Chapter 1
Introduction

Introduction

- **Introduction:**
  - This chapter provides an overview of the TCP/IP protocol suite,to establish an adequate background for the remaining chapters.

- **Layering:**

Application	Telnet, FTP, e-mail, etc
Transport	TCP, UDP
Network	IP, ICMP, IGMP
Link	device driver and interface card

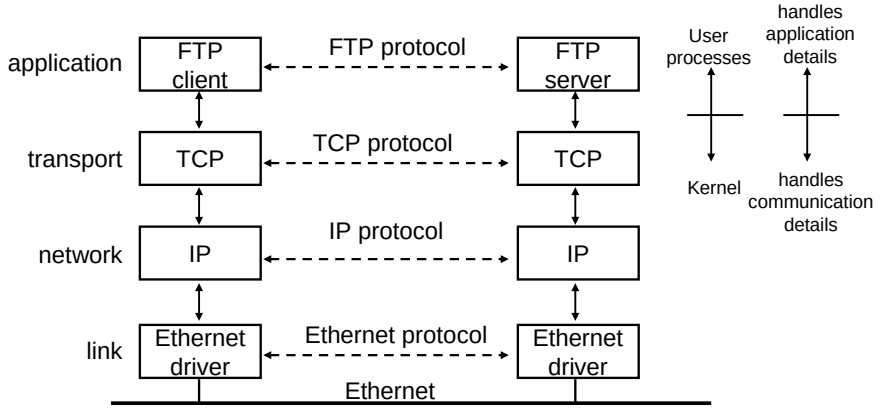
Figure 1.1 The four layers of the TCP/IP protocol suite

Layering

- **Each layer's responsibility:**
  - The link layer (data-link layer, network interface layer)
    - handle all the hardware details of physically interfacing with the cable
  - The network layer (internet layer)
    - handles the movement of packets around the network
  - The transport layer
    - provides a flow of data between two hosts, for the application layer above
    - TCP => provides a reliable flow of data between two hosts
    - UDP => unreliable => reliability must be added by the application layer
  - The application layer
    - handles the details of the particular application

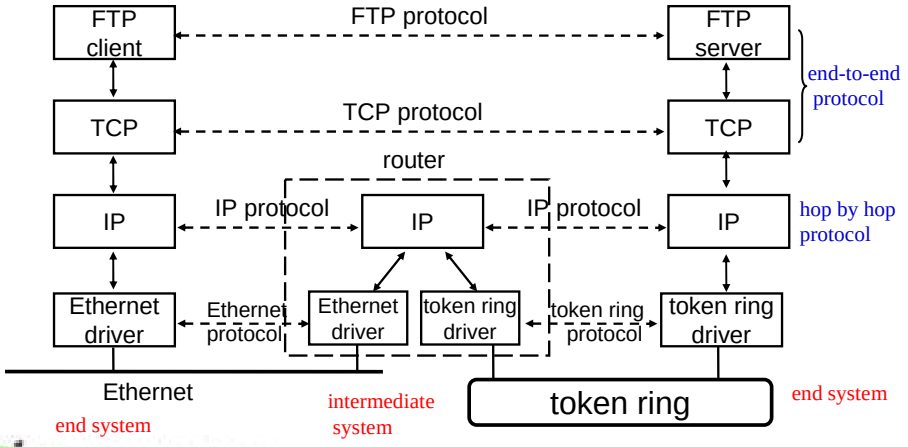
Layering (Cont.)

- **Two hosts on a LAN running FTP**



Layering (Cont.)

- **Two networks connected with a router**



Layering (Cont.)

- **Compare with router and multihomed**
  - A router, by definition, has two or more network interface layers
  - Any system with multiple interfaces is called multihomed
  - A host can also be multihomed but unless it specifically forwards packets from one interface to another, it is not called a router
    - mutihomed = router except above situation
- **Compare with bridge and router**
  - Bridges connect networks at the link layer
  - Routers connect networks at the network layer

TCP/IP Layering

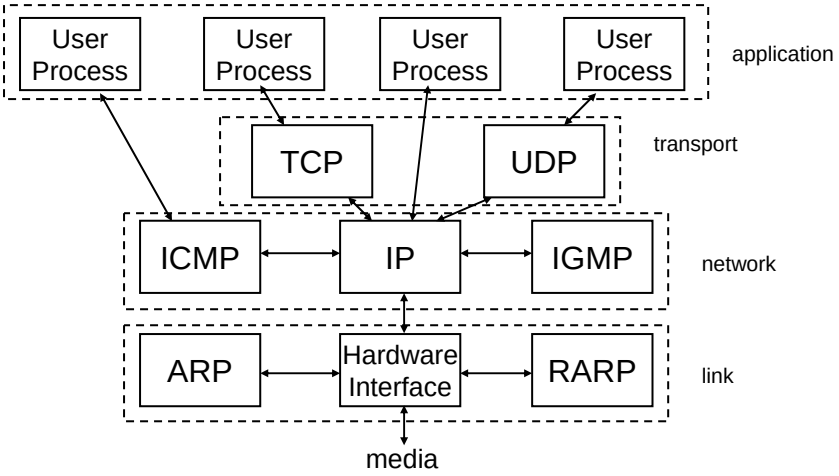


Figure 1.4 Various protocols at the different layers in TCP/IP protocol suite

TCP/IP Layering (Cont.)

- **TCP provides a reliable transport layer**
  - TCP applications:Telnet and Rlogin, FTP, SMTP
- **UDP is unreliable, sends and receives datagrams for applications**
  - UDP applications: DNS, Trivial FTP, Bootstrap Protocol, SNMP
- **IP is the main protocol at the network layer**
  - An application accessing IP is rare, but possible
- **ICMP is used by IP layer to exchange error messages and other vital information with the IP layer in another host or router**
- **IGMP is used with multicasting: sending a UDP datagram to multiple hosts**
- **ARP and RARP to covert between the addresses used by the IP layer and the addresses used by the network interface**

Internet Addresses

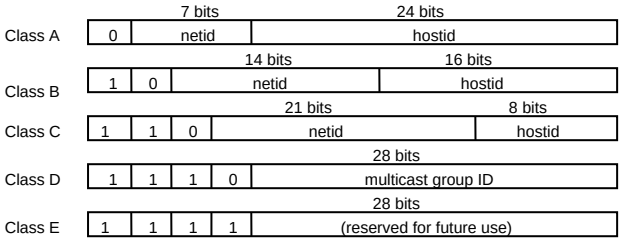


Figure 1.5 The five different classes of Internet addresses

Class	Range
A	**0**.0.0.0 to **127**.255.255.255
B	**128**.0.0.0 to **191**.255.255.255
C	**192**.0.0.0 to **223**.255.255.255
D	**224**.0.0.0 to **239**.255.255.255
E	**240**.0.0.0 to **255**.255.255.255

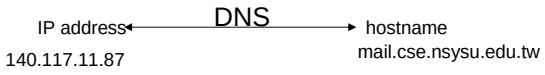
Figure 1.6 Range for different classes of IP addresses.

Internet Addresses (Cont.)

- **Internet address**
  - also called an IP address, 32-bit numbers, unique
- **How to differentiate between the different classes of addresses?**
  - look at the first number of a dotted-decimal address
- **Multihomed host will have multiple IP addresses**
  - Single network interface can have multiple IP addresses
- **Who allocating these unique IP address?**
  - InterNIC (Internet Network Information Center)
- **Three types of IP addresses**
  - unicast (destined for a single host)
  - broadcast (destined for all hosts on a given network)
  - multicast (destined for a set of hosts that belong to a multicast group)

The Domain Name System

- **Domain Name System (DNS)**
  - is a distributed database that provides the mapping between IP addresses and hostnames



- **Encapsulation**
  - Each layer adds information to the data by prepending headers (and sometimes adding trailer information) to data that it receives
  - For example: UDP passes to IP is called a UDP datagram, and the size of the UDP header is 8 bytes

Encapsulation

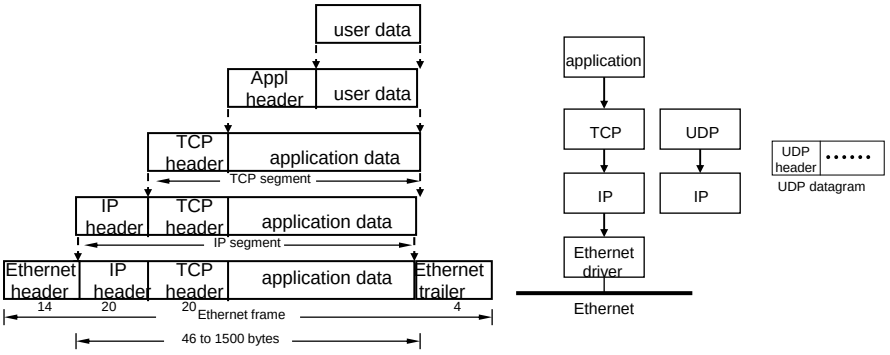


Figure 1.7 Encapsulation of data as it goes down the protocol stack

Demultiplexing

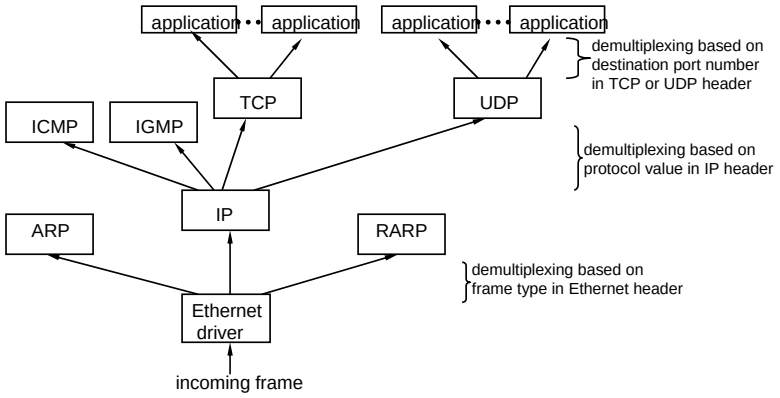


Figure 1.8 The demultiplexing of a received Ethernet frame

Client-Server Model

- **Two classes of servers**
  - iterative
    - I1. Wait for a client request to arrive
    - I2. Process the client request
    - I3. Send the response back to the client that send the request
    - I4. Go back to step I1
  - concurrent
    - C1. Wait for a client request to arrive
    - C2. Start a new server to handle this client's request. This may involve creating a new process, task, or thread, depending on the operating system. This new server handles this client's entire request. When complete, this new server terminates
    - C3. Go back to step C1

Port Numbers

- **TCP servers are concurrent, UDP servers are iterative, but there are a few exceptions**
- **How are port numbers chosen?**
  - Servers are normally known by their well-known port number
    - FTP server is on TCP port 21
    - Telnet server is on TCP port 23
    - TFTP is on UDP port 69
    - Rlogin is on TCP port 513
  - Client port number are called ephemeral ports (i.e., short lived)
    - certain of port number is unique, exists only as long as user running the client needs its service
    - ephemeral port numbers between 1024 and 5000
  - Well-known port numbers are in */etc/services* on most Unix system

Standardization Process

- **Reserved Ports**
  - Unix systems have the concept of reserved ports. Only a process with superuser privileges can assign itself a reserved port (1 to 1023)
- **Who controls the TCP/IP protocol suite, approves new standards?**
  - The Internet Society (ISOC)
  - The Internet Architecture Board (IAB)
  - The Internet Engineering Task Force (IETF)
  - The Internet Research Task Force (IRTF)
    - Both the IRTF an the IETF fall under the IAB
- **RFCs**
  - All the official standards in the internet community are published as *Request for Comment* (RFC)

Standard, Simple Services

- **TCP and UDP port number**
  - When the same service is provided using both TCP and UDP, both port numbers are normally chosen to be the same
- **Why the port numbers most are odd numbers?**
  - Because they are derived from the NCP port numbers
    - An even-odd pair of port numbers was reserved for each application

Name	TCP port	UDP port	RFC	Description
echo	7	7	862	Server returns whatever the client sends.
discard	9	9	863	Server discards whatever the client sends.
daytime	13	13	867	Server returns the time and date in a human-readable format.
chargen	19	19	864	TCP server sends a continual stream of characters, until the connection is terminated by the client. UDP server sends a daragram containing a random number of characters each time the client sends a datagram.
time	37	37	868	Server returns the time as a 32-bit binary number. This number represents the number of seconds since midnight January 1,1900, UTC.

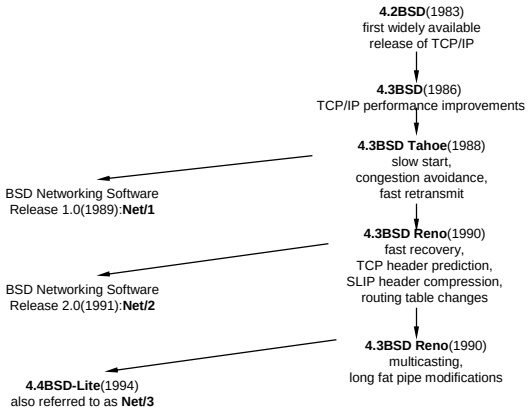
Figure 1.9 Standard,simple services provided by most implementations.

The Internet

- **What's the difference between *internet* and *Internet***
  - *internet* means multiple networks connected together, using a common protocol suite.
  - *Internet* refers to the collection of hosts (over one million) around the world that can communicate with each using TCP/IP
- **Implementations**
  - The standard for TCP/IP implementations is the one from the Computer Systems Research Group at the University of California at Berkeley
  - SunOS 4.x, SVR4, and AIX 3.2 that were originally developed from the Berkeley sources. These implementations have much in common, often including the same bugs!

Implementations

- **Various BSD release with important TCP/IP features.**



Application Programming Interfaces

- **Two popular application programming interfaces (APIs):**
  - *Sockets*
    - developed by Berkeley, sometimes called “Berkeley sockets”
  - *TLI* (Transport Layer Interface)
    - developed by AT&T, sometimes called “XTI” (X/Open Transport Interface)
- **Summary**
  - Distinction between the network layer and the transport layer
    - network layer (IP) provides a hop-by-hop service
    - transport layers (TCP and UDP) provide an end-to-end service
  - Internet is an internet that spans the globe and consists of more than 10,000 networks and more than one million computers
  - Servers use well-known ports while clients use ephemeral ports

Test Network

- Test network used for all the examples in the text.
- All IP addresses begin with 140.252.