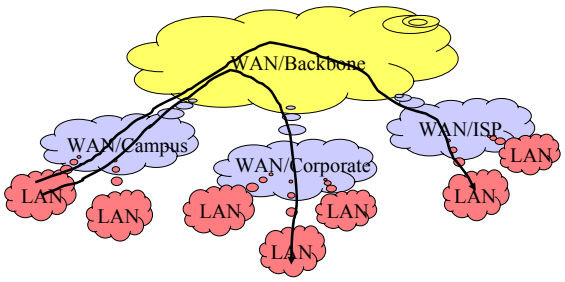
Internet – Structural View



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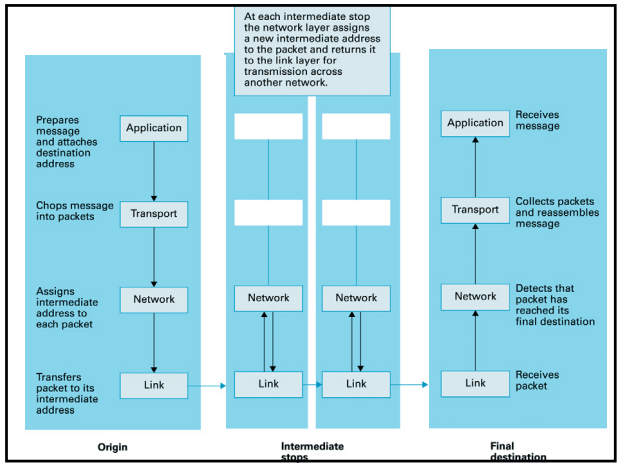
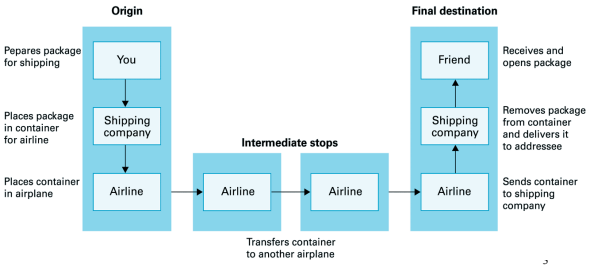
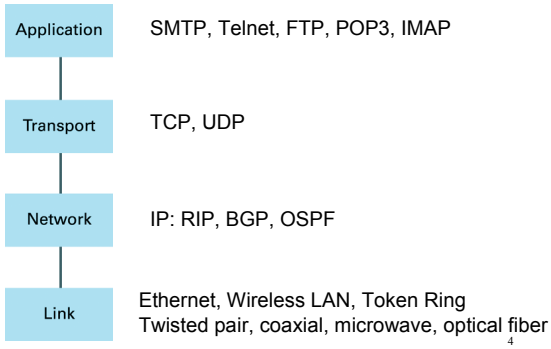


Package-shipping example



The Internet software layers



4

TCP

- Transmission Control Protocol
- Establishing a connection before sending a message
- Reliable transmission
  - Retransmit lost data
- Congestion control
  - Speed up when continue to receive acknowledgements
  - Slow down when experience data lost

- Enhanced registered letters (雙掛號信)
- E.g. E-mail

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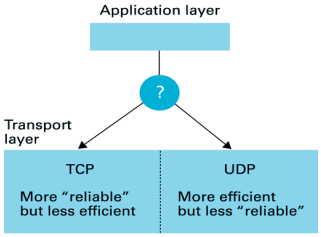
UDP

- User Datagram Protocol
- No establishing a connection before sending a message
- No acknowledgement/retransmission
- No reliable transmission
- No congestion control
- Efficient, if an application is prepared to handle the potential consequences of UDP

- As if regular letters (平信)
- E.g. from mnemonic form into IP form in name servers, Voice over IP

6

Choosing between TCP and UDP



e.g. E-mail

e.g. from mnemonic form into IP form in name servers

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TCP/UDP for Different Applications

- Different applications use different ports, like different windows in a post office
- E.g.
  - DNS port: 53 UDP
  - RIP port: 520 UDP
  - SMTP port: 25 TCP
  - FTP port: 20 TCP (FTP data)
  - FTP port: 21 TCP (FTP control)
  - Telnet port: 23 TCP
  - HTTP port: 80 TCP
- Port numbers can also be assigned on purpose.

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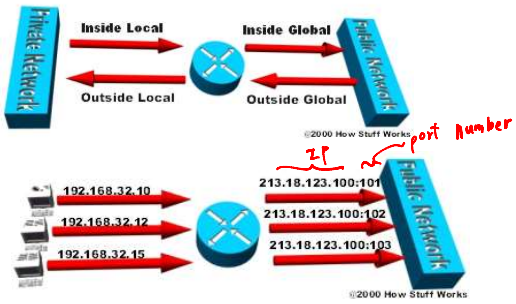
Network Address Translation (NAT) -- IP sharing



http://computer.howstuffworks.com/nat.htm/printable

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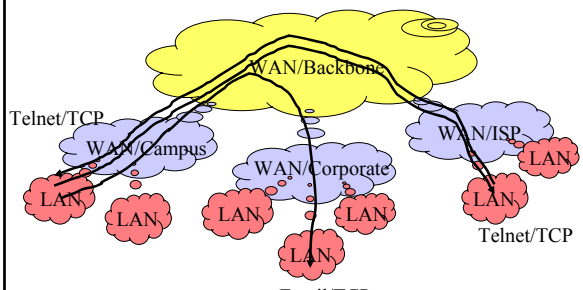
TCP/IP Network



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TCP/IP Suite

Application Layer	• SMTP (Email), Telnet
TCP Layer	• UDP, TCP
IP Layer	• RIP/OSPF, BGP
Link Layer	• (ARP)
Mac Layer	• Ethernet, Wireless LAN
Physical Layer	• Twisted pair, coaxial, microwave

(an informal layer structure)

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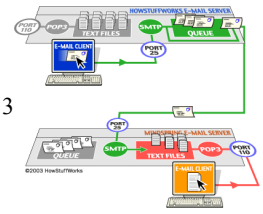
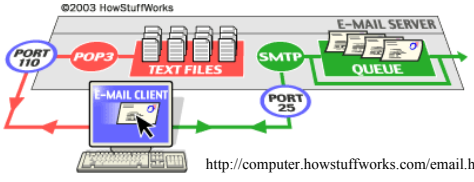
- SMTP
  Simple Mail Transfer Protocol
- POP3
  Post Office Protocol – version 3
- IMAP
  Internet Mail Access Protocol
  Edit/organize e-mails on the server





http://computer.howstuffworks.com/email.htm/printable

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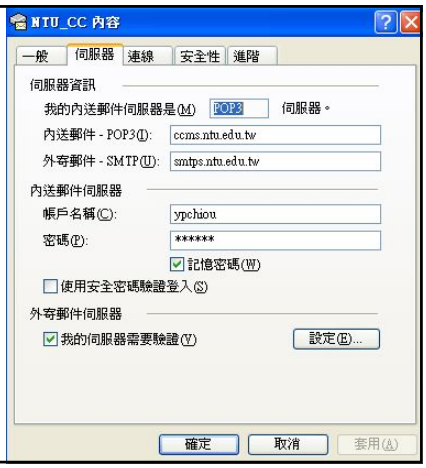
In Outlook Express



Presentation Matters

A

Introduction to Computers for non-CS/EE majors
Fall 2003, Class#: 901 60100, Session#: 01
Latest News…

B

Introduction to Computers

for non-CS/EE majors
Fall 2003
Class#: 901 60100, Session#: 01

Latest News

14

Therefore, HTML

```
<center>
<H1>Introduction to Computers</H1>
for non-CS/EE majors<br>
Fall 2003<br>
Class#: 901 60100, Session#: 01
</center>
```

Introduction to Computers

for non-CS/EE majors
Fall 2003
Class#: 901 60100, Session#: 01

Latest News

15

```
<P>
<A HREF="news.html">Latest News</A>
```

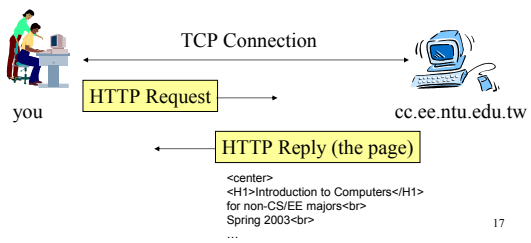
HTTP

- HyperText Transport Protocol
- Another application layer protocol
- A simple way to transmit data through the so-called World Wide Web

16

This Simple

http://cc.ee.ntu.edu.tw/~ypchiou/Intro_Comp/Intro_Comp.htm



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Mosaic

- First point-and-click browser
- For X windows at first
- Ported to Windows and Macintosh OS's
- Now we have Netscape, Internet Explorer, Firefox

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Web Browsers

- HTTP client
  - Takes URLs (Uniform Resource Locator)
    - Ex. http://cc.ee.ntu.edu.tw/~phuang/teach/intro-cs-spring-03/
  - Sends HTTP Requests
- HTML interpreter
  - Takes HTTP Replies (HTML files)
  - Renders nice-looking information

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The WWW flied from there.

In March of 1993, Web traffic accounts to 0.1% of all on the Internet.

More than 50% in the late 90's

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A New Communication Medium

- Newspapers/magazines
  - Text, graphics
- Radio
  - Audio
- TV
  - Audio, Video
- Web
  - All of the above

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Super Library

- News/magazines
- Directories
- Catalogs
- Maps
- Weather
- Music
- Movie
- …

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Much More Powerful Medium

- Easy to get information on the medium
  - Classified browsing
  - Search engines
- Cheap to put information on the medium
  - Personal: Free HD space
  - Commercial: Web hosting rather cheap
- No one controls the whole Web entirely

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A New Land

- North America
- Australia
- WWW
- Land is wealth

24

To Build a Customer Base

- E-Commerce
  - Keep the price low
- Web-based company
  - Free membership
  - Solely on advertisement income

25

Irrational Exuberance!

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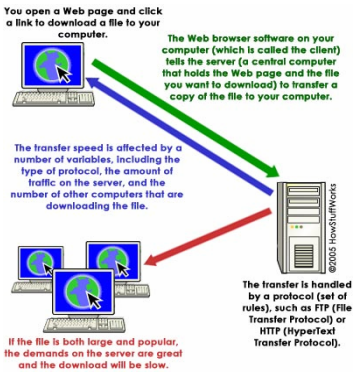
File Downloading

Traditional Client-Server Downloading



P2P File Sharing

- Collection exchange
  - I lend you mine. You lend me yours
- Among friends
  - Peer to peer. No central servers needed
- Popular examples
  - Napster, gnutella, KaZaA, Scour, iMesh, etc
- Data types
  - Music, movie, graphics, etc

http://computer.howstuffworks.com/file-sharing.htm/printable

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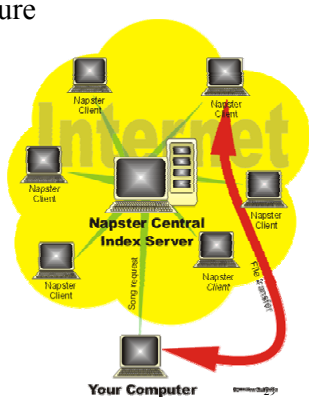
Napster's Architecture

Webs server ⇔ Browsers

Napster pioneered the concept of **peer-to-peer file sharing**. With Napster, individual people stored files that they wanted to share (typically MP3 music files) on their hard disks and shared them directly with other people. Users ran a piece of Napster software that made this sharing possible. Each user machine became a mini server.



File sharing / Gnutella

- The **central database for song titles** was Napster's Achilles' heel. Courts decided that Napster was promoting **copyright infringement**
- Gnutella's Architecture
  - Users place the files they want to share on their hard disks and make them available to everyone else for downloading in **peer-to-peer** fashion.
  - Users run a piece of **Gnutella software** to connect to the Gnutella network.
  - There is **no central database** that knows all of the files available on the Gnutella network. Instead, all of the machines on the network tell each other about available files using a distributed query approach.
  - There are **many different client applications** available to access the Gnutella network.

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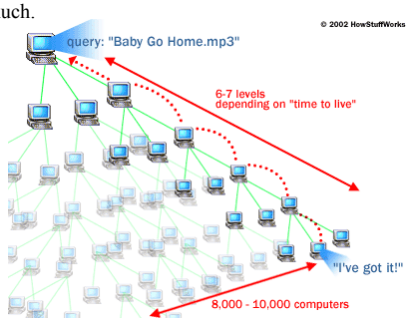
Similar to DNS query, but more powerful (more servers)
Difficult to find copyright infringement
Note: No guarantee for the desired song. Probably longer time
Bandwidth shared due to working as a server. But it doesn't matter much.



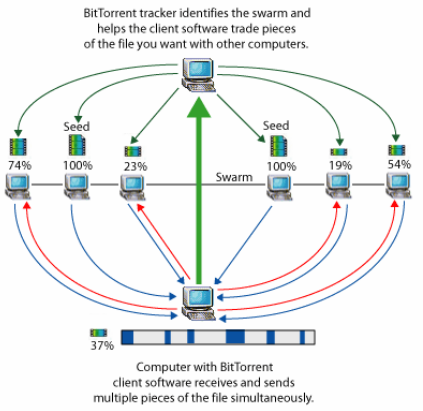
BitTorrent

BitTorrent maximizes transfer speed by gathering pieces of the file you want and downloading these pieces simultaneously from people who already have them

- a protocol that offloads some of the file tracking work to a central server (called a **tracker**)
- **tit-for-tat**, which means that in order to receive files, you have to give them. This solves the problem of leeching
- the more files you share with others,
  the faster your downloads are
- better use of available Internet bandwidth (the pipeline for data transmission

http://computer.howstuffworks.com/bittorrent.htm/printable

BitTorrent
(BT)



http://computer.howstuffworks.com/bittorrent.htm/printable ©2005 HowStuffWorks

- You open a Web page and click on a link for the file you want.
- BitTorrent client software communicates with a **tracker** to find other computers running BitTorrent that have the complete file (**seed** computers) and those with a portion of the file (peers that are usually in the process of downloading the file).
- The tracker identifies the **swarm**, which is the connected computers that have all of or a portion of the file and are in the process of sending or receiving it.
- The tracker helps the client software trade pieces of the file you want with other computers in the swarm. Your computer receives multiple pieces of the file simultaneously.
- If you continue to run the BitTorrent client software after your download is complete, others can receive .torrent files from your computer; your future download rates improve because you are ranked higher in the "tit-for-tat" system.

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Layered Structure of Networks

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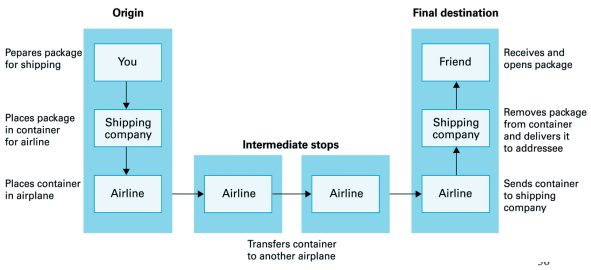
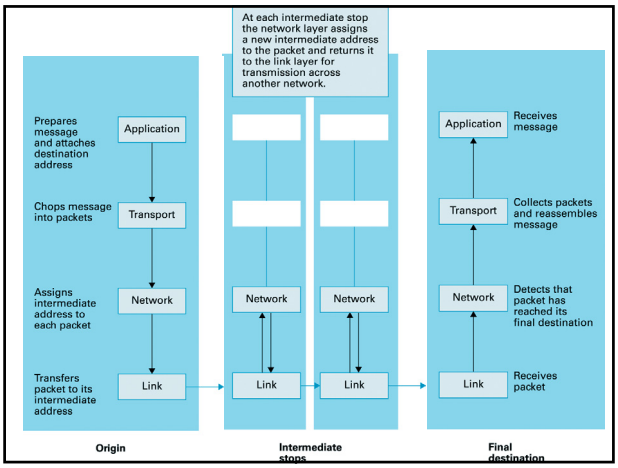
Package-shipping example





The Internet software layers

Application	Telnet, FTP, SMTP, POP3, IMAP, HTTP DHCP,
Transport	TCP, UDP
Network	IP: RIP, BGP, OSPF
Link	Ethernet, Wireless LAN, Token Ring Twisted pair, coaxial, microwave, optical fiber

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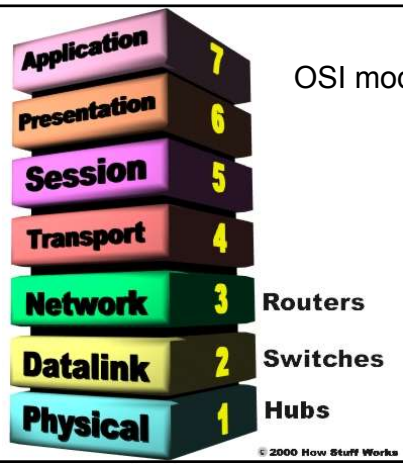

OSI model

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Open Systems Interconnection (OSI) standard

- **Layer 7: Application** - This is the layer that actually interacts with the operation system or application whenever the user chooses to transfer files, read messages or perform other network-related activities.
- **Layer 6: Presentation** - Layer 6 takes the data provided by the Application layer and converts it into a standard format that the other layers can understand.
- **Layer 5: Session** - Layer 5 establishes, maintains and ends communication with the receiving device.

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- **Layer 4: Transport** - This layer maintains **flow control** of data and provides for error checking and recovery of data between the devices. Flow control means that the Transport layer looks to see if data is coming from more than one application and integrates each application's data into a single stream for the physical network.
- **Layer 3: Network** - The way that the data will be sent to the recipient device is determined in this layer. Logical protocols, routing and addressing are handled here.
- **Layer 2: Data** - In this layer, the appropriate physical protocol is assigned to the data. Also, the type of network and the packet referencing is defined.
- **Layer 1: Physical** - This is the level of the actual hardware. It defines the physical characteristics of the network such as connections, voltage levels and timing.

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DoD Model	OSI Model	
Application	Application Presentation Session	SMTP, POP3, Telnet, FTP HTTP
Transport	Transport	TCP, UDP
Network	Network	IP: RIP, BGP, OSPF, ARP
Link	Data link	LLC (Logical Link Control) MAC (Media Access Control)
	Physical	Twisted pair, coaxial, μ–wave, fiber

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