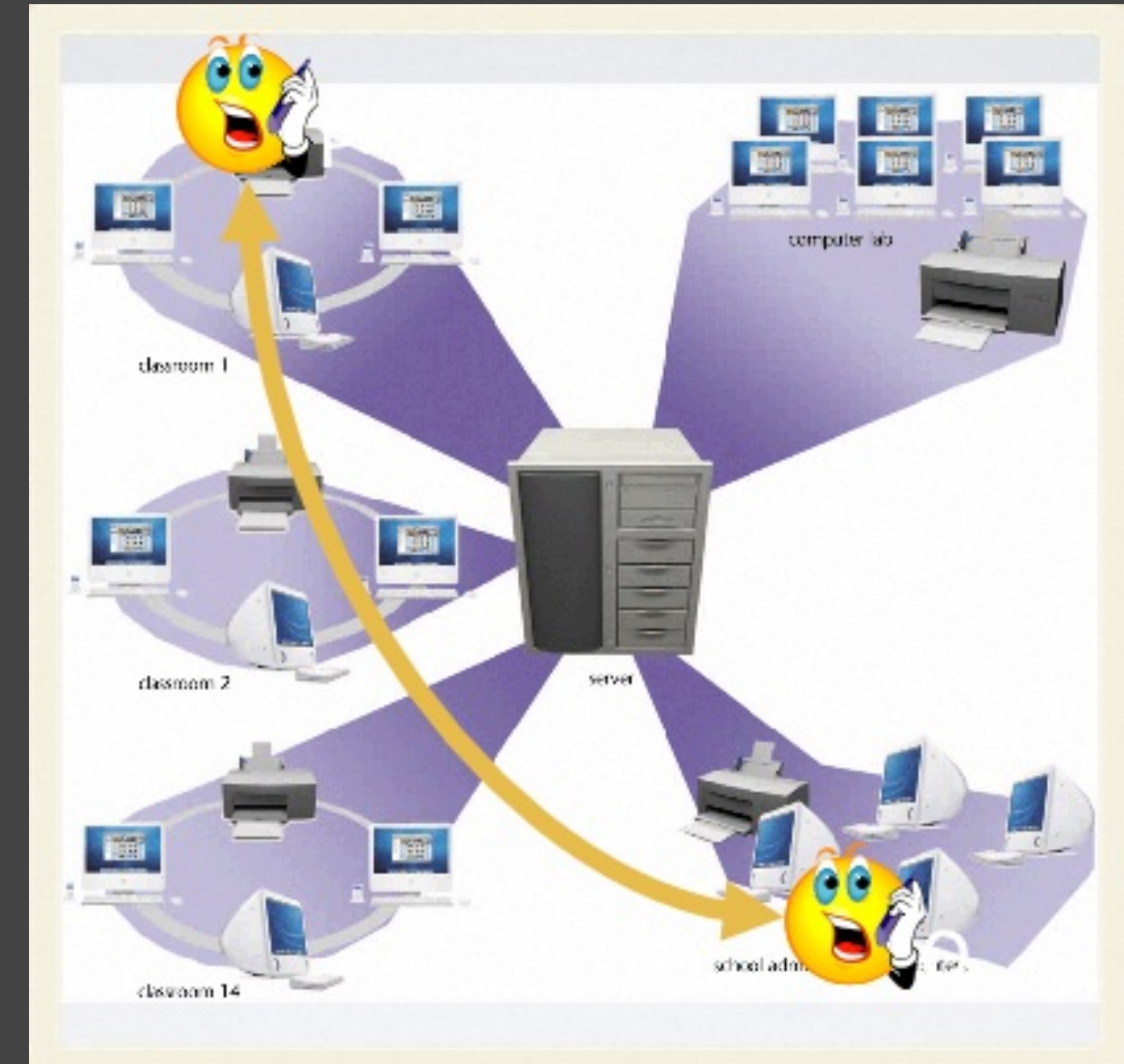
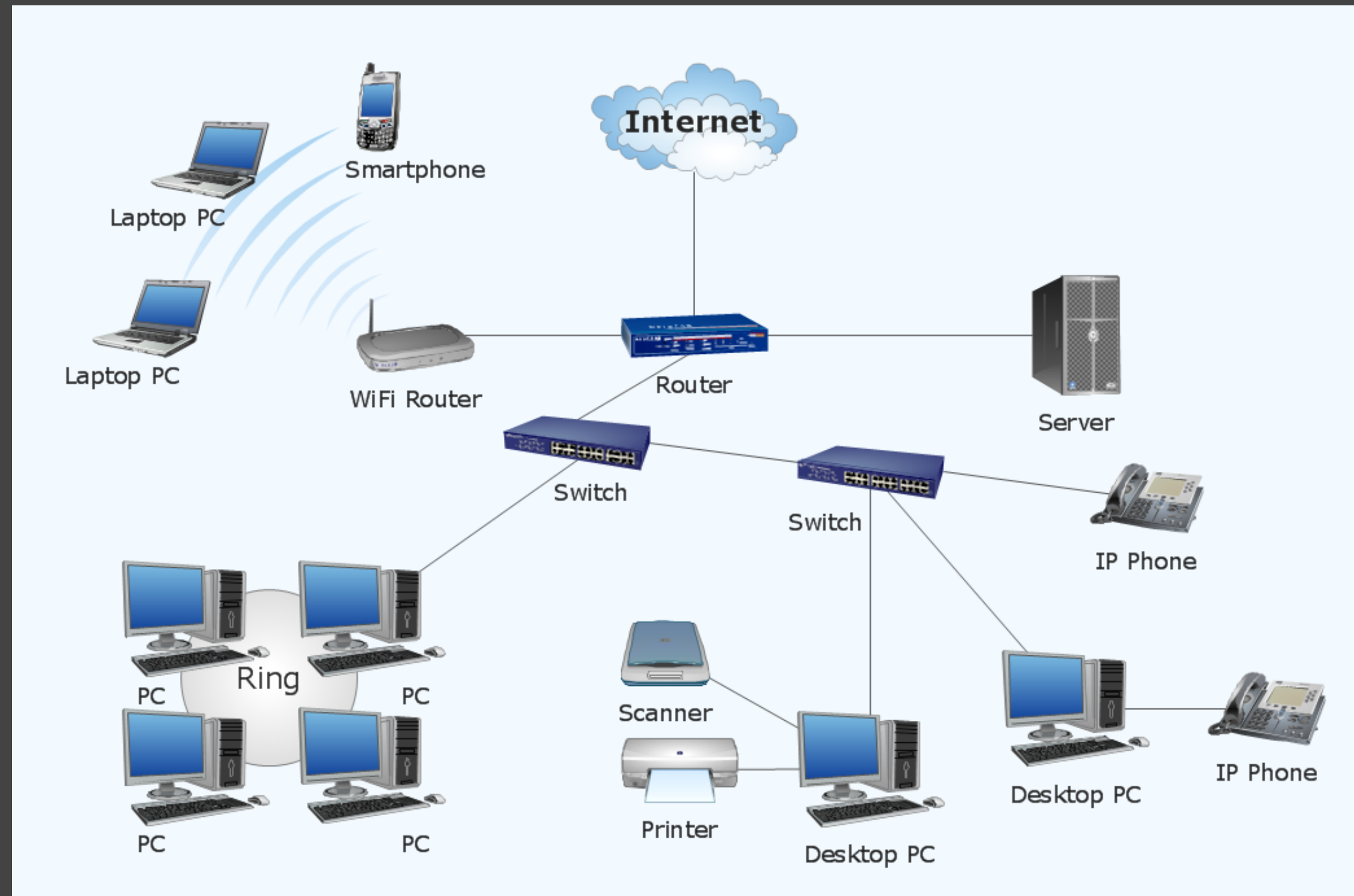


Computer Network Basic

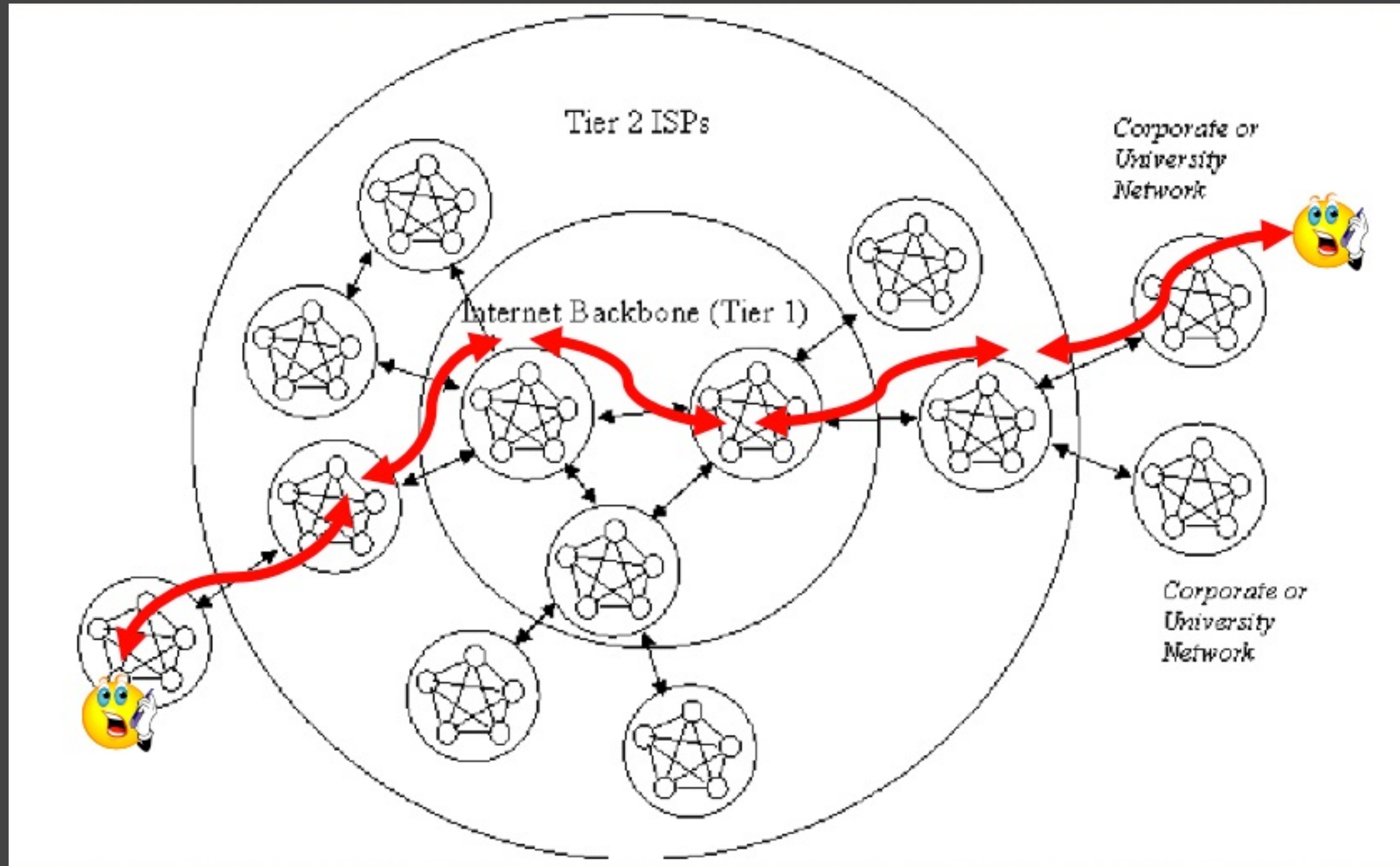
Arthur Pai

THE COMPUTER NETWORK IS...



- An interconnected collection of autonomous computers and devices
- Processes communicate with one another across the network
- Such communication is often transparent to end-users

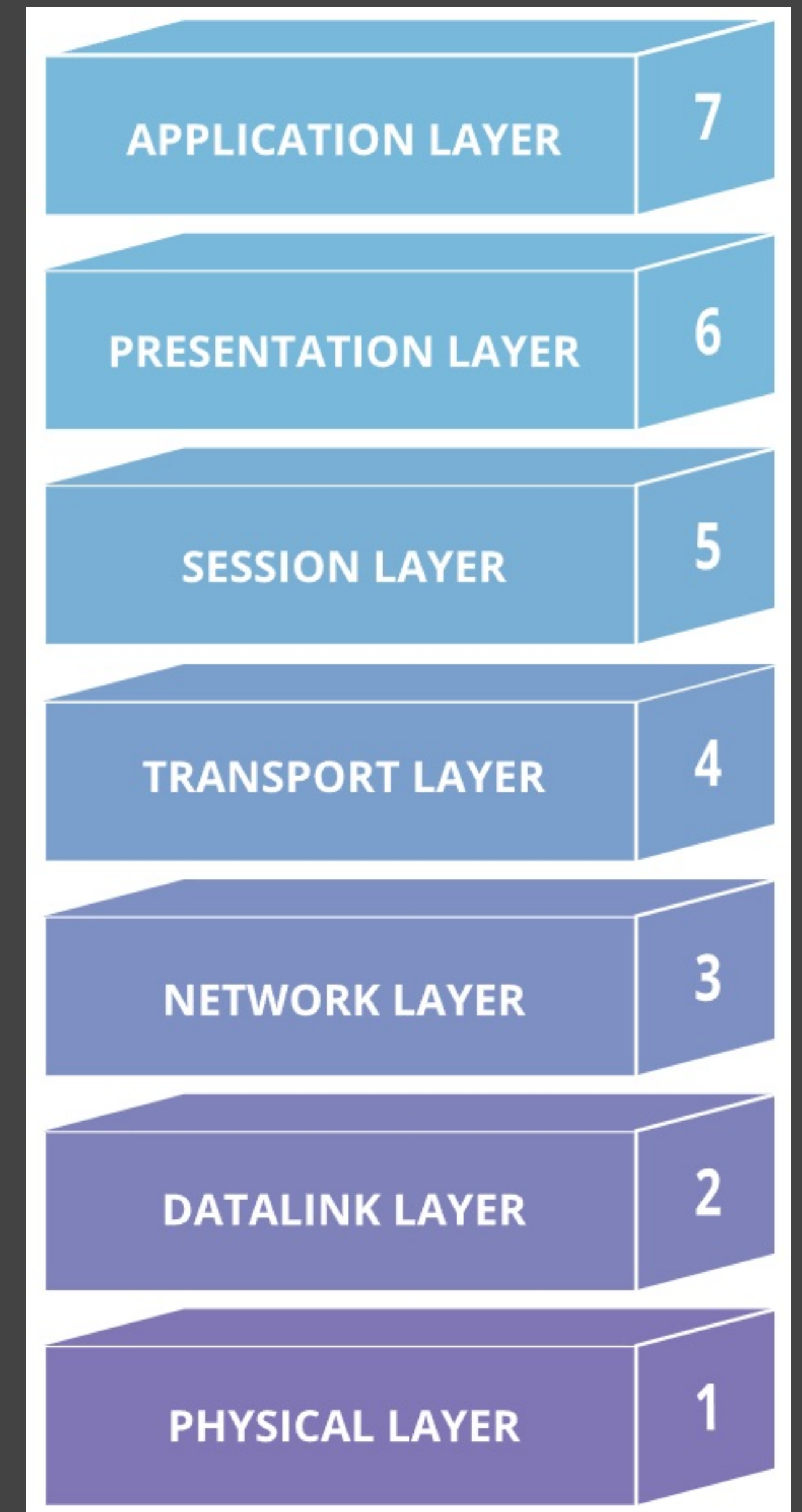
THE COMPUTER NETWORK IS...



BASICS

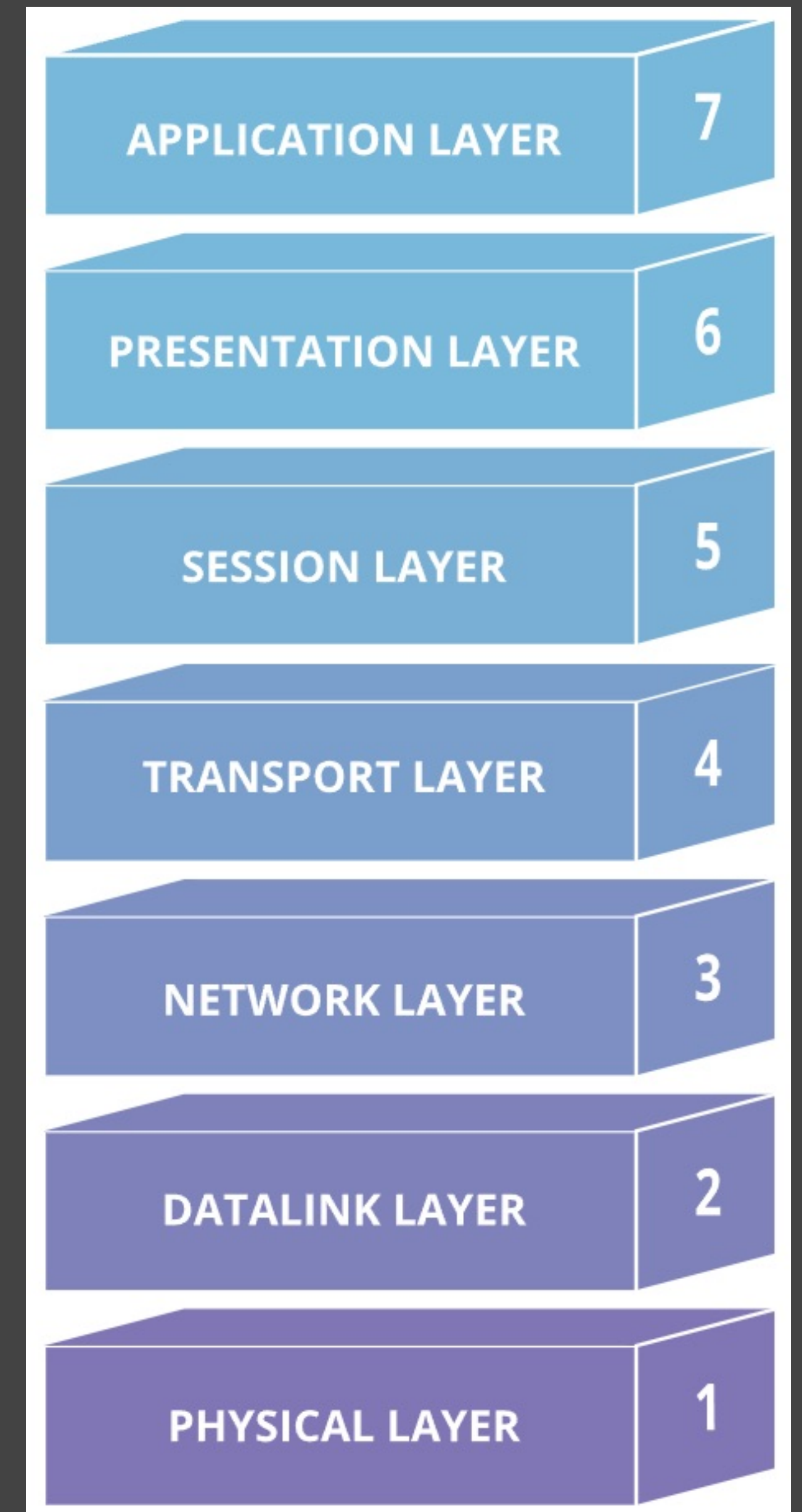
The **OSI** Reference Model 網路七層

- **O**pen **S**ystem **I**nterconnection
- The **I**nternational **S**tandards **O**rganization (**ISO**) proposal for the standardization of the various protocols used in computer networks
- The **Seven-Layer** protocol stack



BASICS

7. 應用層: HTTP, HTTPS, FTP, Telnet, SSH, SMTP, POP3, [Socket Programming](#)
6. 表達層: 把數據轉換為能與接收者的系統格式相容並適合傳輸的格式
5. 會議層: 負責在數據傳輸中設定和維護電腦網路中兩台電腦之間的通訊連接
4. 傳輸層: 把傳輸表頭(TH)加至資料以形成封包。傳輸表頭包含了所使用的協定等傳送資訊。[TCP, UDP](#)
3. 網路層: 決定數據的路徑選擇和轉寄，將網路表頭(NH)加至數據包，以形成封包。網路表頭包含了網路資料。[網際網路協定\(IP\)](#)
2. 資料連結層: 負責網路尋址、錯誤偵測和改錯。[乙太網路, MAC位址](#)
1. 實體層: 用來定義網路裝置之間的位元資料傳輸，也就是在電線或其他物理線材上，傳遞0與1電子訊號



BASICS

應用層(Application Layer)

表現層(Presentation Layer)

會談層(Session Layer)

傳送層(Transport Layer)

網路層(Network Layer)

資料鏈結層(Data Link Layer)

實體層(Physical Layer)

應用層
通訊協定

TCP

UDP

IP

ICMP

ARP

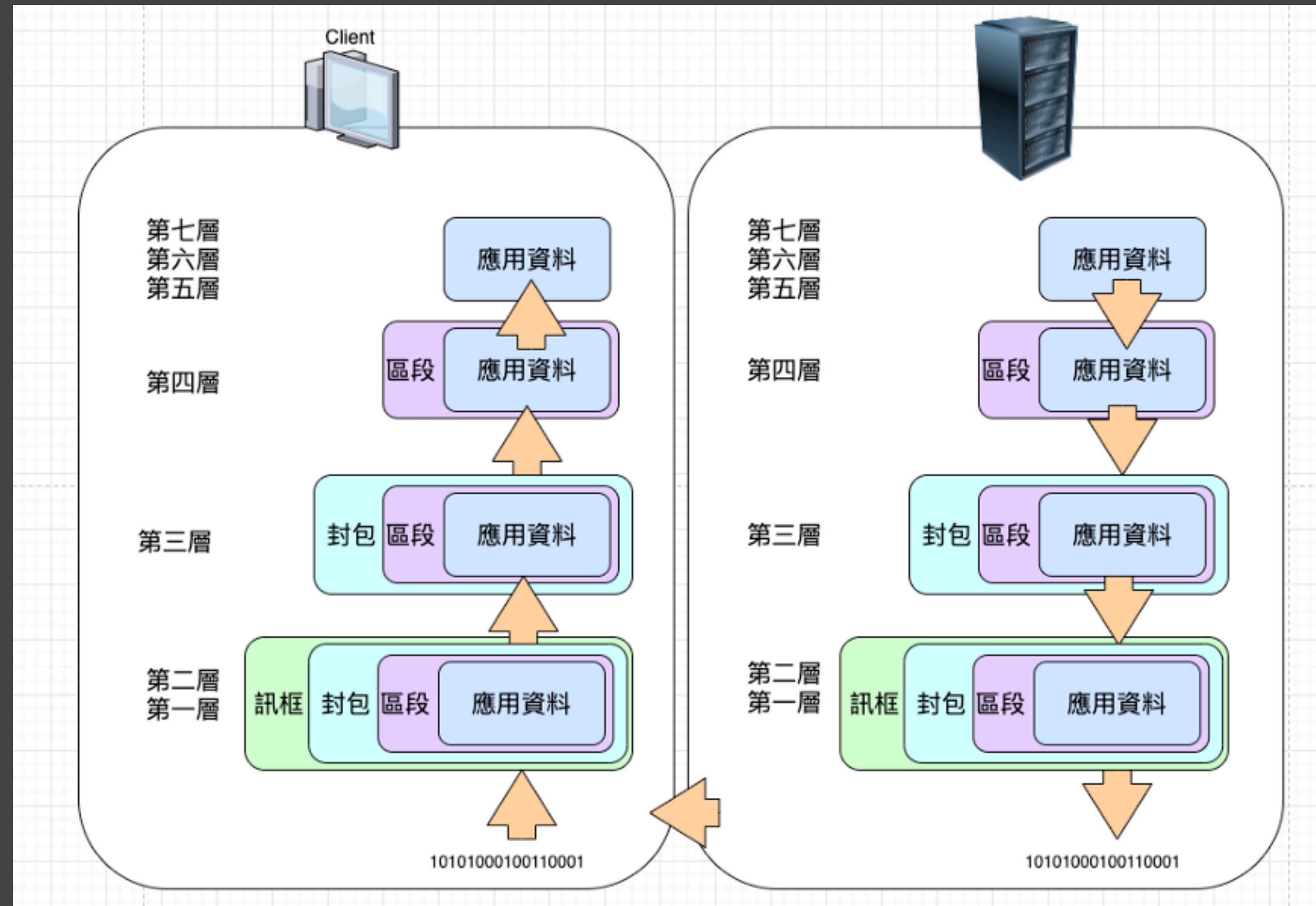
乙太網路
MAC位址

NAT/NAPT
防火牆

Routing
路由器

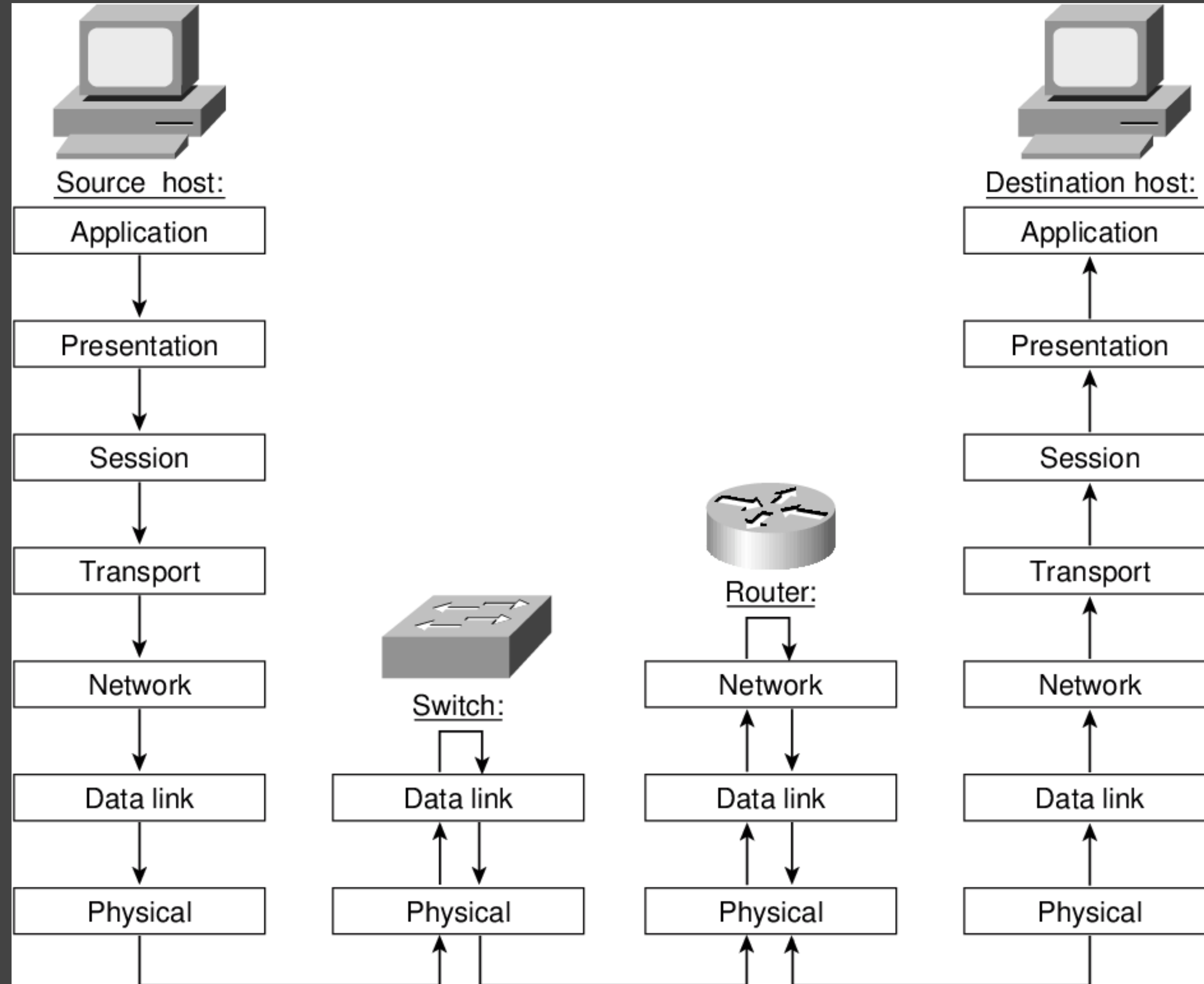
Switching
交換器

MESSAGE PACKING



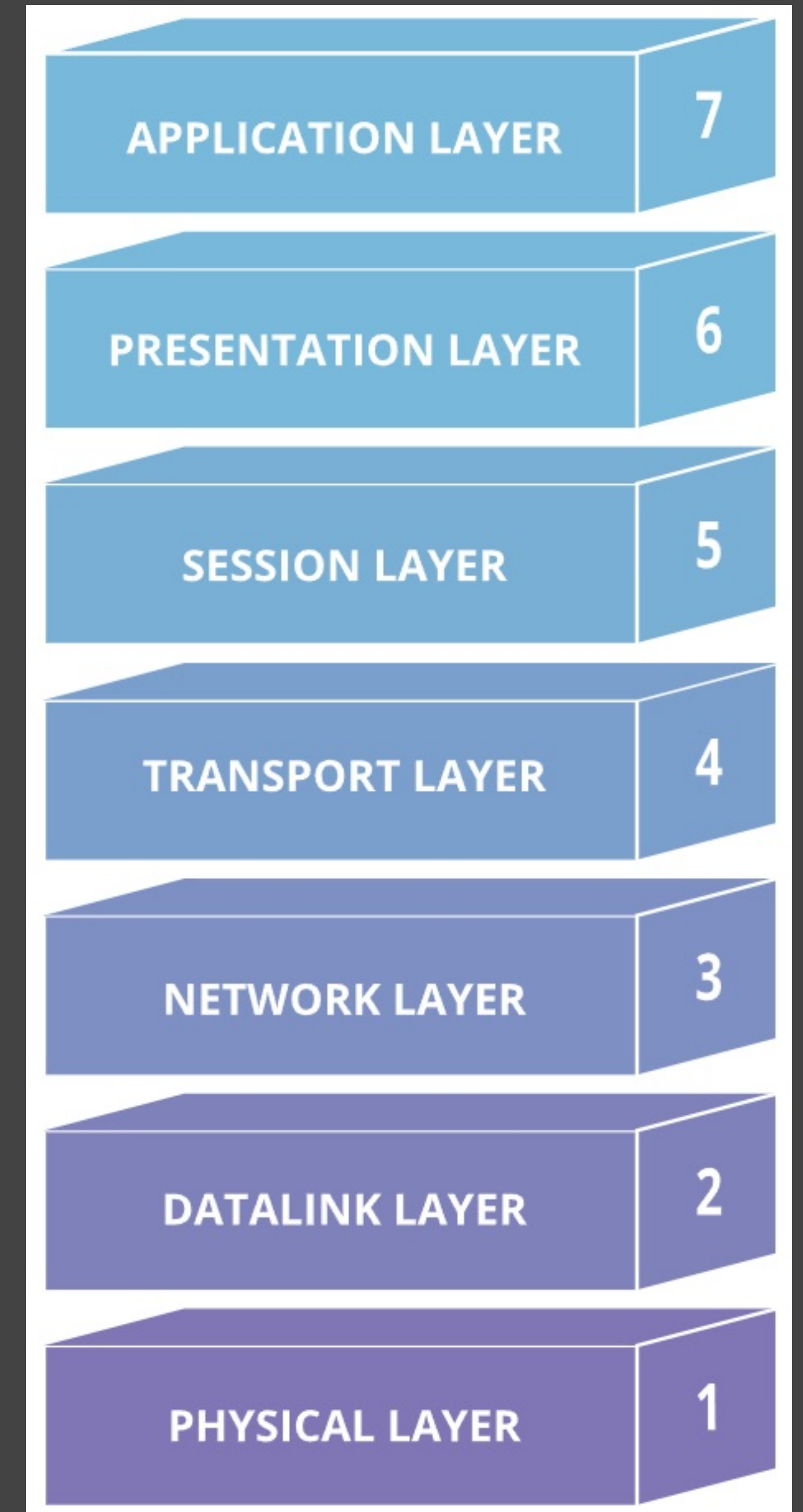
Each layer prepends or appends its information in a *header* or trailer

NETWORK ROUTING



ETHERNET

- **Physical layer**
 - Ethernet physical infrastructure
 - Ethernet encompasses both
 - the data link layer
 - the physical layer
 - IEEE 802.3 standard



ETHERNET

- Every Ethernet interface is assigned a unique **48-bit** (hardware) address
- Represented as a sequence of **6 hexadecimal bytes** delimited by ':' characters
 - **00:50:56:9F:27:3E**
 - **ipconfig** to see network interfaces in windows system
- Also known as **MAC address** or **physical address**
- Ethernet addresses are assigned to vendors by a central authority

ETHERNET



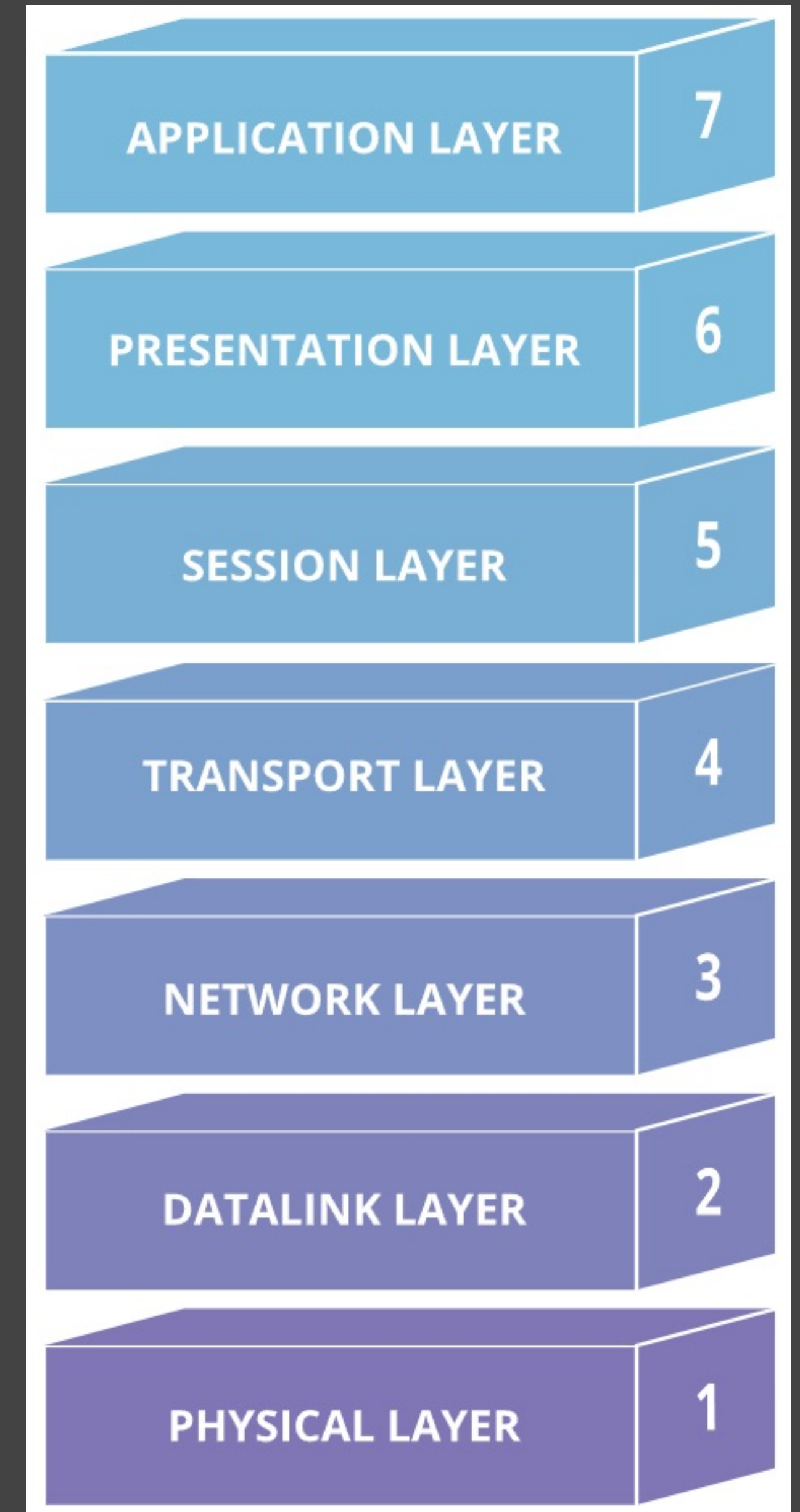
Messages are sent over Ethernet via ***frames***:

The ***Preamble*** is a sequence of alternating 1s and 0s for synchronization

(In hex: AA:AA:AA:AA:AA:AA:AA:AB)

IP ADDRESS

- **Network layer**
 - IP address type
 - IP provides host-to-host delivery service of packets (called **datagrams**)
 - IP is connectionless
 - IP is unreliable
 - IP also provides translation between different data link protocols



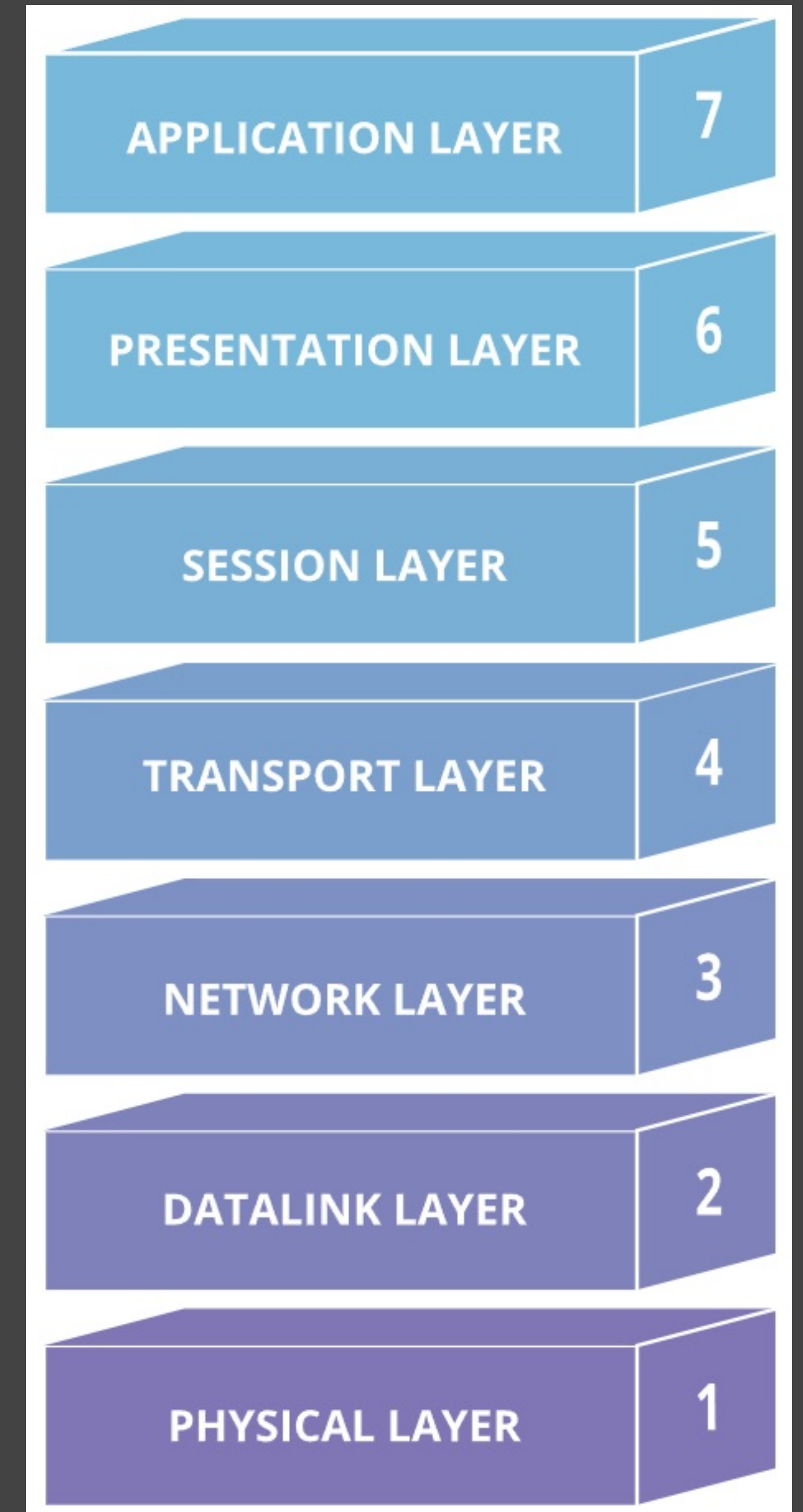
IP ADDRESS

- IP address types
- IPv4 is a series of 4 octets -> 32 bits
 - 192.0.2.33
- IPv6 is a series of 16 octets -> 128 bits
 - 2001:0db8:c9d2:aee5:73e3:934a:a5ae:9551
- Each IP address contains information that identifies
 - network ID and host ID

休息5分鐘

TCP & UDP

- **Transport layer**
 - Two protocols at the Transport Layer:
 - TCP (Transmission Control Protocol)
 - UDP (User Datagram Protocol)



TCP & UDP

- TCP (Transmission Control Protocol)
 - A **connection-based** protocol that provides a reliable
 - flow of data between two ends
 - like the phone-call processing
 - dial number
 - connection established
 - speaking to one another
 - the data sent from one end of connection actually gets to the other end

TCP & UDP

- TCP (Transmission Control Protocol)
 - Guarantee send to the other end *in order*
 - Designed for applications that require reliable communications, such as:
 - The HypertextTransfer Protocol (HTTP)
 - File Transfer Protocol (FTP)
 - Telnet
 - so on...

TCP & UDP

- UDP (User Datagram Protocol)
 - **Non connection-based** protocol that sends independent packets of data called - **datagram** from one end to another with no guarantees about arrival
- Like the mail-server processing
 - Sent a letter through the postal service
 - The order of delivery is not guaranteed...
 - Each datagram is independent

TCP & UDP

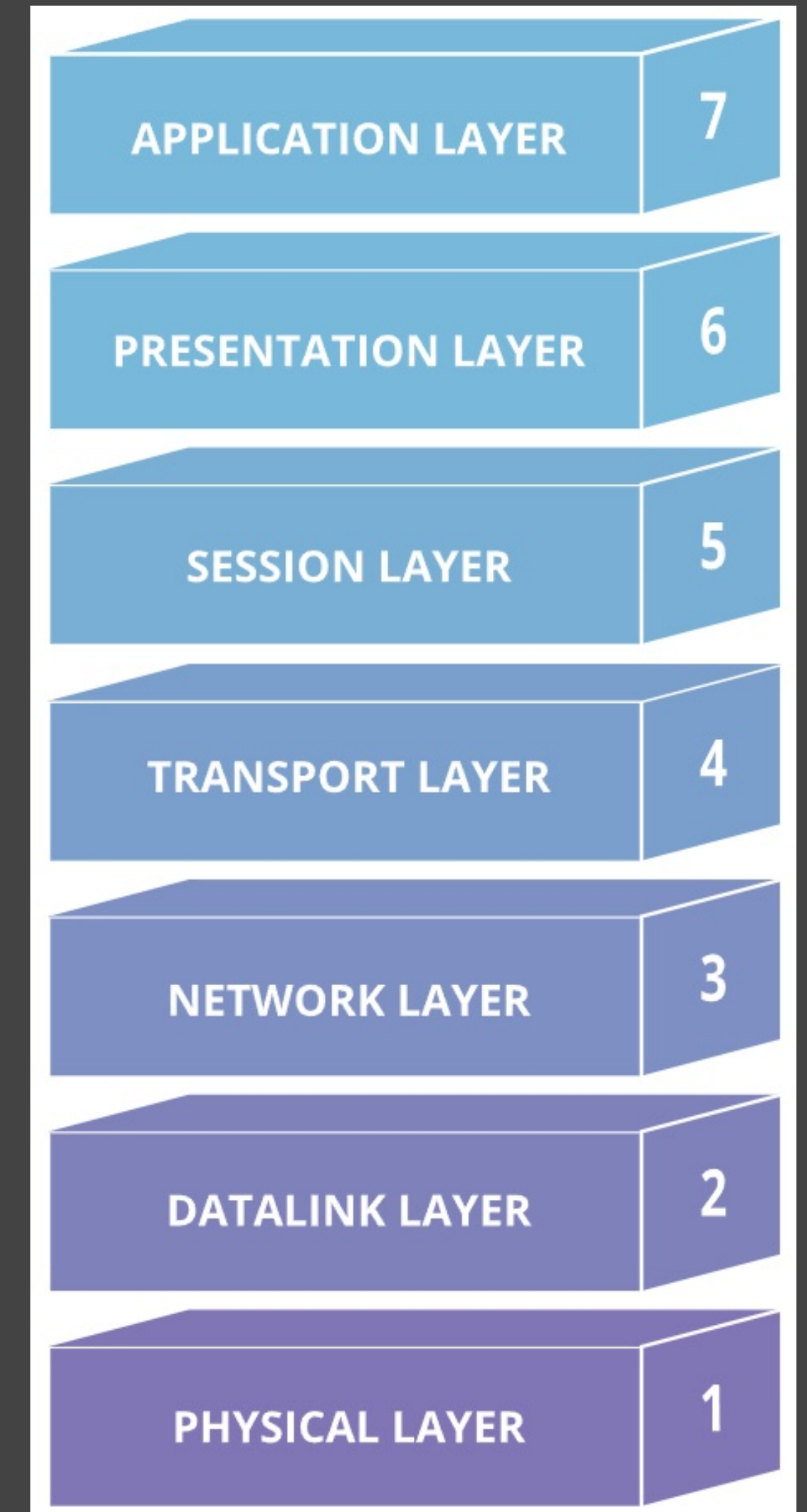
- UDP (User Datagram Protocol)
 - Designed for applications don't require such strict standards, in fact this standard may be slowed down by the extra overhead or the reliable connection
 - Audio or video streaming
 - Part of game genres
 - ...
 - Many firewalls and routers do not allowing UDP packets pass through by default configured settings

TCP & UDP

- Port number
 - the computer is identified by its 32-bit IP address
 - which IP used to deliver data to the right computer on the network
 - ports are identified by a 16-bit number, which TCP and UDP use to deliver the data to the right application
 - 0~1023 are reserved by well-known services such as HTTP(80) and FTP and other system services

SOCKET PROGRAMING

- Application layer
 - Network APIs provide the bridge between applications and protocol software
 - Services are made available (often by the OS)



SOCKET PROGRAMING

- Network API often provides a generic programming interface:
 - support for multiple communication protocol suites/families (e.g. TCP, UDP, IP)
 - endpoint address representation independence
 - network data types (for portability)
 - With from-host and to-host conversion functions
 - e.g. htons(), ntohs(), htonl(), ntohl(), etc.

SOCKET PROGRAMING

- Byte Order
 - Take data **b34f** for example:
 - Big-Endian -> **b34f**
 - Little-Endian -> **4fb3**
- Network Byte Order is **Big-Endian**
 - Means **b34f** for every protocol
- Host Byte Order is
 - **Intel processor** is Little-Endian -> **4fb3**
 - **Motorola processor** is Big-Endian -> **b34f**

SOCKET PROGRAMING

htons()	<u>h</u> ost <u>to</u> <u>n</u> etwork <u>s</u> hort
htonl()	<u>h</u> ost <u>to</u> <u>n</u> etwork <u>l</u> ong
ntohs()	<u>n</u> etwork <u>to</u> <u>h</u> ost <u>s</u> hort
ntohl()	<u>n</u> etwork <u>to</u> <u>h</u> ost <u>l</u> ong

Use convert function before transferring data (integer type)

Good news is,
modern network SDK tackles all of this...

SOCKET PROGRAMING

What is a socket?

- A way to speak to other programs using standard **Unix file descriptors**
- Everything in Unix is a file!
 - a FIFO, a terminal, a real on-the-disk file...etc
 - a network connection **is still a file**
- A file descriptor is simply an **integer** associated with an opened file
 - Like **FILE object** in C language
 - When Unix programs do any sort of I/O, they do it by reading or writing to a file descriptor

SOCKET PROGRAMING

- There are two types of internet Sockets
 - Stream socket
 - connection sockets
 - reliable type
 - 1, 2, 3 -> 1, 2, 3
 - TCP protocol
 - Datagram socket
 - connectionless sockets
 - un-reliable type
 - 1,2,3 -> maybe 1,3,2 or 2,1,3 or nothing
 - UDP protocol

References

- MIS — 網路概論- OSI、MAC、IP
- 什麼是OSI的7層架構？和常聽到的Layer 7有關？
- WIKI - OSI模型
- Cloudflare - 什麼是 OSI 模型？
- J.Day, Zimmermann H, “The OSIreference model” published in IEEEvol.71,issue 12, pages:1334-1340,1983.

休息5分鐘