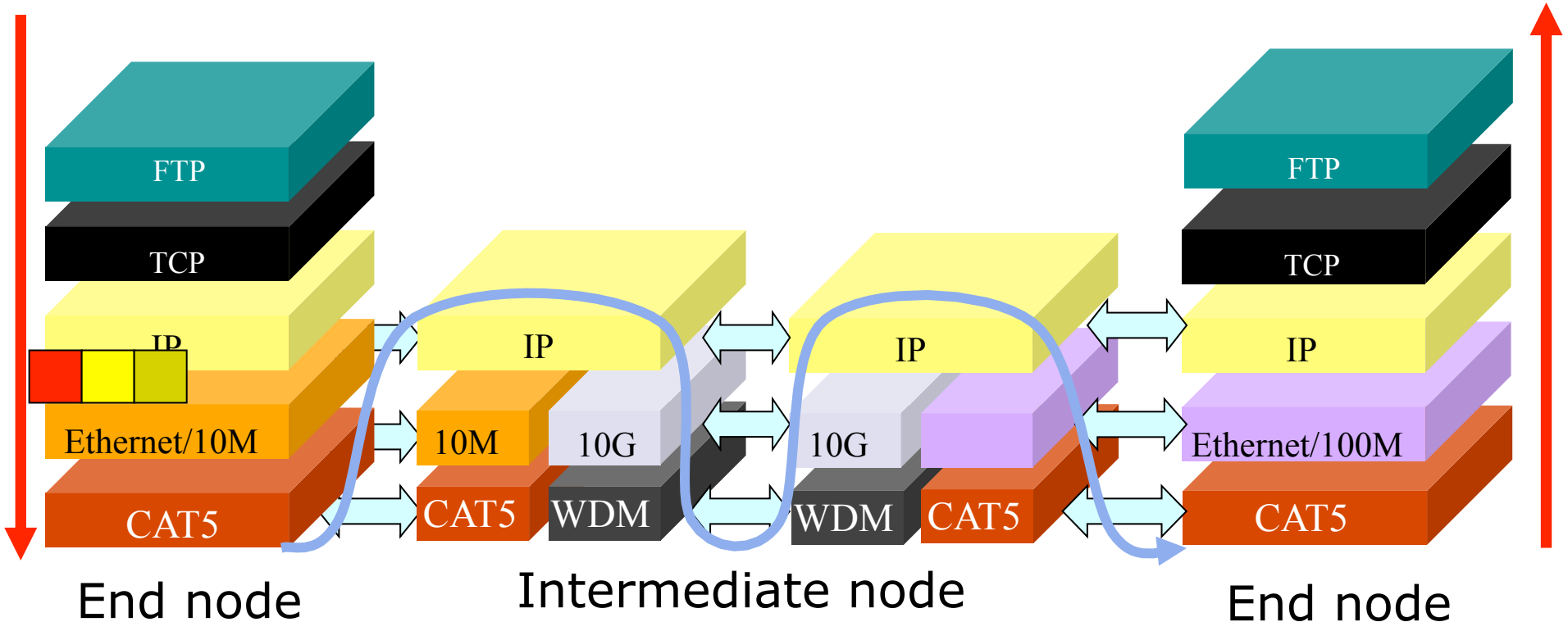

Dữ liệu - payload

# Protocol stack and encapsulation

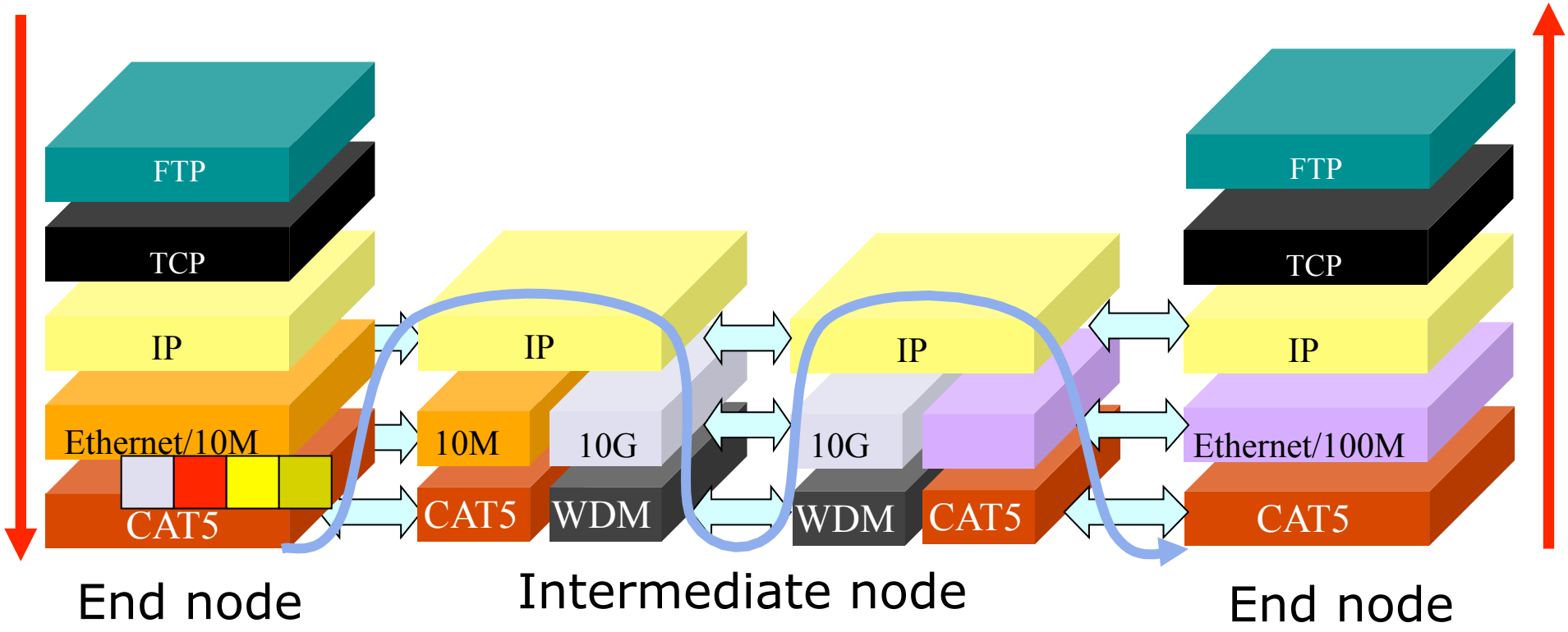


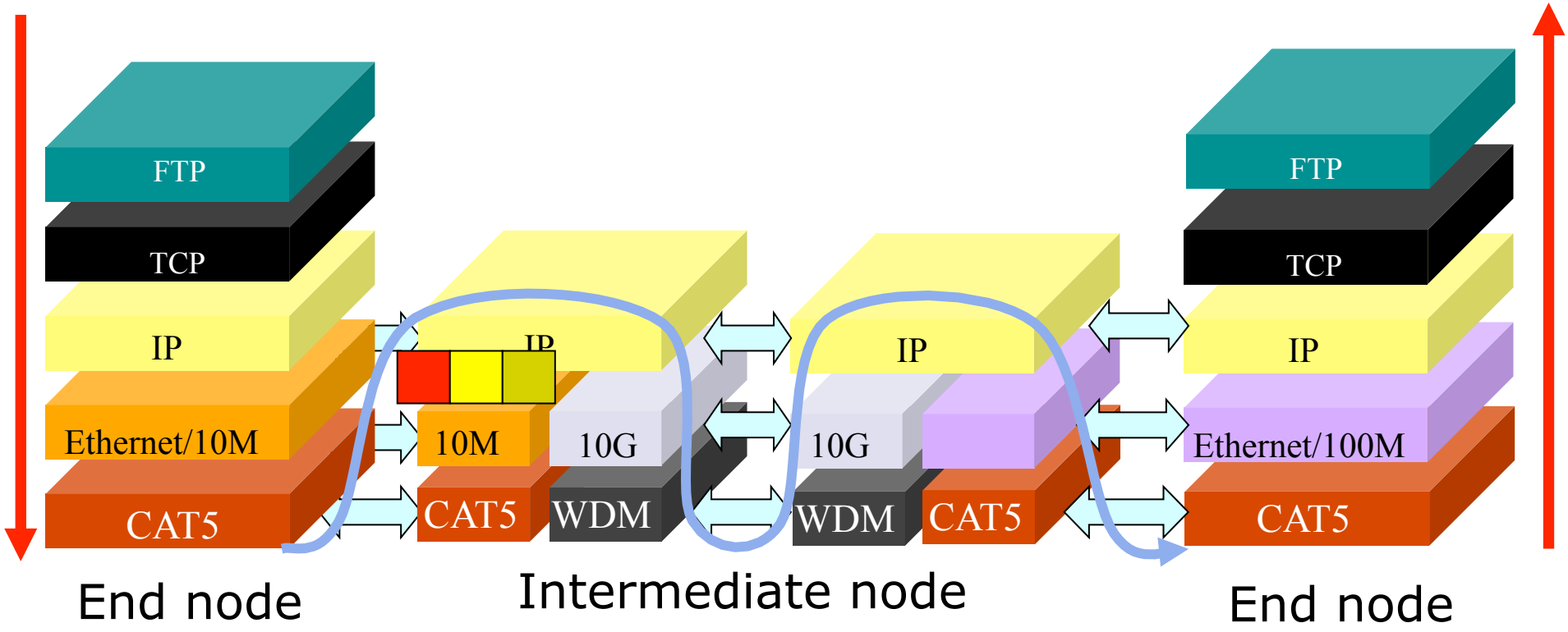
# Protocol stack and encapsulation



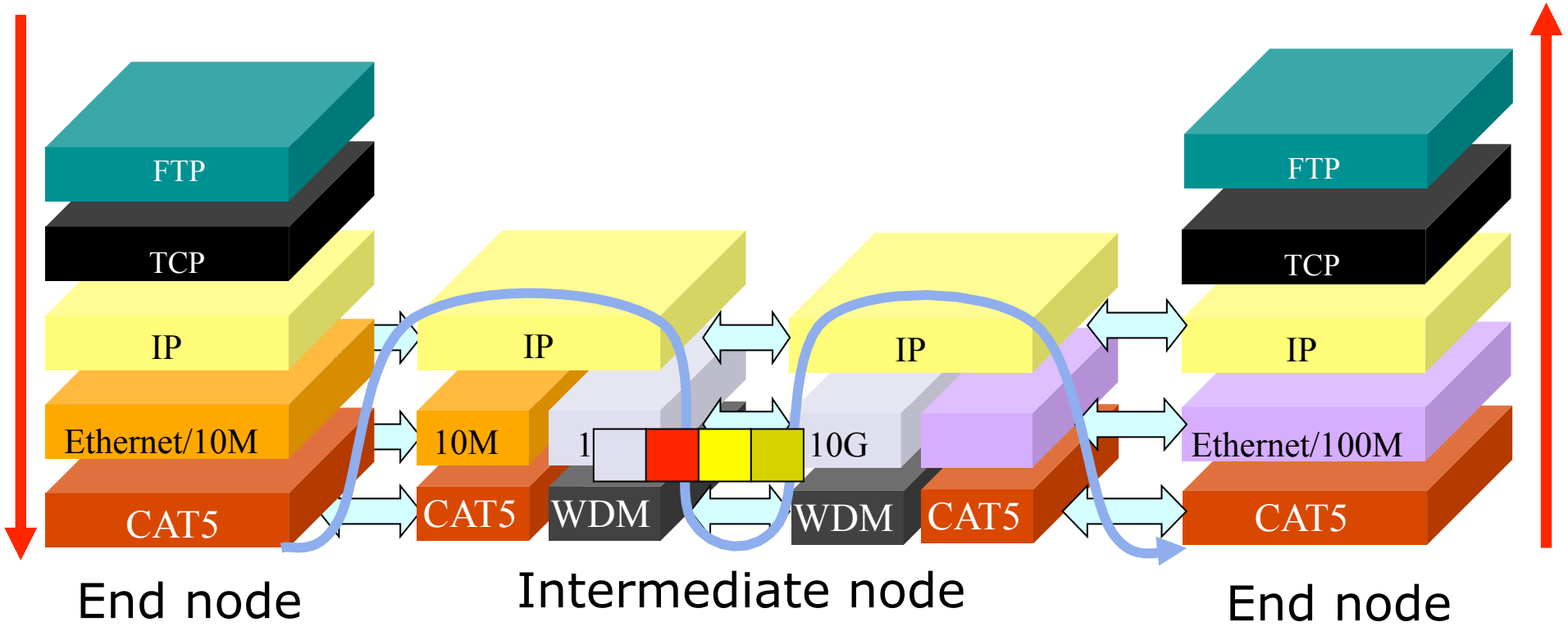

# Protocol stack and encapsulation



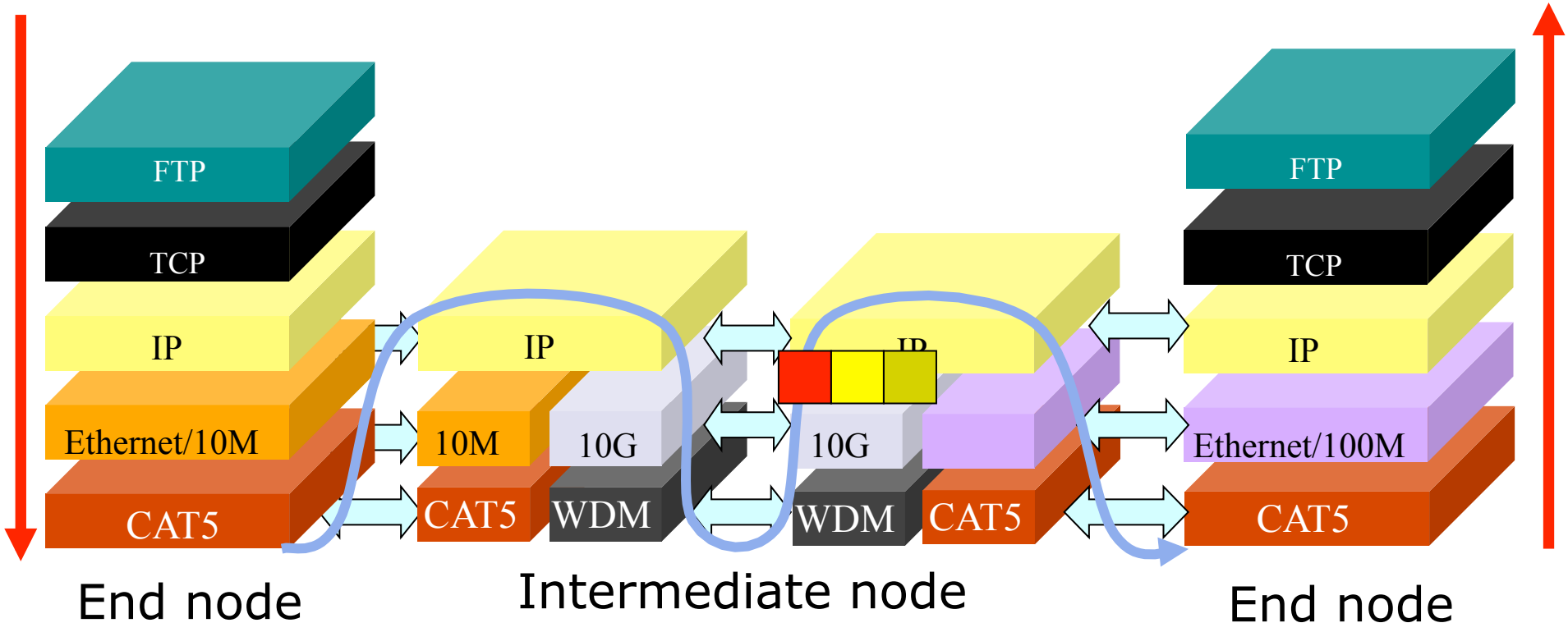

# Protocol stack and encapsulation



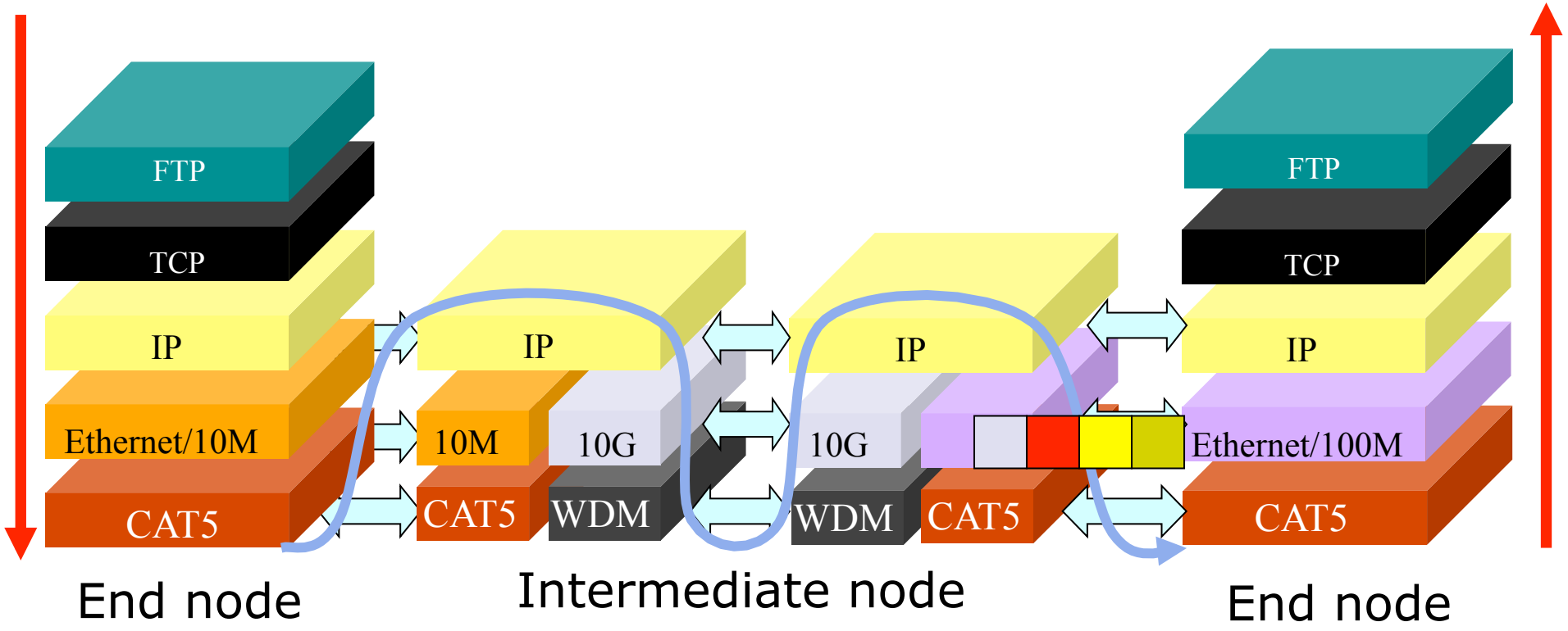

# Protocol stack and encapsulation



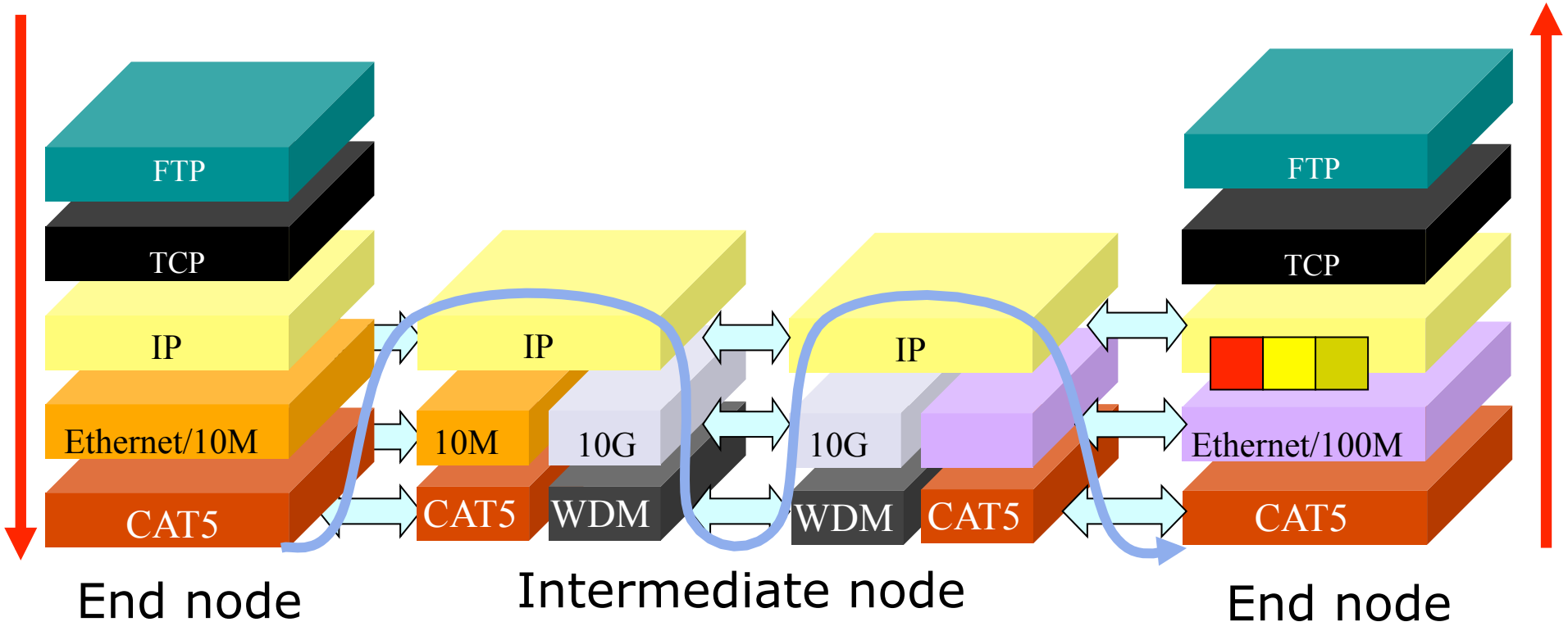

# Protocol stack and encapsulation



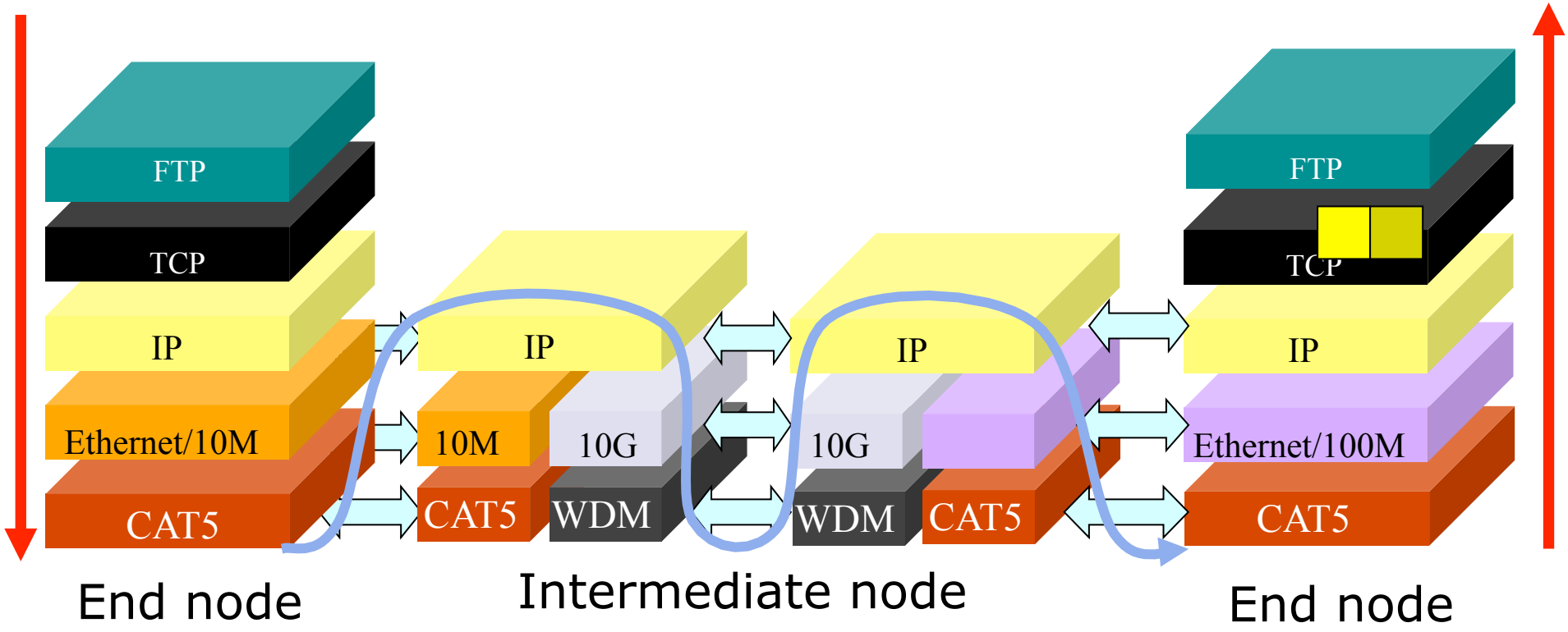

# Protocol stack and encapsulation



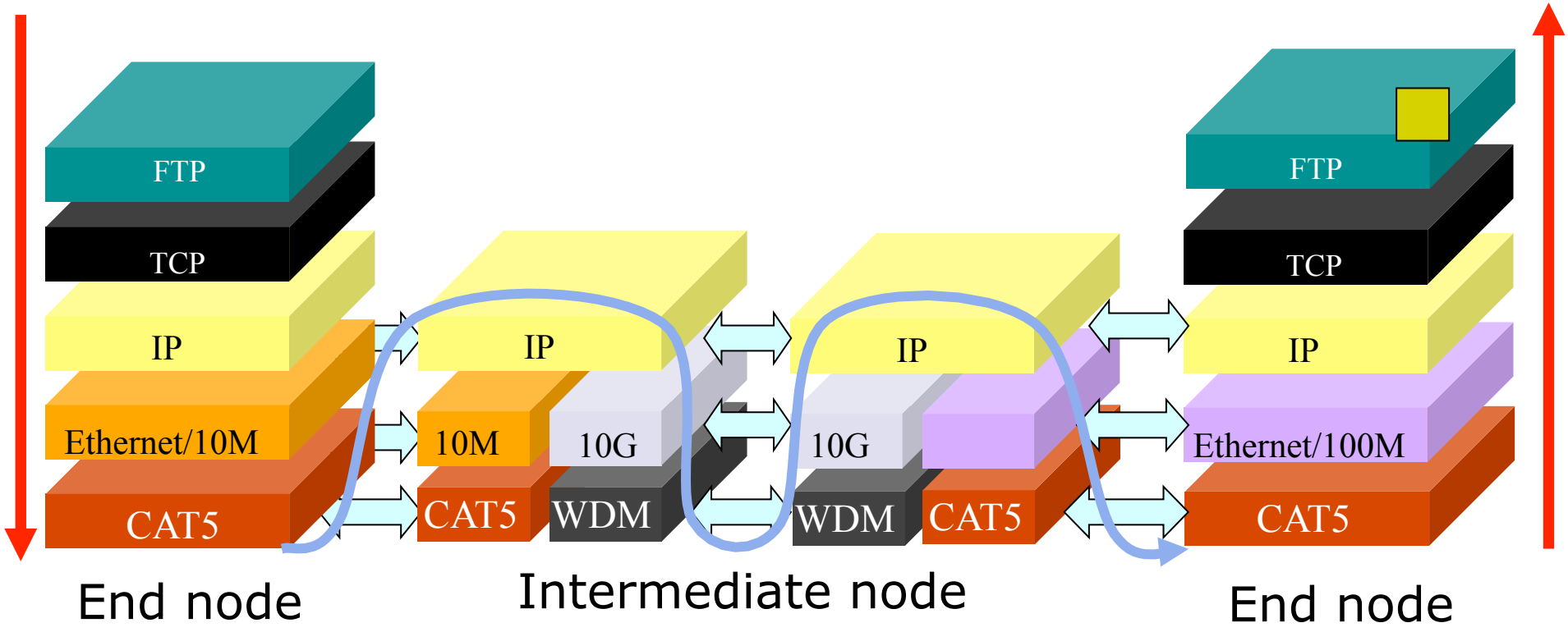

# Protocol stack and encapsulation




# Protocol stack and encapsulation




# Protocol stack and encapsulation




Dữ liệu - payload

# Summary: Advantage of layering architecture

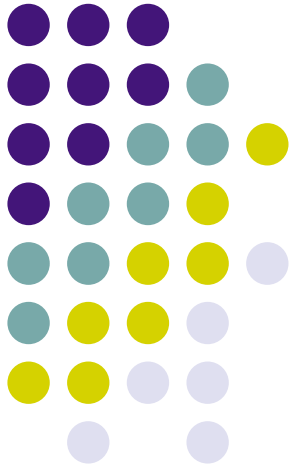
- Layering architecture allows to divide the functionalities of networks into small components
- Layers are independent:
  - An upper layer makes use of the functionality of its right bellow layer but does not care about further layer.
- Extensibility/Scalability
- Flexible
  - It is possble to upgrade 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.

# Identification in the Internet

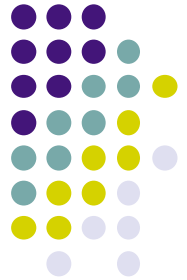
MAC Address

IP Address

Port number



# Identification

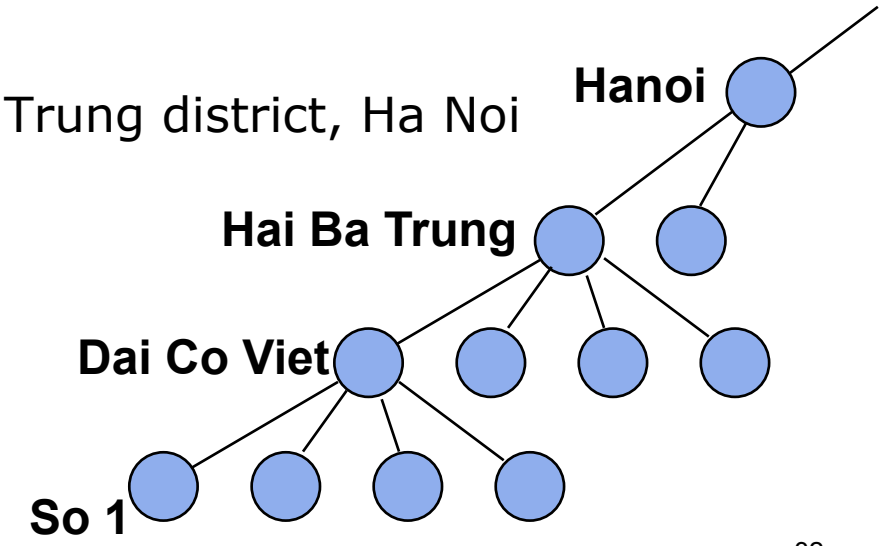


- Identification allows identify a person or an object
  - Name
    - Nguyen Thuc Hai
  - Address
    - 1 Dai Co Viet, Hai Ba Trung, Ha Noi
  - Telephone number
    - 8680896
  - Email
    - hai--xxx@it.hut.edu.vn

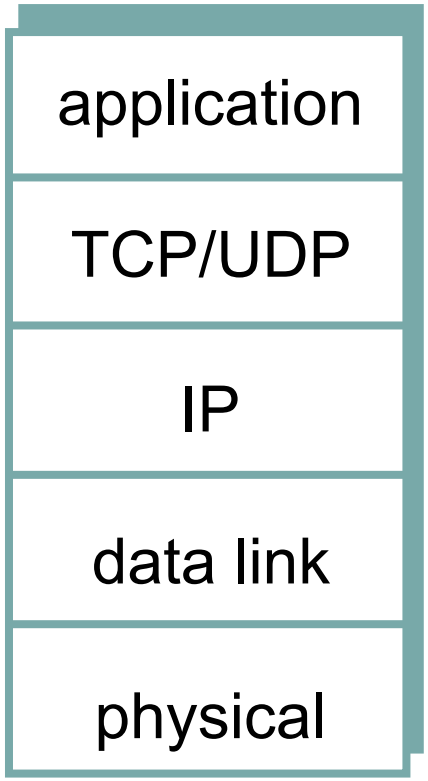
# Identification

- 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




Port Number, e.g. Port 80

IP address, e.g. 203.12.15.165

Physical address / MAC address
e.g. 00:11:24:79:8e:82

# Addressing in the Datalink layer

- Physical address/ MAC address
  - Using in Datalink layer
  - Fixed on NIC (Network Interface Card)
  - Used for identifying machine in broadcast network segment.

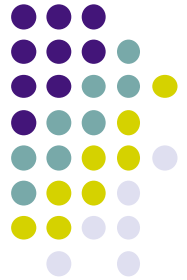
HEX 00:11:24:79:8e:82

BIN 00000000 00010001 00100100 01111001 10001110 10000010

OUI — Gán bởi nhà sản xuất

OUI (Organizationally Unique Identifier):
Each Manufacture have an some OUI unique

# 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
    - Buiding 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 …

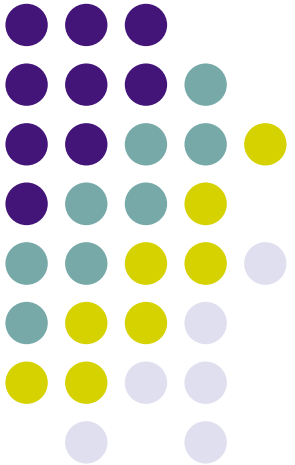
# Mapping to address

Domain name

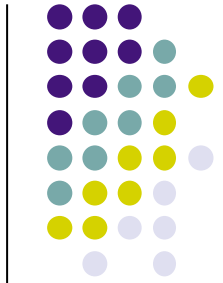
Domain name resolution

nslookup

arp

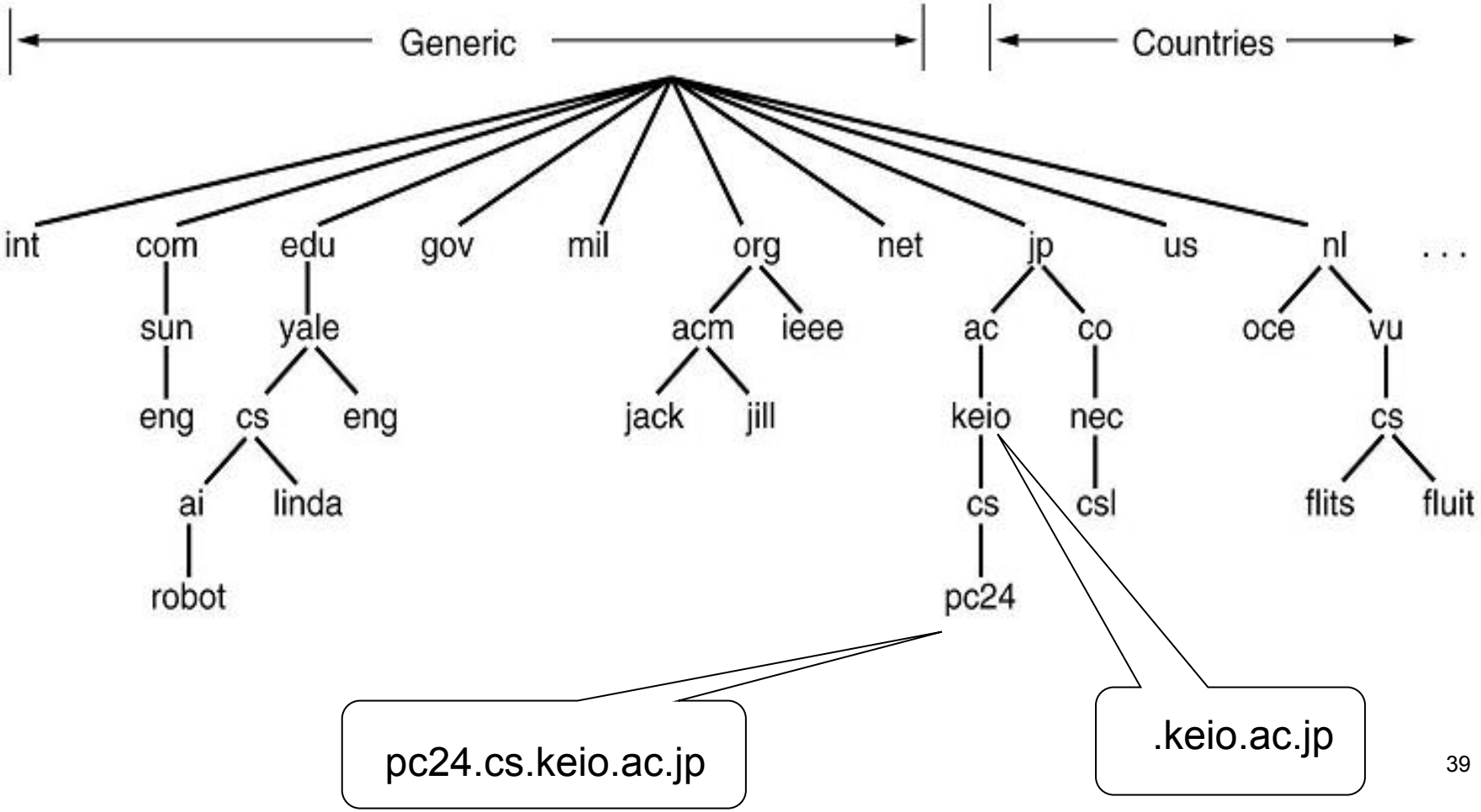


# Domain name



- 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

# Conversion/resolution of address

- Computer prefers numbers
- Human prefers names

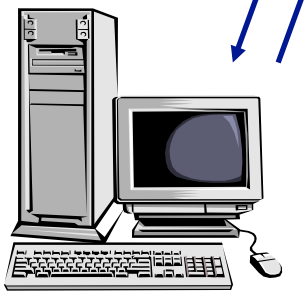
Need address conversion

User

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

Need to access to 202.47.142.40

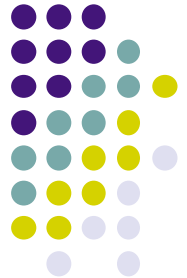
Domain name server



Webserver of www.hust.edu.vn 202.47.142.40

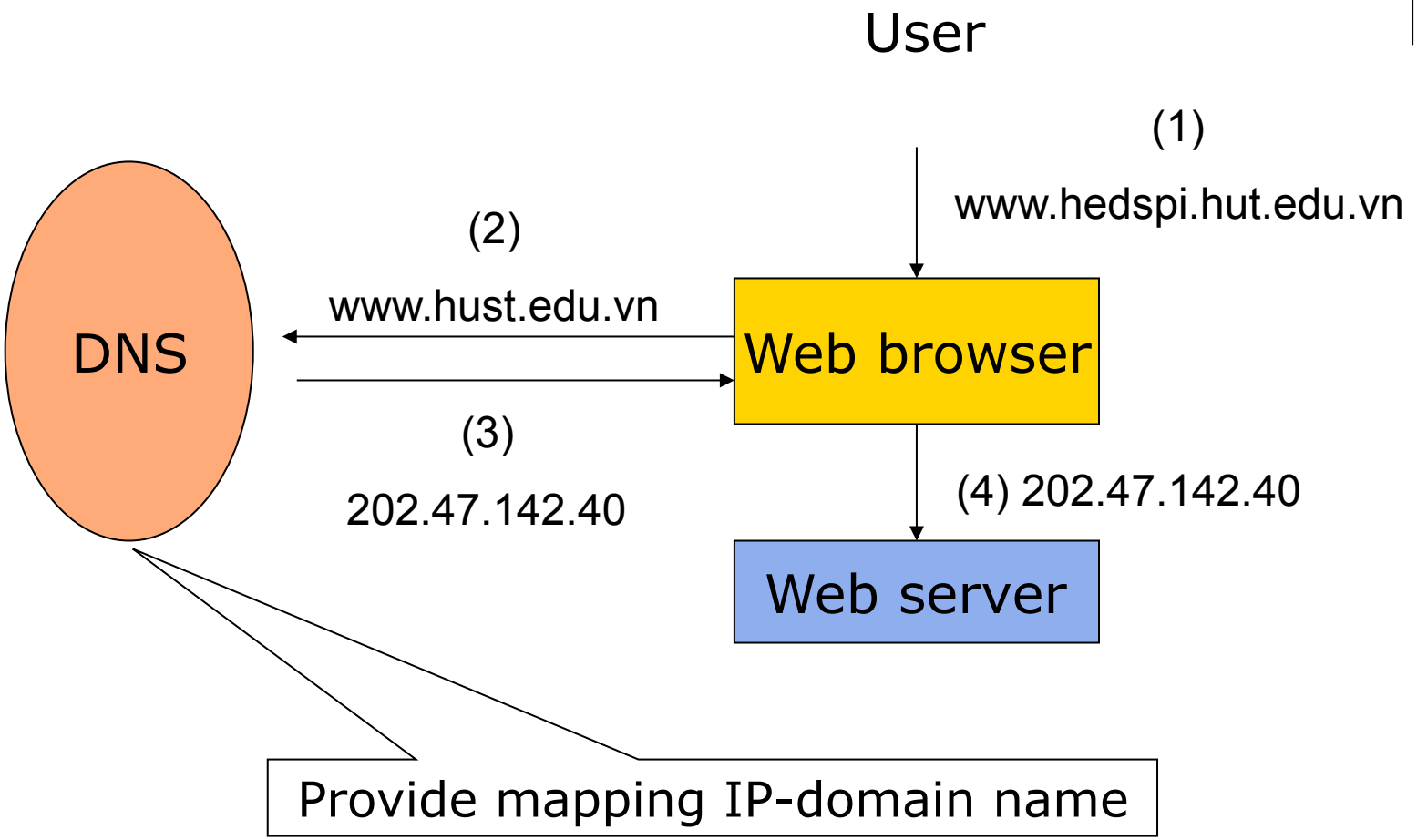
*If user knows the IP address of the webserver, he can access via IP address from Browser*

# Address resolution/conversion

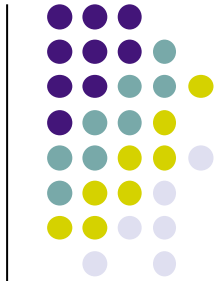


- Concept
  - Mechanism finding address IP from a domain name and vice versa.
  - There is no mathematical formula for this conversion.
- Domain name server (DNS)
  - Store the mapping of IP address and Domain name of the same host in a database
  - Answer requests of resolution of IP or domain name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

# Example


User
(1)
www.hedspi.hut.edu.vn
(2)
www.hust.edu.vn
DNS
Web browser
(3)
202.47.142.40
(4) 202.47.142.40
Web server
Provide mapping IP-domain name

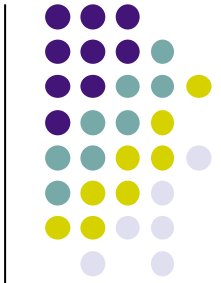
# Nslookup tool on Windows, Linux



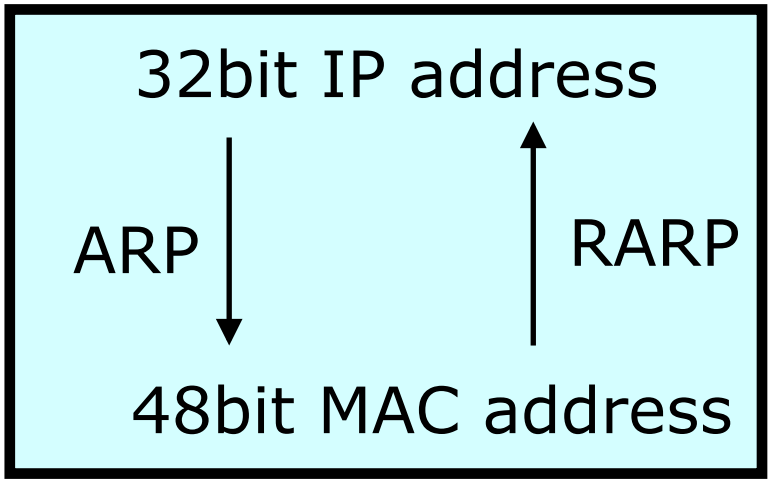
- nslookup www.hedspi.hut.edu.vn
- Conversion "name⇔ IP address"

```
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



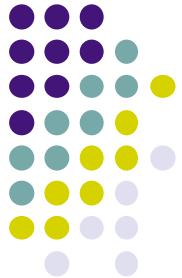
# Example: ARP table (on Windows)

```
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

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

**IP address**

**MAC address**

# Summary



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

# Quizz