中国科学技术大学软件学院
SCHOOL OF SOFTWARE ENGINEERING OF USTC

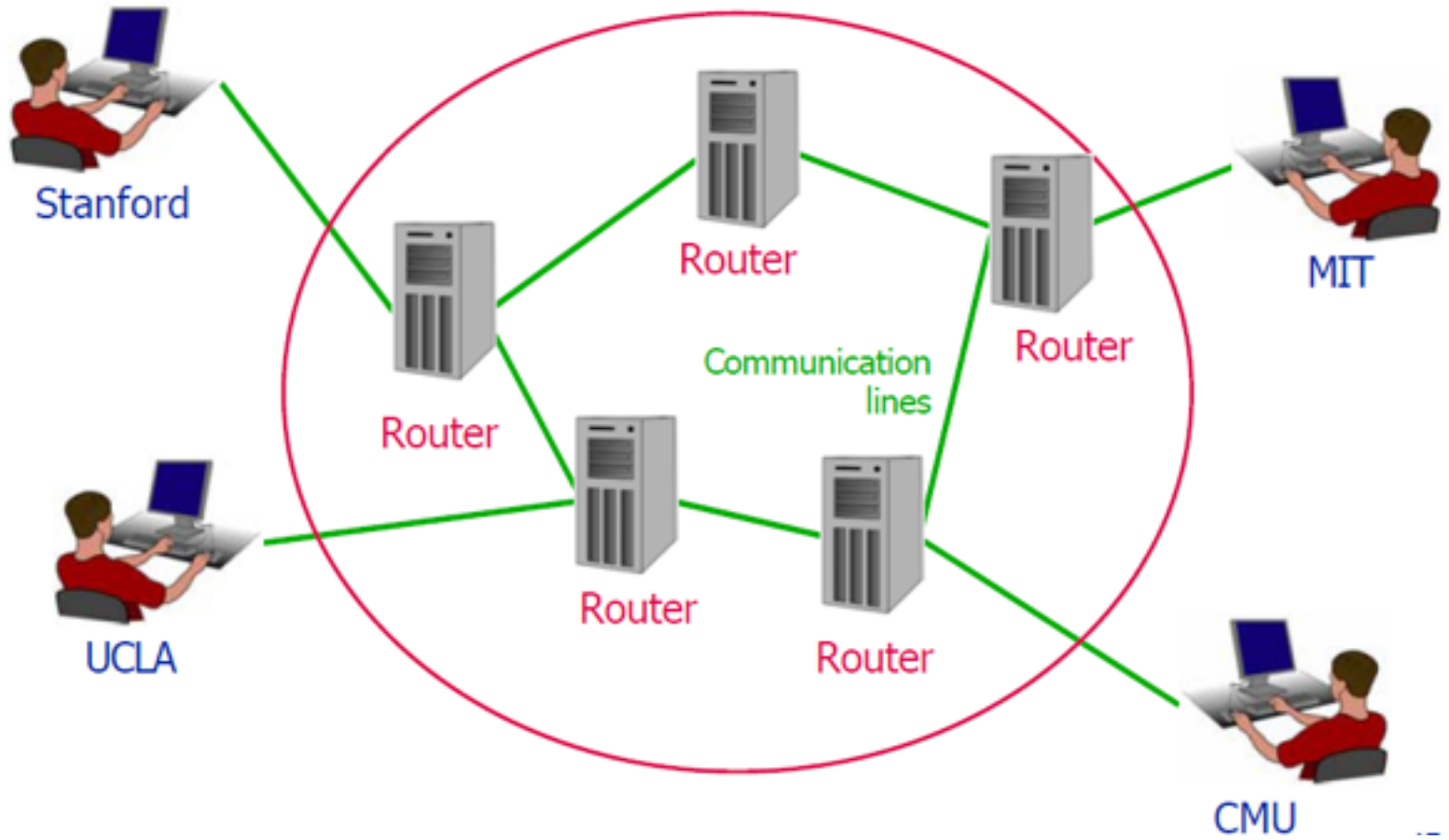
网络程序设计导论

主讲：孟宁
电话：0512-68839303
E-mail：mengning@ustc.edu.cn
主页：http://staff.ustc.edu.cn/~mengning

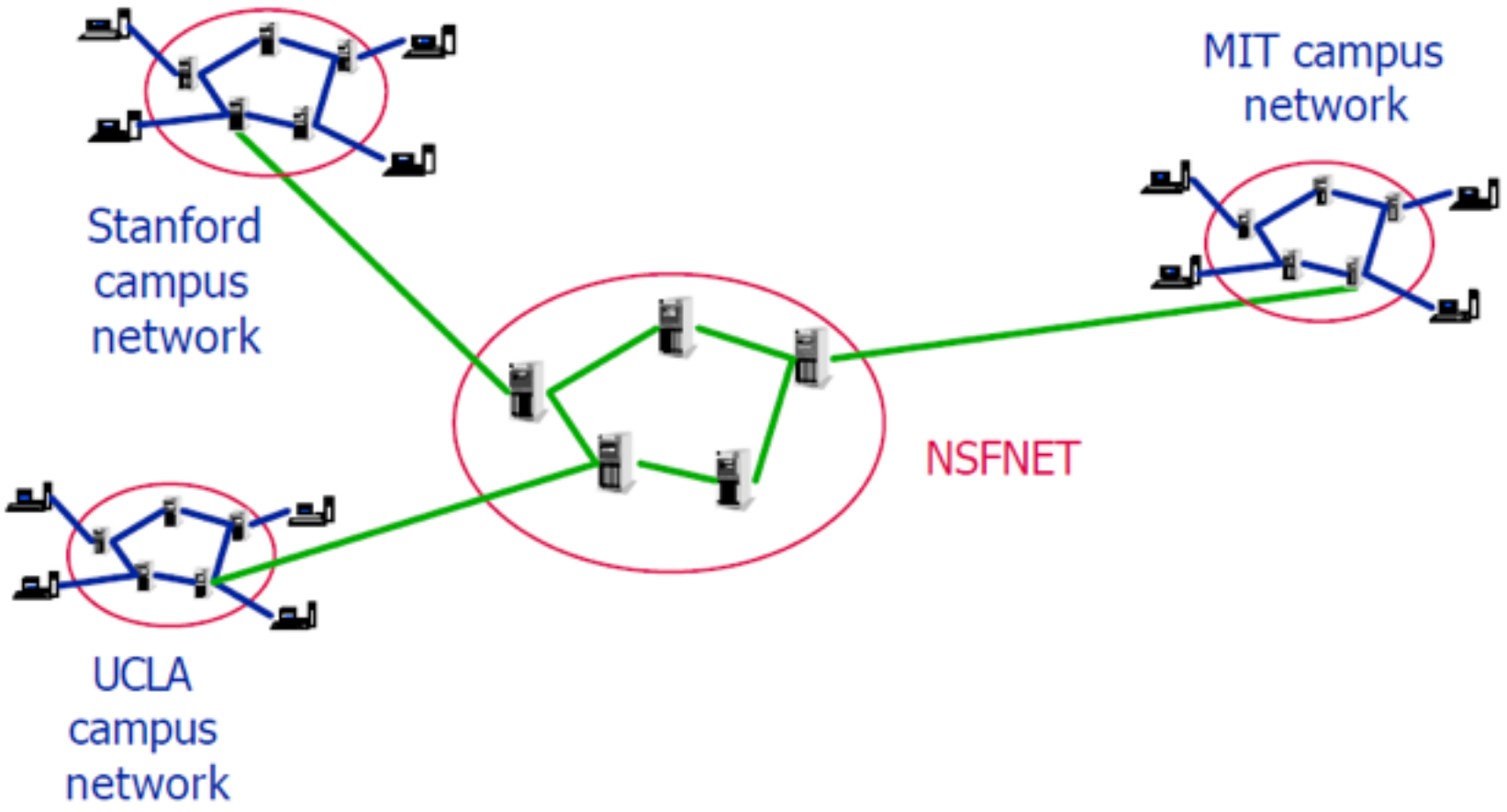
网络程序设计导论

- 计算机网络的发展
- OSI模型与TCP/IP协议族
- IPv4 and IPv6
- ARP协议
- 网络程序设计中的几种不同视角
- 电信/通信行业软件开发主要涉及的领域

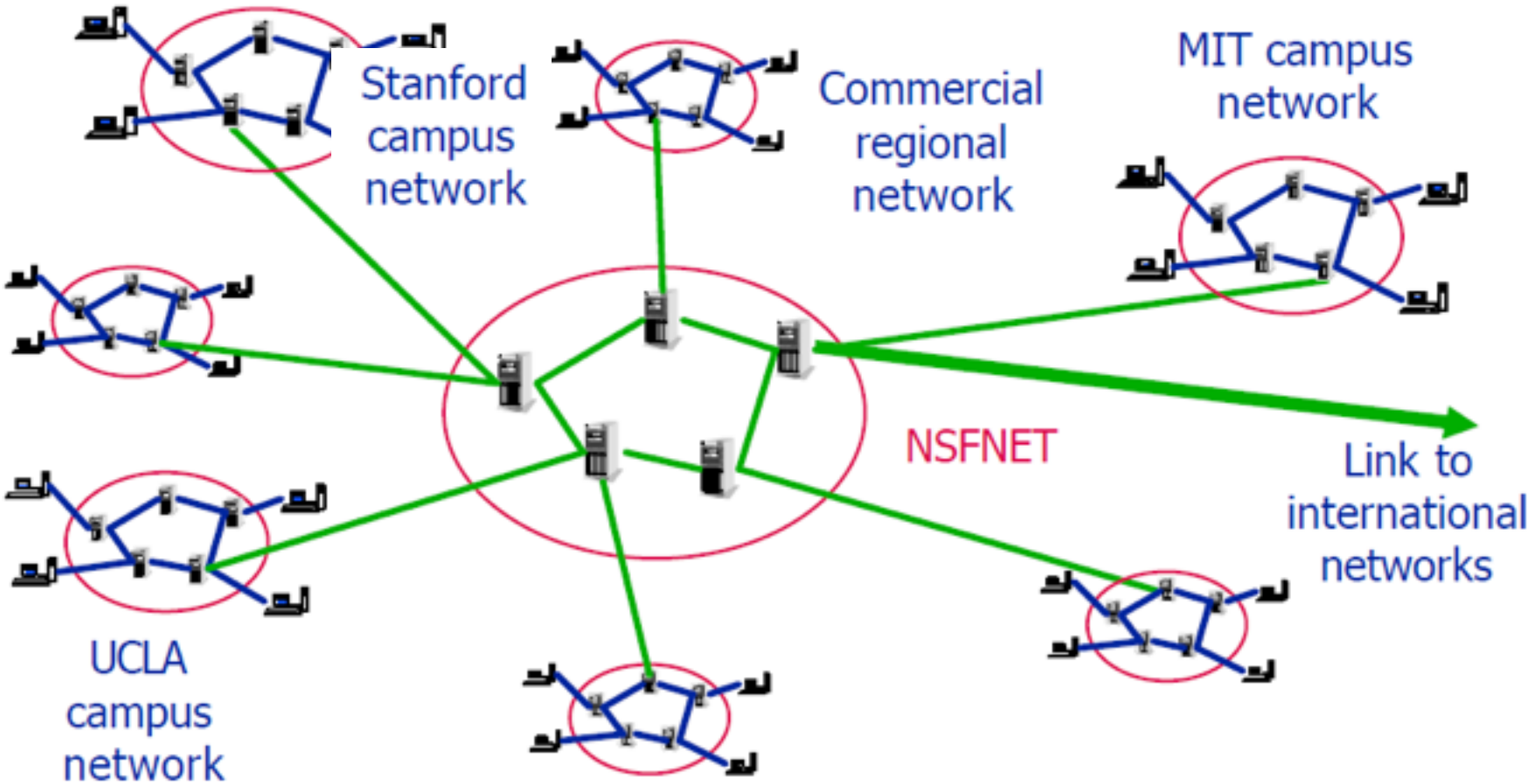
ARPANET (1970s)



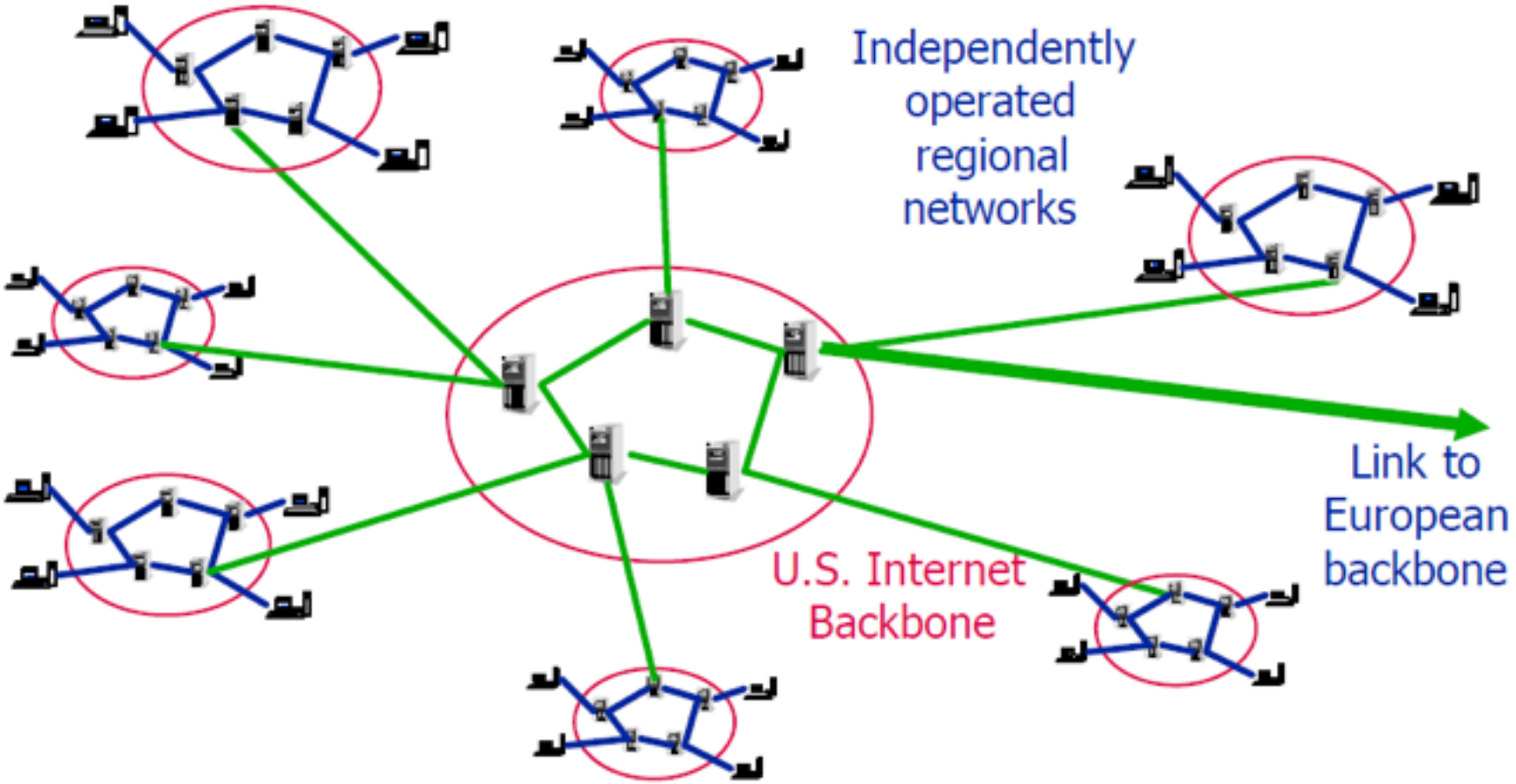
NSFNET (1980s)



Growth of NSFNET



The Internet: a Network of Networks



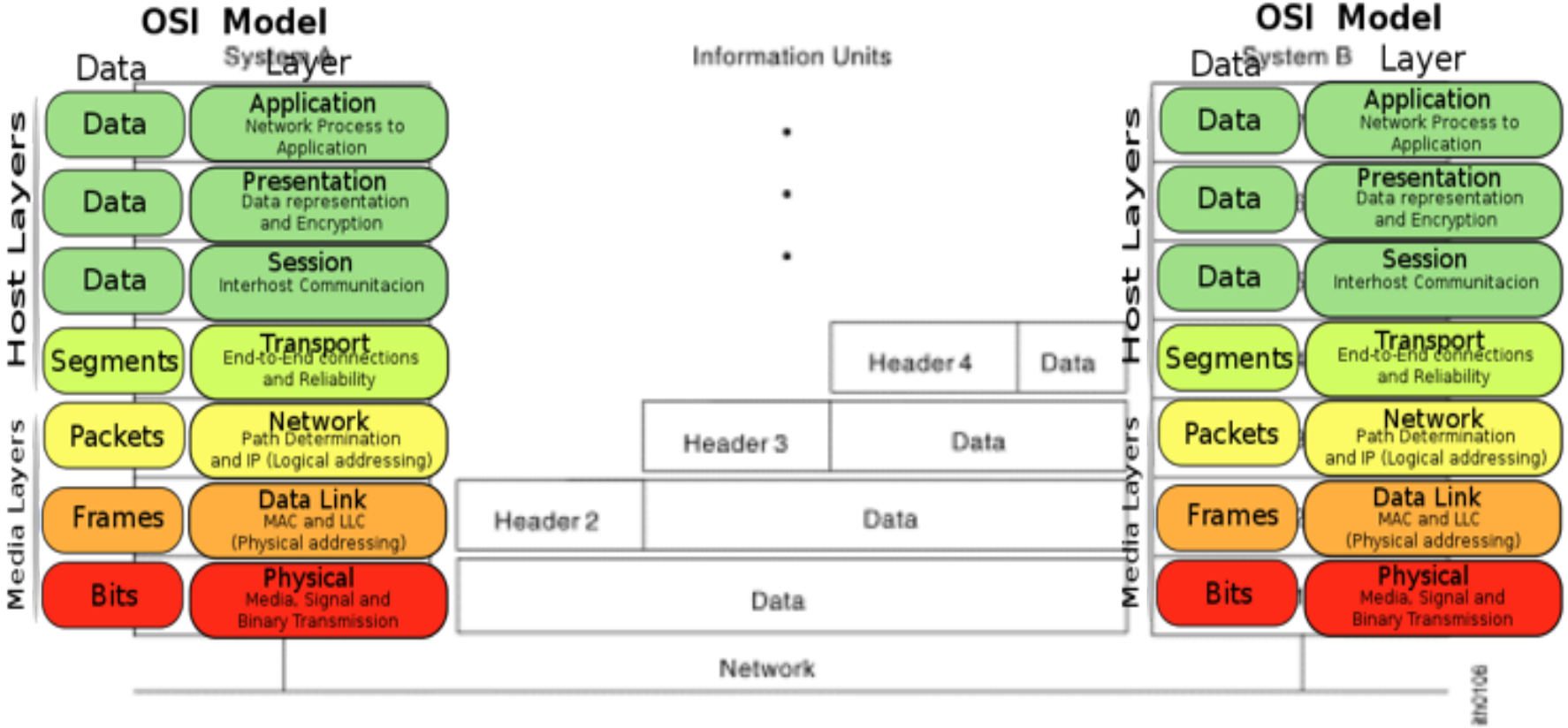
Internet Properties

- All hosts on the Internet communicate using common network protocols
  - TCP/IP, first developed for ARPANET
- Different parts of the Internet are operated by different entities
  - governments, telephone companies, universities etc.
- No single organization controls or owns the Internet

OSI Abstraction Layers

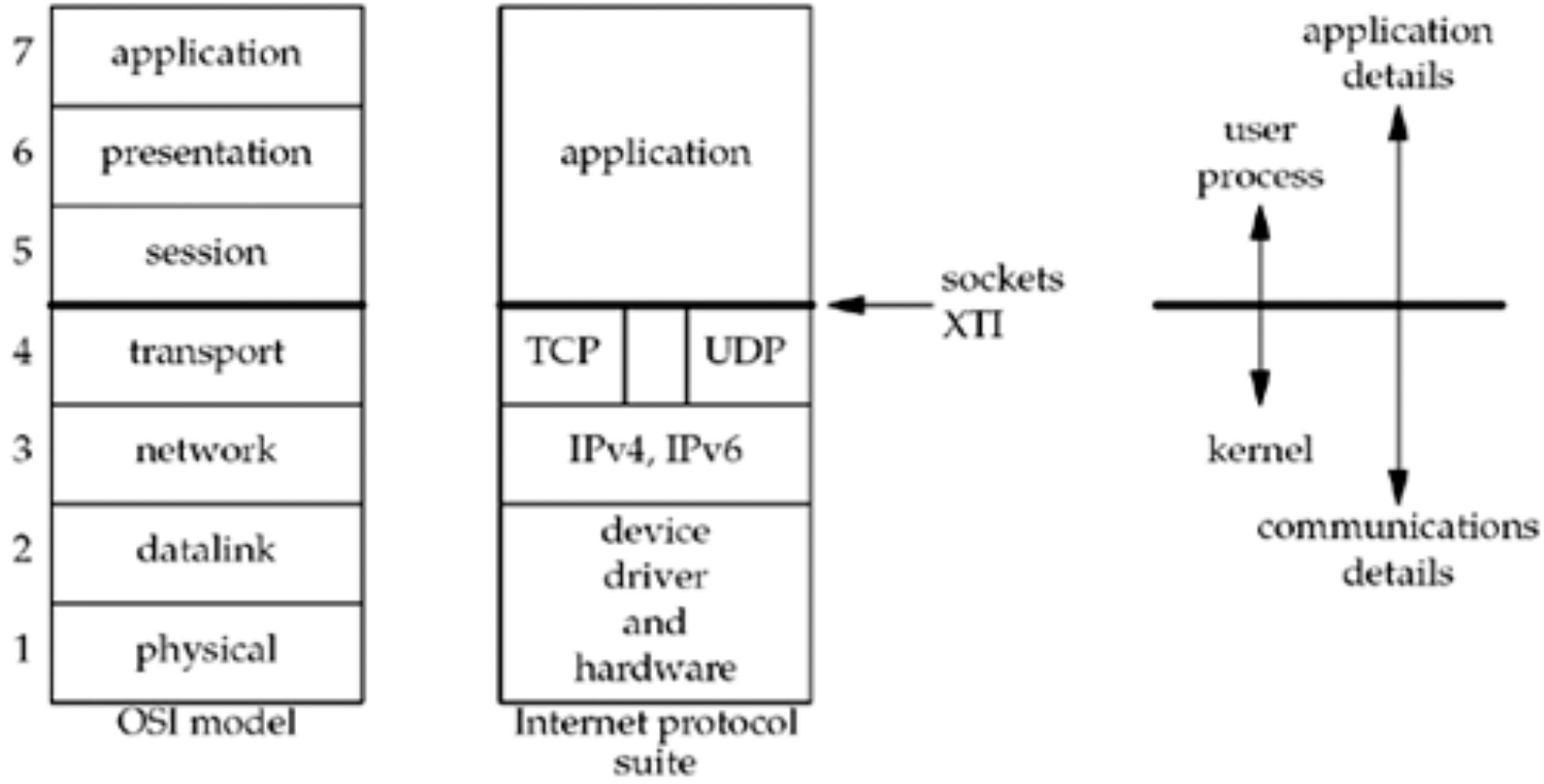
- **7: Application layer**
  - **E.g., terminal emulation, file transfer**
- **6: Presentation layer**
  - **Handles encryption, compression, other translation of messages**
- **5: Session layer**
  - **Establishes and terminates connections between applications**
- **4: Transport layer**
  - **Divides messages into packets;assembles packets into messages**
- **3: Network layer**
  - **Finds routes for packets; transmits them to next node**
- **2: Link layer**
  - **Breaks packets into frames; sends frames between nodes**
- **1: Physical layer**
  - **Sends bits over wires**

Information Exchange Process through OSI Layers



TCP/IP vs OSI Model

Figure 1.14. Layers in OSI model and Internet protocol suite.



Byte Ordering

- Different computer architectures use different byte ordering to represent multibyte values.
- 16 bit integer:

Byte Order and Networking

- Suppose a Big Endian machine sends a 16 bit integer with the value 2:

```
0000000000000010
```

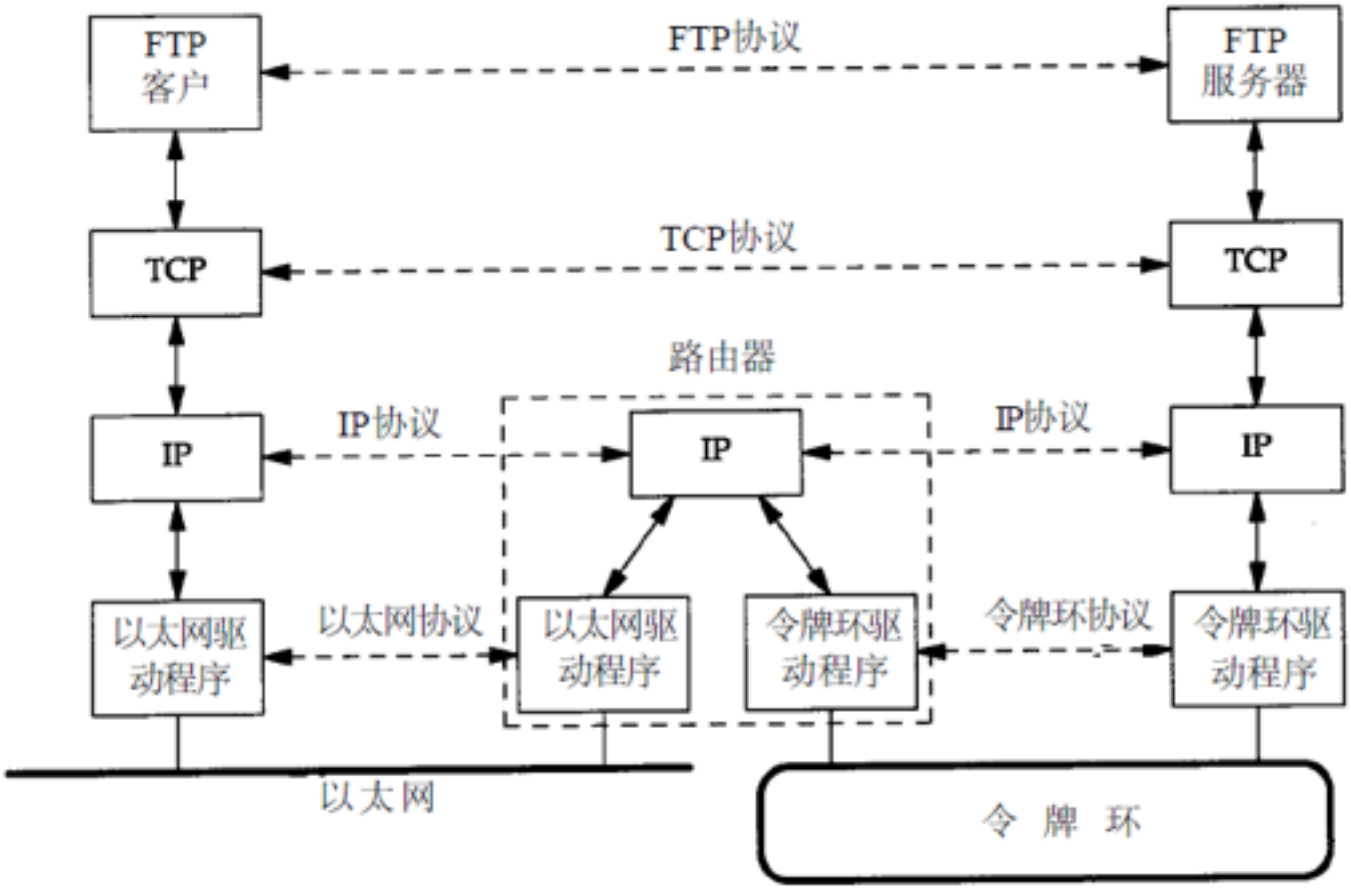
- A Little Endian machine will think it got the number 512:

```
0000001000000000
```

Byte Order and Networking

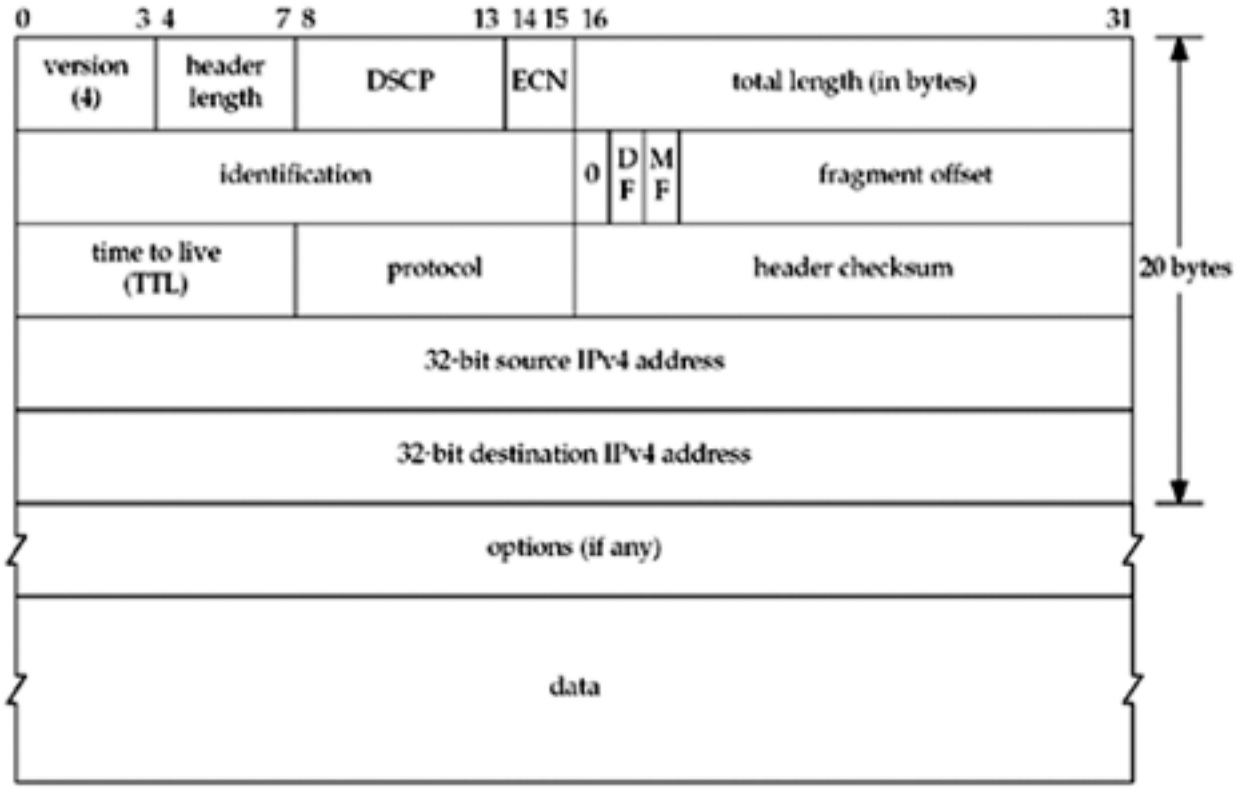
- Big Endian - PowerPC，Sparc64,etc
- Little Endian - X86
- 网络字节顺序是Big Endian还是Little Endian？

TCP/IP Layer

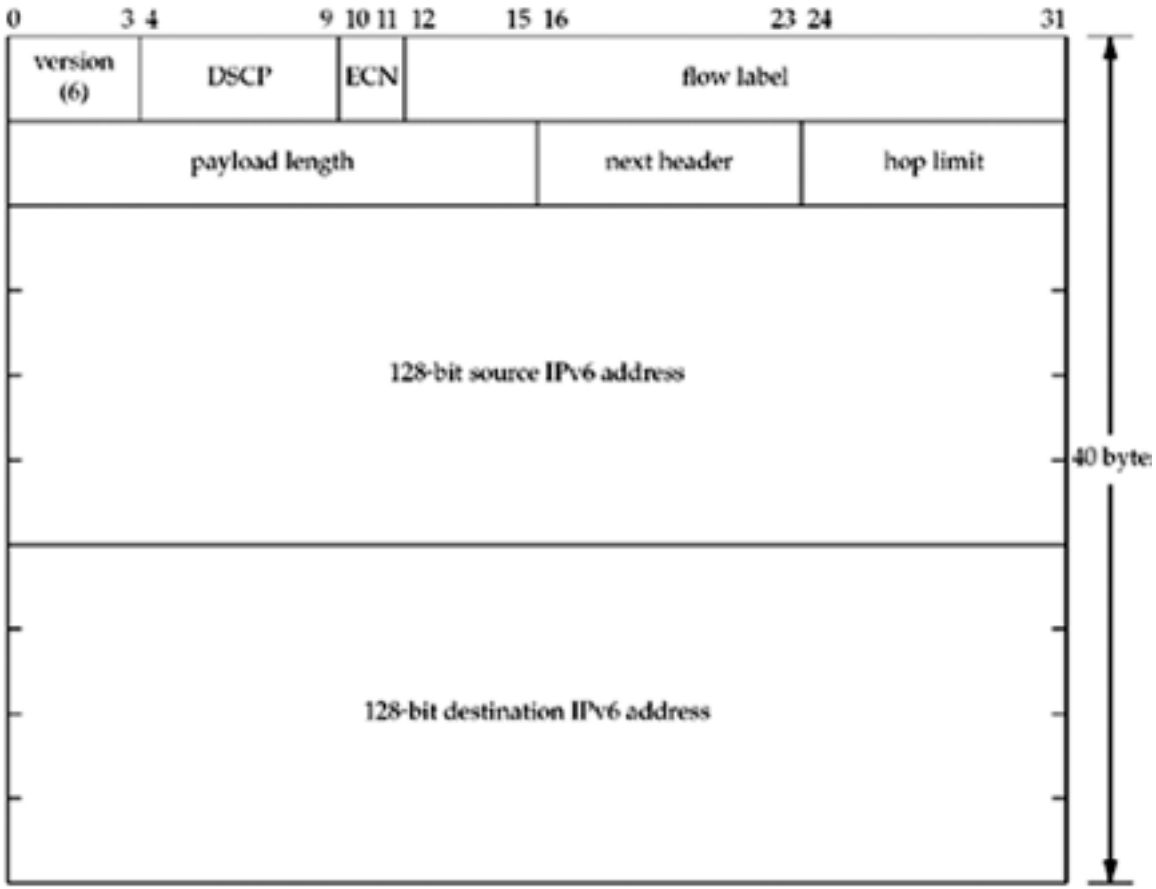

FTP
客户
FTP协议
FTP
服务器
TCP
TCP协议
TCP
路由器
IP
IP协议
IP
IP协议
IP
以太网驱
动程序
以太网协议
以太网驱
动程序
令牌环驱
动程序
令牌环协议
令牌环驱
动程序
以太网
令 牌 环

Format of the IPv4 header

Figure A.1. Format of the IPv4 header.



Format of the IPv6 header

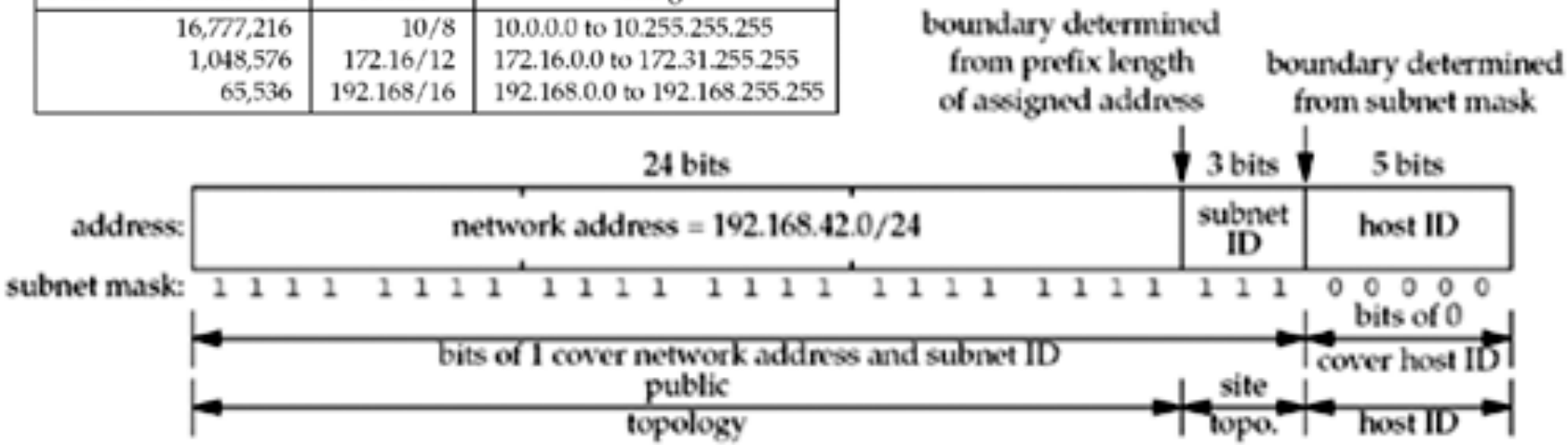


IPv4 Addresses

Usage	Class	Range
Unicast	A, B, C	0.0.0.0 to 223.255.255.255
Multicast	D	224.0.0.0 to 239.255.255.255
Experimental	E	240.0.0.0 to 255.255.255.255

Subnet	Prefix
0	192.168.42.0/27 †
1	192.168.42.32/27
2	192.168.42.64/27
3	192.168.42.96/27
4	192.168.42.128/27
5	192.168.42.160/27
6	192.168.42.192/27
7	192.168.42.224/27 †

Number of addresses	Prefix	Range
16,777,216	10/8	10.0.0.0 to 10.255.255.255
1,048,576	172.16/12	172.16.0.0 to 172.31.255.255
65,536	192.168/16	192.168.0.0 to 192.168.255.255



IP地址的分配与管理

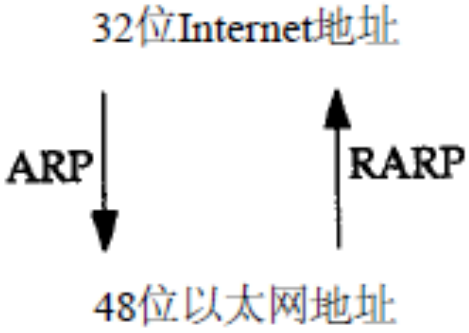
- 192.168.10.0/24地址段需要分配给5个不同的部门来使用：
  - 部门1-4均需要30个IP
  - 部门5需要100个IP
- 您作为管理员该如何划分子网？

IPv6 Addresses

Figure A.7. Meaning of high-order bits of IPv6 addresses.

Allocation	Interface ID size	Format prefix	Reference
Unspecified	n/a	0000 0000 ... 0000 0000 *(128 bits)*	RFC 3513
Loopback	n/a	0000 0000 ... 0000 0001 *(128 bits)*	RFC 3513
Global unicast address	any	000	RFC 3513
Global NSAP-based address	any	0000001	RFC 1888
Aggregatable global unicast address	64-bit	001	RFC 3587
Global unicast address	64-bit	*(anything not otherwise mentioned)*	RFC 3513
Link-local unicast address	64-bit	1111 1110 10	RFC 3513
Site-local unicast address	64-bit	1111 1110 11	RFC 3513
Multicast address	n/a	1111 1111	RFC 3513

ARP



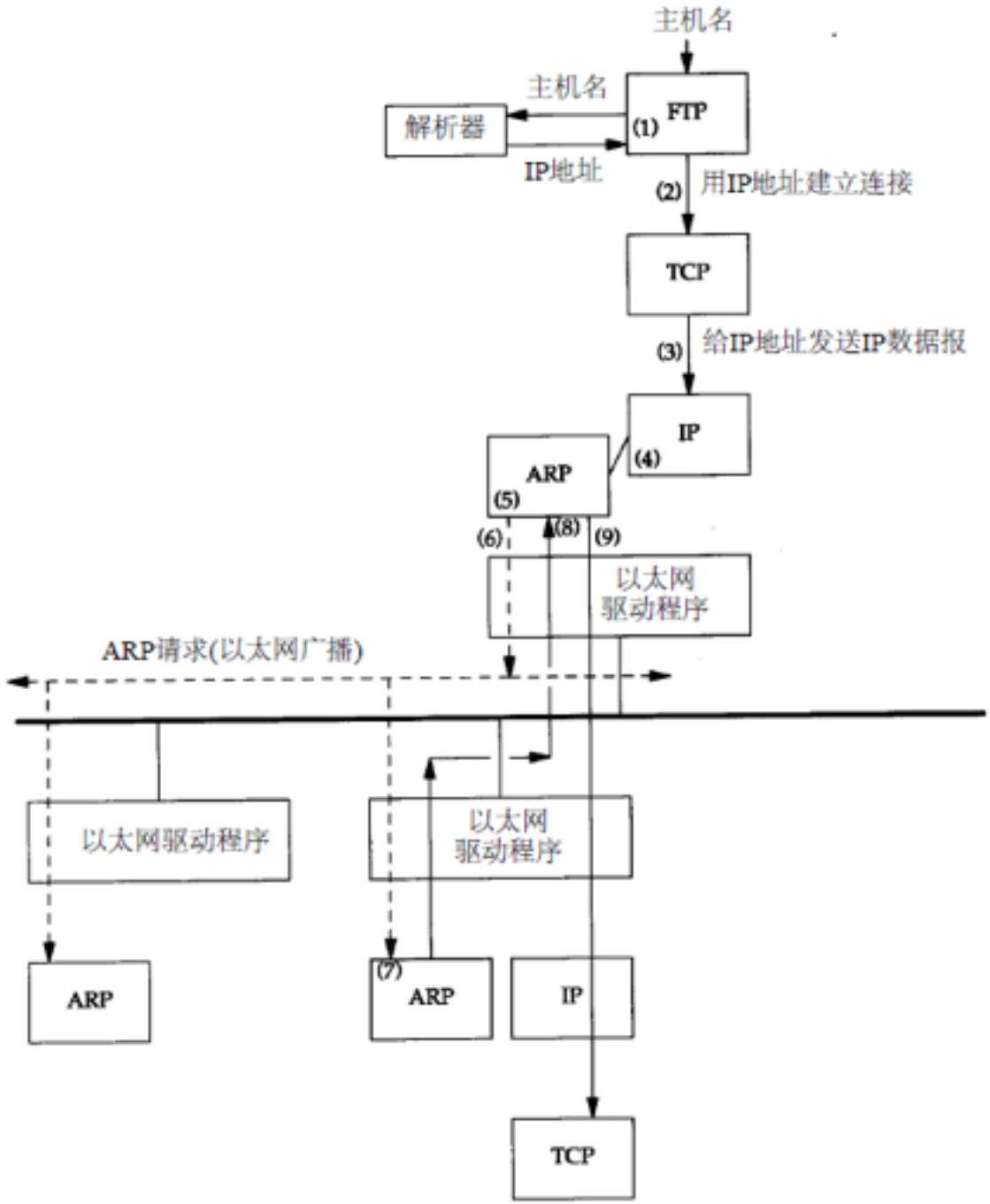
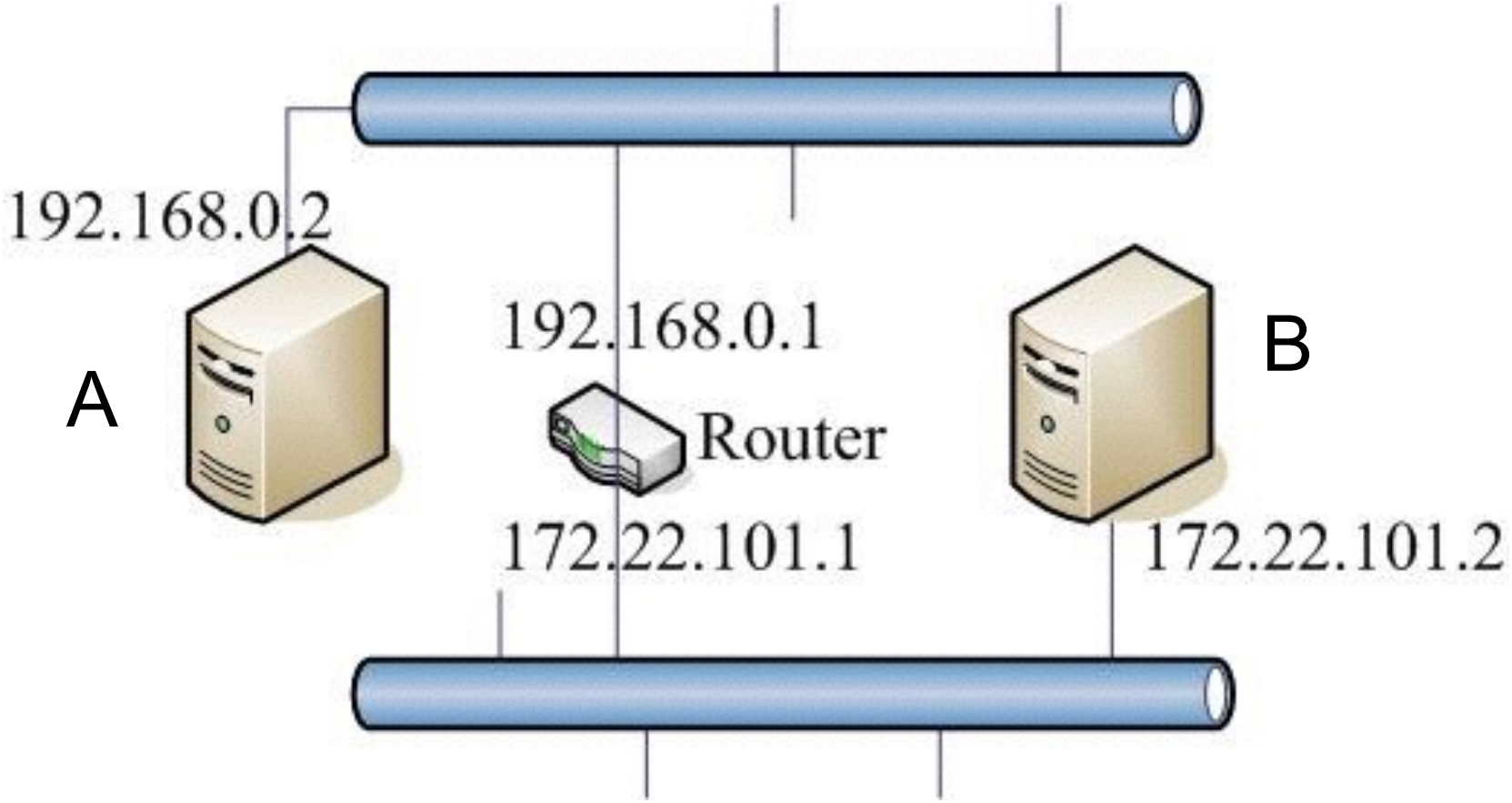


图4-2 当用户输入命令“ftp 主机名”时ARP的操作

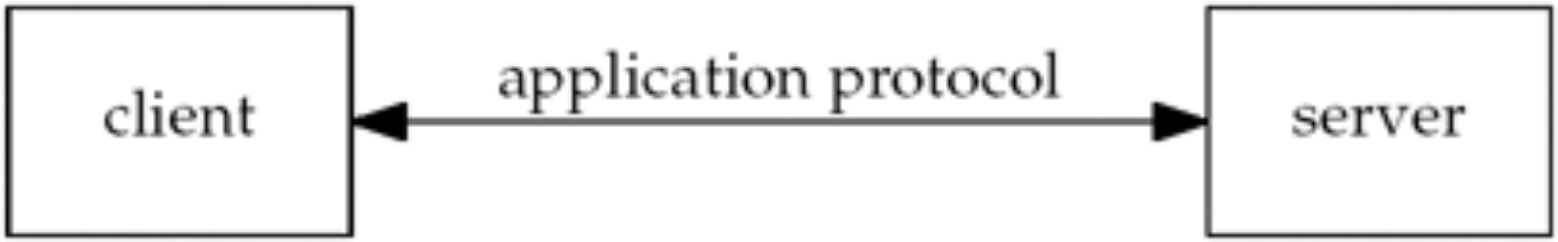
IP包是如何从A送到B?



网络程序设计中的几种不同视角

- Application

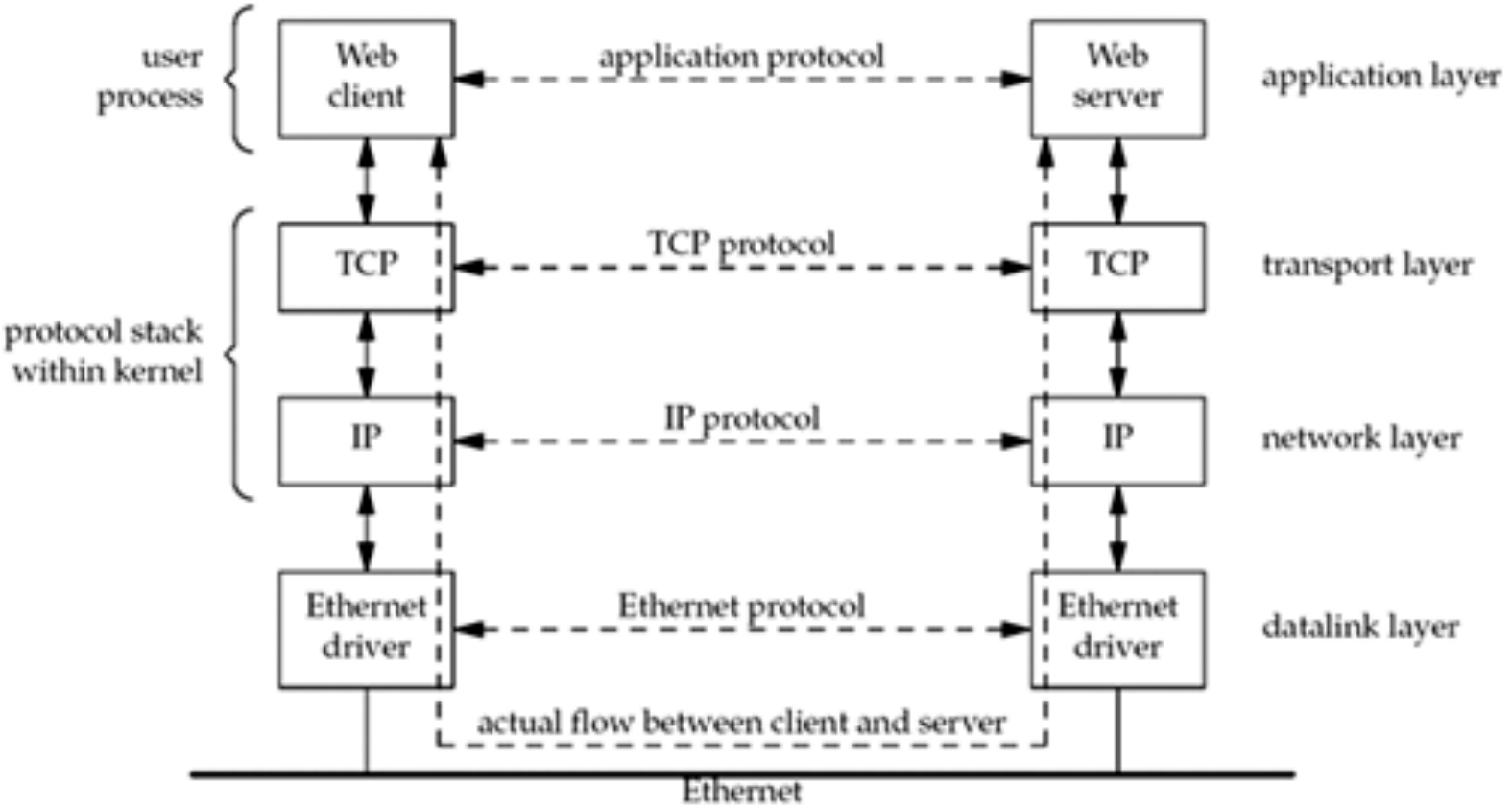
Figure 1.1. Network application: client and server.



网络程序设计中的几种不同视角

- Layering Protocols

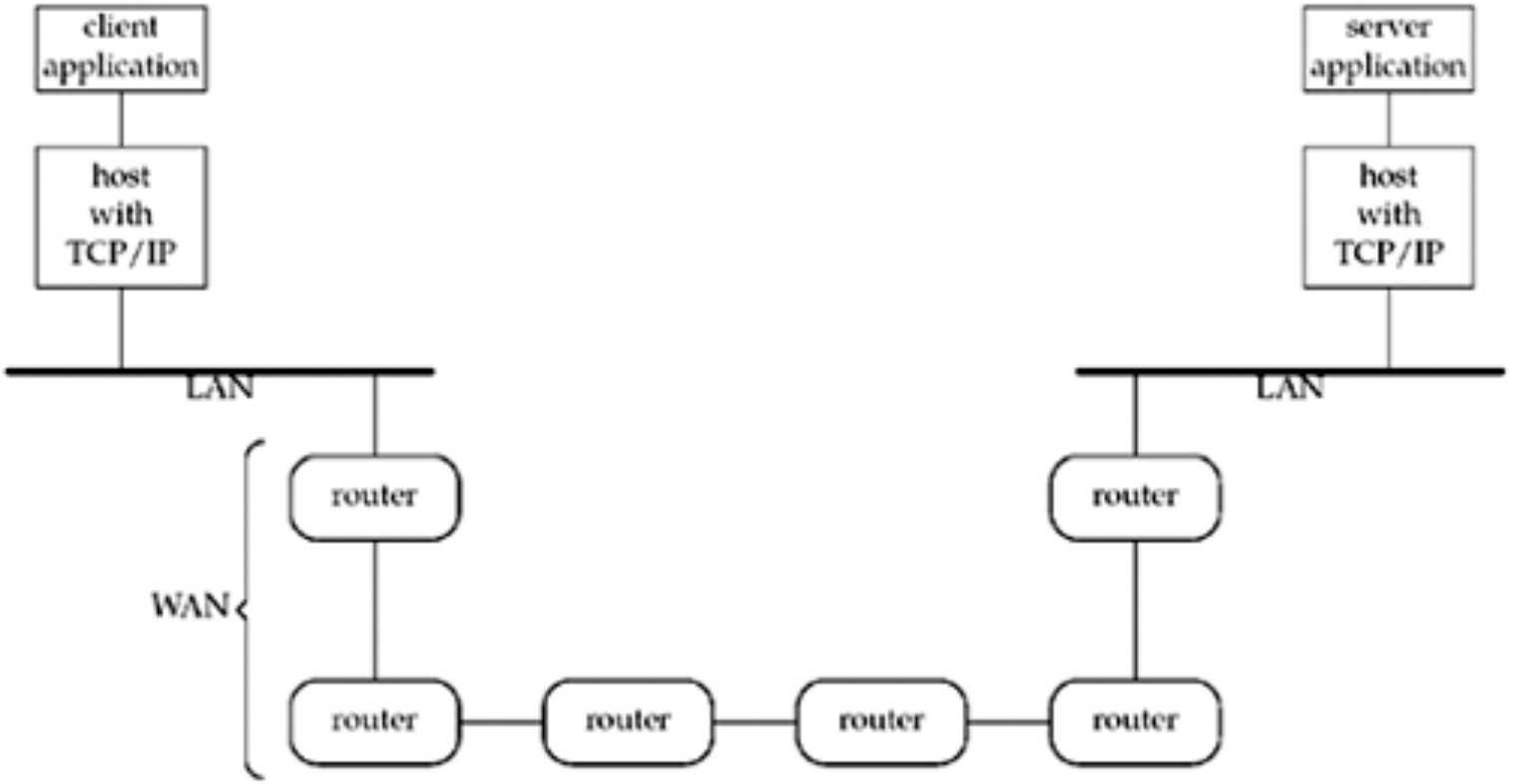
Figure 1.3. Client and server on the same Ethernet communicating using TCP.



网络程序设计中的几种不同视角

- Inter-Net/Internet

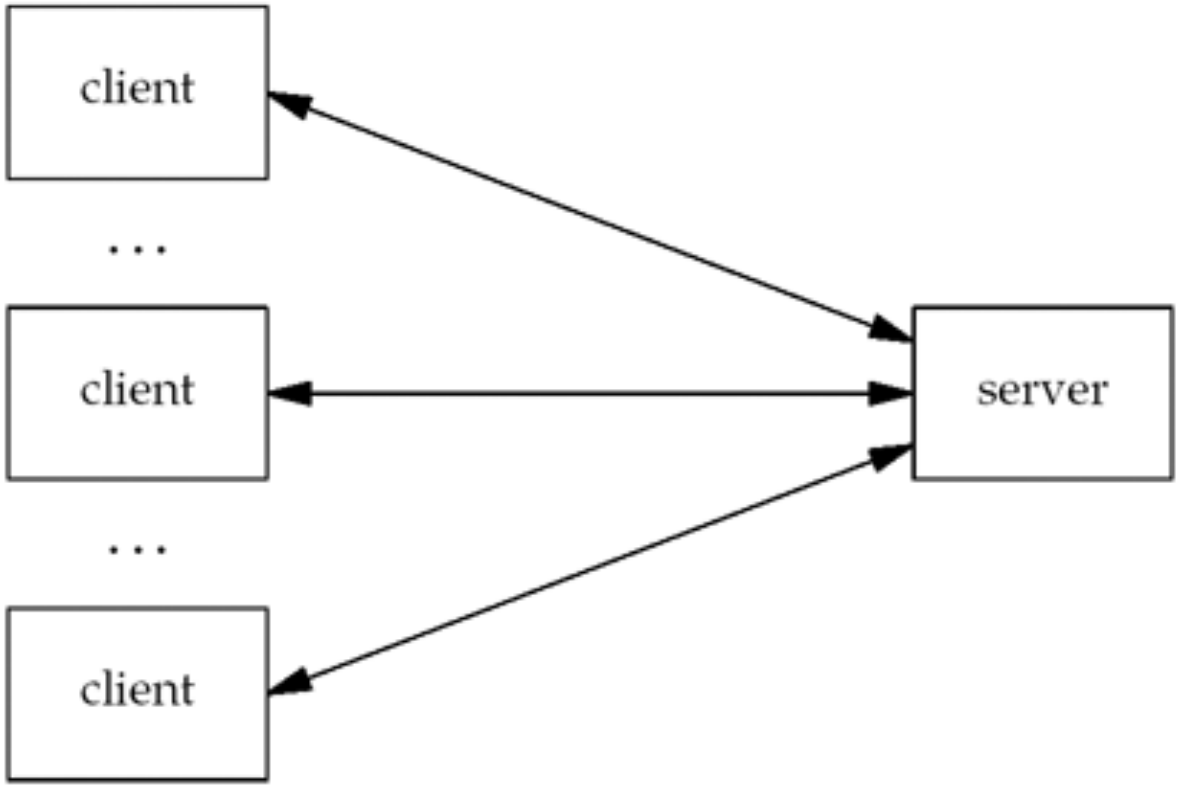
Figure 1.4. Client and server on different LANs connected through a WAN.



网络程序设计中的几种不同视角

- Performance/Control

Figure 1.2. Server handling multiple clients at the same time.



电信/通信行业软件开发主要涉及的领域

- 局端管理系统
  - SNMP Manager网管系统
  - OSS/BOSS运营支撑系统
  - SDN Controller
- 电信设备开发与设备管理
  - 协议栈的实现
  - CLI
  - SNMP Agent
  - web管理

课后作业

- 请计算最多有多少个A类、B类和C类网络号。
- 获取一份RFC 1000的拷贝，了解R F C这个术语从何而来。
- 什么叫CIDR?
- 一个IP包是如何到达它的目的地IP主机的?

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谢谢大家！

参考资料：

MIT Open Courseware - http://ocw.mit.edu
UNIX® Network Programming Volume 1, Third Edition
TCP/IP Illustrated Volume 1:The Protocols
庖丁解牛Linux内核分析https://j.youzan.com/pfzVl9