Chapter 4:
Networking and the Internet

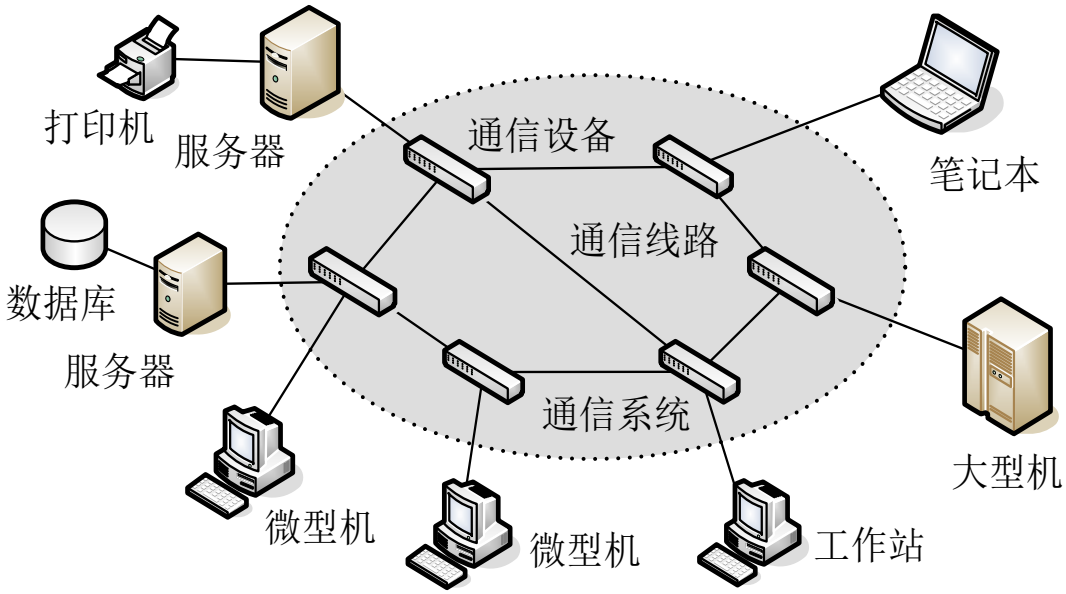
Computer Science: An Overview
Tenth Edition

by
J. Glenn Brookshear


PLACE
STAMP
HERE
GOOGLE
CLASSIC
QUERY:
IMAGES
NEWS
FILM
MAPS
OTHER
SEND YOUR QUERY TO: GOOGLE INC., 1600 AMPHITHEATRE PARKWAY, MOUNTAIN VIEW, CA 94043, UNITED STATES
PLEASE ALLOW 30 DAYS FOR SEARCH RESULTS

What is a computer network?

- How many devices? 2 or more
- Connected
- Sharing resources



Element of a computer network

- Sender / Receiver
- Messages (signal)
- Media
- Protocol (rules)

LANs and WANs - Geographical coverage

- LANs (local area networks)
  - A single geographical location, such as office building, school, etc.
  - Typically High speed and cheaper.
- WANs (wide area networks)
  - Spans more than one geographical location often connecting separated LANs
  - Slower
  - Costly hardware, routers, dedicated leased lines and complicated implementation procedures.

Network Topologies

- Topology - Physical and logical network layout
  - Physical – actual layout of the computer cables and other network devices
  - Logical – illustrates how data flows within a network, regardless of its physical design.
  - Common topologies:
    - Bus, ring, star, mesh and wireless
    - Token-based and Shared media

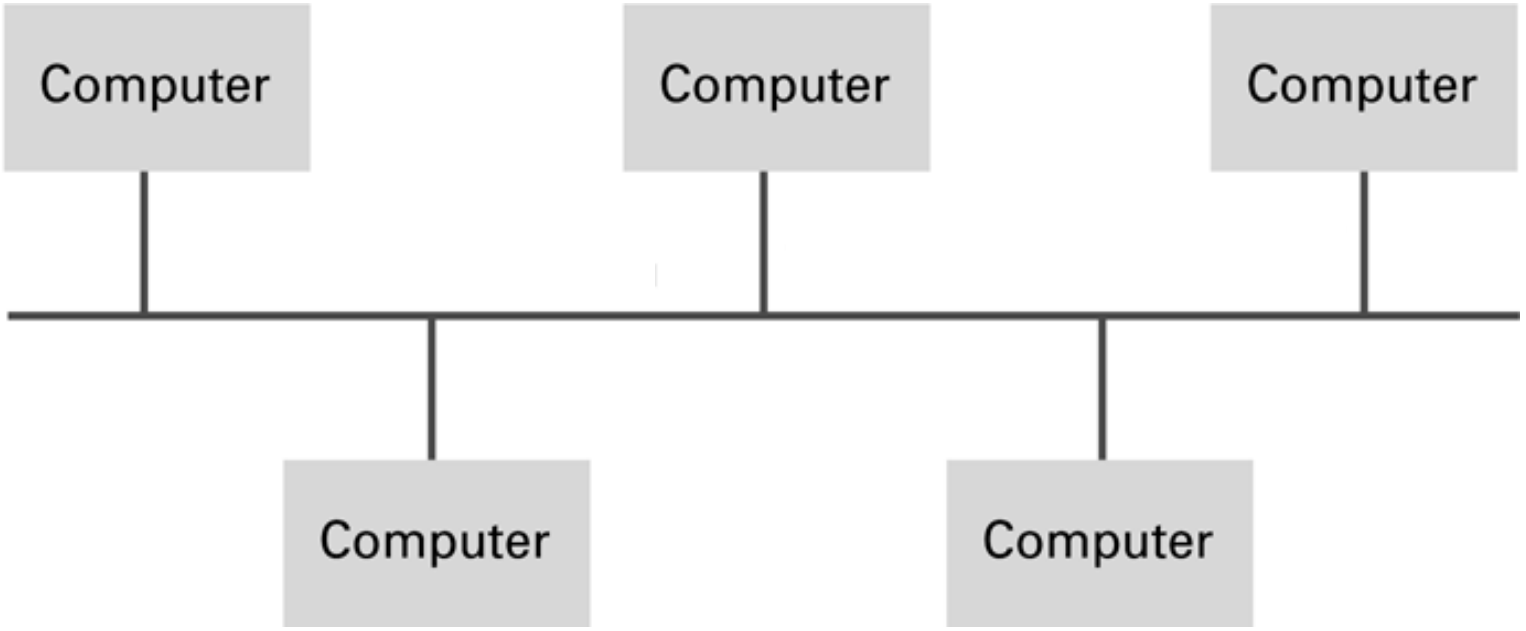
Topology

- Ring
  - Token Ring

http://belajarramerame.blogspot.com/2008/08/protokol-lan.html

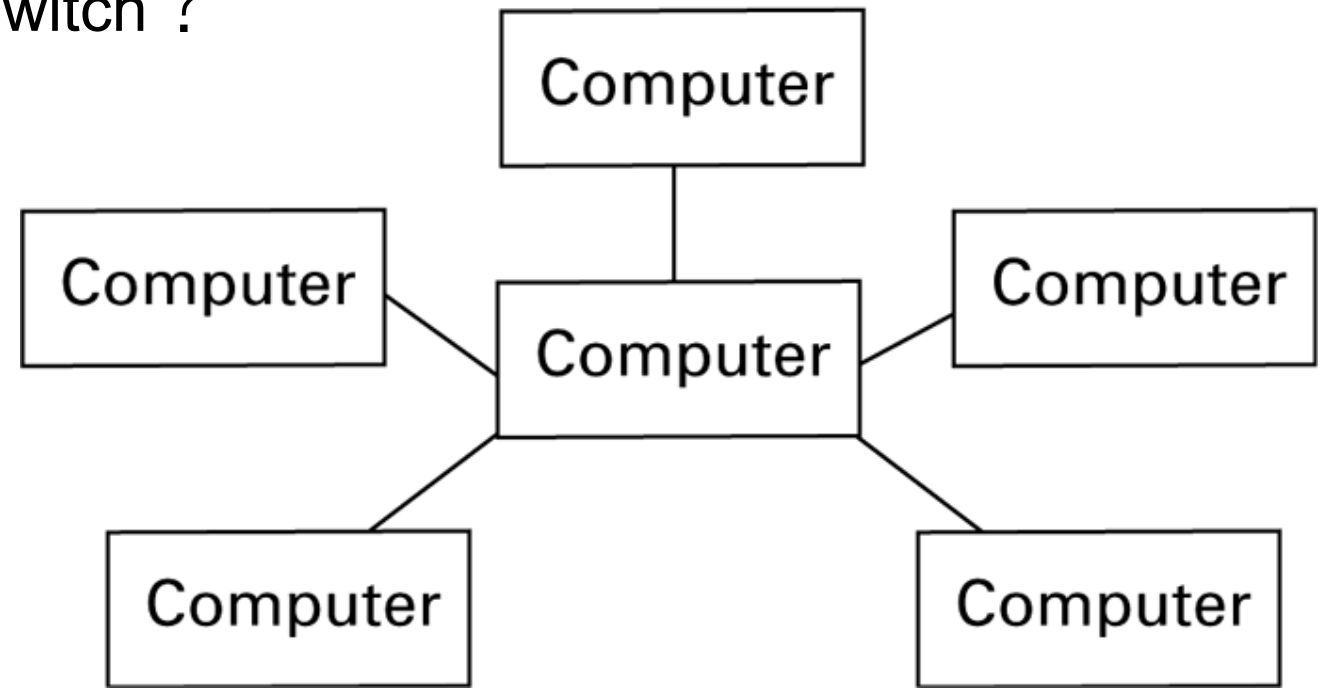
Topology

- Bus
  - Ethernet
  - CSMA/CD (Carrier Sense, Multiple Access with Collision Detection)



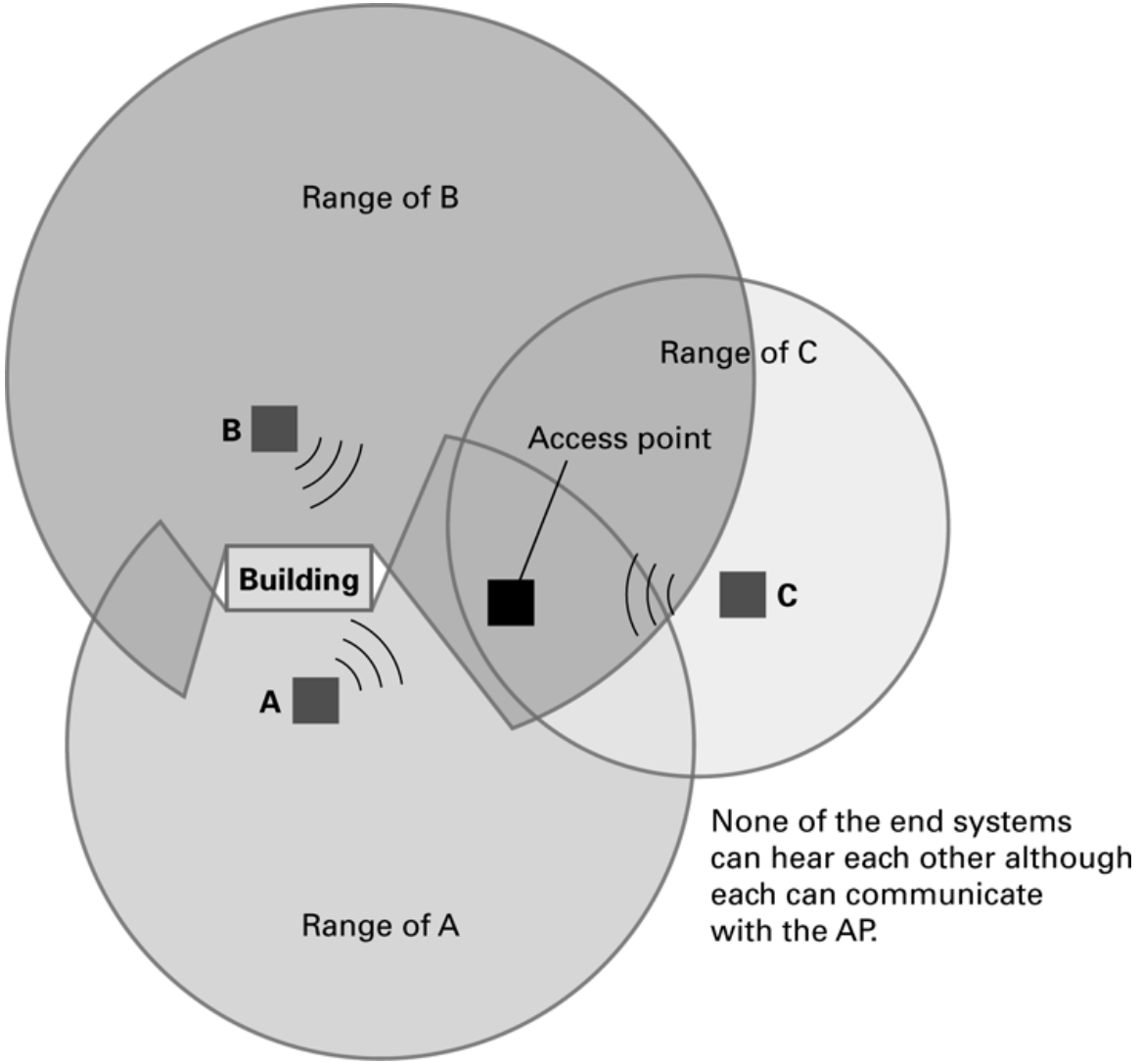
Topology (logical)

- Star
  - Wireless
  - Hub or Switch ?



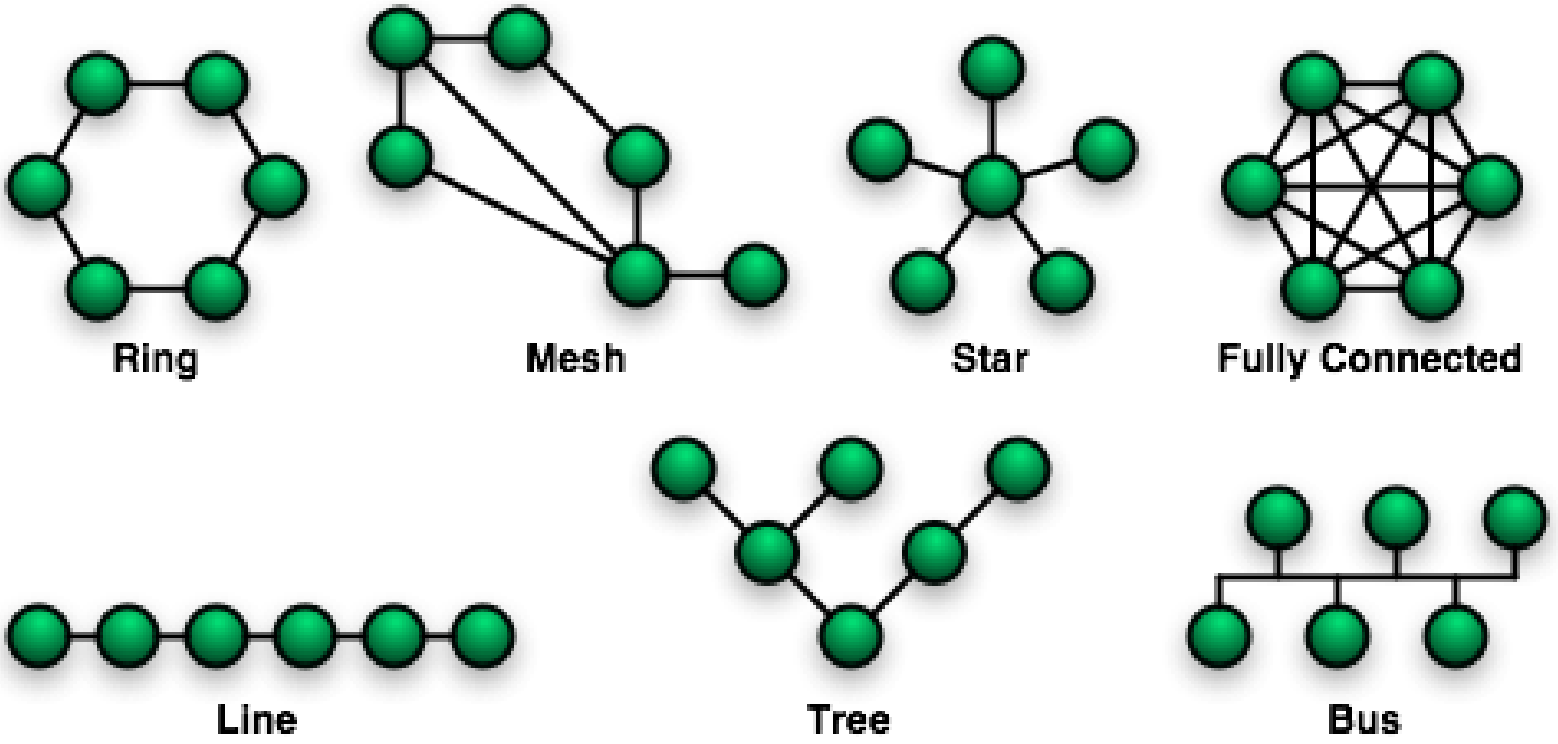
CSMA/CA

- Carrier Sense, Multiple Access with Collision Avoidance



Hidden terminal problem

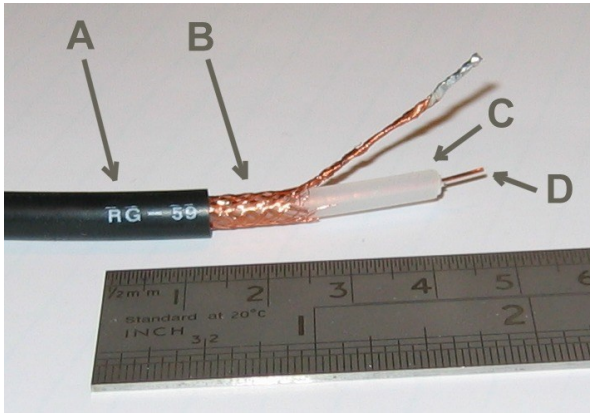
Various topologies



Wikipedia

How to build a LAN?

- Ethernet
  - Interface (NIC)
  - Media (coaxial cable, twisted-pair cables or fiber cable)
  - 10BASE-T, 100BASE-TX and 1000BASE-T



Connecting Networks

- **Repeater:** Extends a network
- **Bridge:** Connects two compatible networks
- **Switch:** Connect several compatible networks
- **Router:** Connects two incompatible networks resulting in a network of networks called an **internet**

Hub

- the ***simplest*** of these devices
- ***cannot filter data*** so data packets are sent to all connected devices/computers
- **Bandwidth of each port: Total bandwidth / W (numbers of ports)**

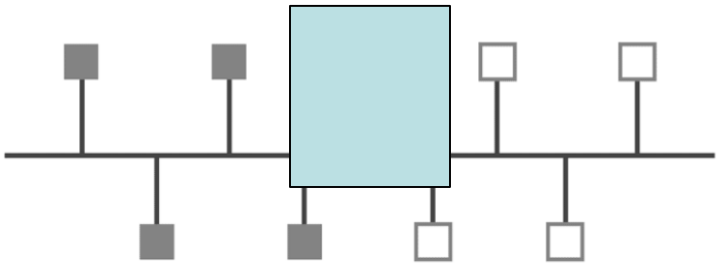
http://www.teqlog.com/switch-vs-router-hub-bridge-repeater-wireless-access-point.html

Switch

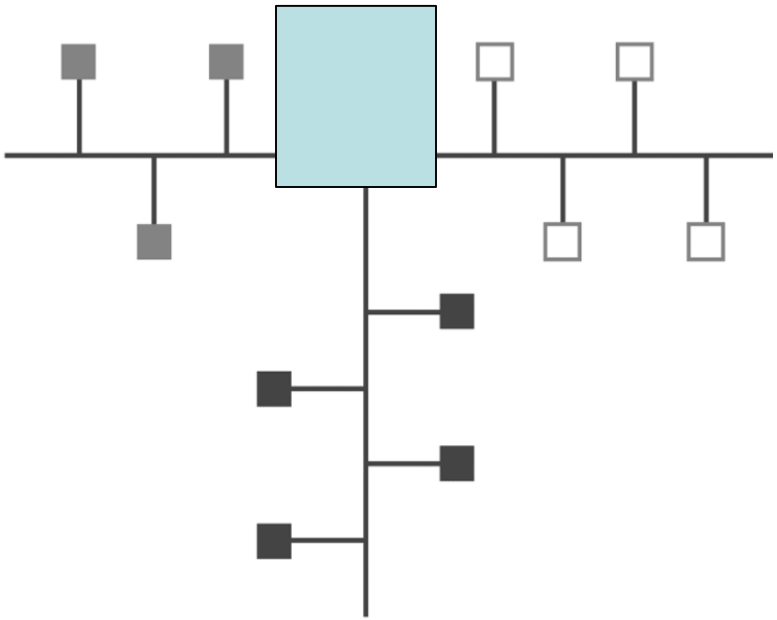
- ***maintains a MAC address table***
- ***filters traffic on the LAN***
- ***looks at the destination of the packet before forwarding***
- **Each port: Total bandwidth**

http://www.teqlog.com/switch-vs-router-hub-bridge-repeater-wireless-access-point.html

Figure 4.4 Building a large bus network from smaller ones



a. A repeater or bridge connecting two buses



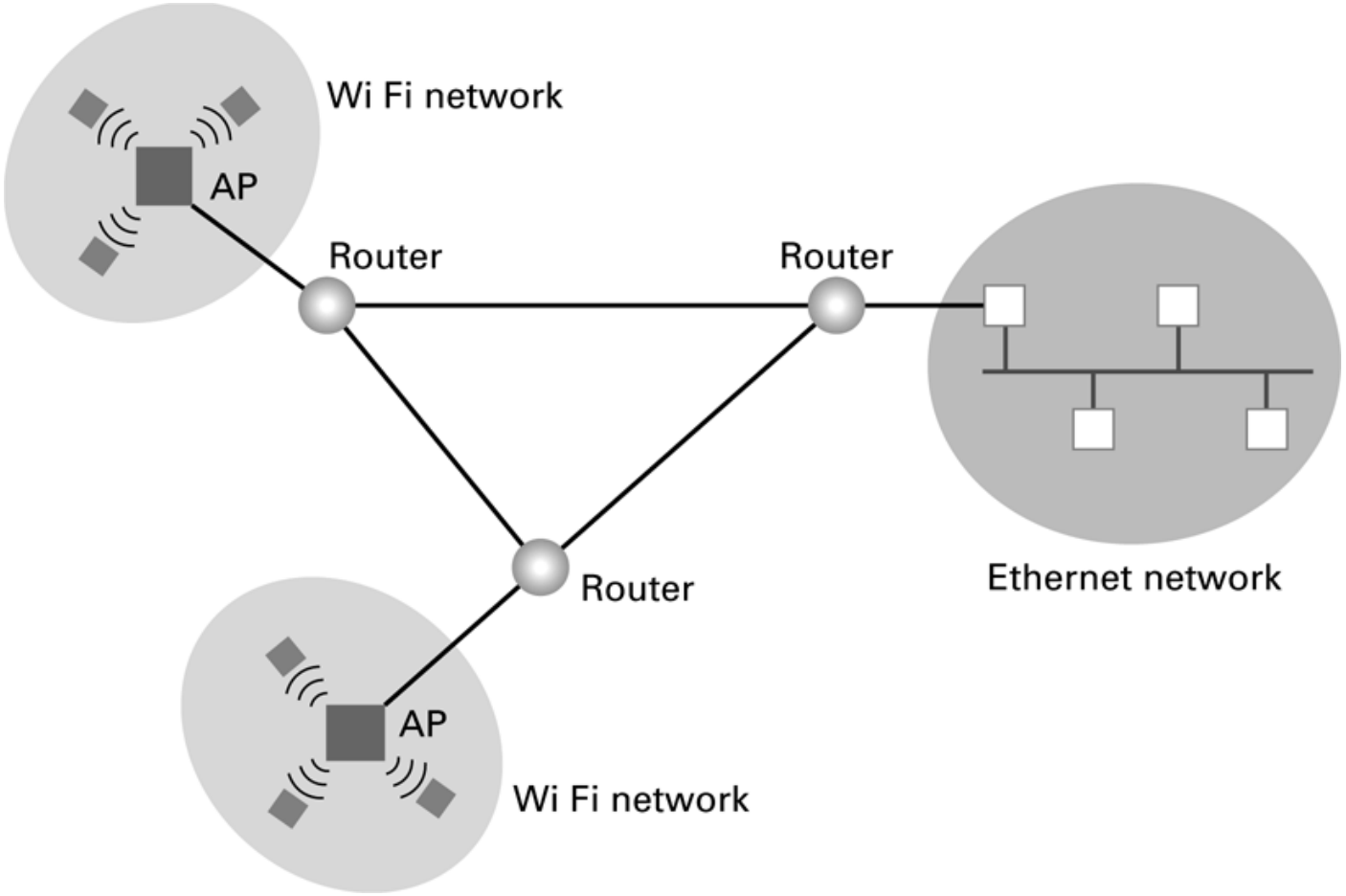
b. A switch connecting multiple buses

Router

- ***uses the IP address to forward packets***
- ***forward packets based on software***
- ***support different WAN technologies*** but switches do not
- Wireless Routers have ***Access Point built in***

http://www.teqlog.com/switch-vs-router-hub-bridge-repeater-wireless-access-point.html

Figure 4.5 Routers connecting two WiFi networks and an Ethernet network to form an internet



Inter-process Communication

- Client-server
  - One server, many clients
  - Server must execute continuously
  - Client initiates communication
- Peer-to-peer (P2P)
  - Two processes communicating as equals
  - Peer processes can be short-lived

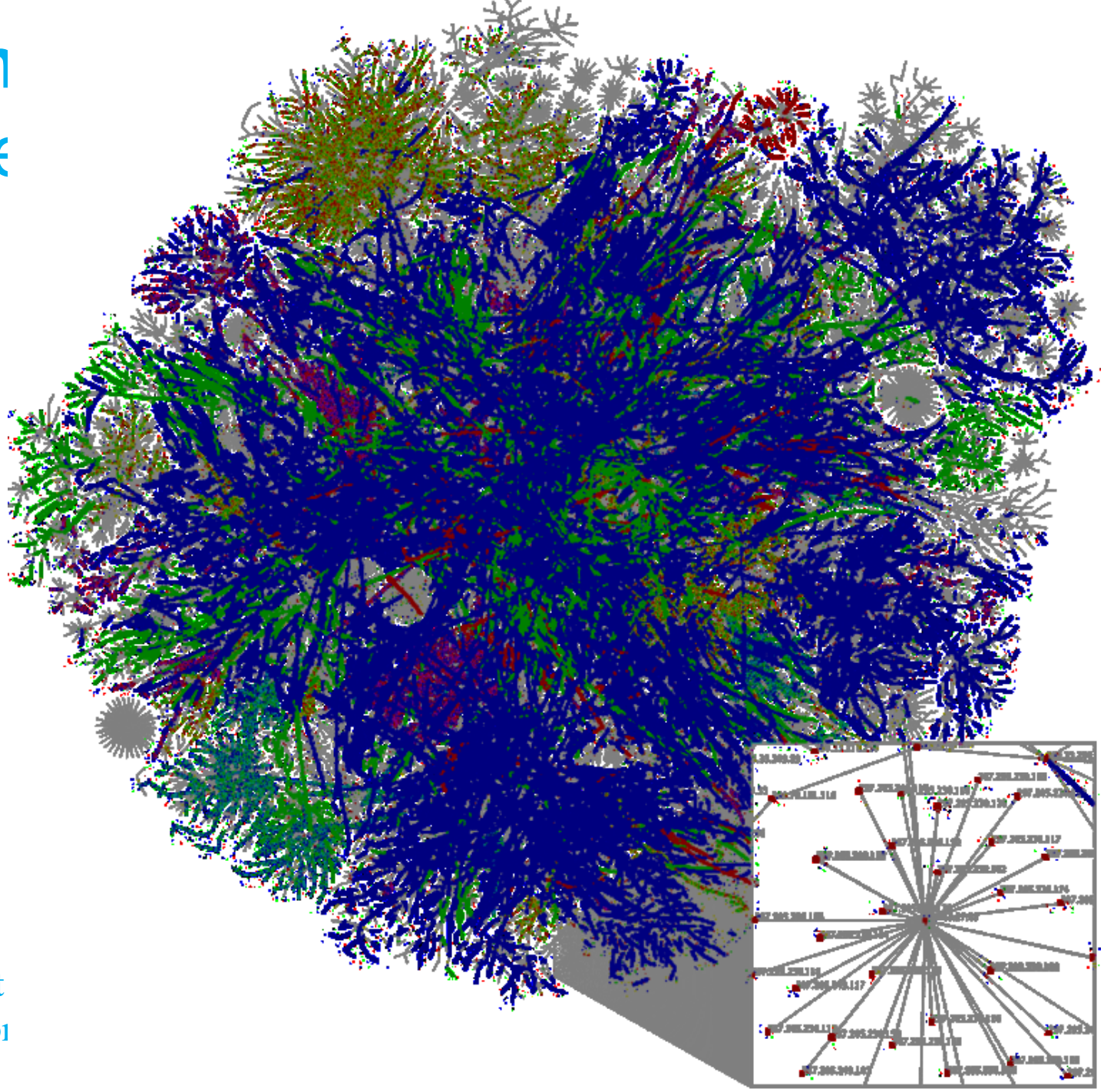
Protocols

- They define how networks are connected
- They define how computers communicates with each other
- They define the data format of the communication over the network

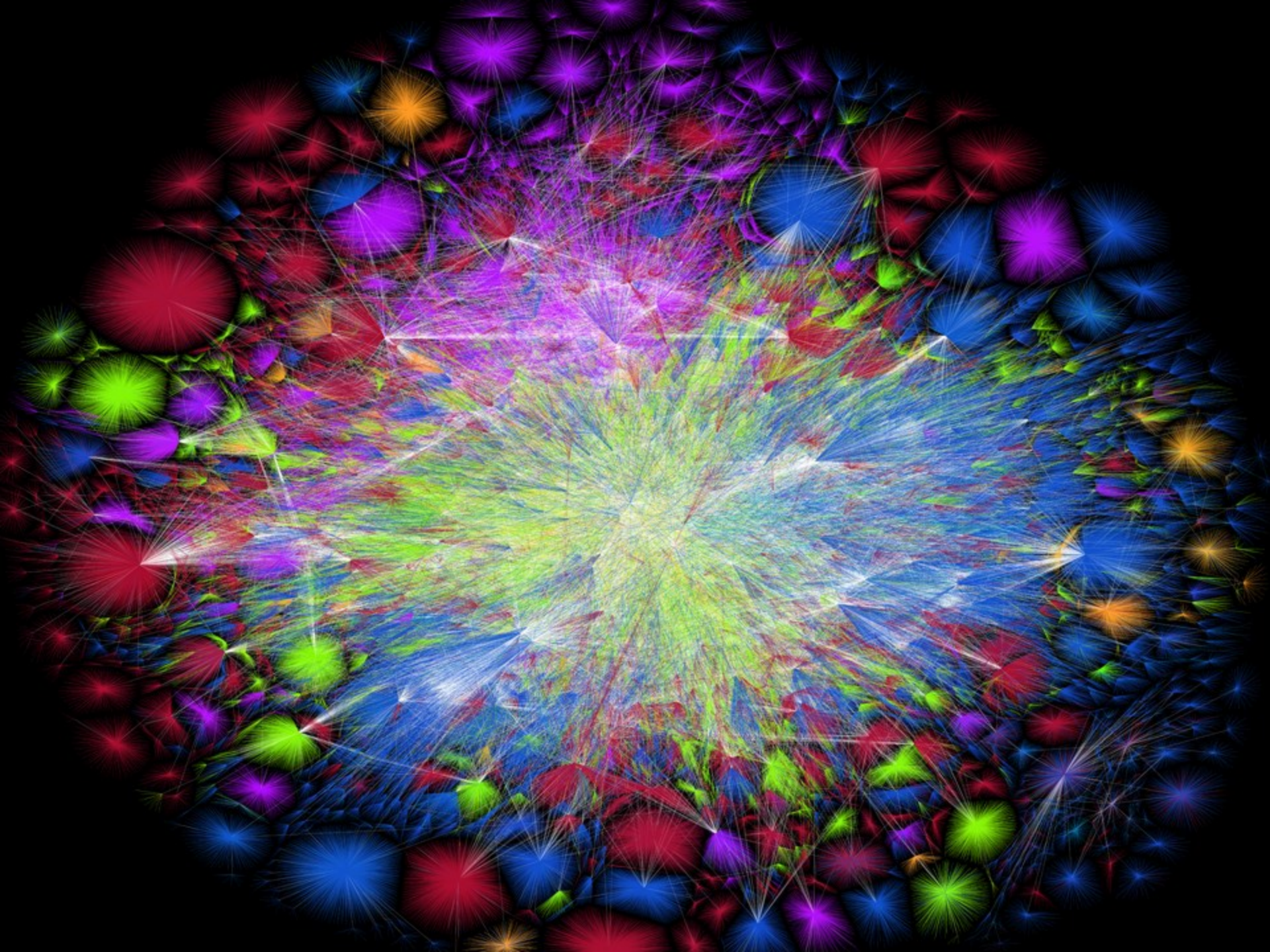
CSMA/CD vs CSMA/CA

- It is used in Ethernet
- It is used in WLan
- The differences between the two? Why?
- Are they still used today?

The In
An inte



An Opte Project
through a portio

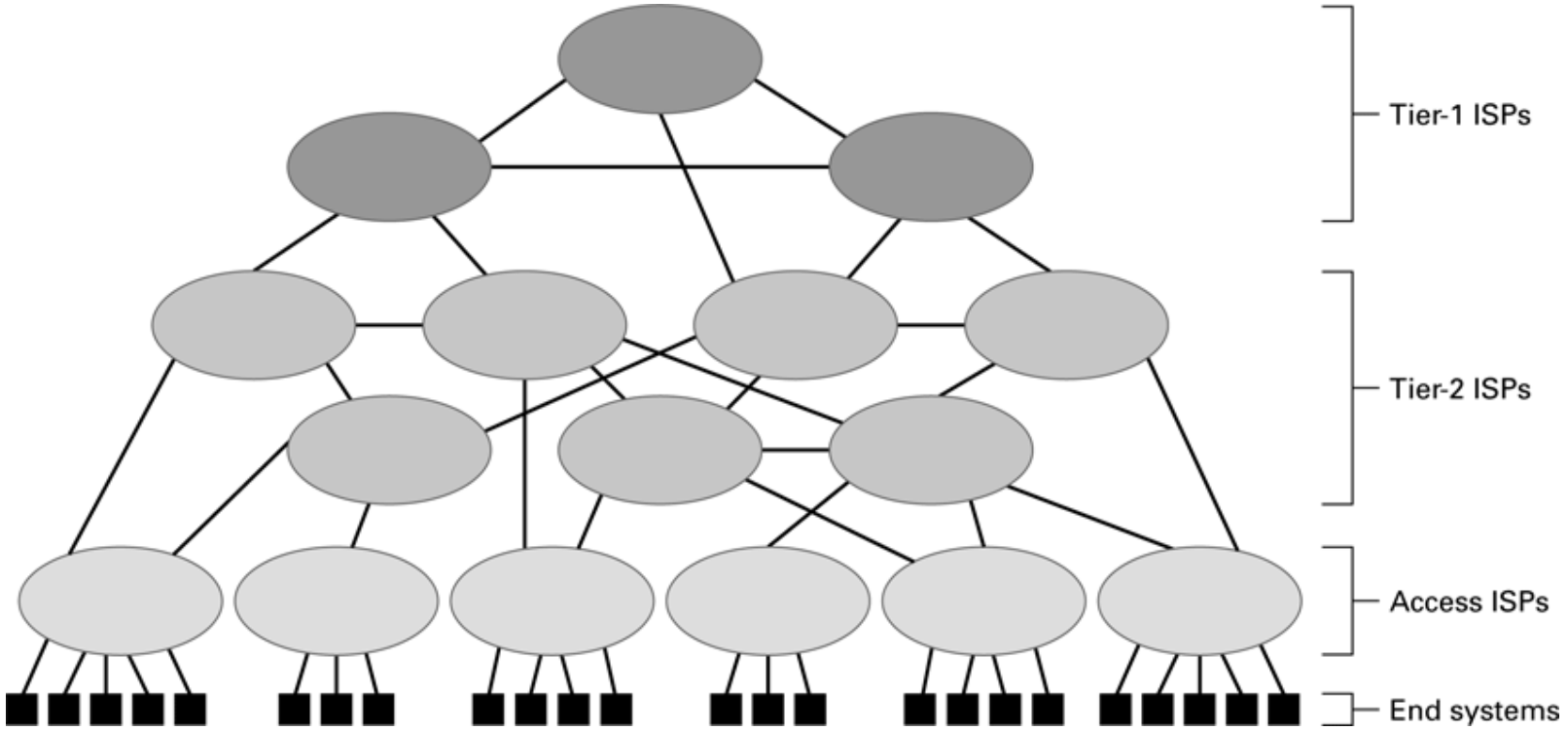


History of the Internet

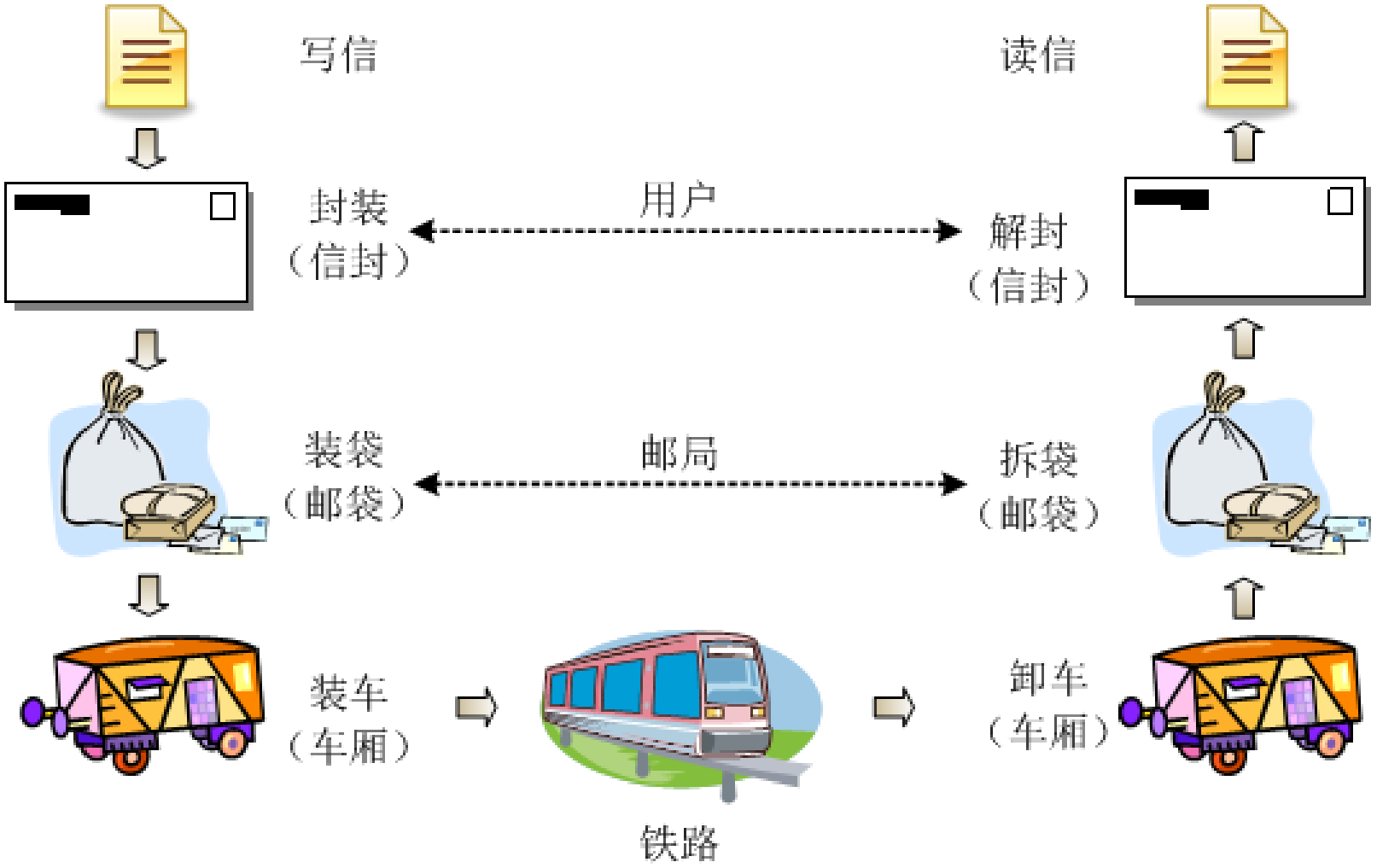
Internet Architecture

- Internet Service Provider (ISP)
  - Tier-1
  - Tier-2
- Access ISP: Provides connectivity to the Internet
  - Traditional telephone (dial up connection)
  - Cable connections
  - DSL
  - Wireless

Figure 4.7 Internet Composition

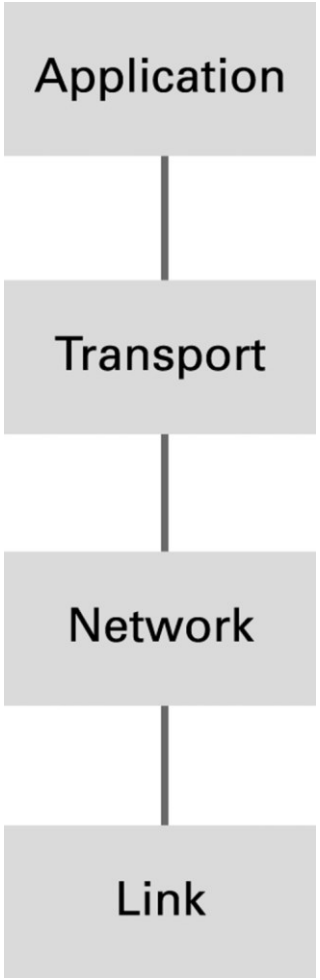


Package-shipping example



Internet Software Layers

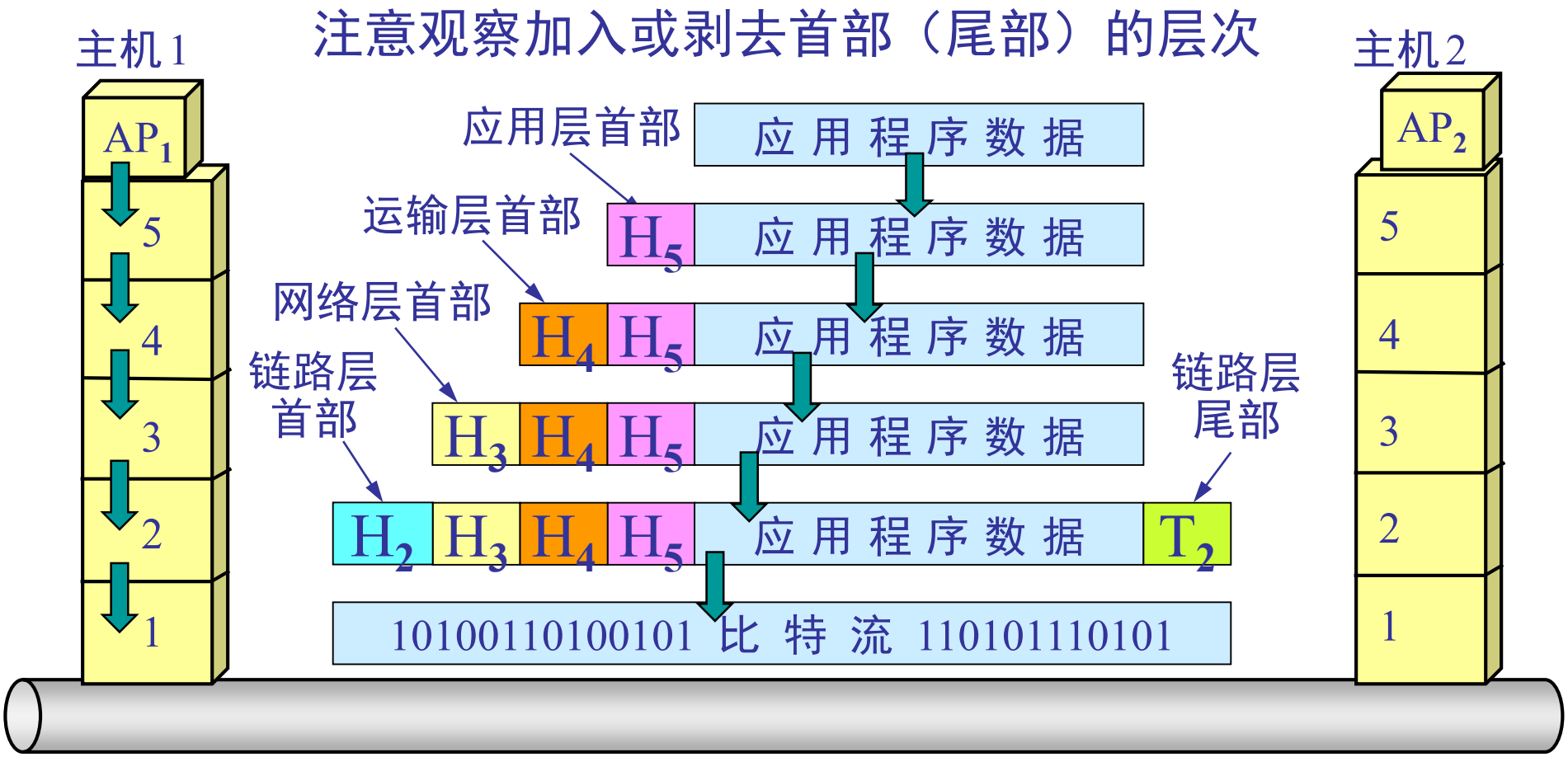
- **Application:** Constructs message with address
- **Transport:** Chops message into packets
- **Network:** Handles routing through the Internet
- **Link:** Handles actual transmission of packets



Layered Approach: Why?

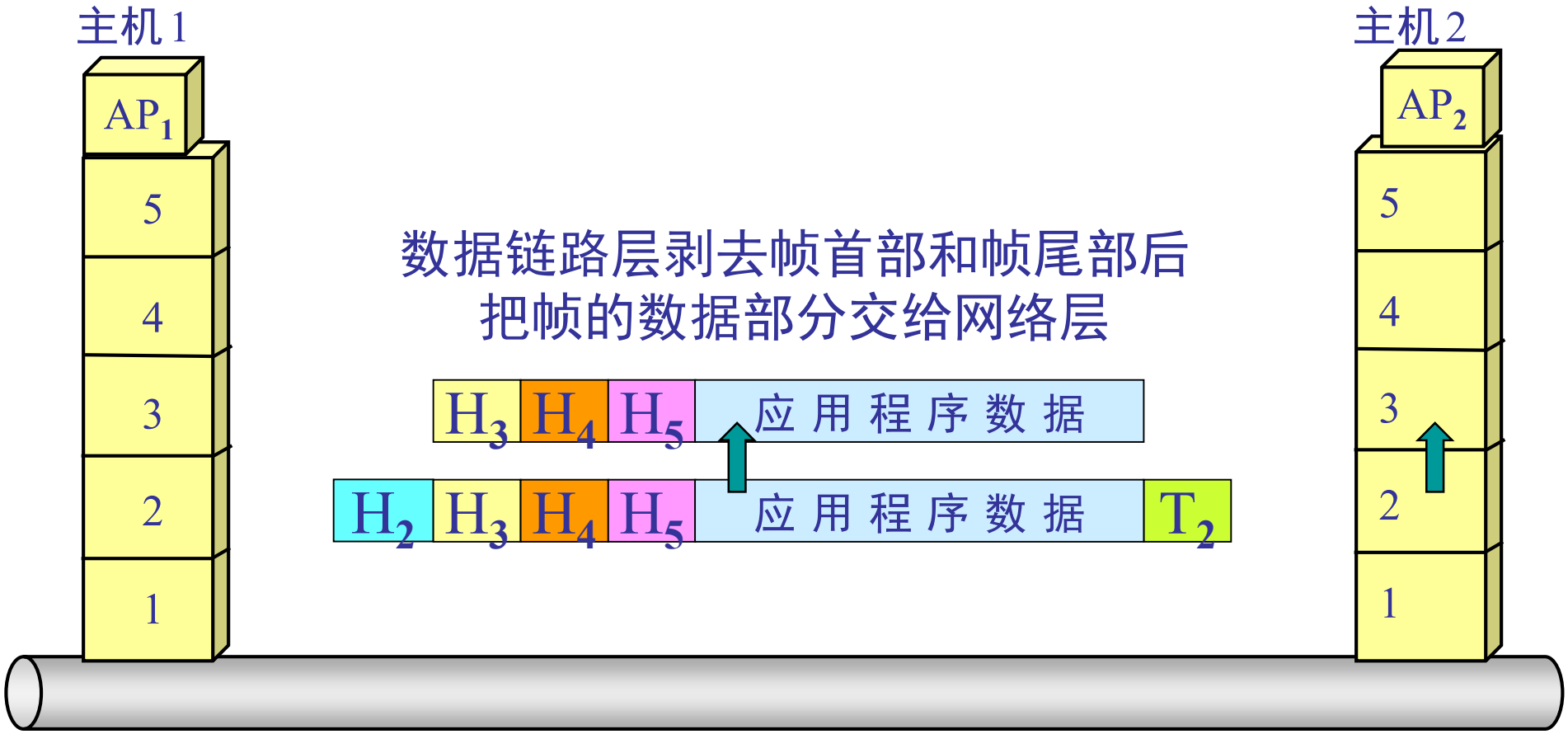
- Each task in different layer can be handled more easily without considering the details of the tasks in other layers.
- Methods in different layers can be changed easily.
  - For example, different applications can use the same transport protocol.

主机 1 向主机 2 发送数据

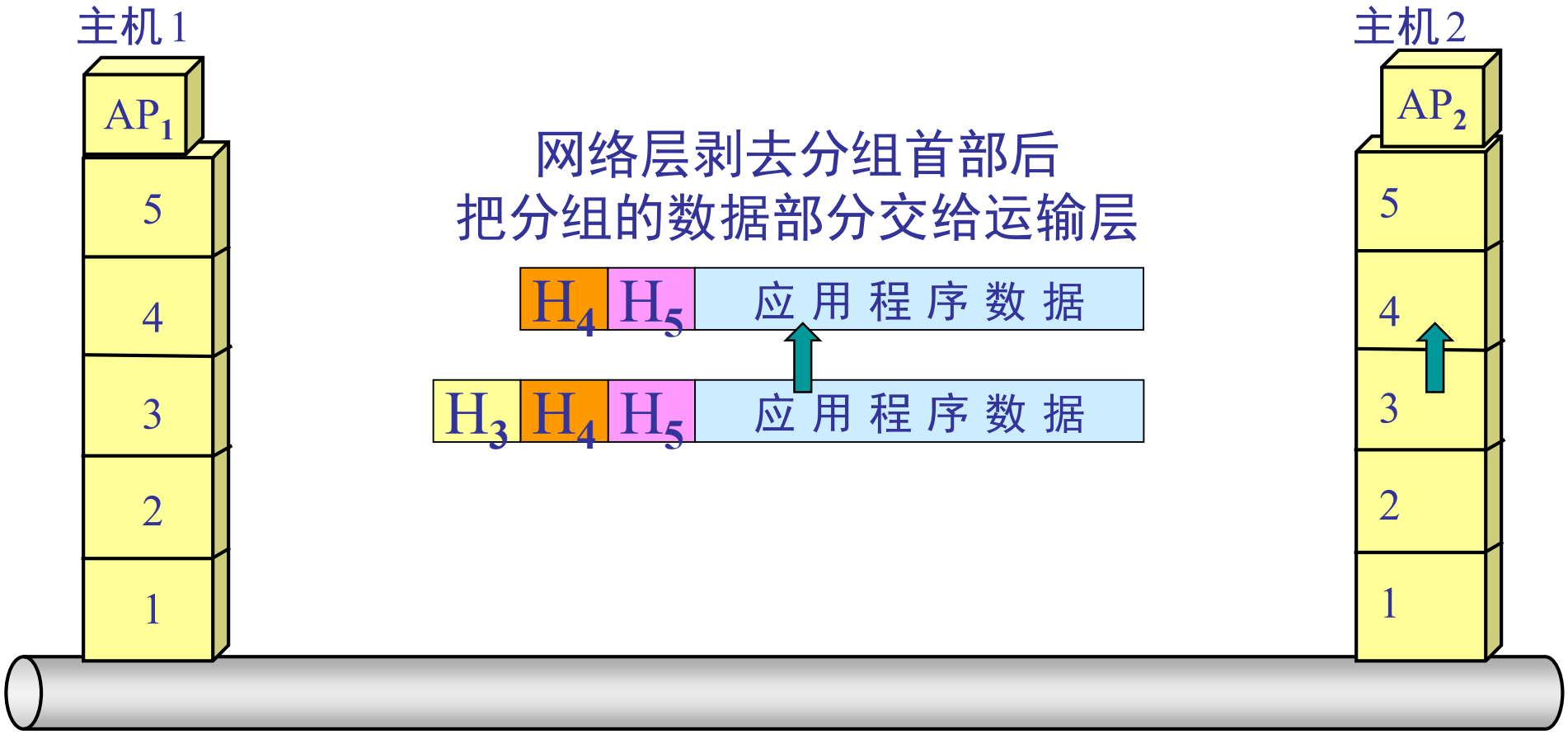


主机 1 向主机 2 发送数据

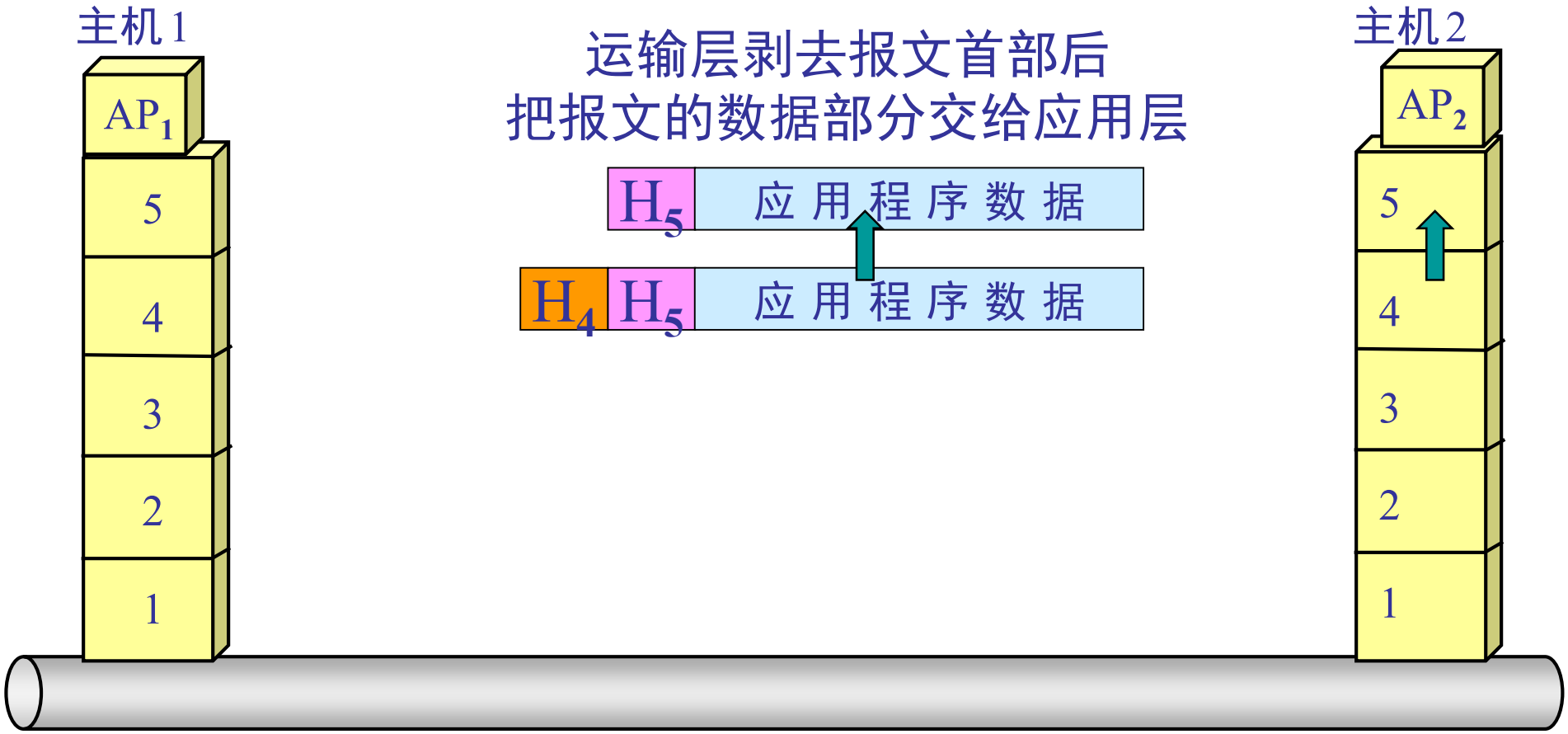
主机 1 向主机 2 发送数据



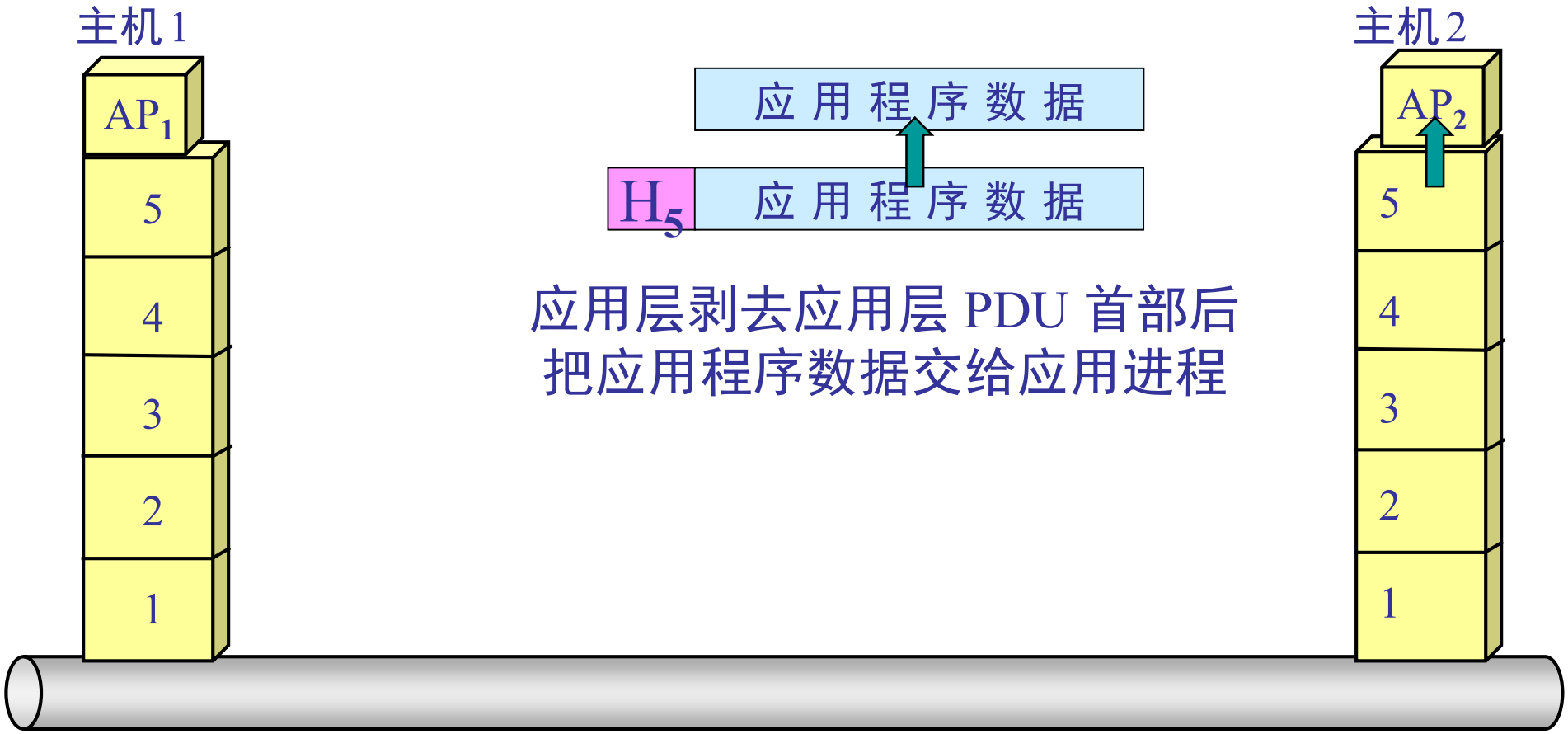
主机 1 向主机 2 发送数据



主机 1 向主机 2 发送数据



主机 1 向主机 2 发送数据



应用层剥去应用层 PDU 首部后
把应用程序数据交给应用进程

主机 1 向主机 2 发送数据

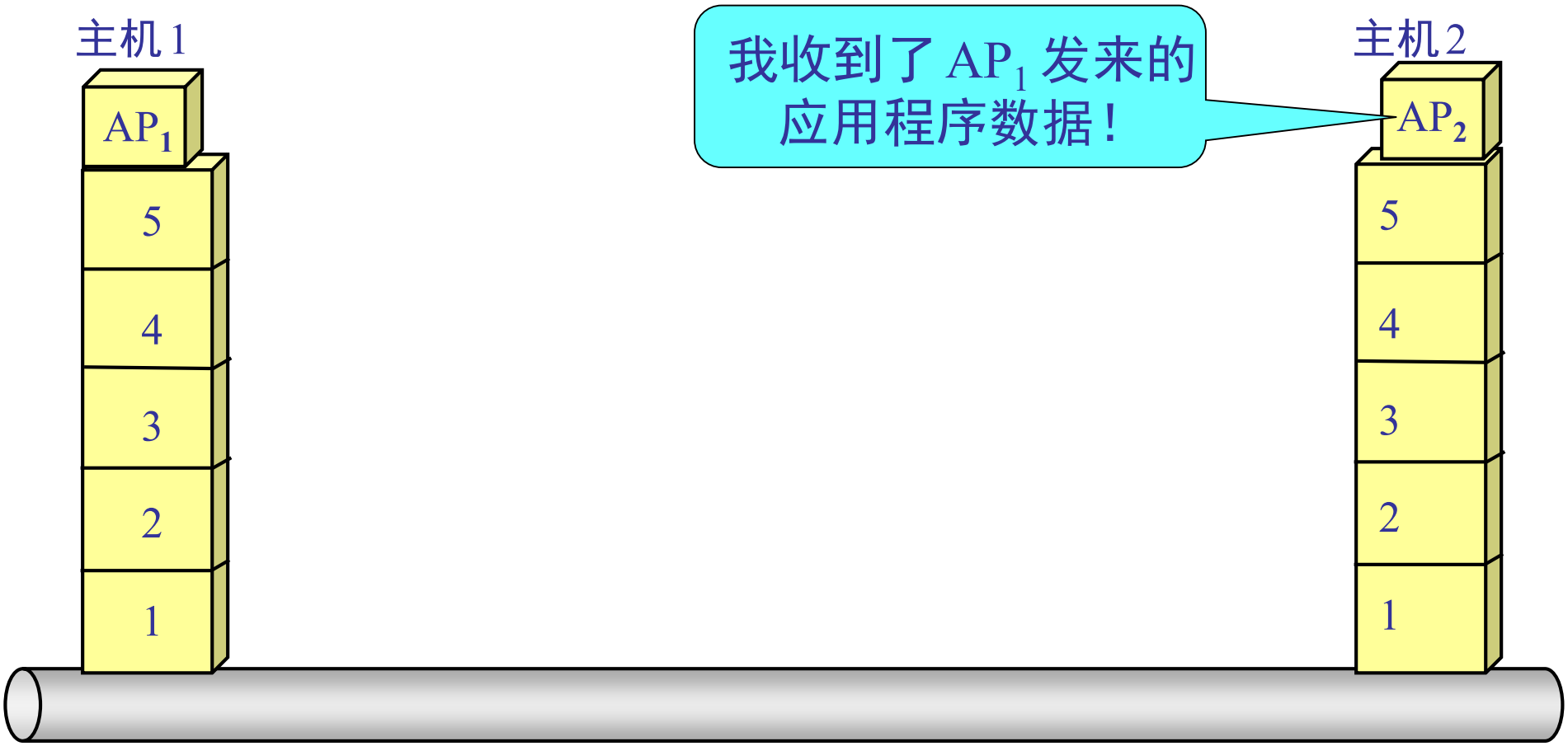
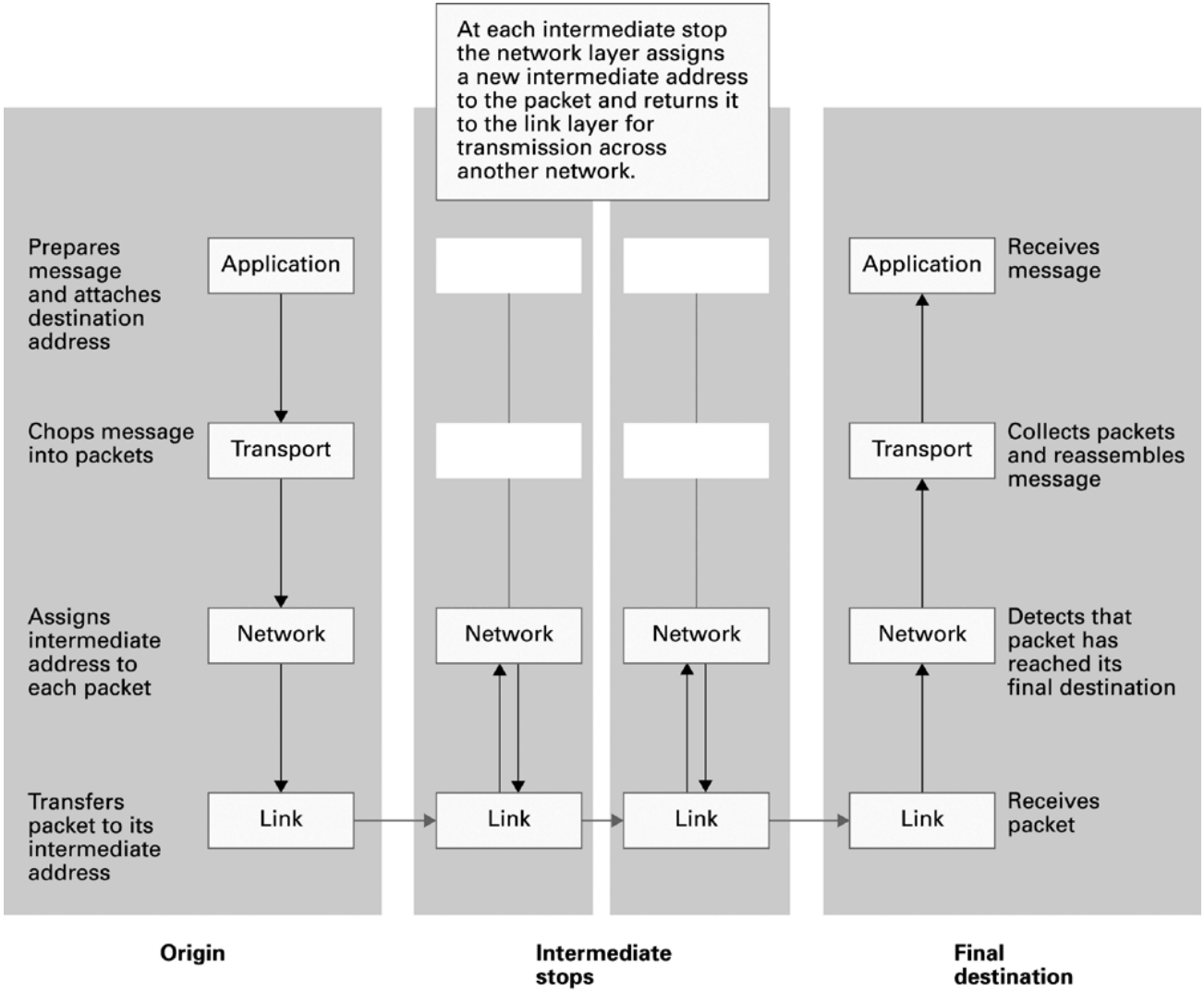


Figure 4.14 Following a message through the Internet



Open Systems Interconnection model (OSI)

- A conceptual model that characterizes and standardizes the internal functions of a communication system by partitioning it into abstraction layers.

OSI Model			
	Data unit	**Layer**	**Function**
Host layers	Data	7. Application	Network process to application
		6. Presentation	Data representation, encryption and decryption, convert machine dependent data to machine independent data
		5. Session	Interhost communication, managing sessions between applications
	Segments	4. Transport	Reliable delivery of segments between points on a network.
Media layers	Packet/Datagram	3. Network	Addressing, routing and (not necessarily reliable) delivery of datagrams between points on a network.
	Bit/Frame	2. Data link	A reliable direct point-to-point data connection.
	Bit	1. Physical	A (not necessarily reliable) direct point-to-point data connection.

Wikipedia

网络协议

应用层

DHCP · DNS · FTP · Gopher · HTTP · IMAP4 · IRC · NNTP · XMPP · POP3 · SIP · **SMTP** · SNMP · SSH · TELNET · RPC · RTCP · RTP · RTSP · SDP · SOAP · **GTP** · STUN · NTP · SSDP · 更多

传输层

TCP · UDP · TLS · DCCP · SCTP · RSVP · **PPTP** · 更多

网络层

IP (IPv4 · IPv6) ·
ICMP · ICMPv6 · **IGMP** · RIP ·
OSPF · **BGP** · **IS-IS** · IPsec · 更多

数据链路层

802.11 · **802.16** · Wi-Fi · WiMAX · ARP · RARP · ATM · **DTM** · 令牌环 · 以太网 · FDDI · 帧中继 · GPRS · **EVDO** · HSPA · HDLC · PPP · **L2TP** · **ISDN** · 更多

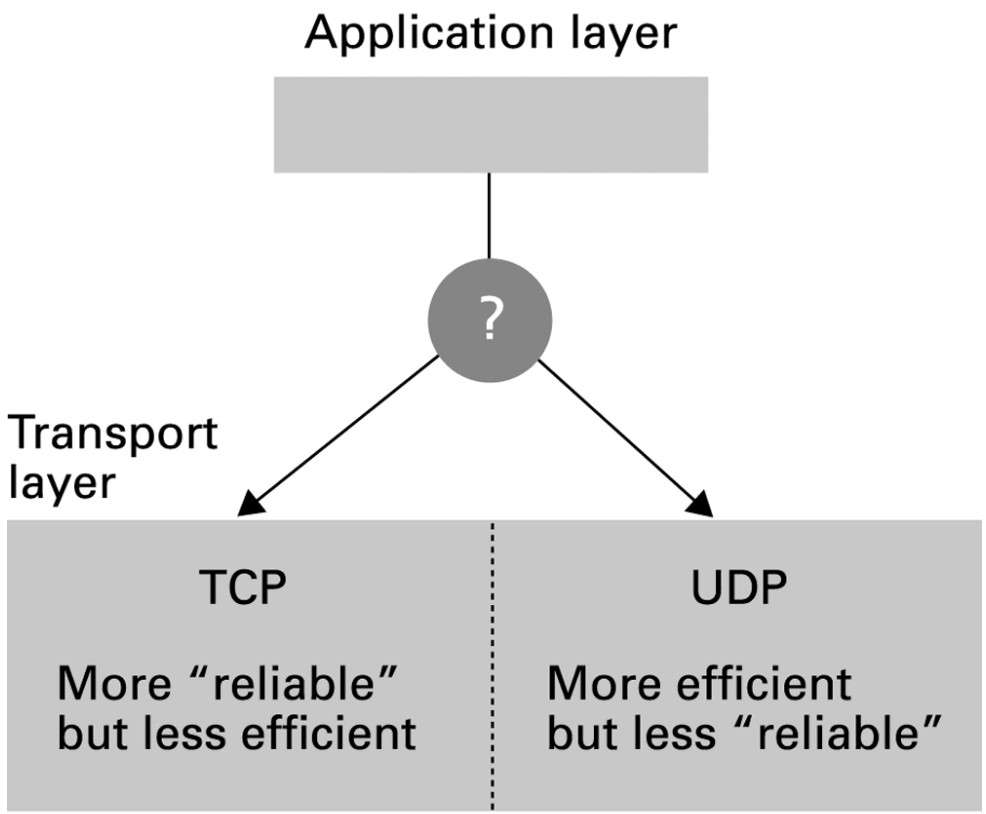
物理层

以太网 · 调制解调器 · PLC(Power Line Communication) · SONET/SDH · **G.709** · **光导纤维** · 同轴电缆 · 双绞线 · 更多

- Questions?

TCP/IP Protocol Suite

- TCP/IP is a family of protocols for communication between computers.
- Transport Layer
  - TCP
  - UDP
- Network Layer
  - IP (IPv4 and IPv6)



TCP

- Windowing
- *vs* UDP

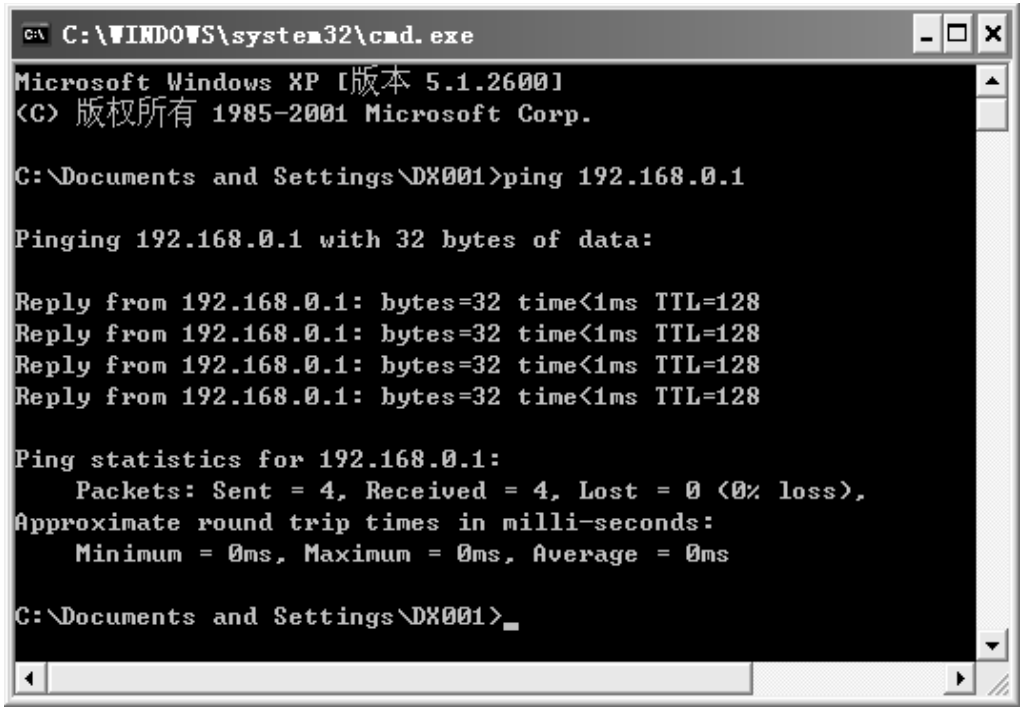
IP Address

- An **Internet Protocol address** (**IP address**) is a numerical label assigned to each device (e.g., computer, printer) participating in a computer network that uses the Internet Protocol for communication
- An IP address serves two principal functions: host or network interface identification and location addressing

202.112.0.36

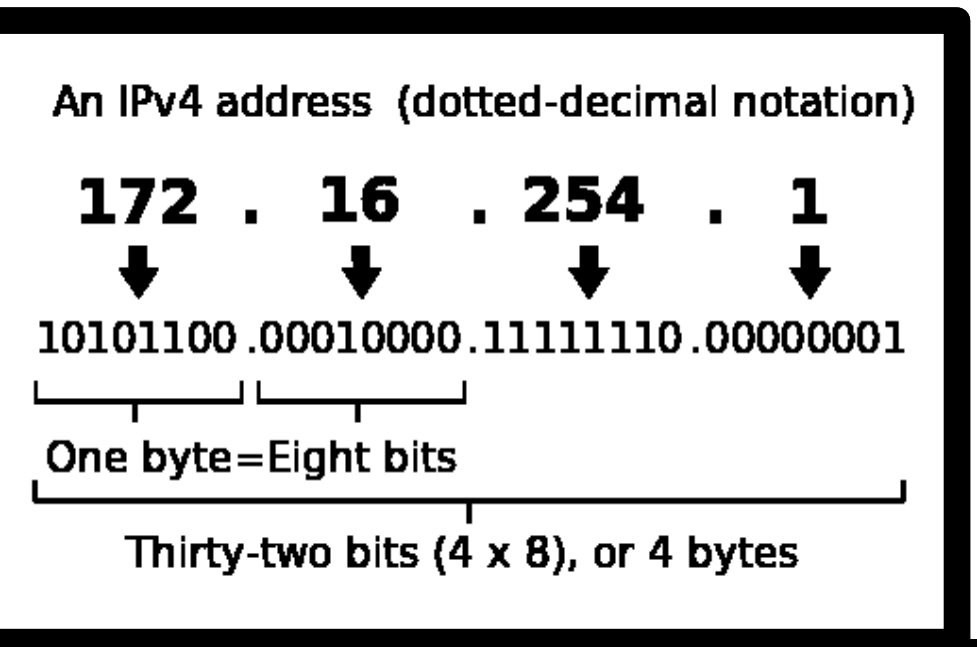
Test Internet Connection

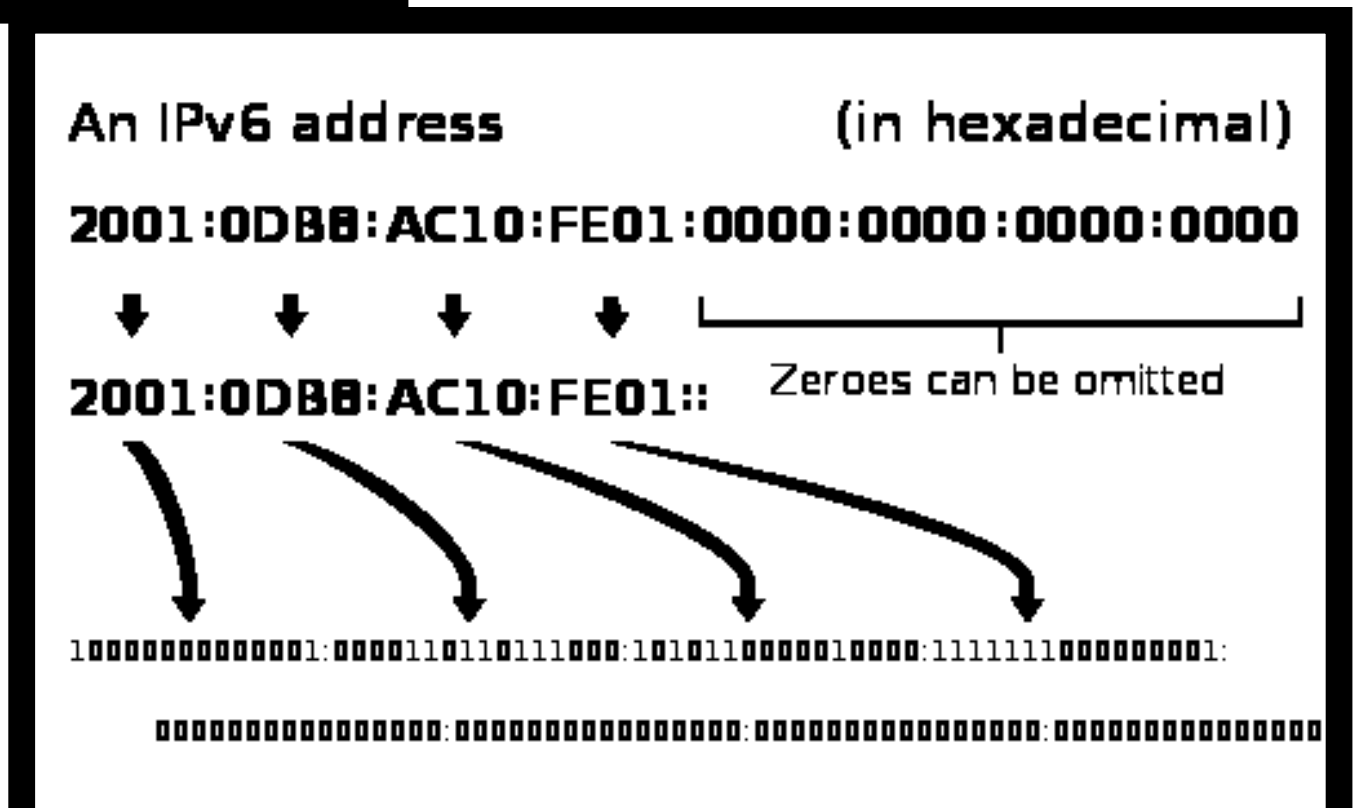
- Find IP address
  - ipconfig /all
- Test Internet connection
  - ping IP address or web address



IPv4 and IPv6

- Two versions of the Internet Protocol (IP) : IP Version 4 and IP Version 6
- In IPv4 an address consists of 32 bits which limits the address space to 4294967296 (2^{32}) possible unique addresses.
- This next generation of the Internet Protocol, is. The address size was increased from 32 to 128.


An IPv4 address (dotted-decimal notation)
172 . 16 . 254 . 1
10101100.00010000.11111110.00000001
One byte=Eight bits
Thirty-two bits (4 x 8), or 4 bytes

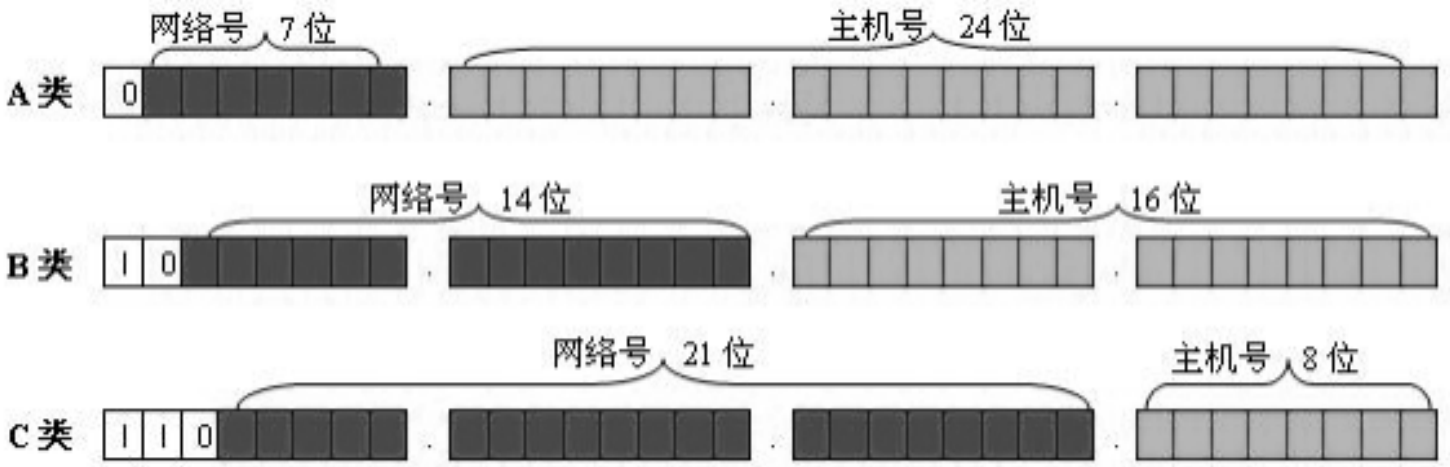

An IPv6 address (in hexadecimal)
2001:0DB8:AC10:FE01:0000:0000:0000:0000
2001:0DB8:AC10:FE01::
Zeroes can be omitted

Internet Corporation for Assigned Names & Numbers (ICANN)

- Allocates IP addresses to ISPs who then assign those addresses within their regions.
- Oversees the registration of domains and domain names.

IP地址

- IP地址=网络ID+主机ID
  - A类： 1.0.0.0 到126.255.255.255
  - B类： 128.0.0.0到191.255.255.255
  - C类： 192.0.0.0到223.255.255.255

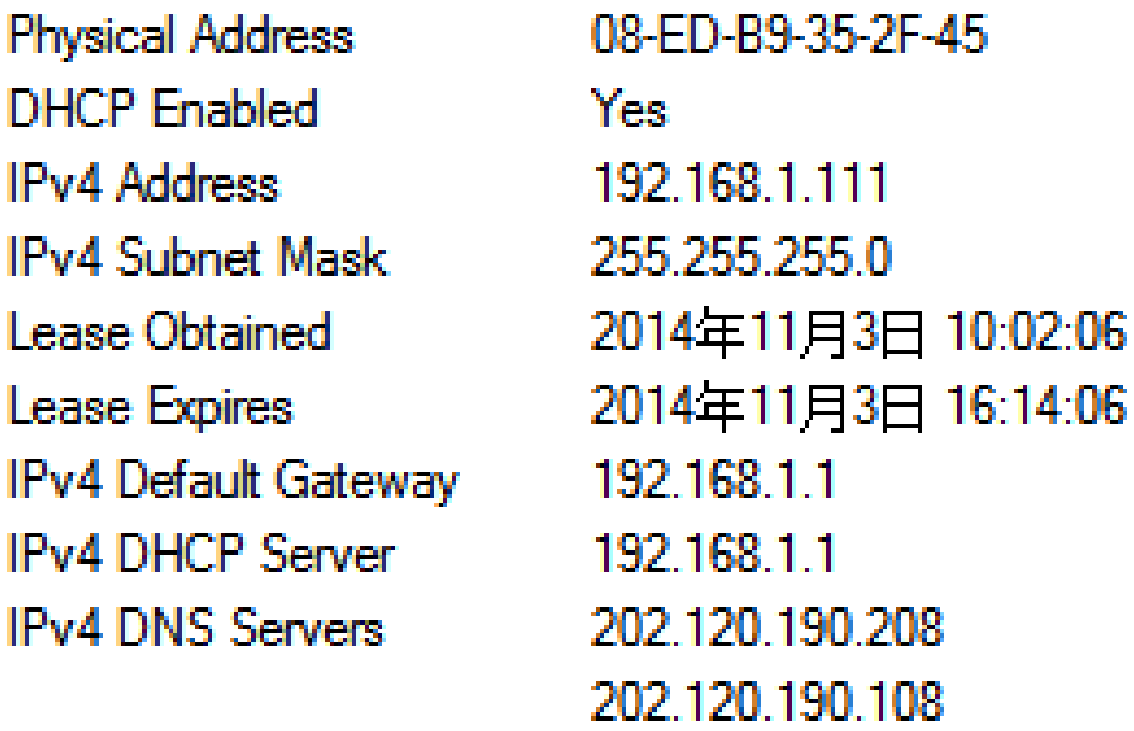


公有地址-私有地址

- NAT (Network Address Translation)
- 私有地址
  - A类 10.0.0.0 --10.255.255.255
  - B类 172.16.0.0--172.31.255.255
  - C类 192.168.0.0--192.168.255.255

Subnet

- Default Gateway
- DHCP (Dynamic Host Configuration Protocol)
- Subnet Mask



Physical Address	08-ED-B9-35-2F-45
DHCP Enabled	Yes
IPv4 Address	192.168.1.111
IPv4 Subnet Mask	255.255.255.0
Lease Obtained	2014年11月3日 10:02:06
Lease Expires	2014年11月3日 16:14:06
IPv4 Default Gateway	192.168.1.1
IPv4 DHCP Server	192.168.1.1
IPv4 DNS Servers	202.120.190.208
	202.120.190.108

IP address classes

[<< Back]

Class	1st Octet Decimal Range	1st Octet High Order Bits	Network/Host ID (N=Network, H=Host)	Default Subnet Mask	Number of Networks	Hosts per Network (Usable Addresses)
A	1 – 126*	0	N.H.H.H	255.0.0.0	126 ($2^7 - 2$)	16,777,214 ($2^{24} - 2$)
B	128 – 191	10	N.N.H.H	255.255.0.0	16,382 ($2^{14} - 2$)	65,534 ($2^{16} - 2$)
C	192 – 223	110	N.N.N.H	255.255.255.0	2,097,150 ($2^{21} - 2$)	254 ($2^8 - 2$)
D	224 – 239	1110	Reserved for Multicasting			
E	240 – 254	1111	Experimental; used for research			

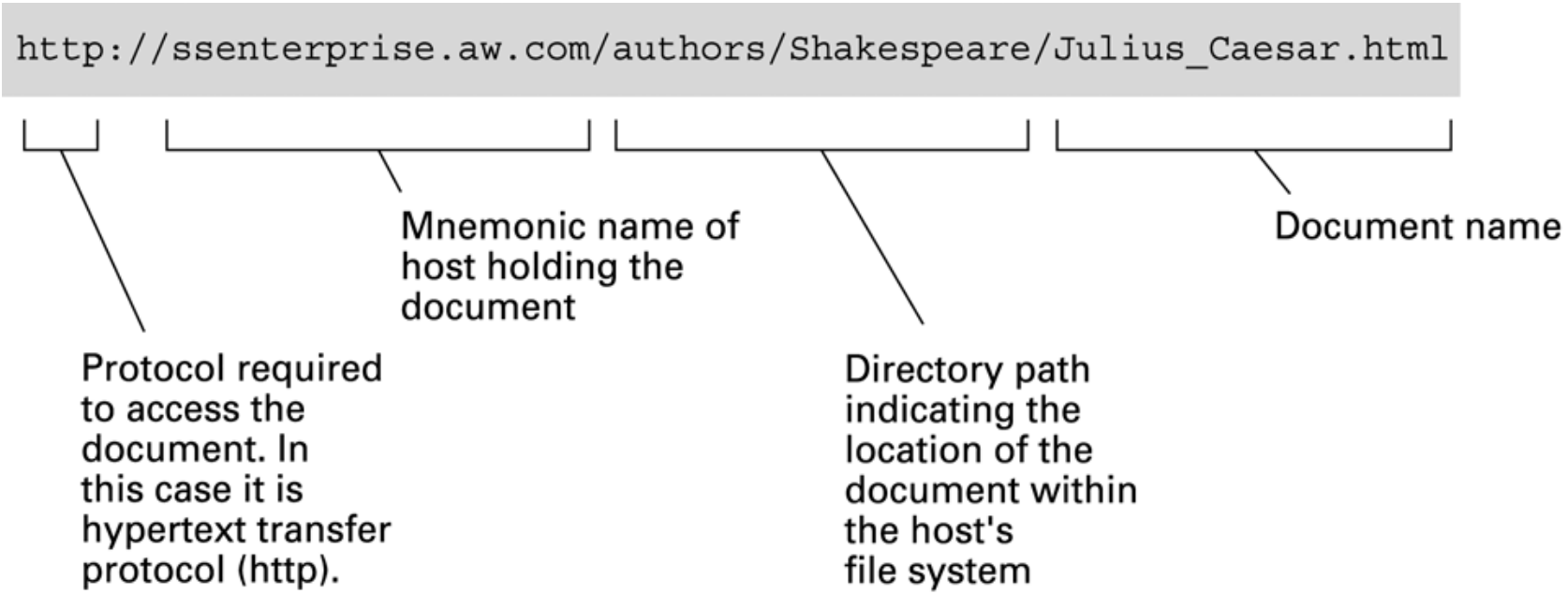
Note: Class A addresses 127.0.0.0 to 127.255.255.255 cannot be used and is reserved for loopback and diagnostic functions.

Private IP Addresses

Class	Private Networks	Subnet Mask	Address Range
A	10.0.0.0	255.0.0.0	10.0.0.0 - 10.255.255.255
B	172.16.0.0 - 172.31.0.0	255.240.0.0	172.16.0.0 - 172.31.255.255
C	192.168.0.0	255.255.0.0	192.168.0.0 - 192.168.255.255

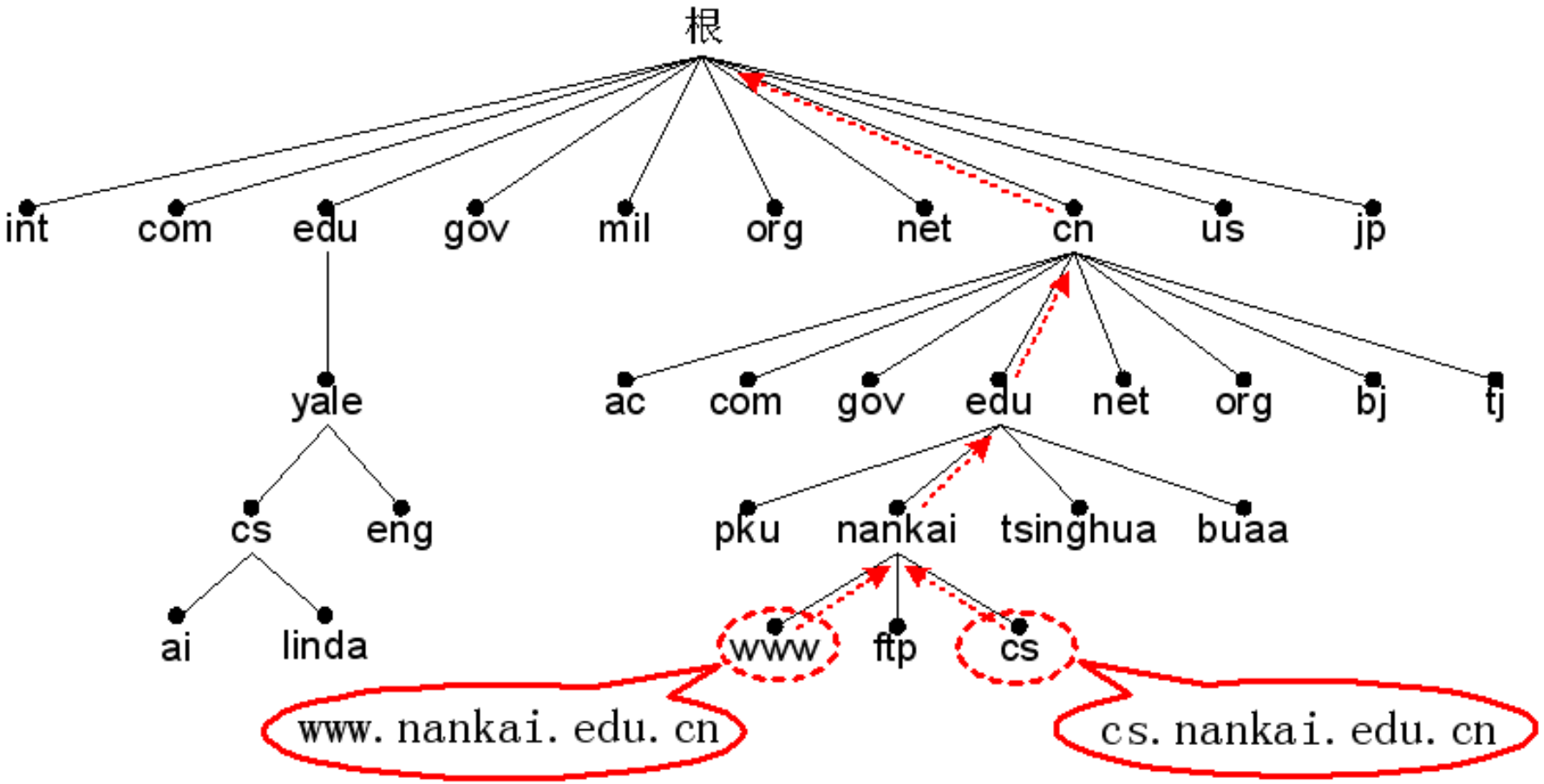
URL

• Uniform Resource Locator or Universal Resource Locator (URL) is a specific character string that constitutes a reference to an Internet resource



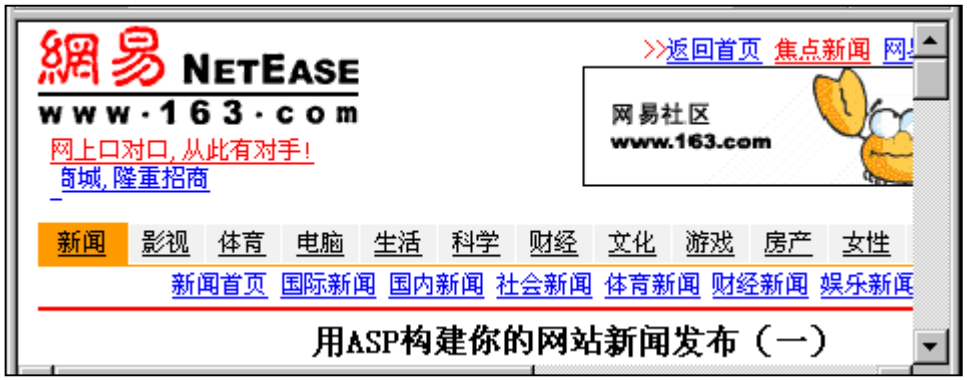
Internet Addressing

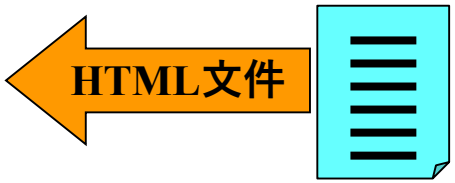
- Mnemonic address:
  - Domain names
  - Top-Level Domains
- Domain name system (DNS)
  - Name servers
  - DNS lookup

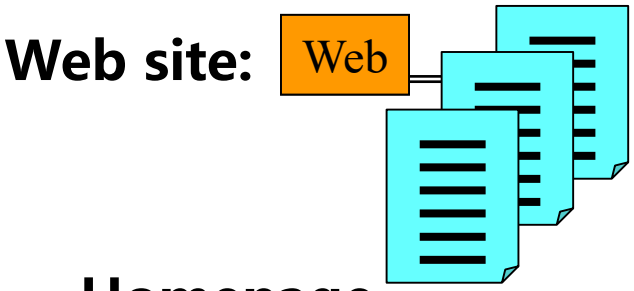

根
int
com
edu
gov
mil
org
net
cn
us
jp
yale
ac
com
gov
edu
net
org
bj
tj
cs
eng
pku
nankai
tsinghua
buaa
ai
linda
www
ftp
cs
www. nankai. edu. cn
cs. nankai. edu. cn

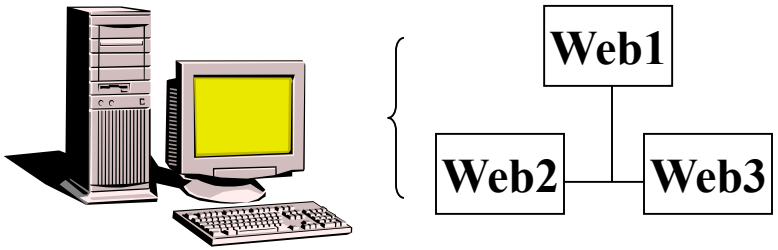
Internet applications
World Wide Web (WWW)

The **World Wide Web** (**WWW** or **W3**) is a system of interlinked hypertext documents accessed via the Internet. With a web browser, one can view web pages that may contain text, images, videos, and other multimedia and navigate between them via hyperlinks.







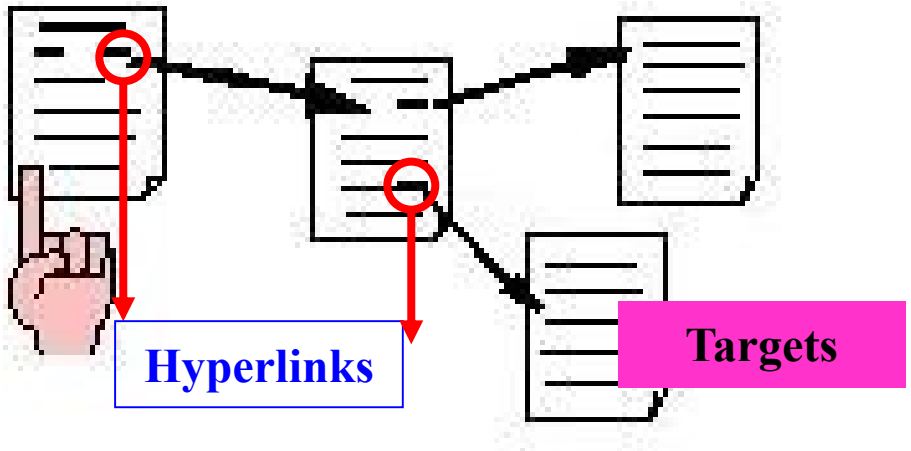


World Wide Web

- Hypertext and HTTP
- Browser gets documents from Web server
- Documents identified by URLs

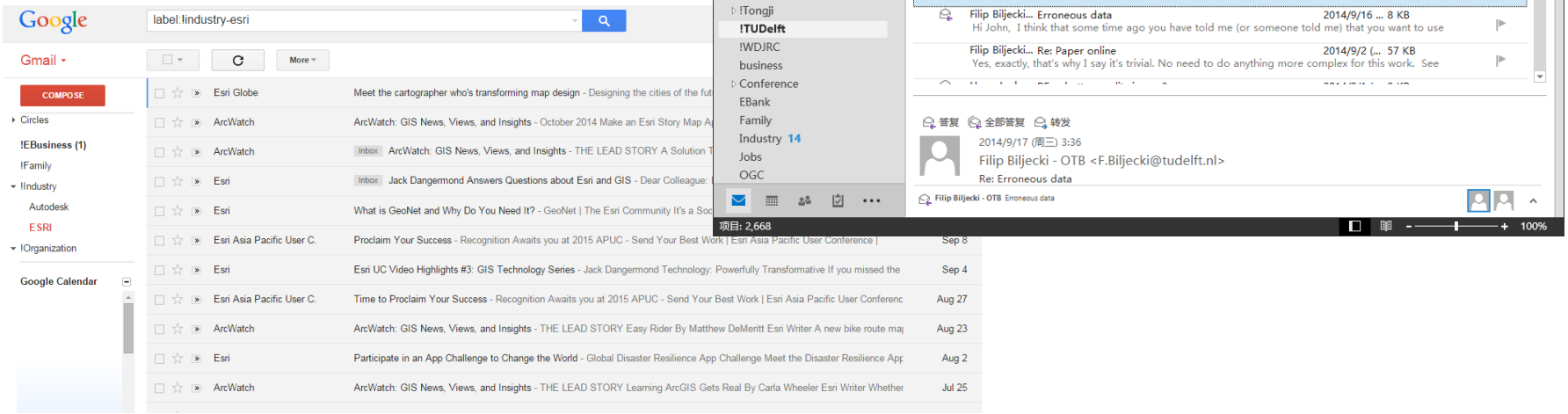
HTTP Protocol

The **Hypertext Transfer Protocol (HTTP)** is a networking protocol for distributed, collaborative, hypermedia information systems. HTTP is the foundation of data communication for the World Wide Web



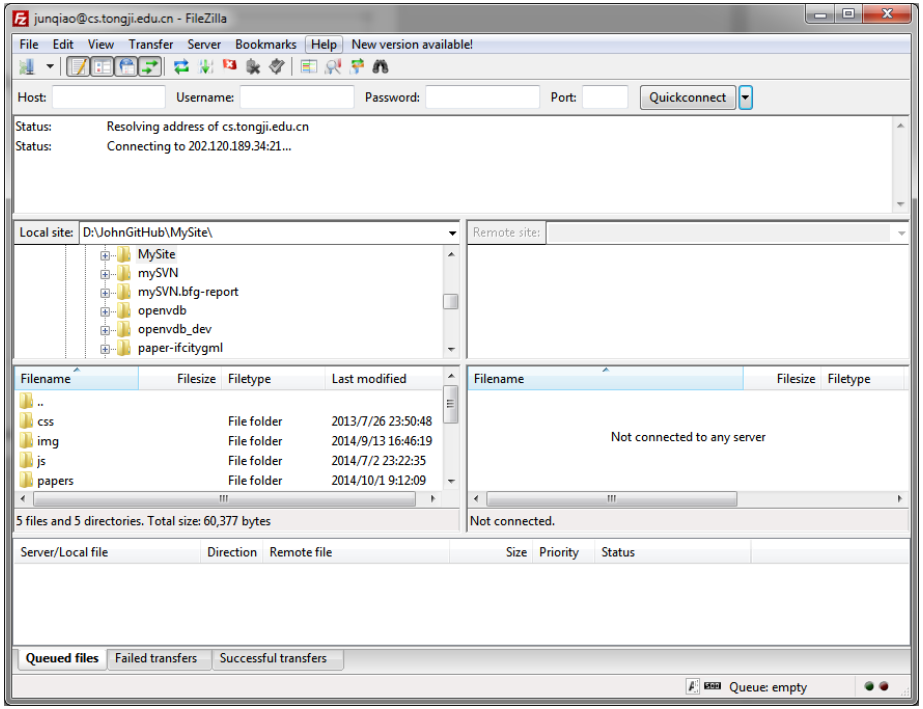
Internet applications

- Email (electronic mail)
  - POP3
  - SMTP
  - IMAP



Internet applications

- File sharing
  - FTP (File Transfer Protocol)



Internet applications

- Telnet and Secure Shell (SSH)
  - BBS
    - telnet://bbs.tongji.edu.cn 同舟共济站
  - SSH

More Recent Applications

- Voice Over IP (VoIP)
  - Skype
  - GTalk
- Internet Radio (IPC)
  - N-unicast
  - **Multicast**

Extensible Markup Language (XML)

- XML: A language for constructing markup languages similar to HTML
  - A descendant of SGML
  - Opens door to a World Wide *Semantic* Web

动态网站开发平台技术比较

LAMP:Linux+Appache+MySQL+PHP

J2EE: Unix+Tomcat+Oracle+JSP

ASP.net: Windows+IIS+SQL Server+ASP

性能比较	LAMP	J2EE	ASP.NET
运行速度	较快	快	快
开发速度	快	慢	快
运行耗损	一般	较小	较大
难易程度	简单	难	简单
运行平台	Linux/UINX/Windows平台	绝大多数平台均可	Windows平台
扩展性	好	好	较差

Encryption

- HTTPs
- Secure Socket Layers (SSL)
- Public key encryption 12.6

Code a Website

- Frontend
- Backend

https://developer.mozilla.org/en-US/docs/Learn

- Questions?