华南理工大学

South China University of Technology

Intro to Computer Science and Software Engineering

Computer Networks

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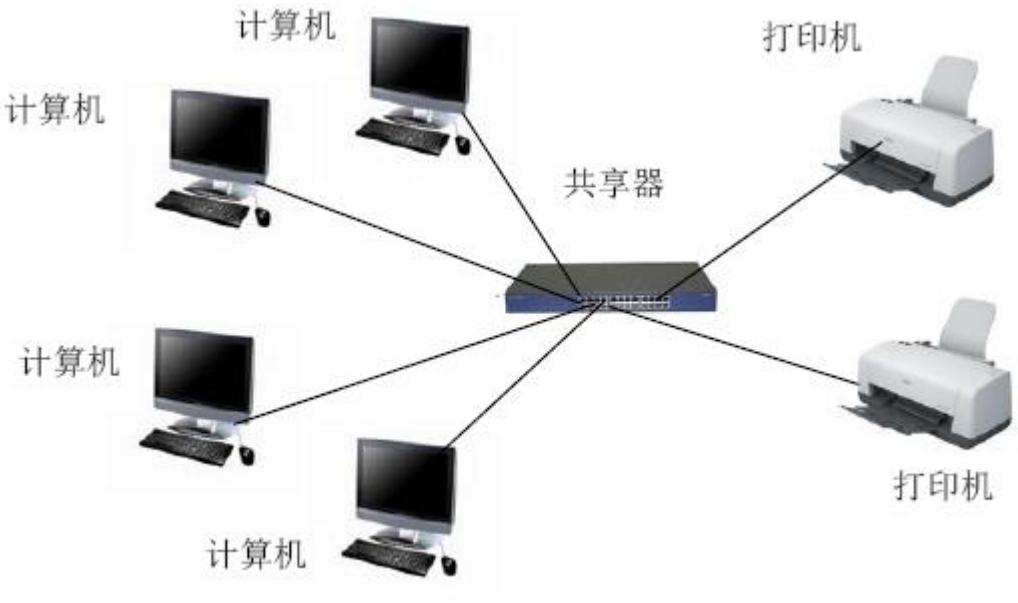
Computer Network

- A collection of computing devices connected in order to communicate and share resources.
- Connections between computing devices can be physical using wires or cables or wireless using radio waves or infrared signals.

Can you name some of the devices in a computer network?



Networking

- **Node (host)**

  Any device on a network

- **Data transfer rate (bandwidth)**

  The speed with which data is moved from one place to another on a network (bits per second).

Why is bandwidth so key?

Networking

Computer networks have opened up an entire frontier in the world of computing called the **client/server model**

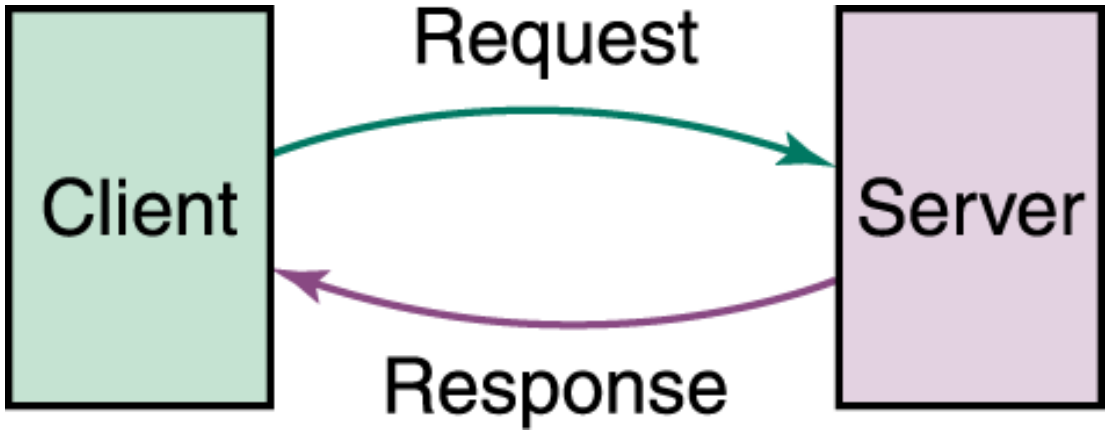


Figure Client/Server interaction

Networking

Protocol

A set of rules that defines how data is formatted and processed on a network; i.e., rules that allow client/server interaction.

File server

A computer that stores and manages files for multiple users on a network.

Web server

A computer dedicated to responding to requests (from the browser client) for web pages.

Types of Networks

Wide-area network (WAN)

A network that connects local-area networks over a potentially large geographic distance

Metropolitan-area network (MAN)

The communication infrastructures that have been developed in and around large cities

Local-area network (LAN)

A network that connects a relatively small number of machines in a relatively close geographical area

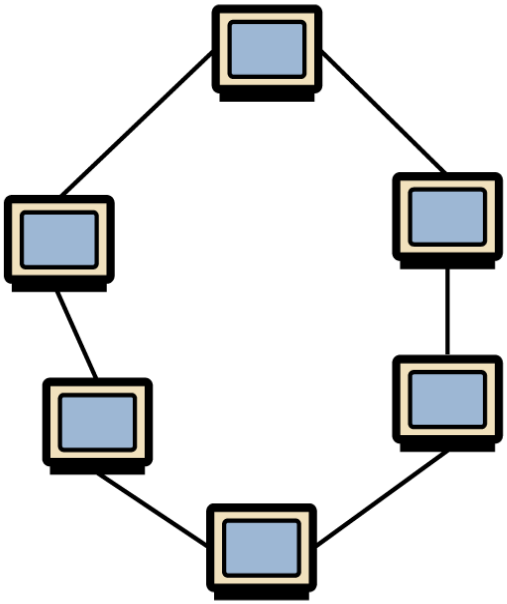
Network Topology

Ring topology connects all nodes in a closed loop on which messages travel in one direction.

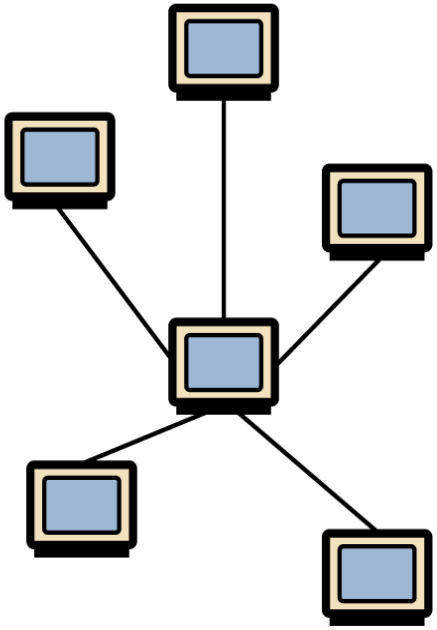
Star topology centers around one node to which all others are connected and through which all messages are sent

Bus topology nodes are connected to a single communication line that carries messages in both directions

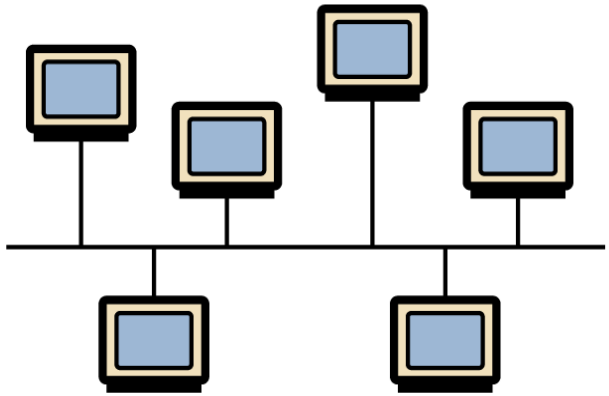
Network Topology



Ring topology



Star topology



Bus topology

Figure **Various network topologies**

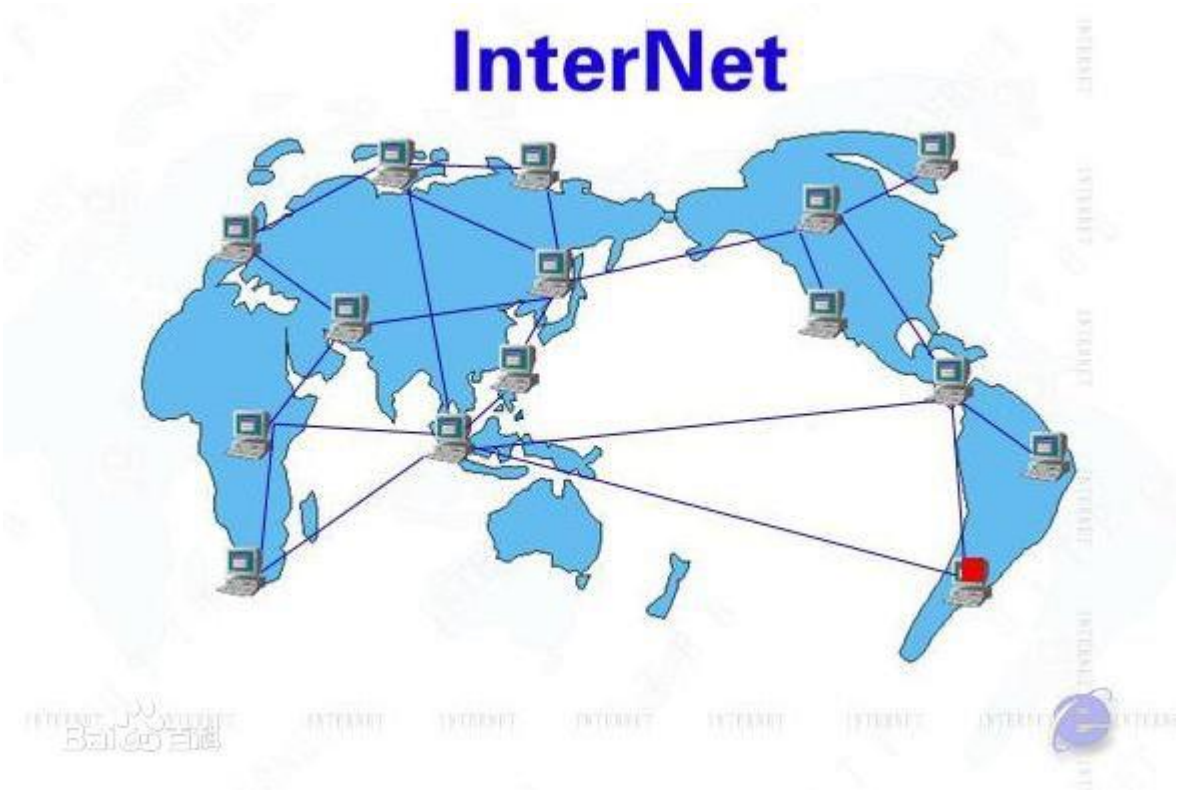
Ethernet

The industry standard bus technology for local-area networks

Types of Networks

Internet

A wide area network that spans the planet.



So, who owns the Internet?

所有图片均来自网络

Internet Connections

Internet backbone

A set of high-speed networks that carry Internet traffic, provided by companies such as AT&T, Verizon, GTE, British Telecom, and IBM

Internet service provider (ISP)

A company that provides other companies or individuals with access to the Internet

Internet Connections

Various technologies available to connect a home computer to the Internet

Phone modem converts computer data into an analog audio signal for transfer over a telephone line, and then a modem at the destination converts it back again into data

ADSL Modem

Digital subscriber line (DSL) uses regular copper phone lines to transfer digital data to and from the phone company's central office

Cable modem uses the same line that your cable TV signals come in on to transfer the data back and forth

电缆调制解调器Cable Modem

Internet Connections

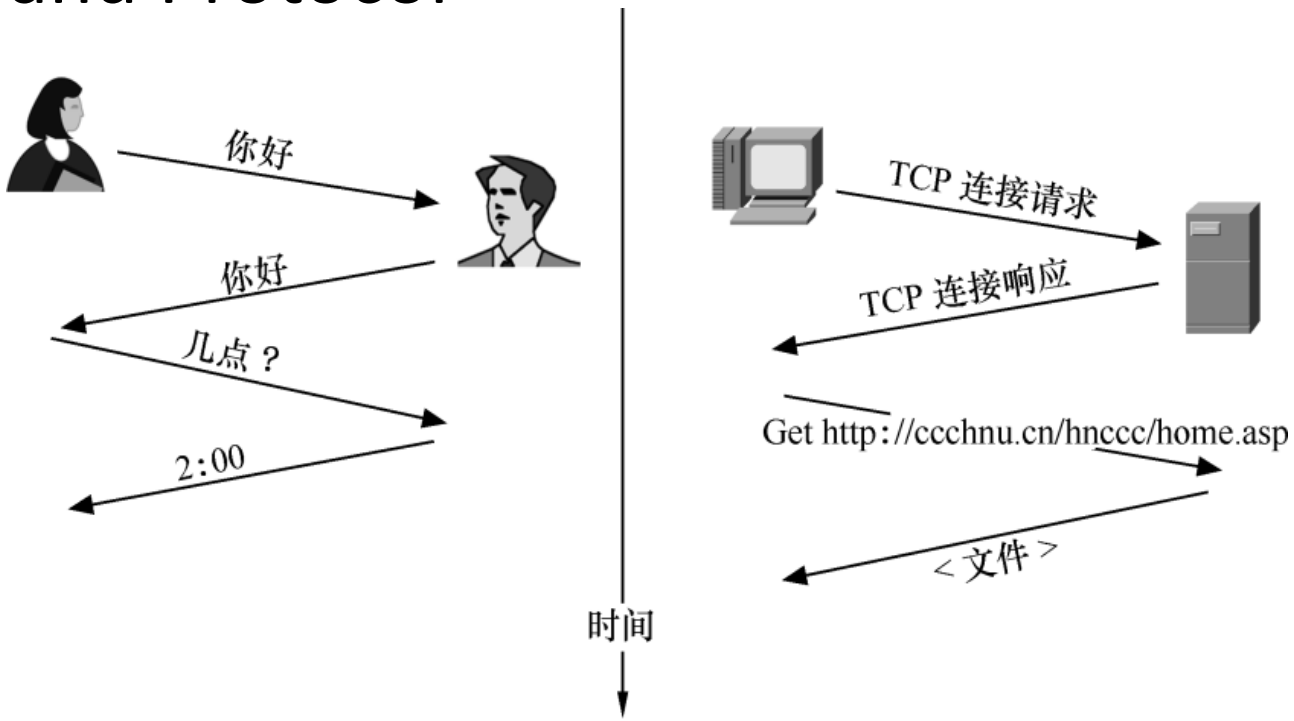
Broadband

A connection in which transfer speeds are faster than 768 kilobits per second

- DSL connections and cable modems are broadband connections
- The speed for **downloads** (getting data from the Internet to your home computer) may not be the same as **uploads** (sending data from your home computer to the Internet)

Networking

- A computer network is a combination of systems (e.g. a computer) connected through transmission media (e.g. a wire, or air).
- Model and Protocol



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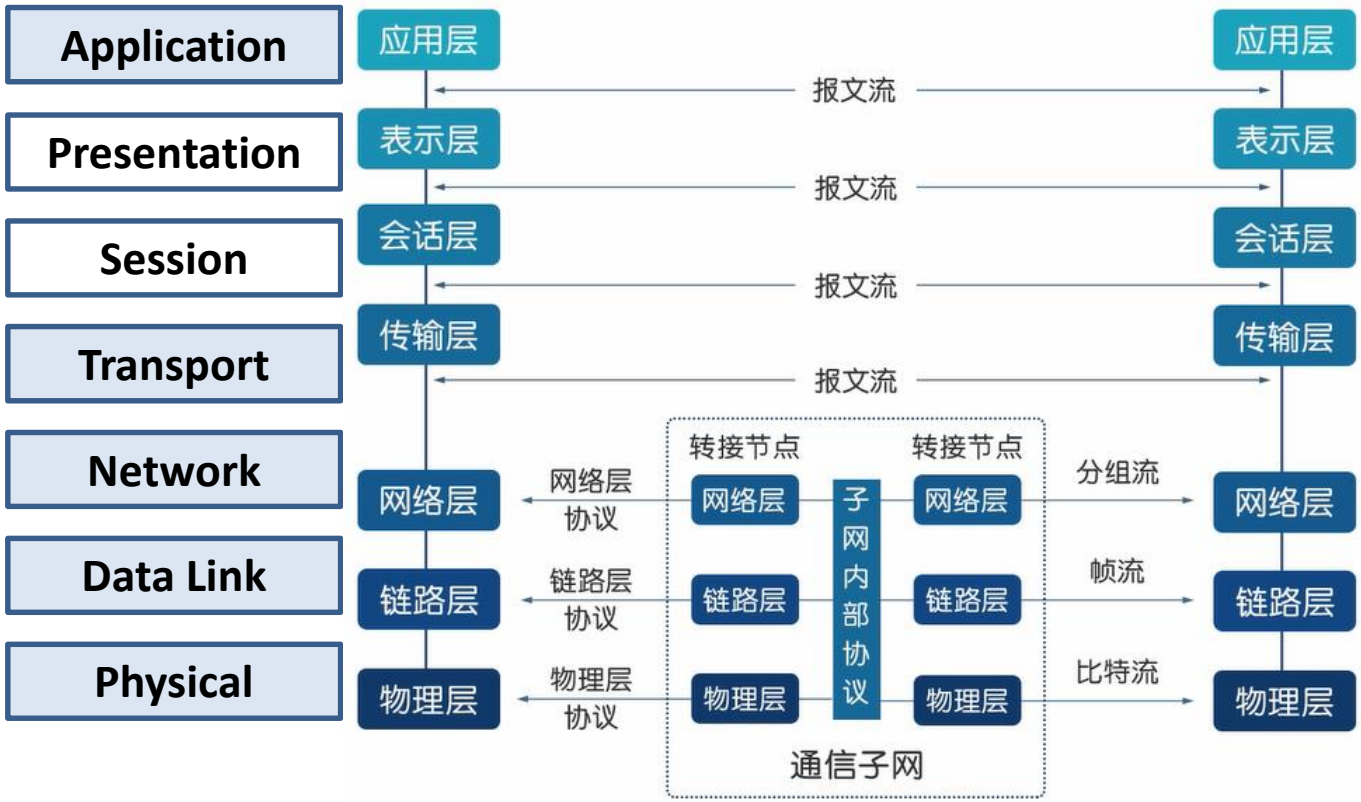
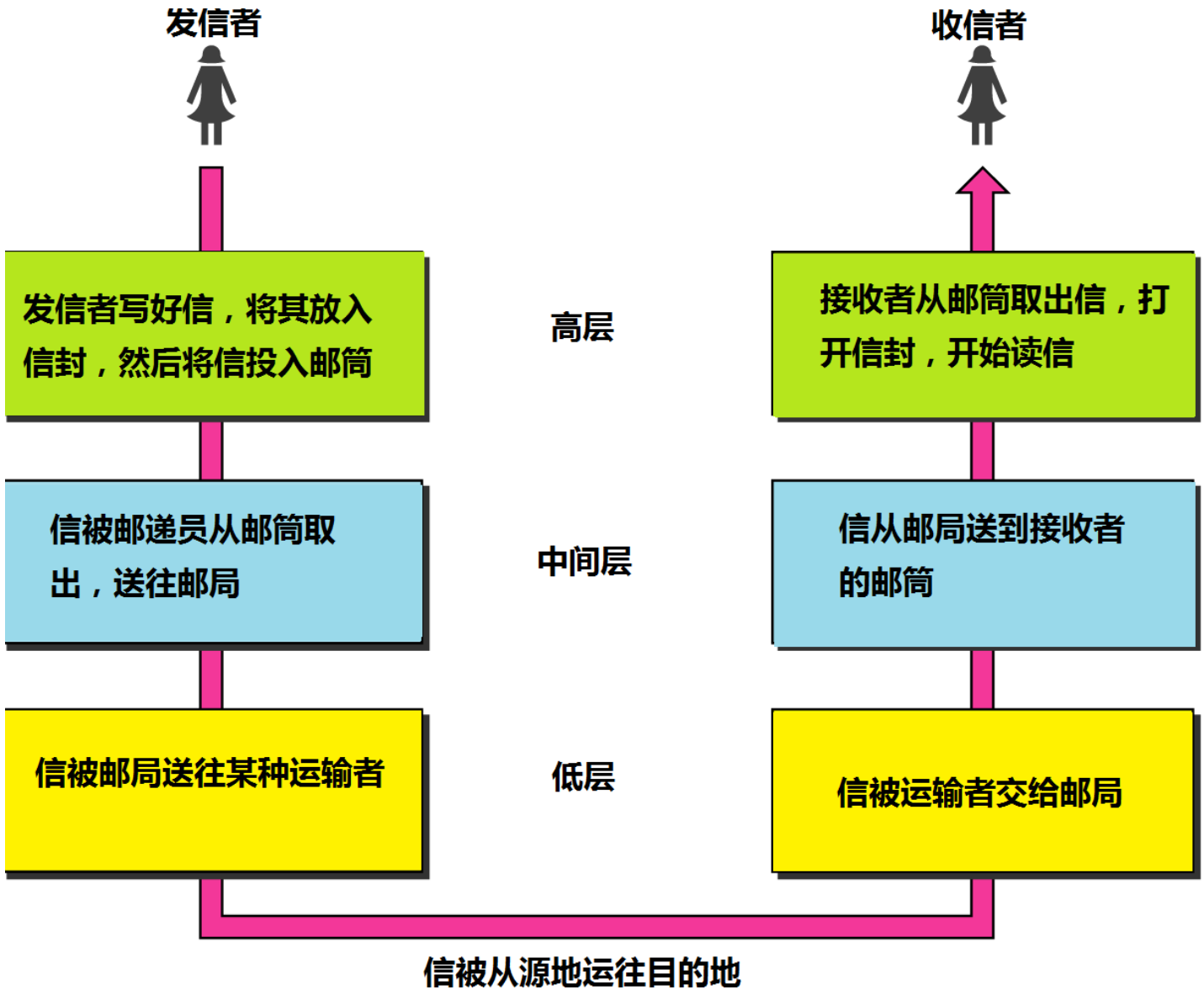
OSI Model

- The Open System Interconnection (OSI) model
  - A theoretical model that shows how any two different systems can communicate with each other.
- 7 Layers:



Flow of data in the OSI model



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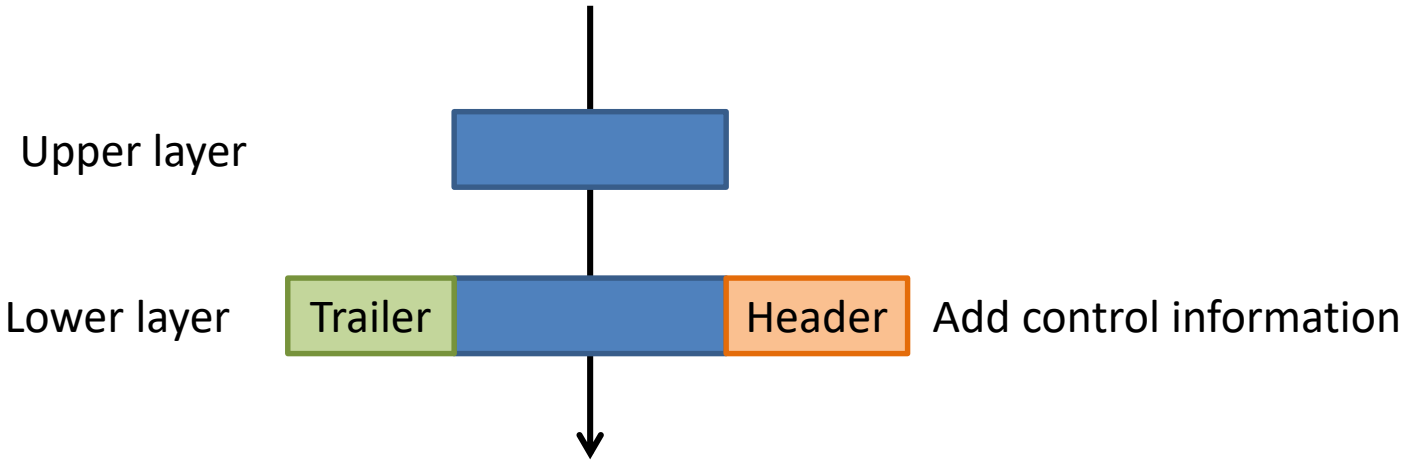
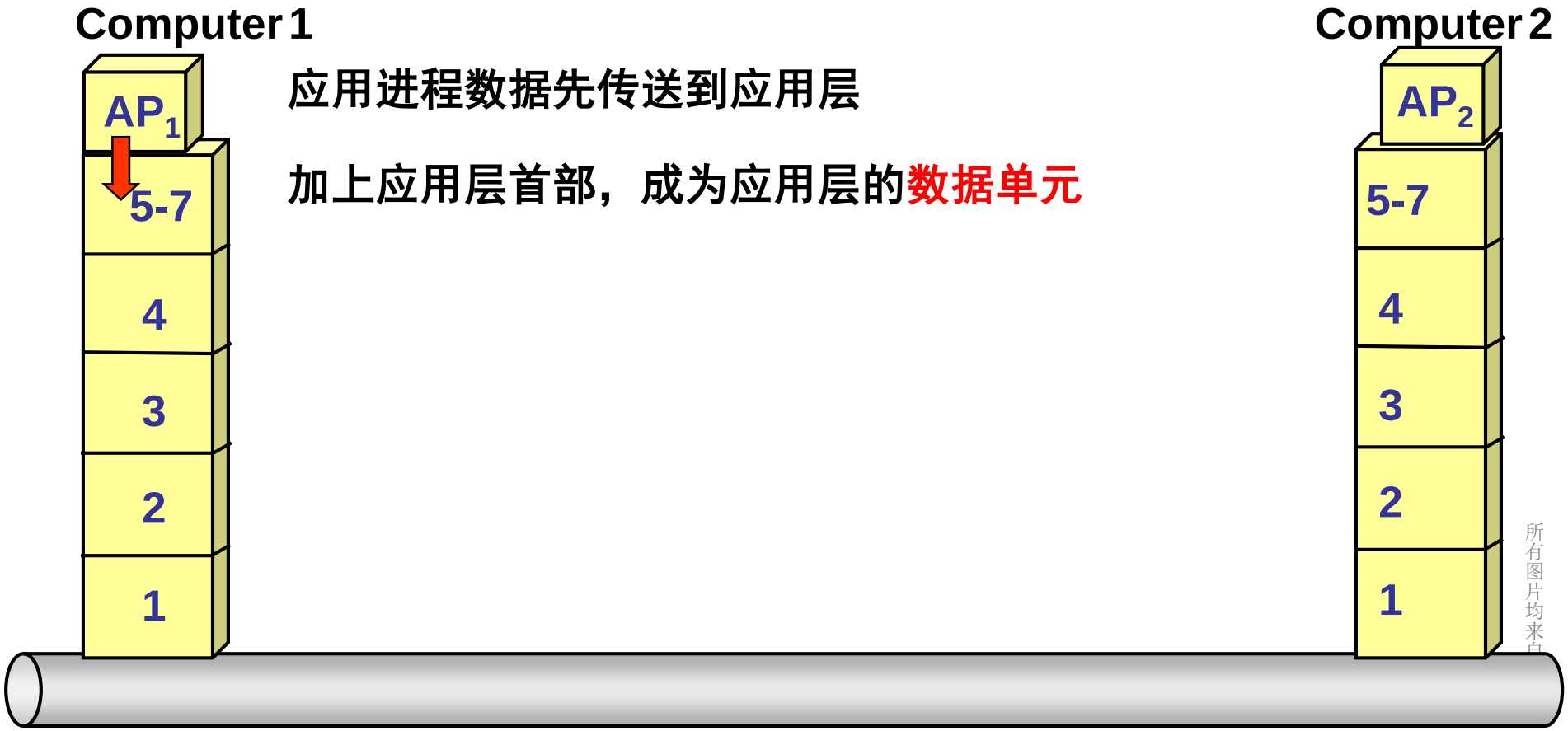


Flow of data in the OSI model

Computer 1 sends data to Computer 2



应用进程数据先传送到应用层

加上应用层首部，成为应用层的数据单元

Flow of data in the OSI model

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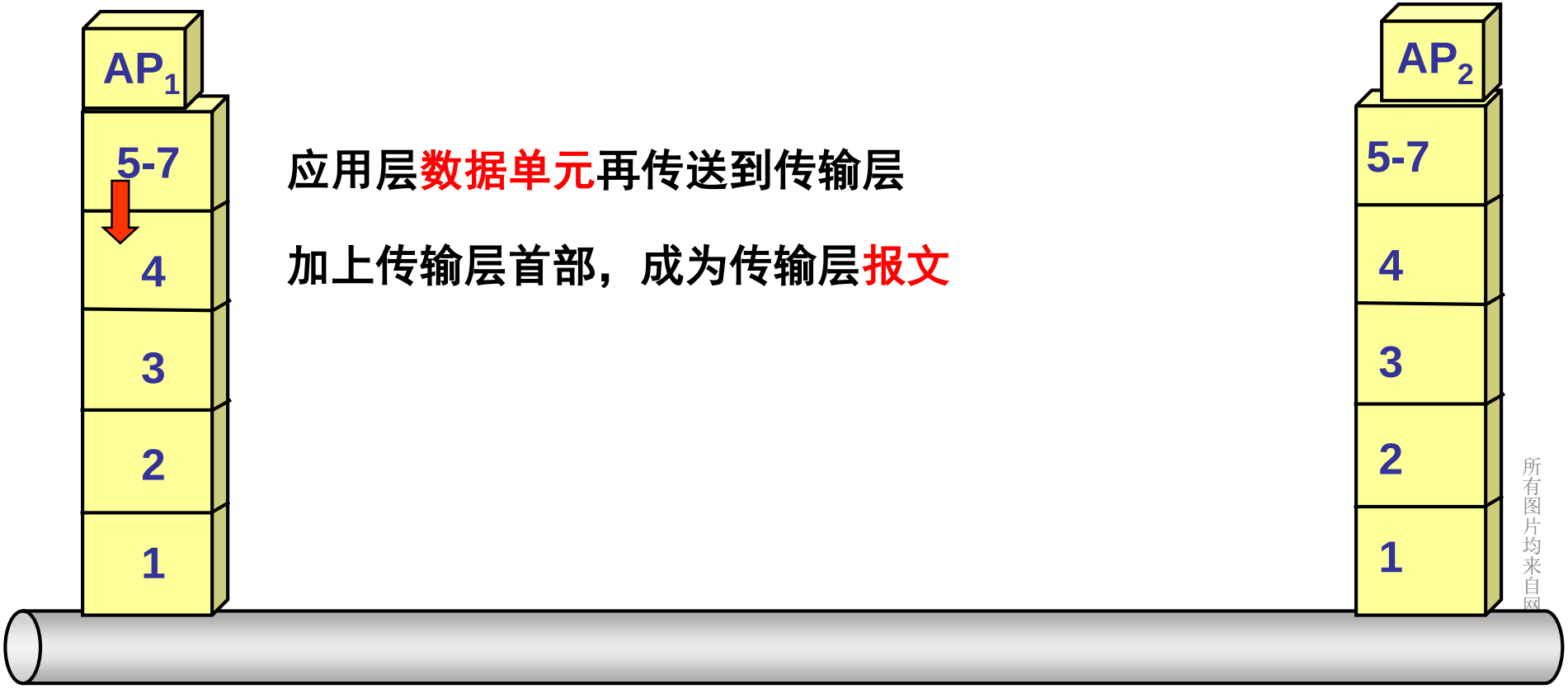

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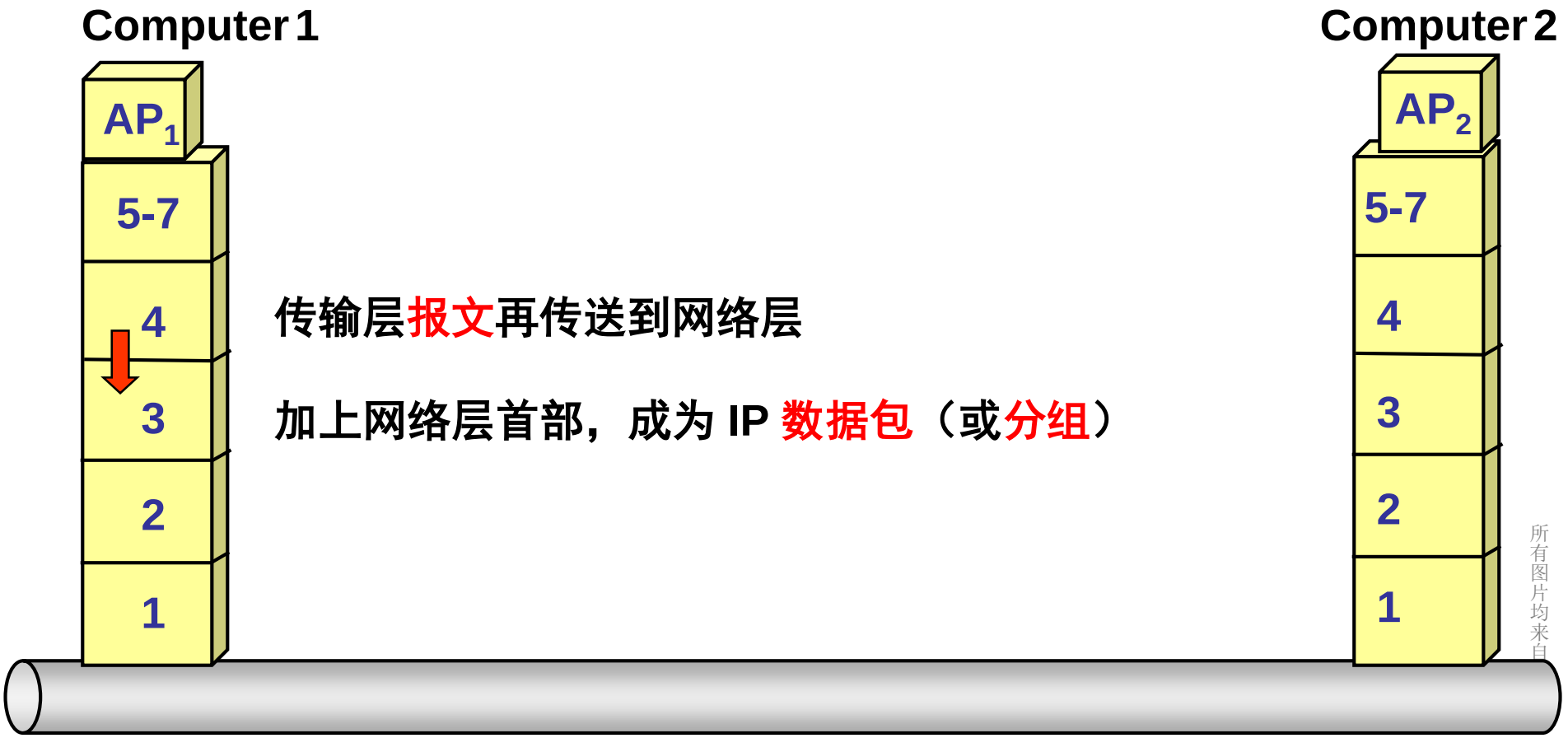

Packet Switching

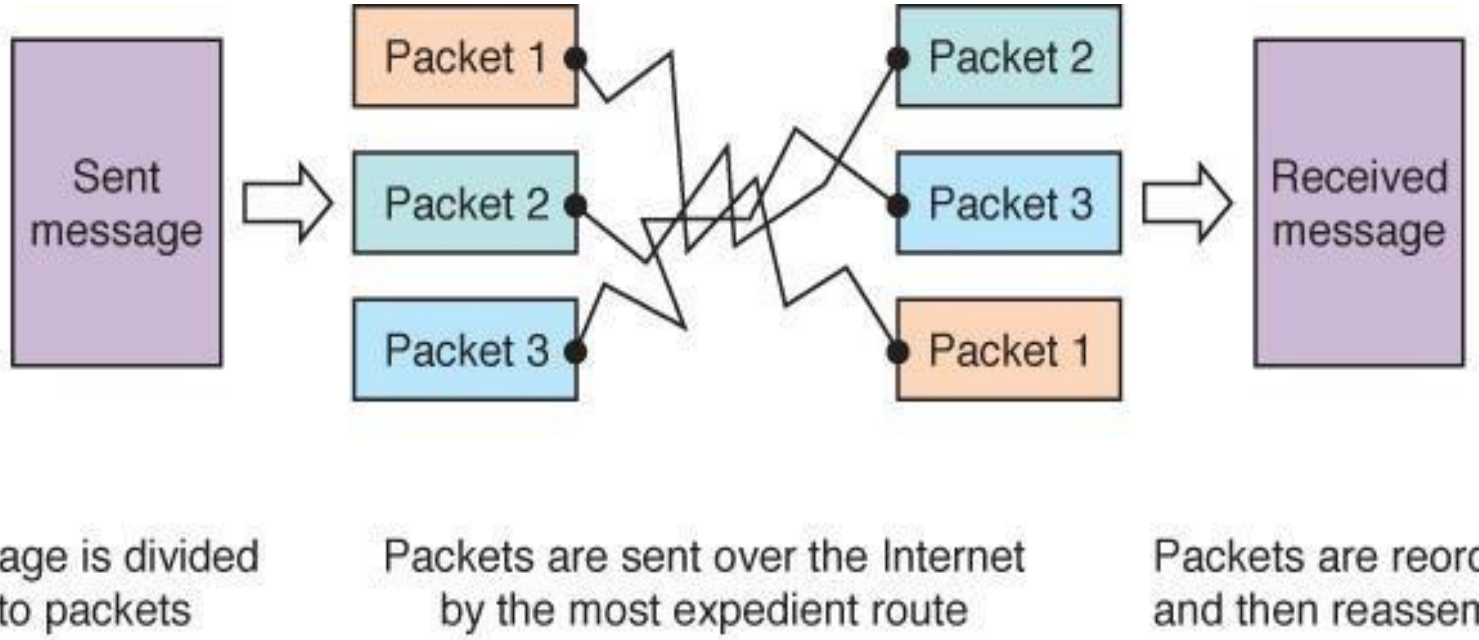

Figure **Messages sent by packet switching**

Take a message, break it into three packets, and simulate this process

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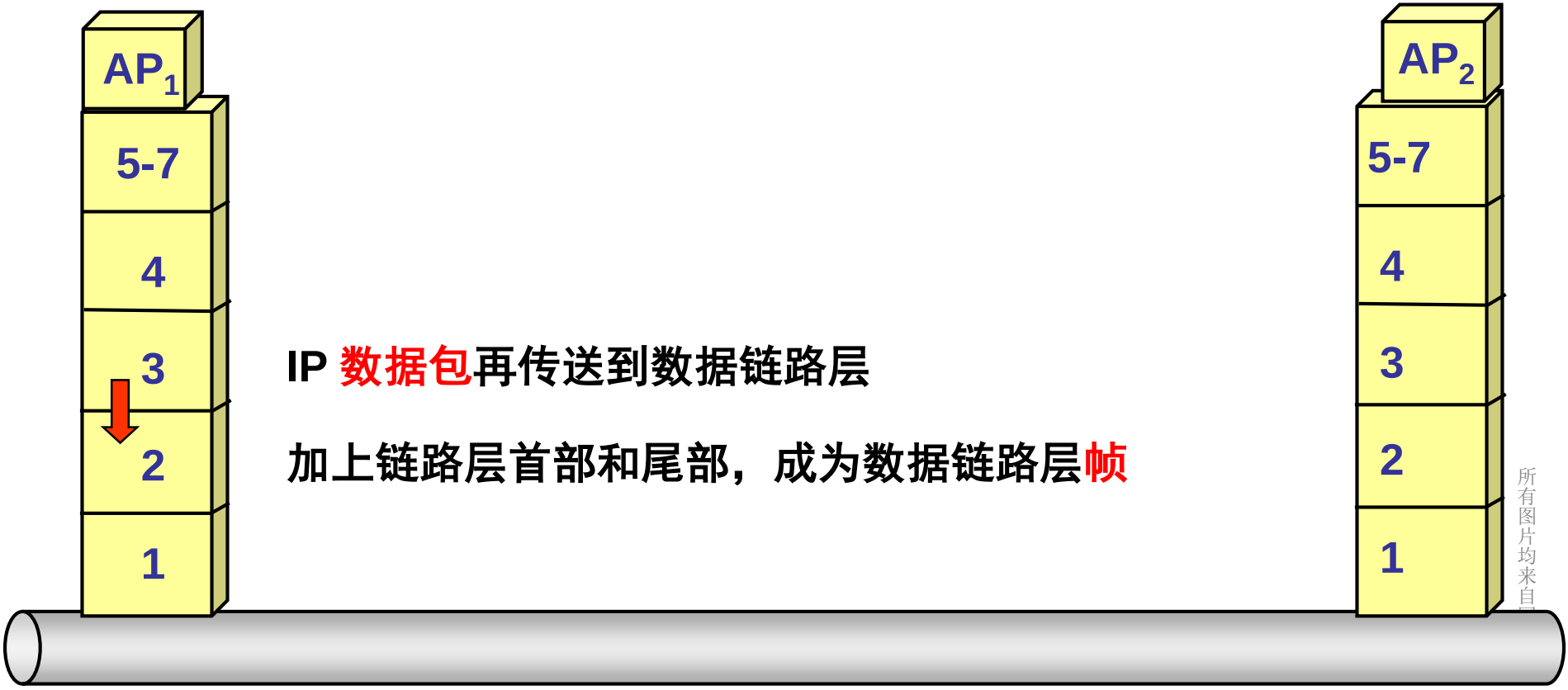

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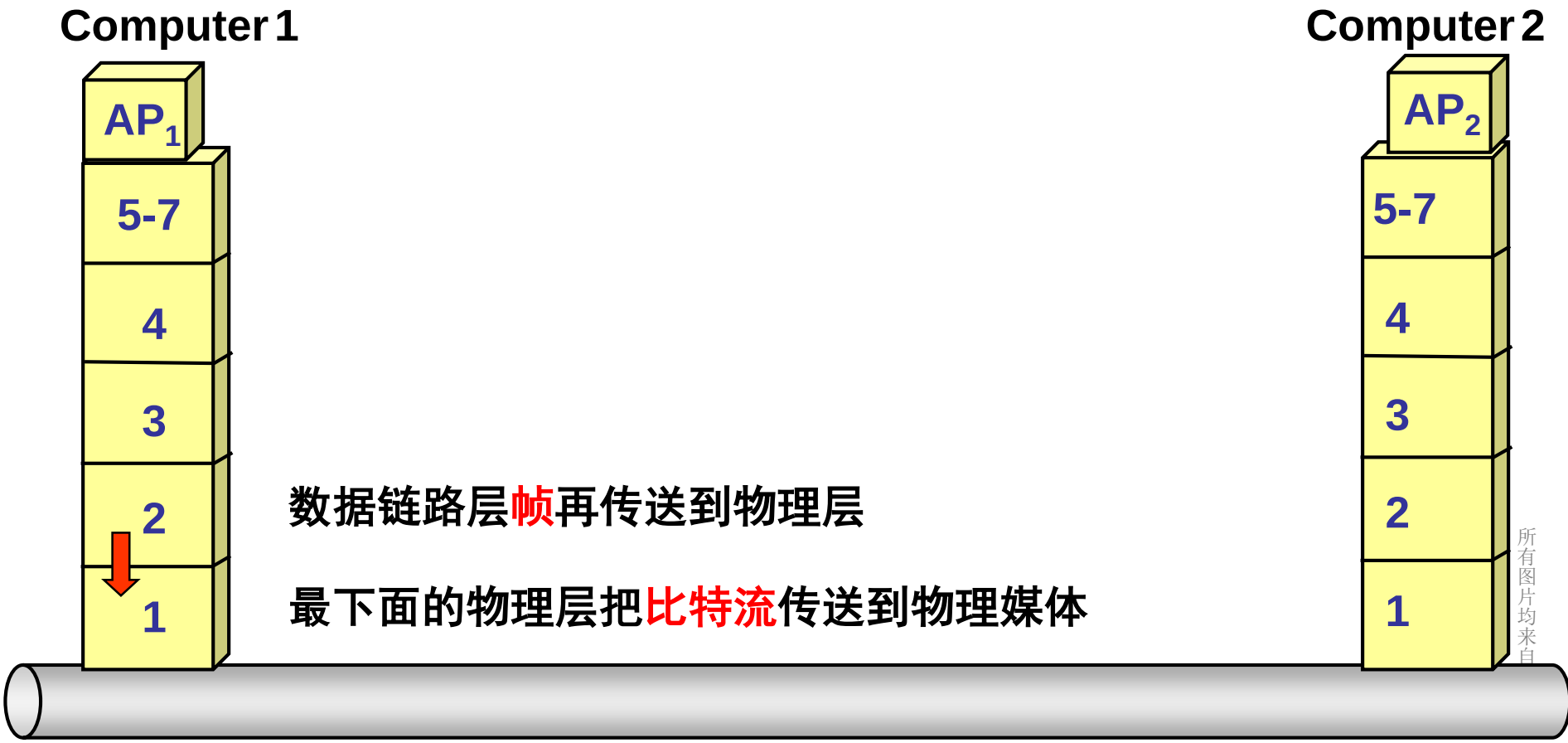

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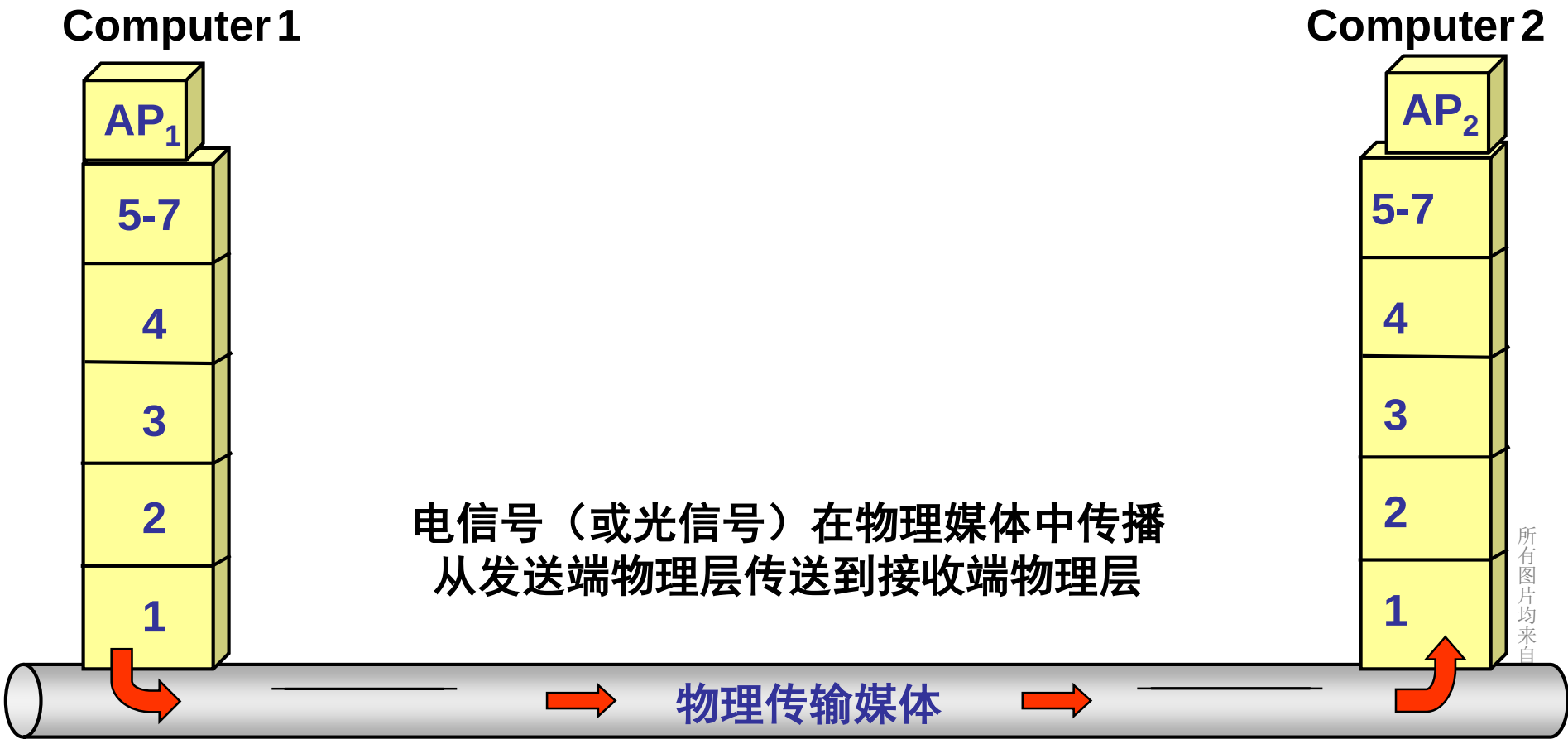

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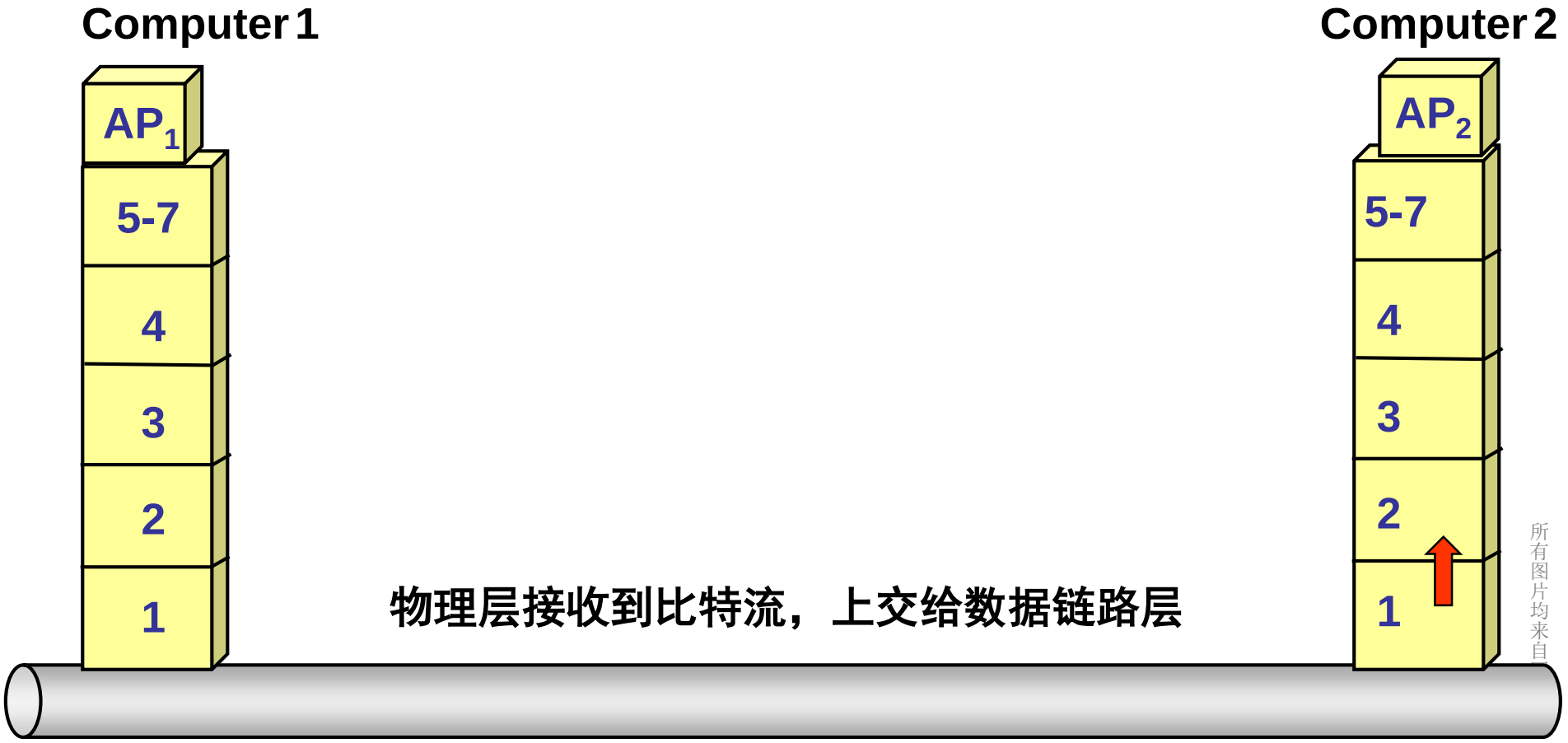

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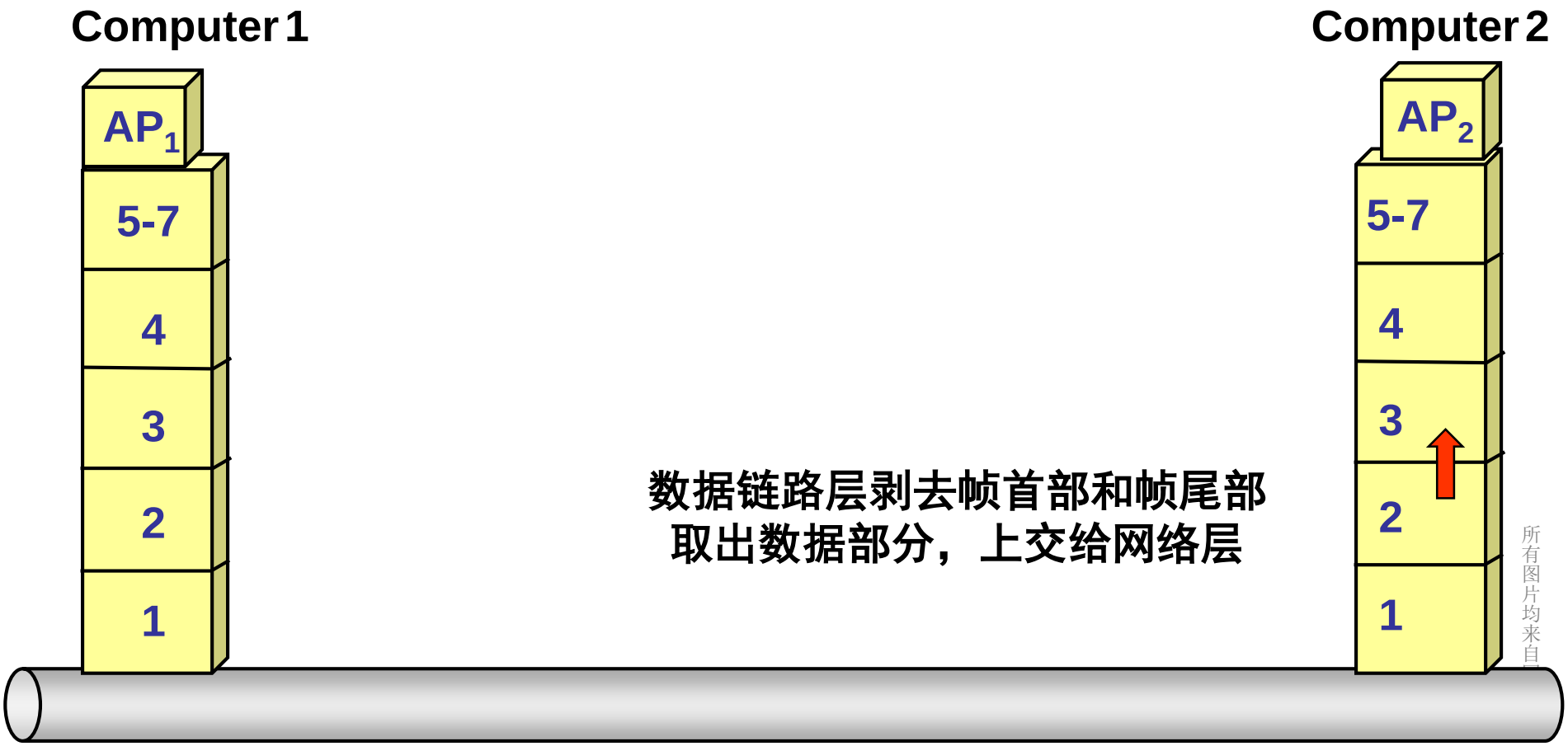

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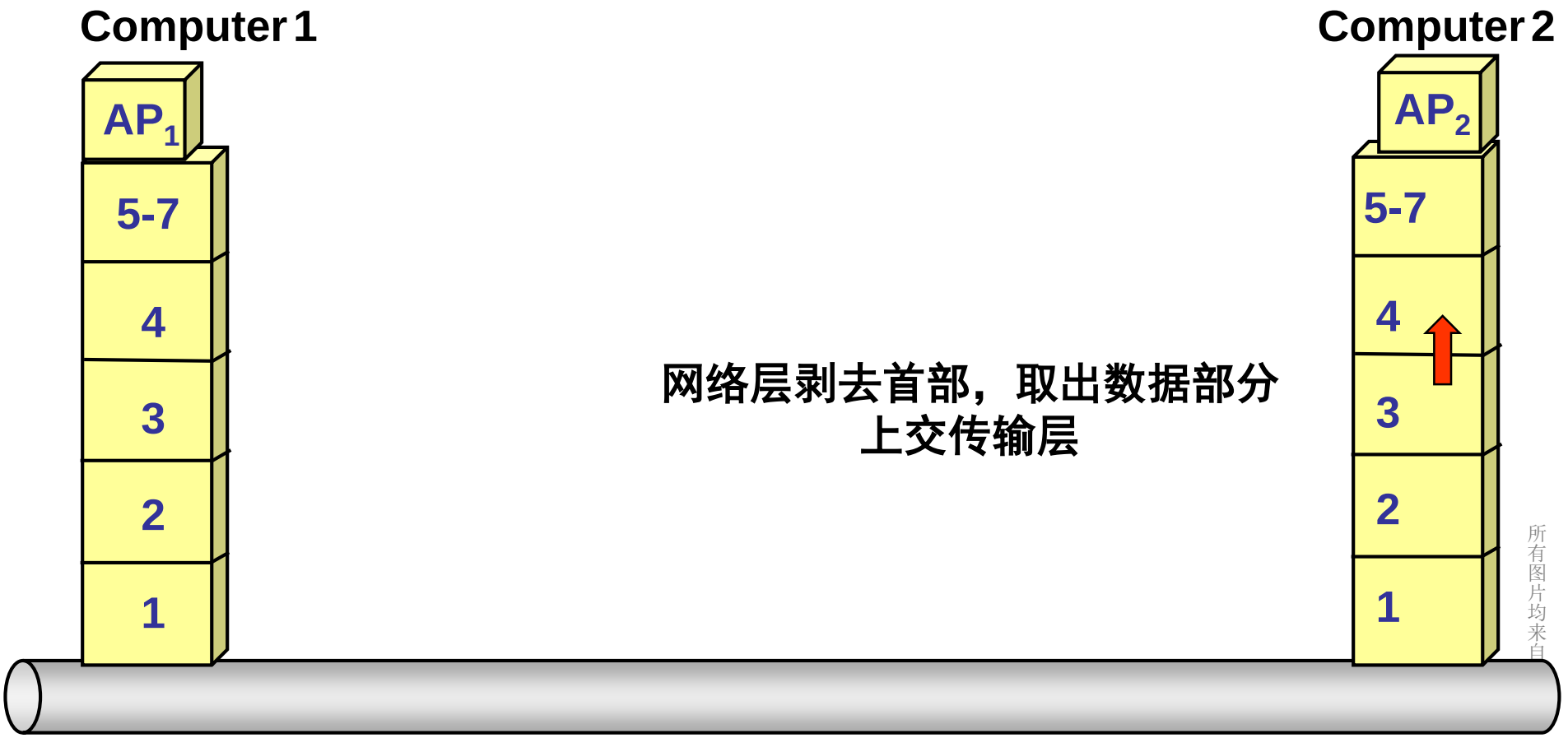

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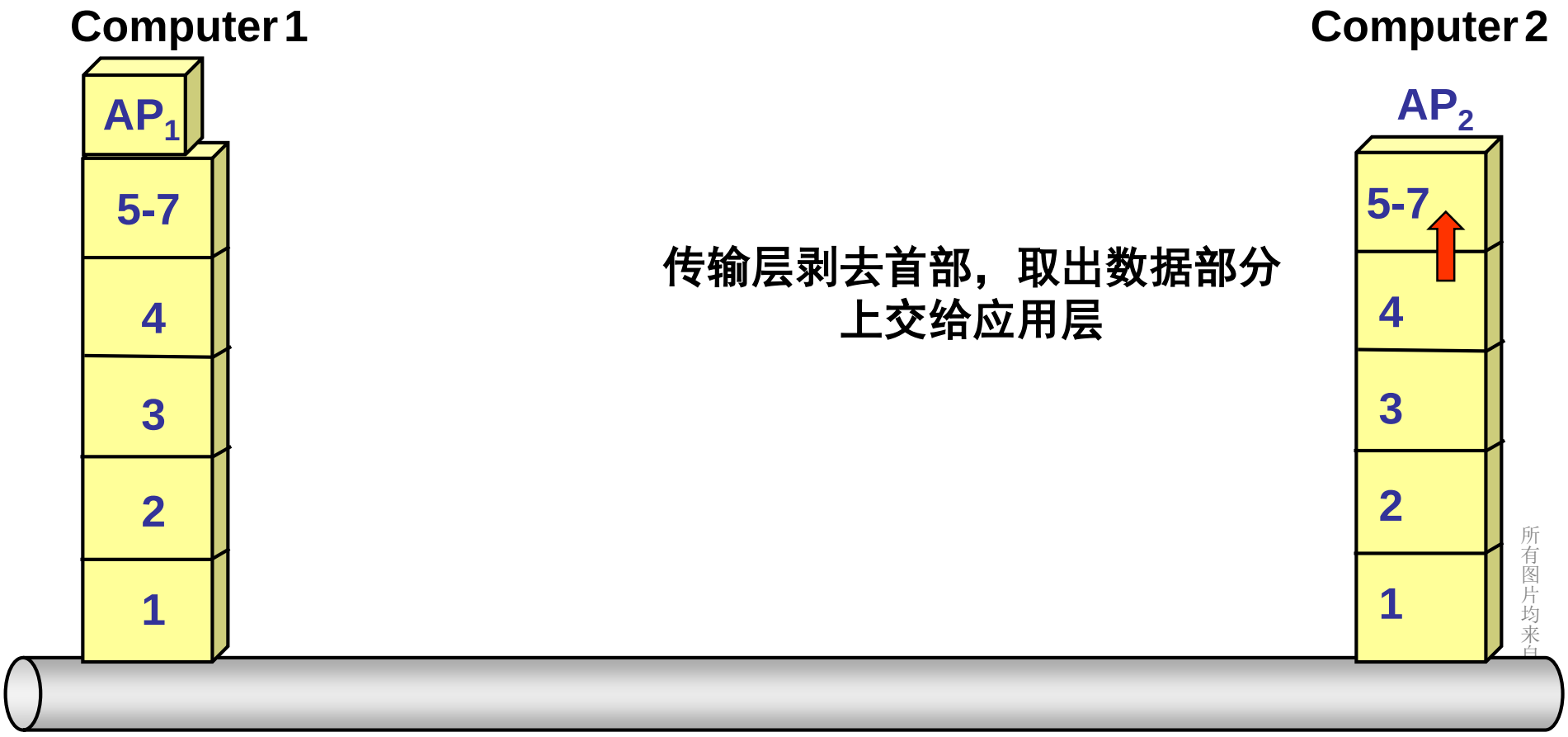

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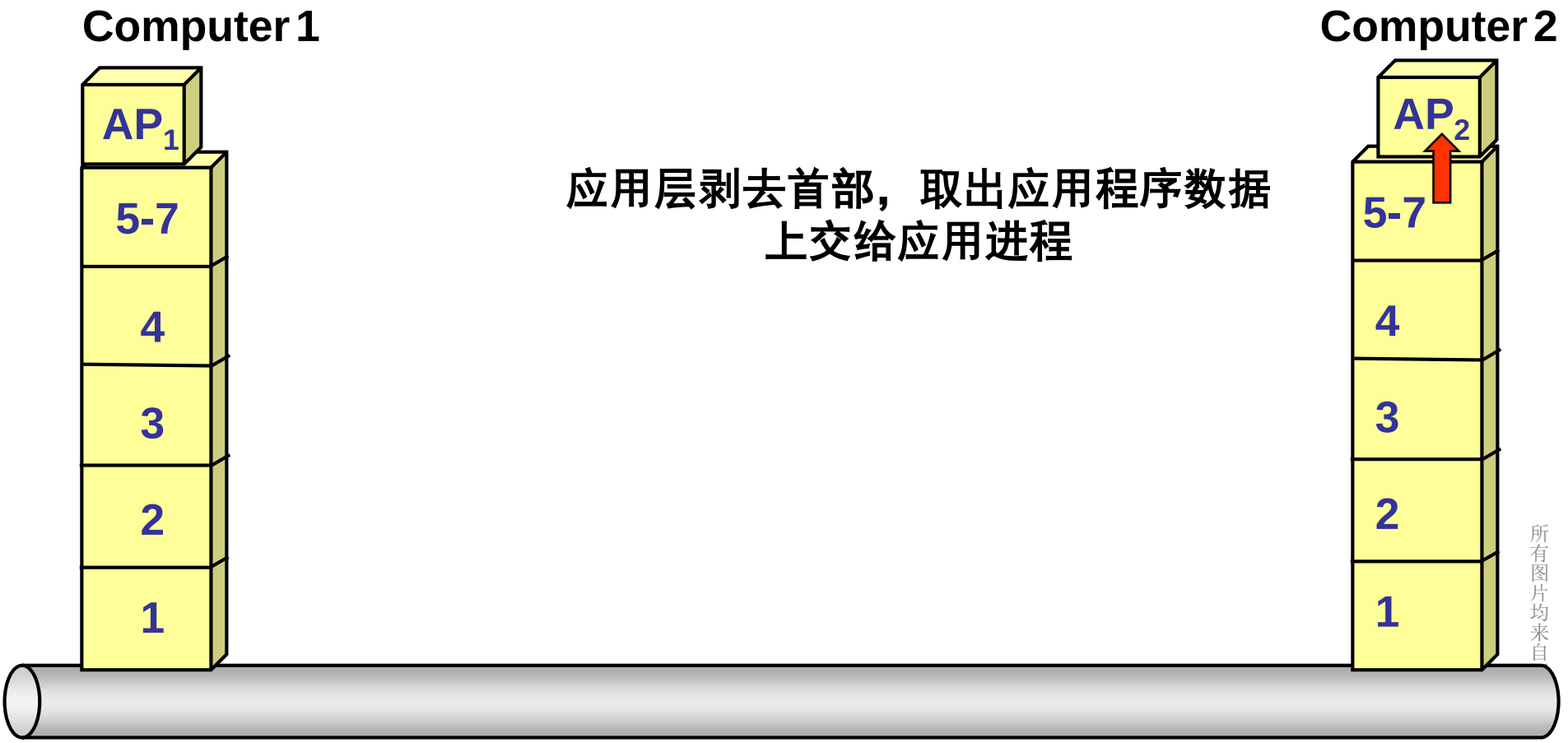

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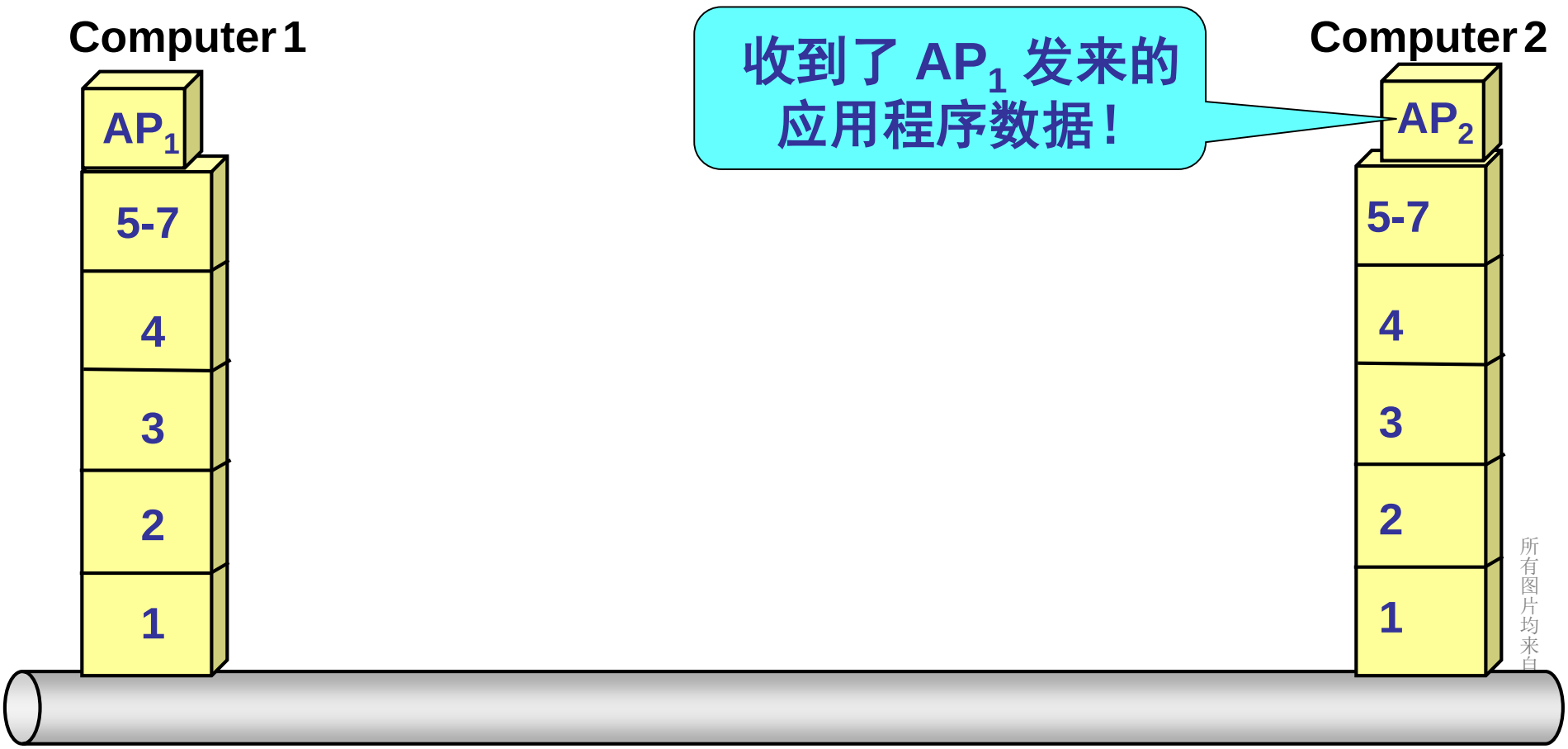
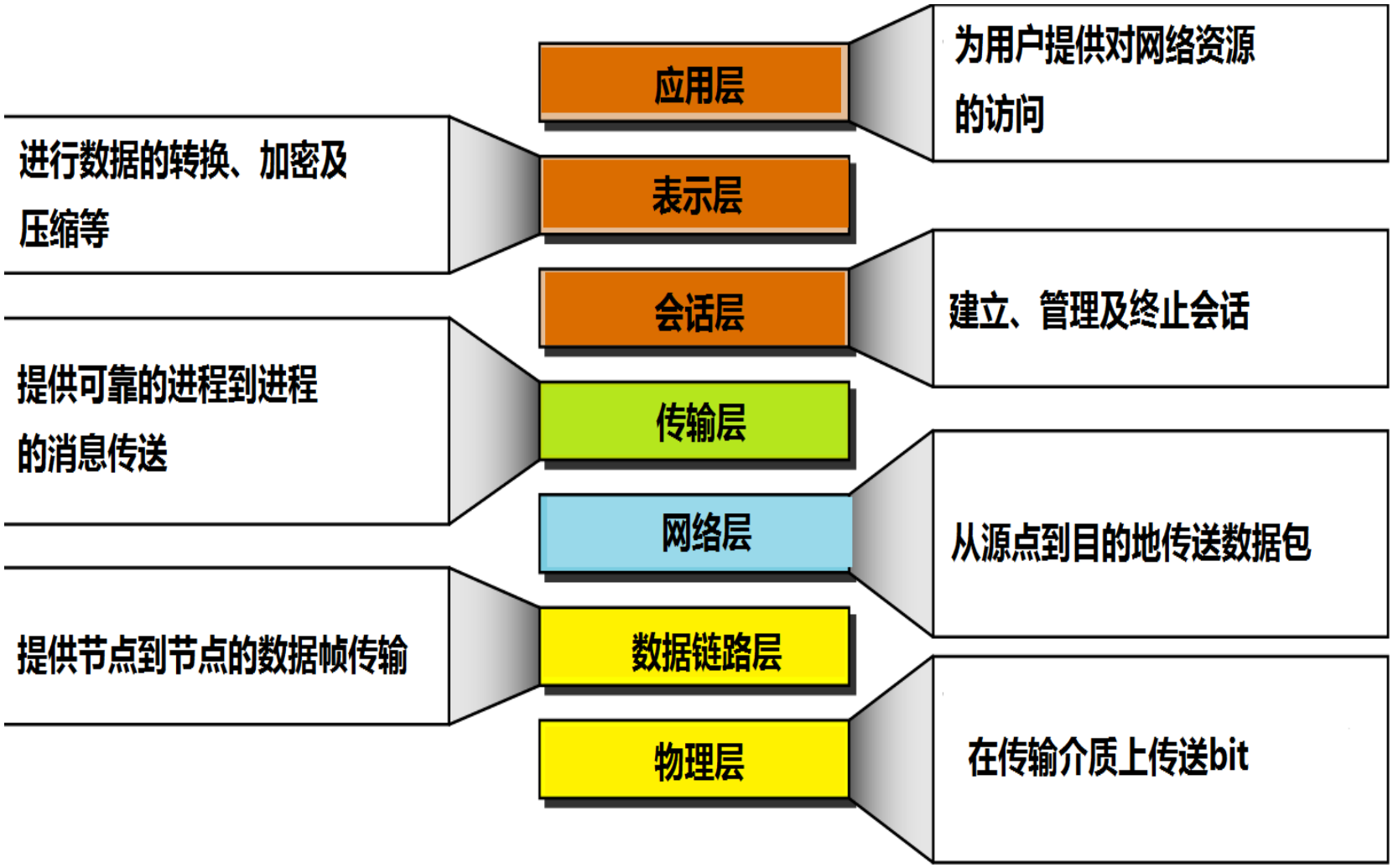
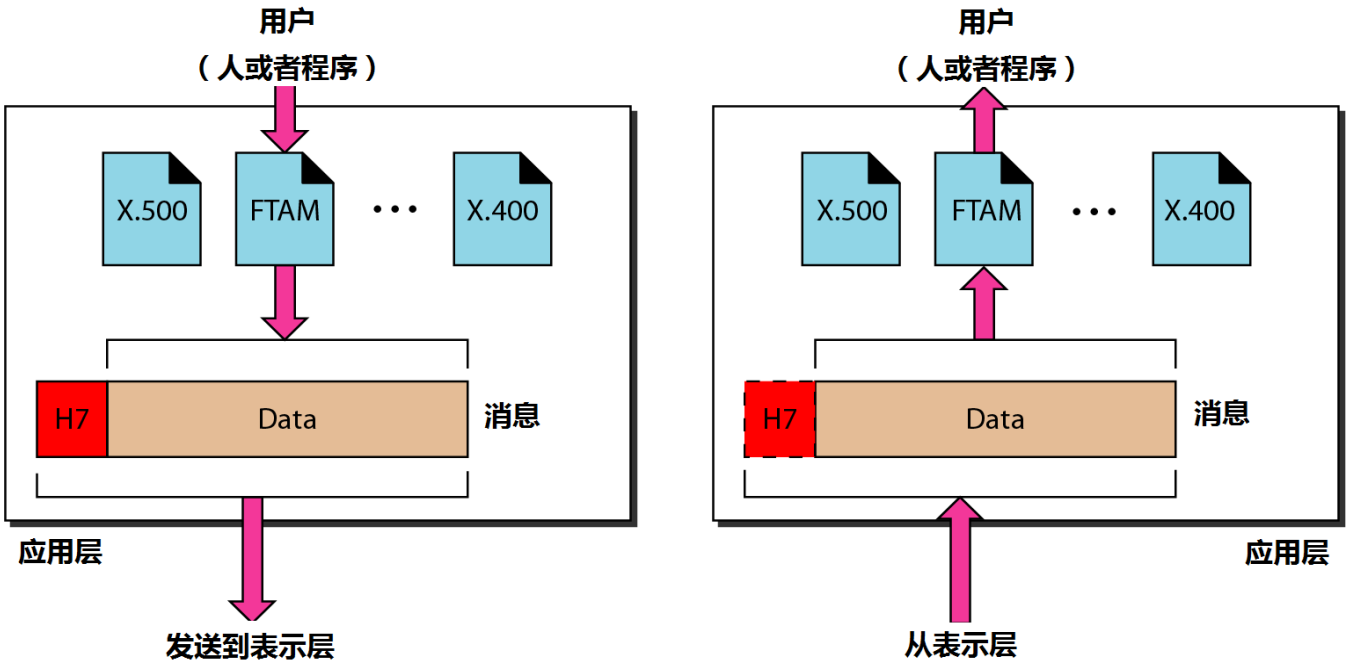


Functions of the Layers



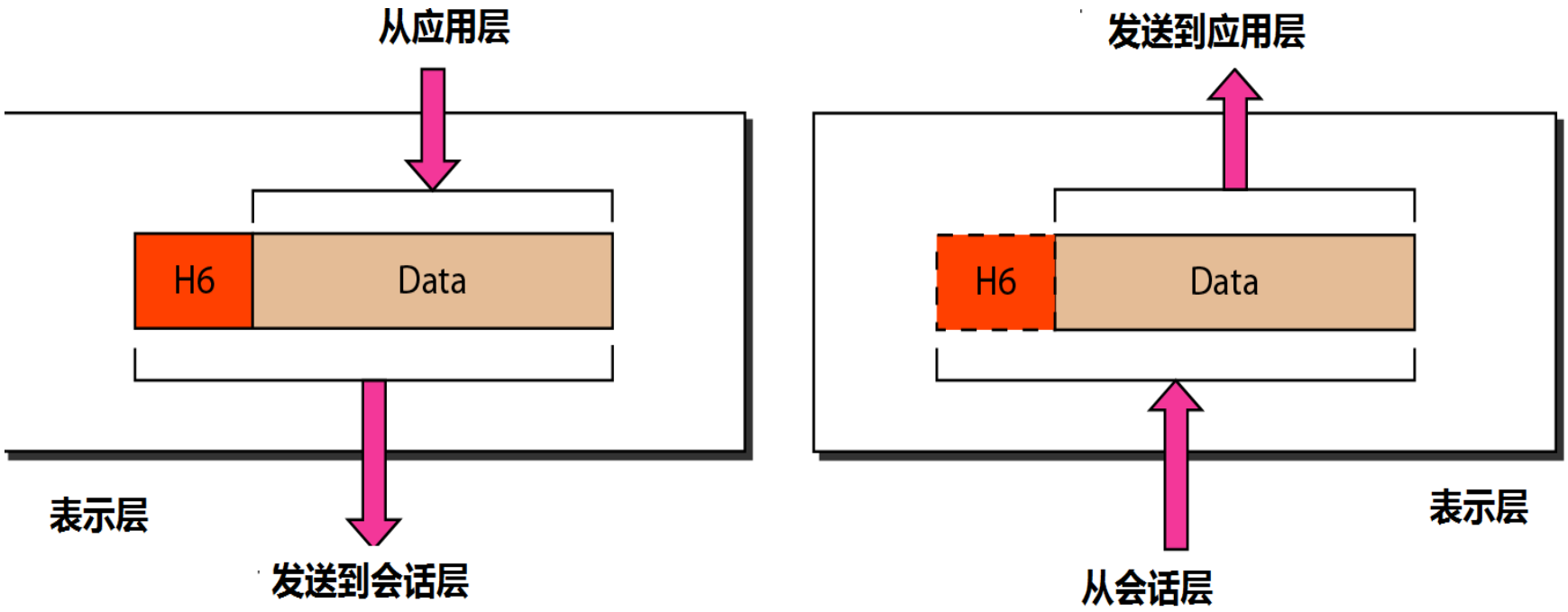
Functions of the Layers

- Application Layers
  - How user would access the network!
    - Send and receive messages



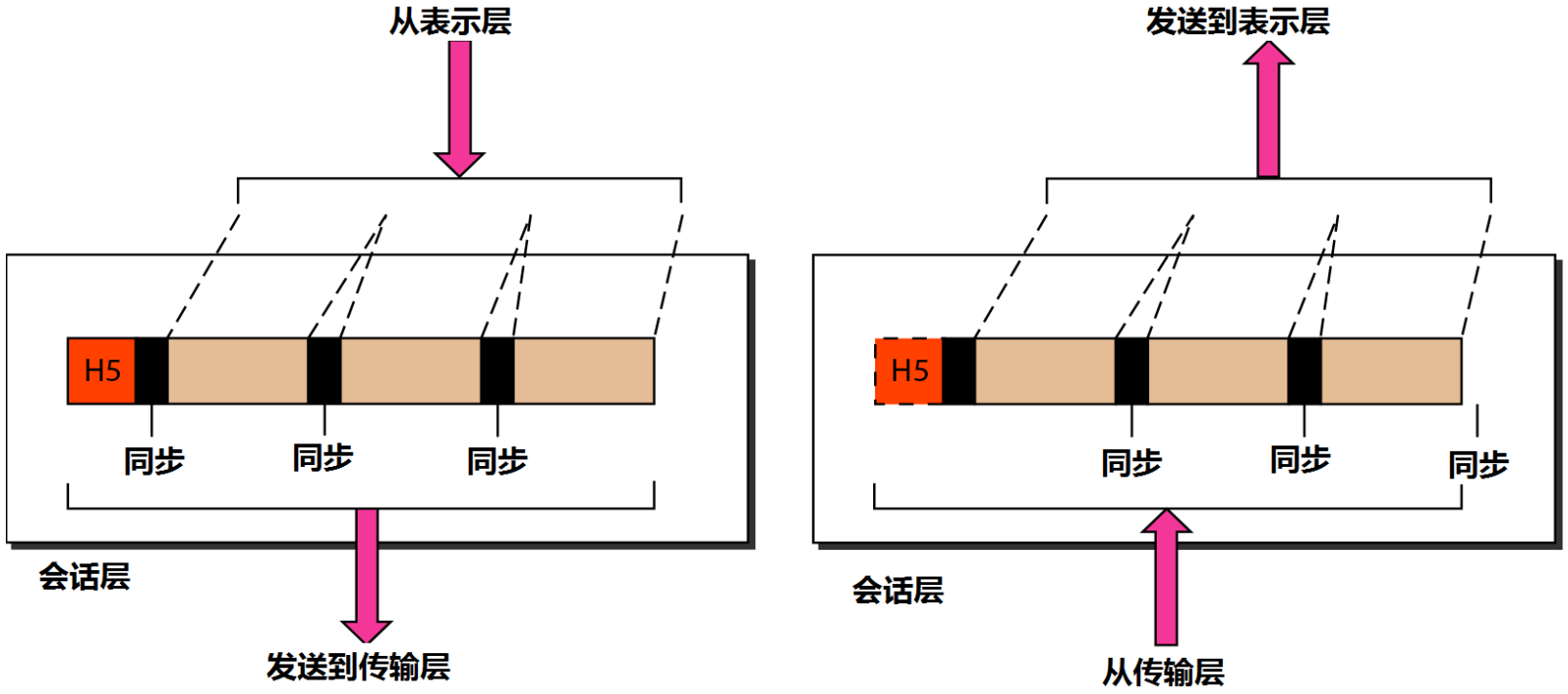
Functions of the Layers

- Presentation Layer
  - Concerned with the syntax (format) and semantics (meaning) of the information exchanged between two systems



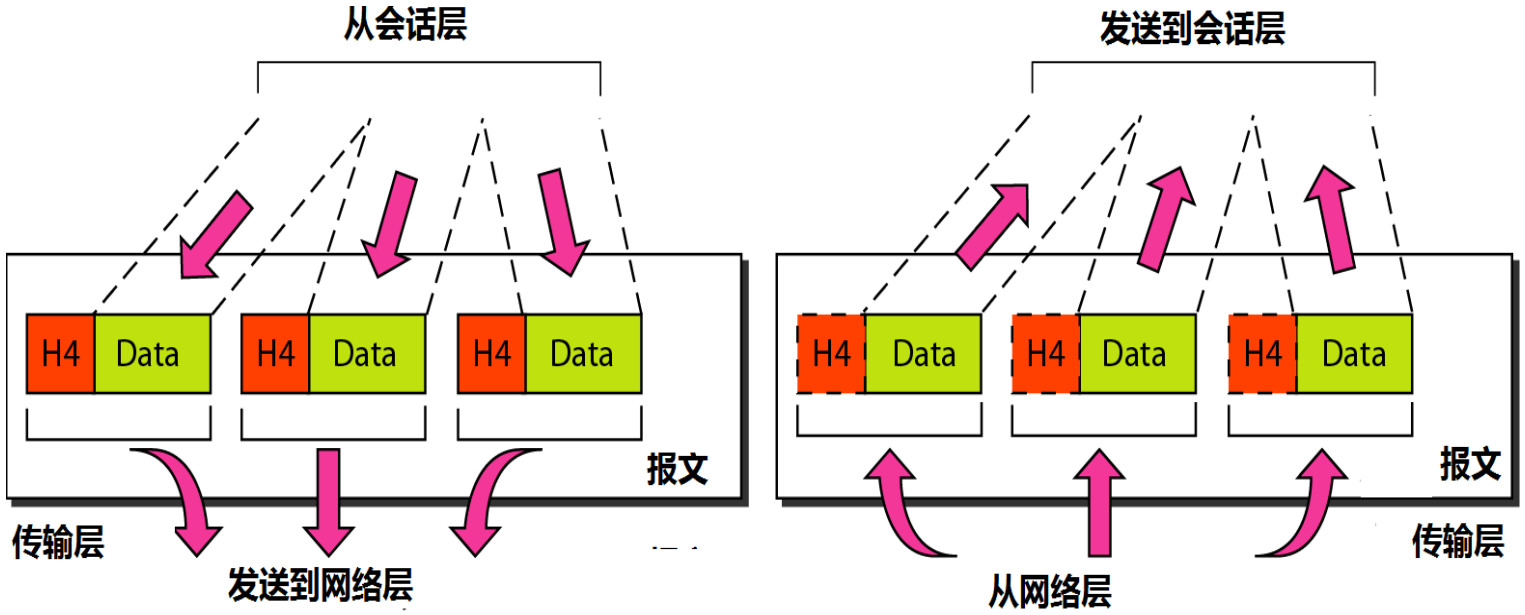
Functions of the Layers

- Session Layer
  - Synchronization control



Functions of the Layers

- Transport Layer
  - Segment: control info for reliable data end-to-end delivery



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Functions of the Layers

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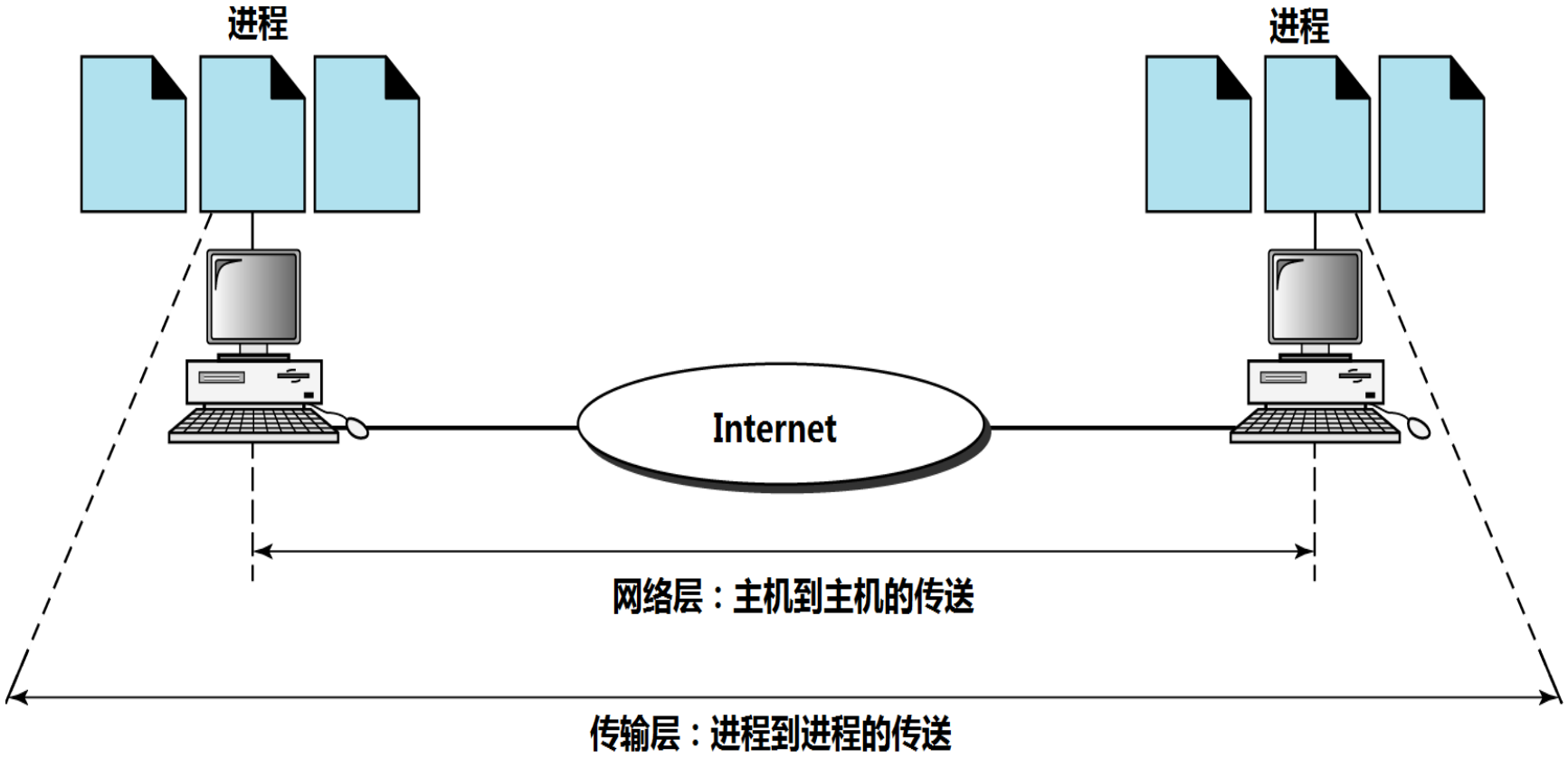
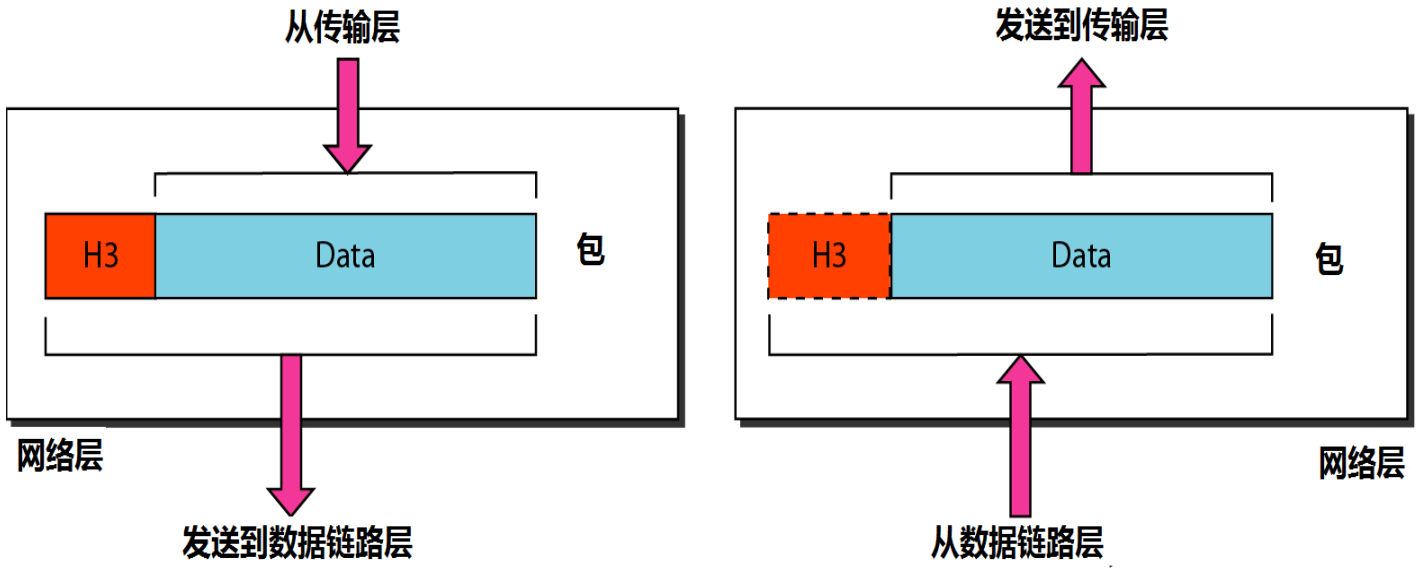


Functions of the Layers

- Network:
  - Packet: network address info, between the source and destination



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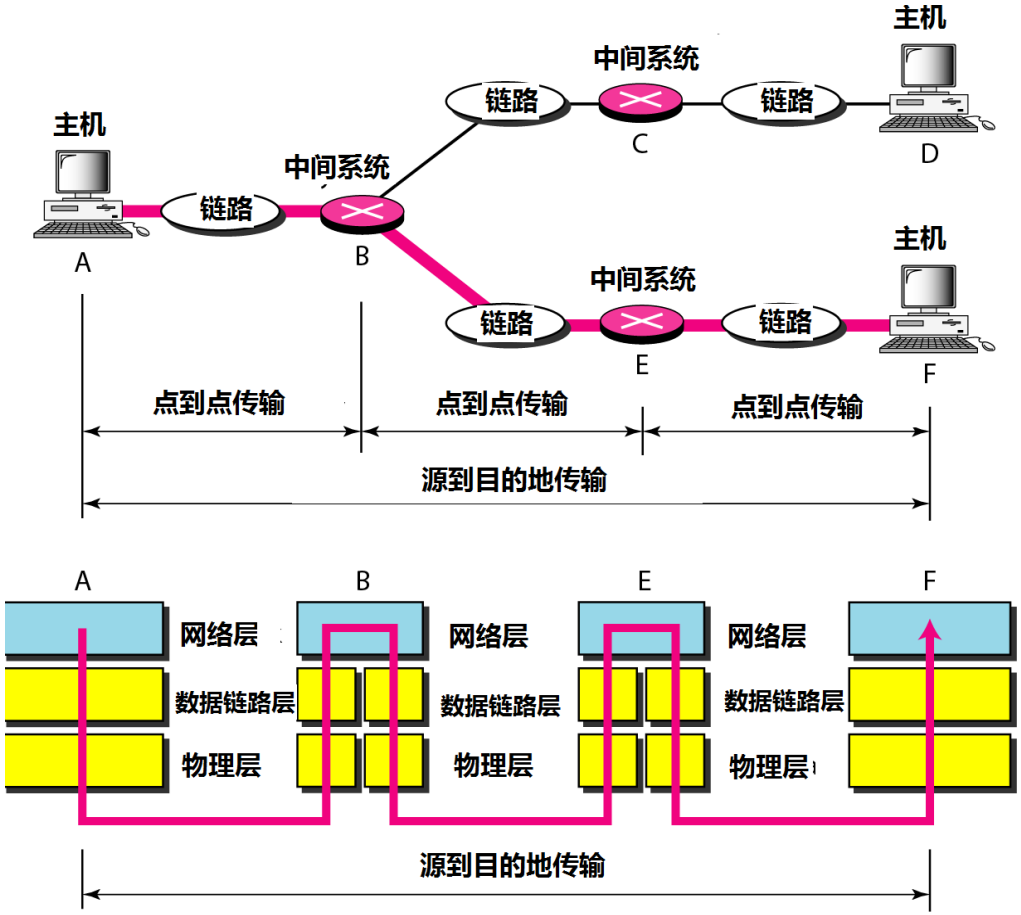
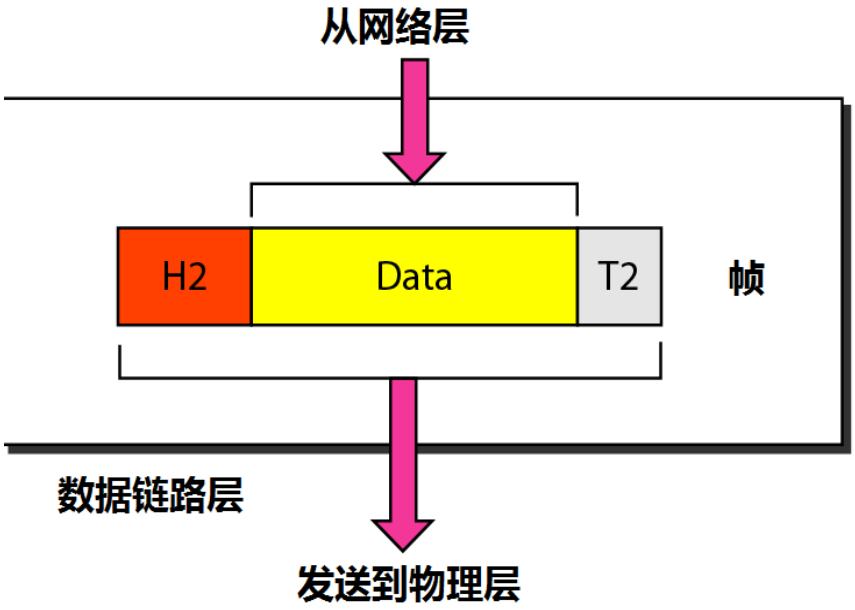
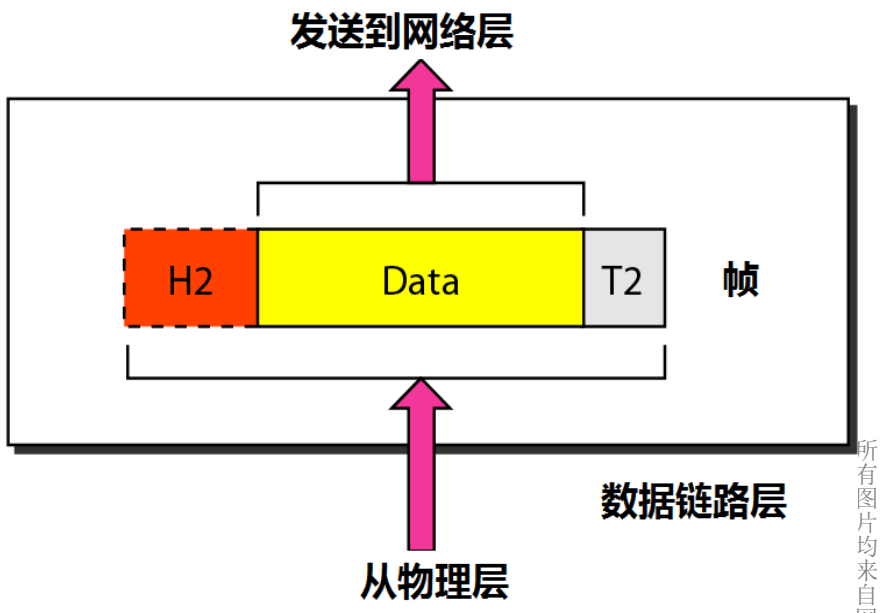


Functions of the Layers

- Data link:
  - Frame: physical address info, between adjacent nodes





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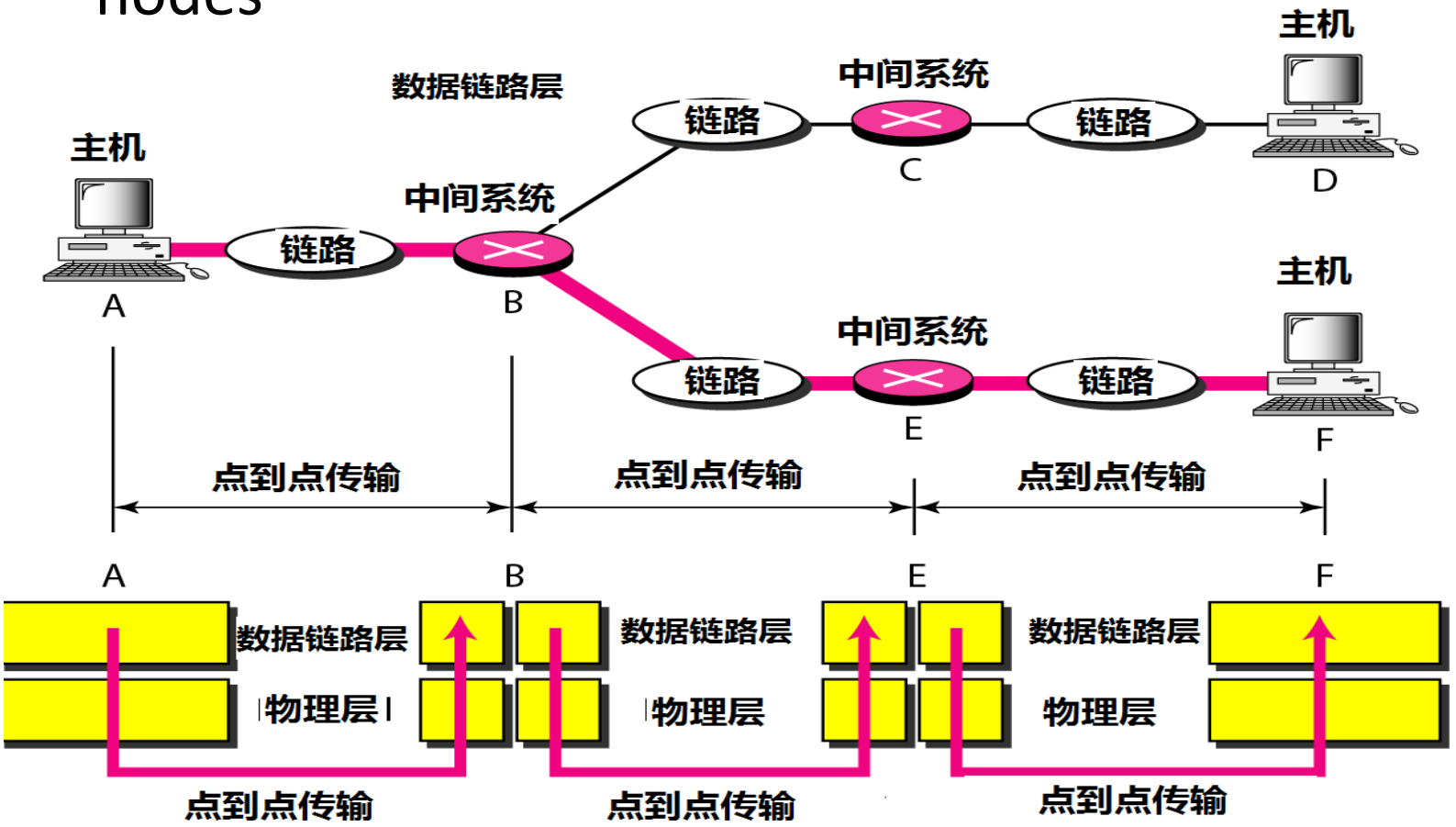
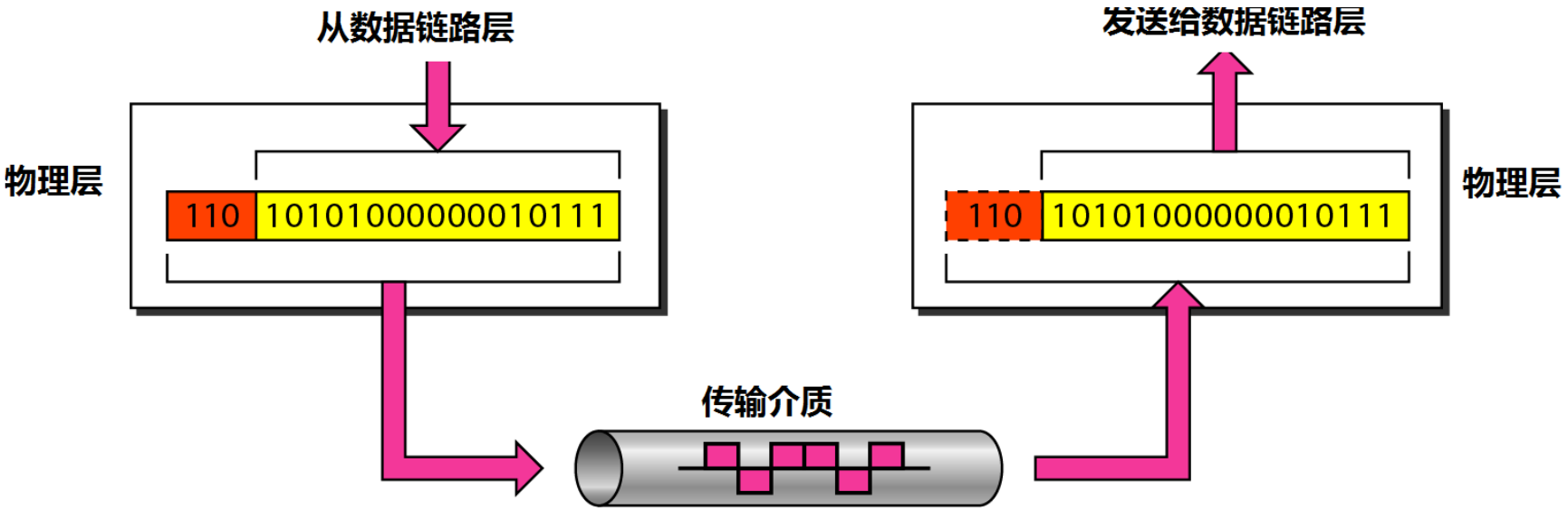


Functions of the Layers

- Physical layer:
  - Signal: a group of bits, between connected interfaces



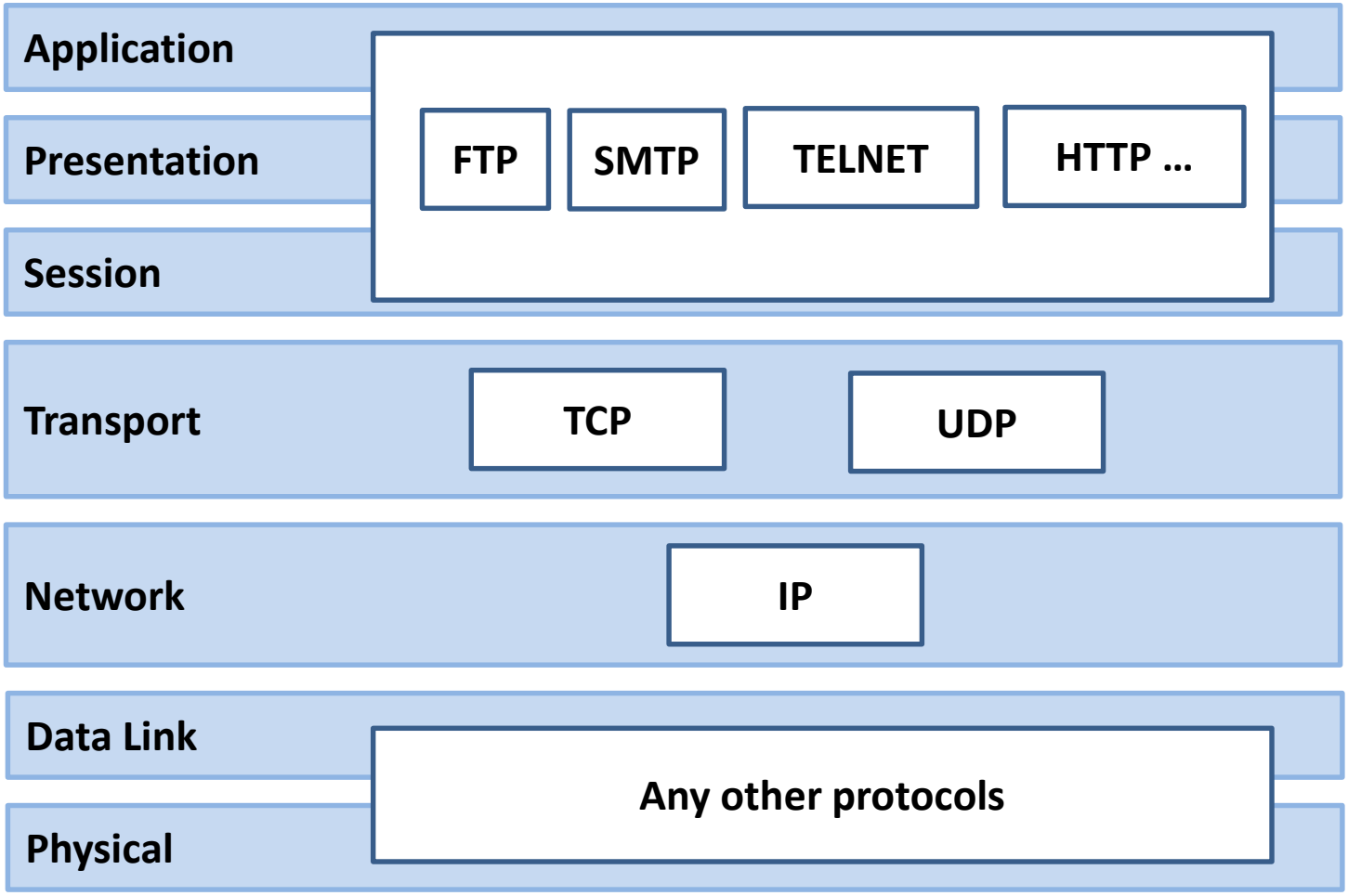
The Internet and TCP/IP

- WOW!! The Internet ~~
  - Try Internet history on the Internet ~~
- Transmission Control Protocol/Internet Protocol (TCP/IP)
  - Before The OSI model!
  - Transmission Control Protocol (TCP)

  Software that breaks messages into packets, hands them off to the IP software for delivery, and then orders and reassembles the packets at their destination
  - Internet Protocol (IP)

  Software that deals with the routing of packets through the maze of interconnected networks to their final destination

The TCP/IP and OSI model



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TCP/IP: Physical and Data-link layer

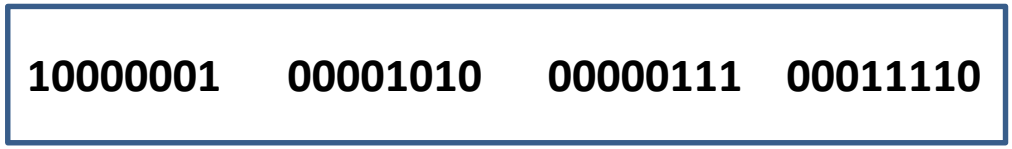
- TCP/IP dose not define any specific protocols in this level
- A famous example is Ethernet!
  - MAC address at link layers

3A-34-52-C4-69-B8

TCP/IP: Network layer

- The IP protocol
  - Best-effort services means no guarantee!
- Addressing
  - Internet Address：32bits (IPv4)

Bit Pattern



Dotted-Decimal Notation

TCP/IP: Network layer

- The IP protocol
  - Best-effort services means no guarantee!
- Addressing
  - **Hostname** A name made up of words separated by dots that uniquely identifies a computer on the Internet
  - **Internet Address**： An address made up of four one-byte numeric values separated by dots that uniquely identifies a computer on the Internet

Bit Pattern

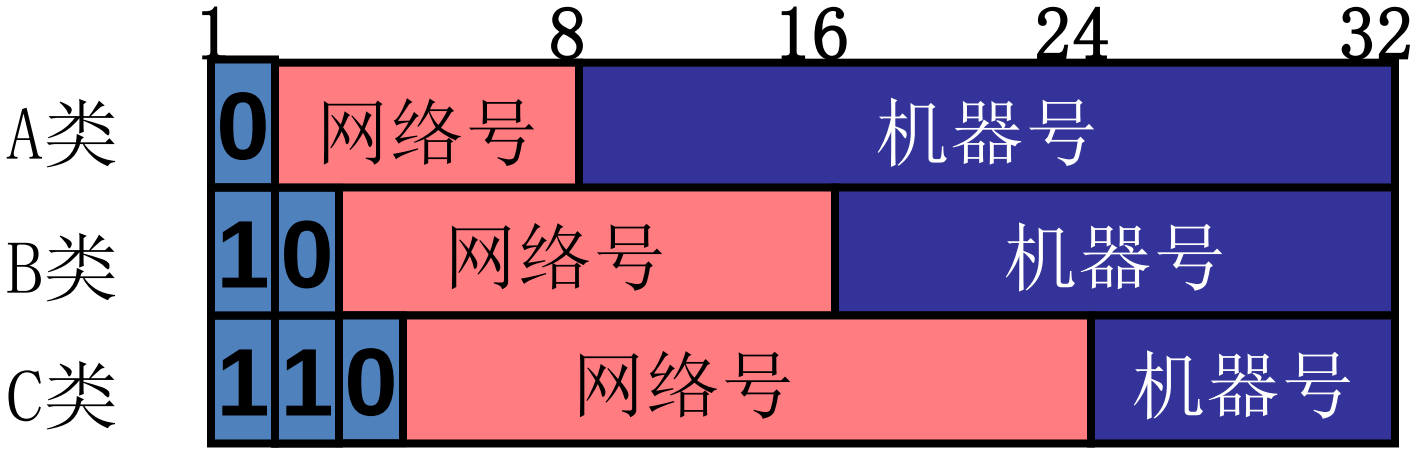
32bits (IPv4)

128bits (IPv6)

Dotted-Decimal Notation

IP address

IP地址： 202.197.96.118



A类	1677214
B类	65534
C类	254

A类 1.0.0.1~126.255.255.254

B类 128.0.0.1~191.255.255.254

C类 192.0.0.1~223.255.255.254

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Domain Name System

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Domain Name System

Host number

-The part of the IP address that specifies a particular host (machine) on the network *Yes, but what is it?*

Domain name

-The part of a hostname that specifies a specific organization or group

Top-level domain (TLD)

-The last section of a domain name that specifies the type of organization or its country of origin

Domain Name System

Domain name system (DNS)

A distributed system for managing hostname resolution

Domain name server

A computer that attempts to translate a hostname into an IP address

TCP/IP: Transport layer

- Transmission Control Protocol (TCP)
  - Reliable data delivery service
- User Datagram Protocol (UDP)
  - Unreliable data delivery service (An alternative to TCP that is faster but less reliable)

TCP/IP: Application Layer

- The client-server model
  - Server: always running, waiting for requests from clients
  - Client: init a request to start a communication with a server
- Protocols in application
  - **FTP: File Transfer Protocol** - allows a user to transfer files to and from another computer
  - **SMTP: Simple Mail Transfer Protocol** - used to specify transfer of electronic mail
  - **TELNET: Terminal NETwork** - used to log onto one computer from another
  - **HTTP: Hyper Text Transfer Protocol** -allows exchange of Web documents

High-level Protocols and Ports

Protocol	Port
Echo	7
File Transfer Protocol (FTP)	21
Telnet	23
Simple Mail Transfer Protocol (SMTP)	25
Domain Name Service (DNS)	53
Gopher	70
Finger	79
Hypertext Transfer Protocol (HTTP)	80
Post Office Protocol (POP3)	110
Network News Transfer Protocol (NNTP)	119
Internet Relay Chat (IRC)	6667

Port
A numeric designation that corresponds to a particular high-level protocol

Figure Some protocols and the ports they use

MIME Types

MIME type

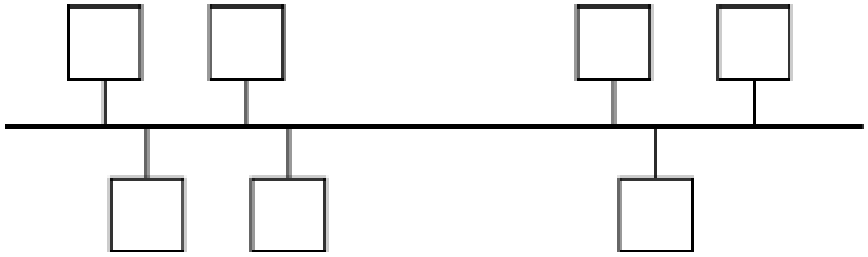
A standard for defining the format of files that are included as email attachments or on websites

What does MIME stand for?

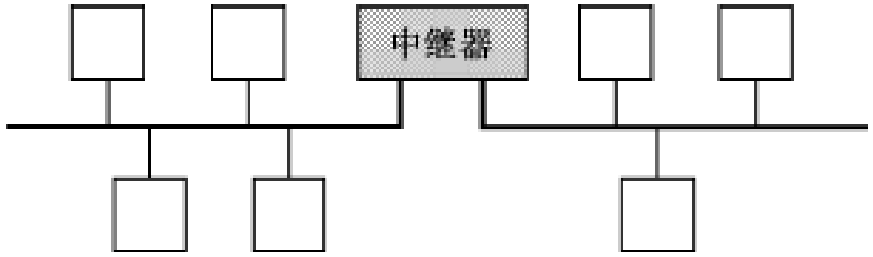
Multipurpose Internet Mail Extension

Networking devices

- Repeaters
  - Regenerate signal in the physical layer



（a）无中继器



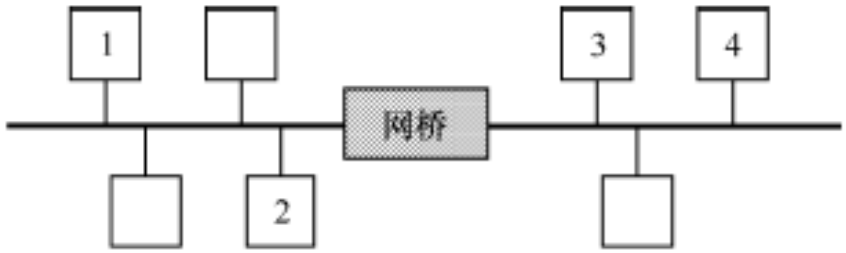
（b）有中继器

片均来自网络

Networking devices

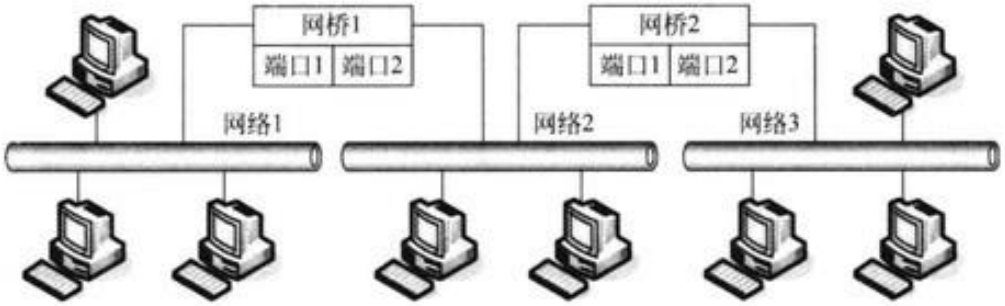
- Bridges
  - Traffic controller for independent bus segments
  - Physical and Data Link layer

（a）无网桥



（b）有网桥

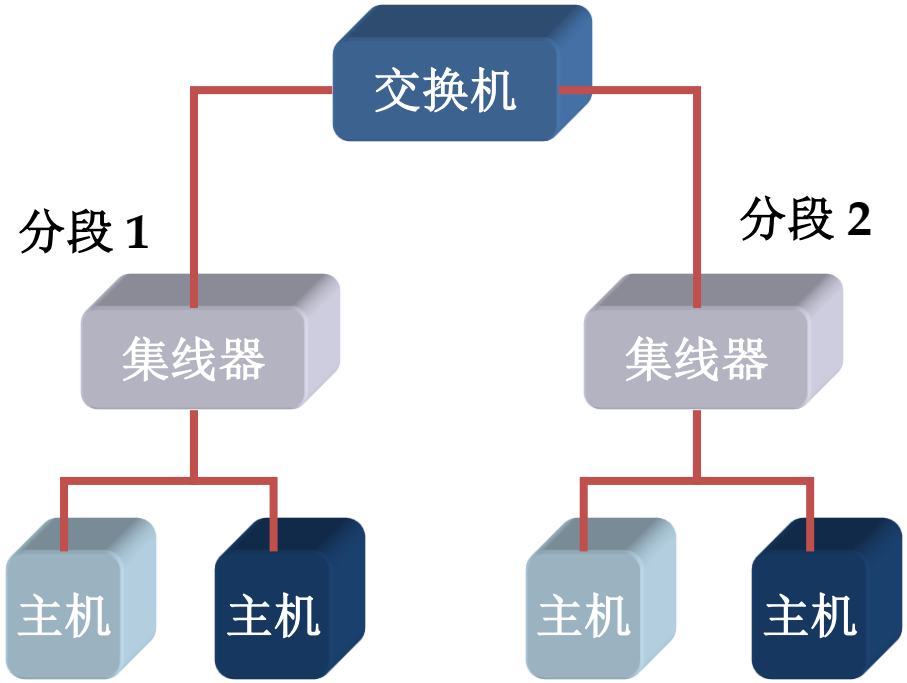
可利用网桥隔离信息，将网络划分成多个网段



Networking devices

- Switches
  - Traffic controller, star topology
  - Physical and Data Link layer

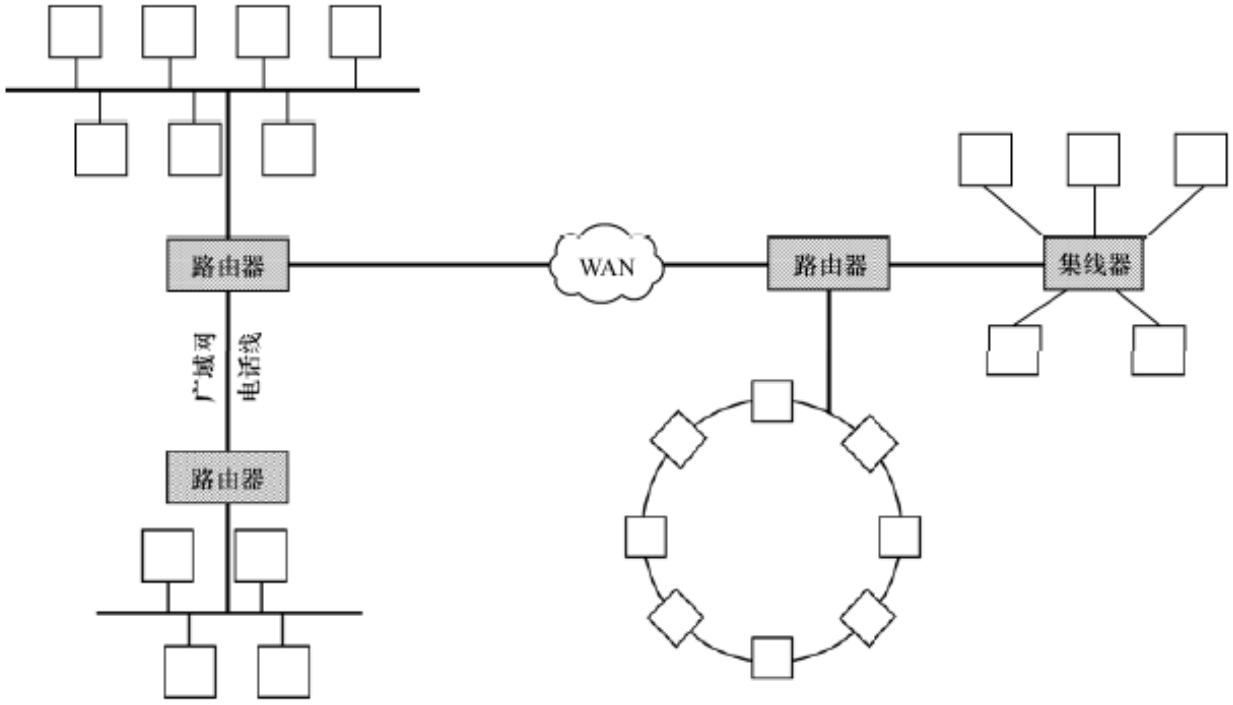
交换机和网桥的区别：交换机通常将一个局域网进行分段，每段在相同的协议下工作；网桥通常连接协议不同的多个局域网



所有图片均来自网络

Internetworking devices

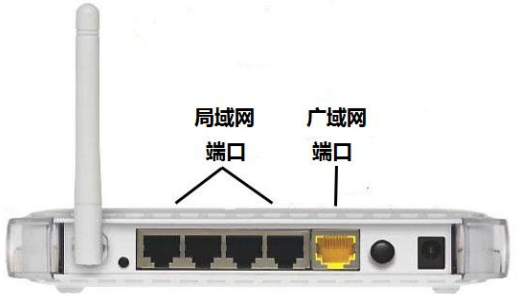
- Routers
  - Connecting LANs, MANs and WANs to form an internetwork (e.g. the Internet)
  - Physical , Data Link layer and Network

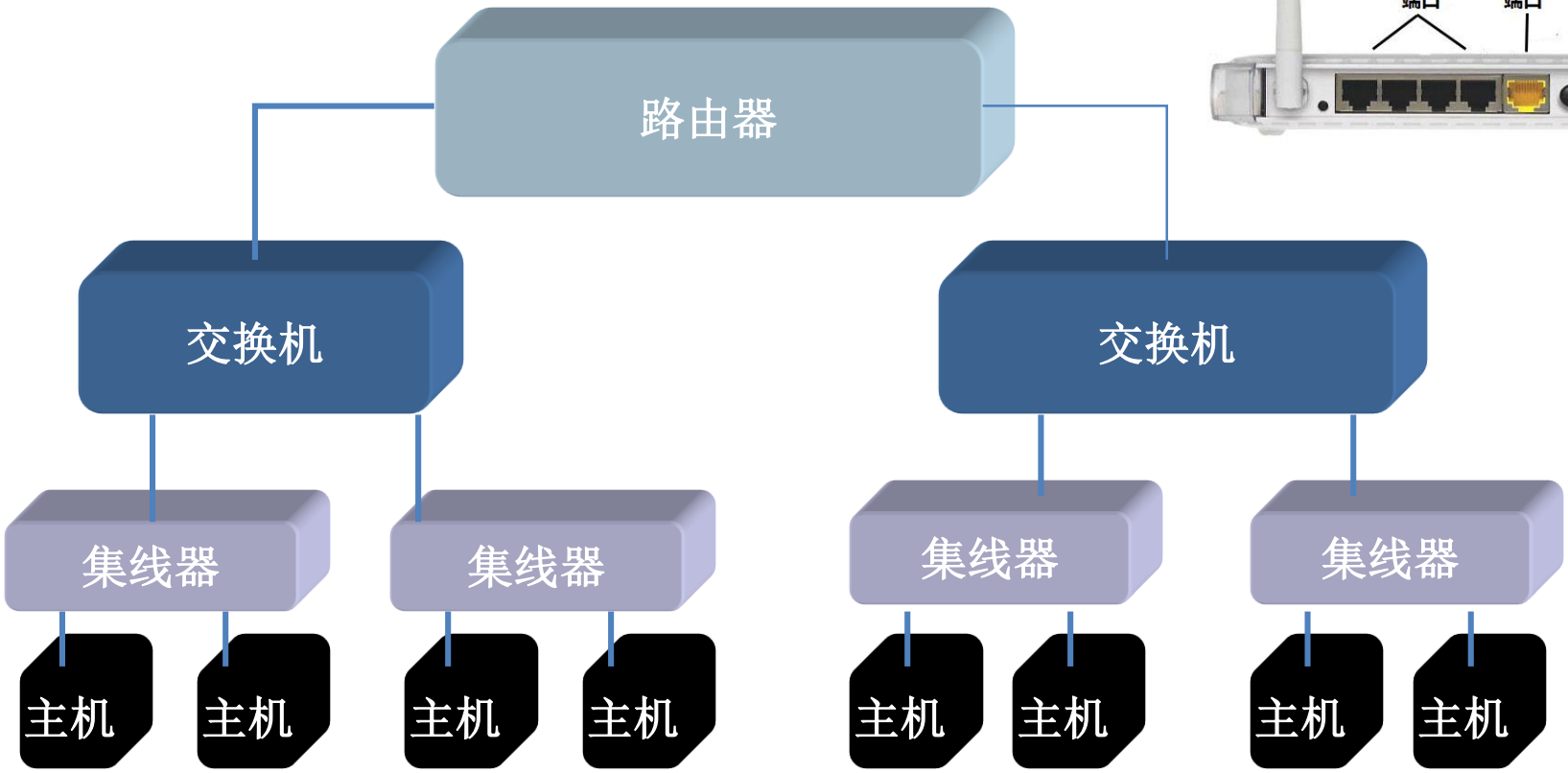


所有图片均来自网络

Internetworking devices

- Routers





所有图片均来自网络

Internetworking devices

- Gateways
  - Acting as a protocol converter
  - Connecting two type of networks (using different set of protocols)
  - All seven layers

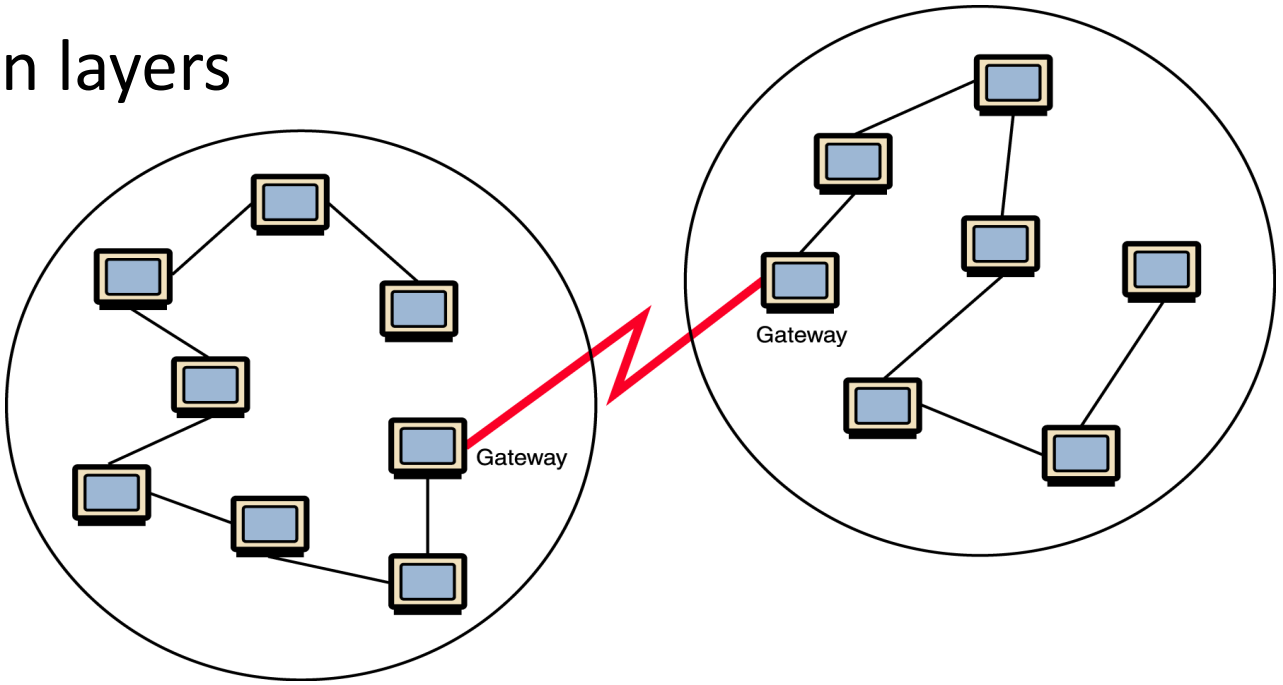


Figure Local-area networks connected across a distance to create a wide-areanetwork

Firewalls

Firewall

A gateway machine and its software that protects a network by filtering the traffic it allows

Access control policy

A set of rules established by an organization that specifies what types of network communication are permitted and denied

Have your messages ever been returned undelivered, blocked by a firewall?

Firewalls

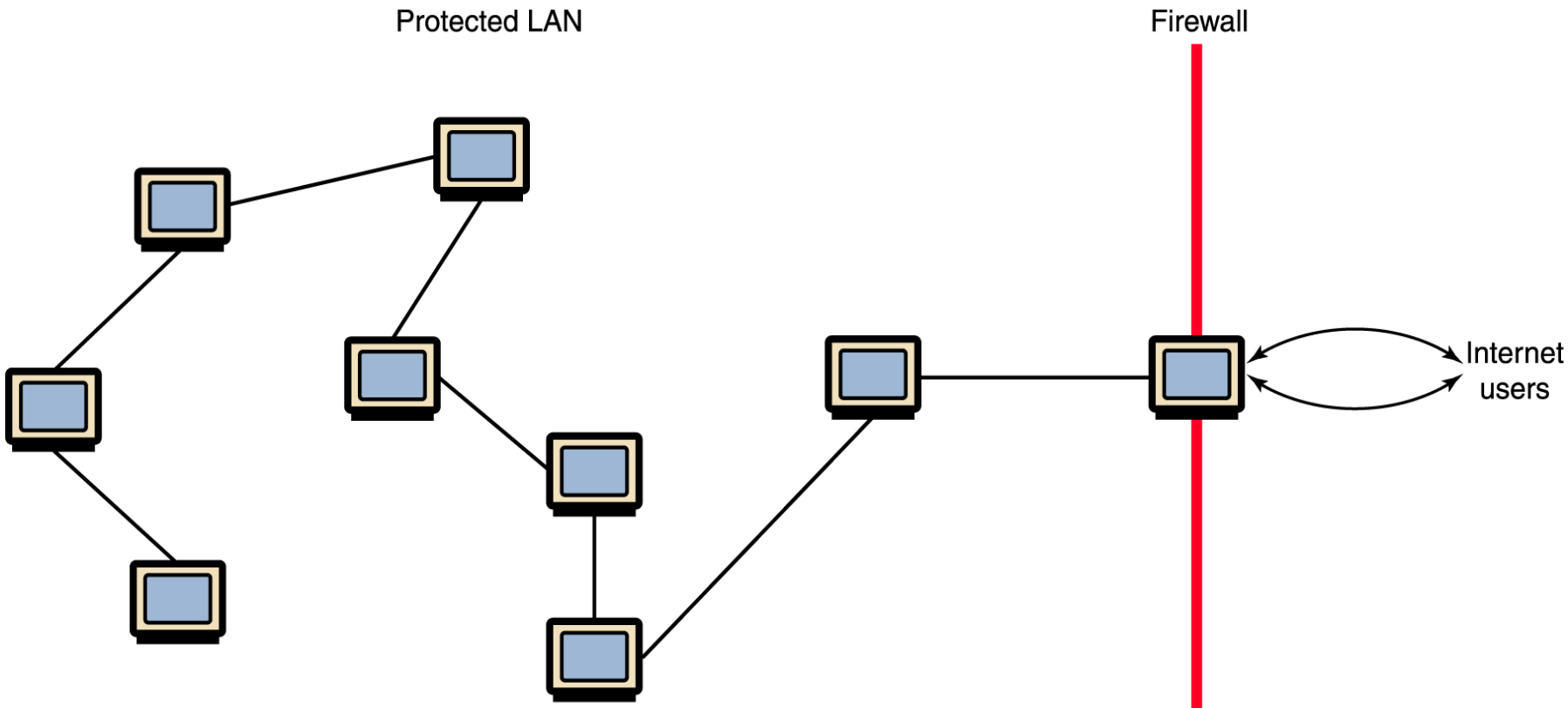


Figure A firewall protecting a LAN

图片均来自网络