CSE 101
Slide Set 5

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Networking and the Internet

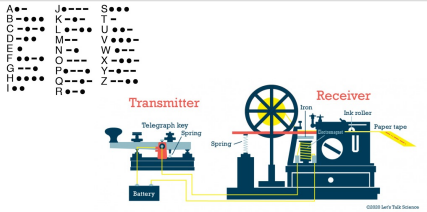
- Network Fundamentals
- The Internet
- The World Wide Web
- Internet Protocols
- Security

2

Early forms of messaging

3

Telegraph



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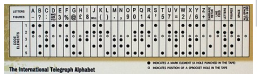
Hughes Telegraph

- How to make sending easy
- Code individual keys to send
- Baudot Code



Hughes telegraph, an early (1855) teleprinter built by Siemens and Halske. The centrifugal governor to achieve synchronicity with the other end can be seen.

5

Teletypewriter

- Type in one city print in another

6

Telex

Switched network of teleprinters.. **Switched network**?

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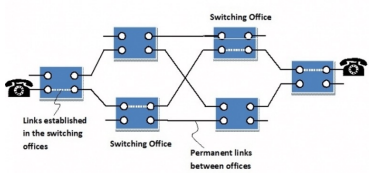
Circuit Switched Network



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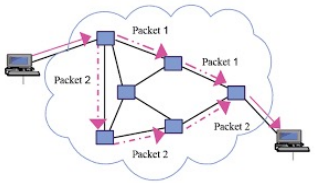
Packet Switched Network



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Modulation

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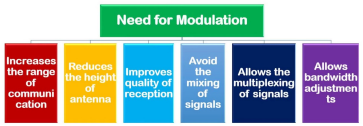
Modulation.. What is it?



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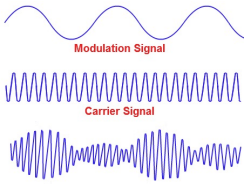
AM modulation



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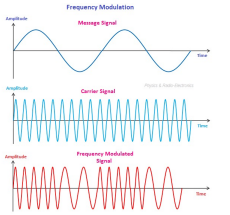
FM modulation



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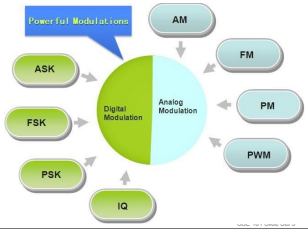
Various Advanced Modulation Types



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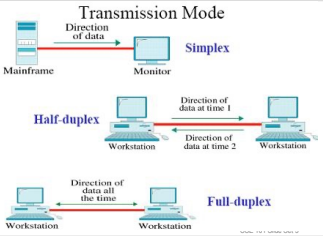
Simplex – Half Duplex – Full Duplex



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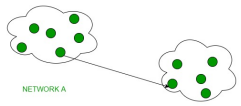
Unicast



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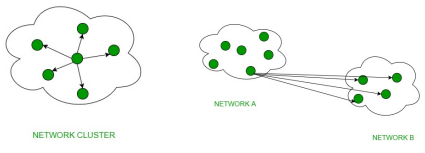
Broadcast



Limited broadcast

Direct broadcast

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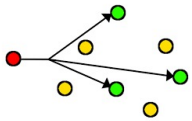
Multicast



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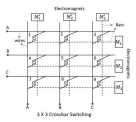
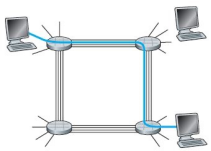
Network ??

- Circuit Switched
- Packet Switched





Circuit switching

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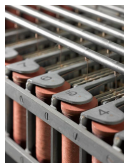
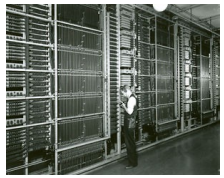
Crossbar Switch

- https://youtu.be/myqHoVcHkkA





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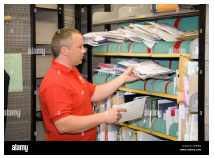
Packet Switching

- Store and forward principle, **routing**…



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Packet Switching

- Delivery

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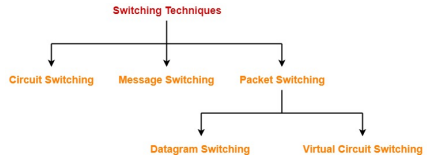
More ?



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Definition

- Connection of individual points is called as **Network**

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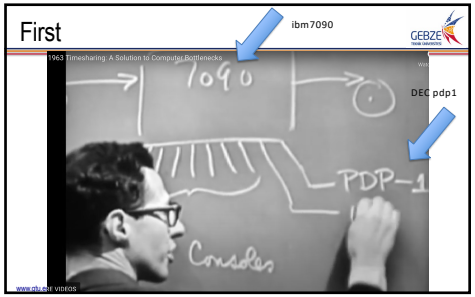

First
ibm7090
1963 Timesharing: A Solution to Computer Bottlenecks
7090
DEC pdp1
PDP-1
Consoles

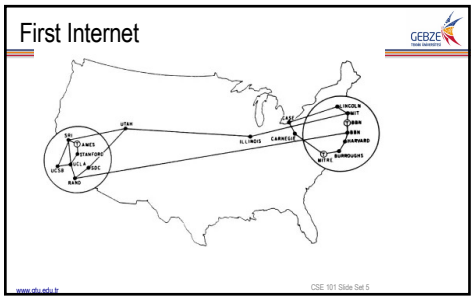
25


IBM7090

26


PDP1

27


First Internet
UTAH
ILLINOIS
CARNEGIE
LINCOLN
MIT
HARVARD
BURROUGHS
SDC
AMES
STANFORD
UCLA
UCSB
RAND
CSE 101 Slide Set 5

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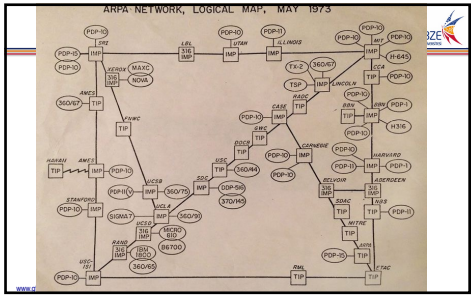

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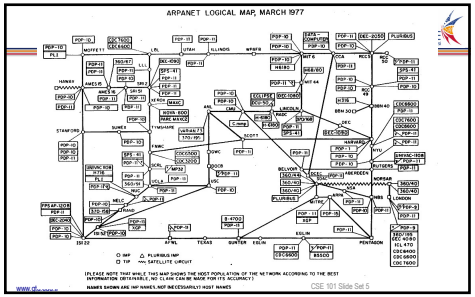

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Network Classifications

- Scope
  - Personal area network (PAN)
  - Local area network (LAN)
  - Metropolitan area (MAN)
  - Wide area network (WAN)
- Ownership
  - Closed versus open
- Topology (configuration)
  - Bus (Ethernet)
  - Star (Wireless networks with central Access Point)

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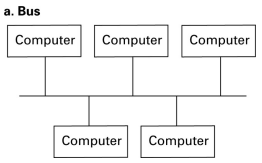
Network topologies



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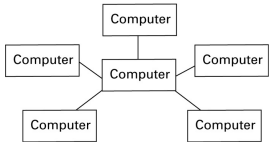
Network topologies (continued)

b. Star



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Protocols

- CSMA/CD
  - Used in Ethernet
  - Silent bus provides right to introduce new message
- CSMA/CA
  - Used in WiFi
  - Hidden terminal problem

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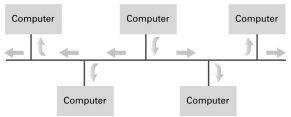
Communication over a bus network



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Connecting Networks

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

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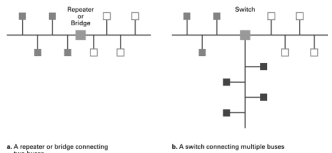
Building a large bus network from smaller ones



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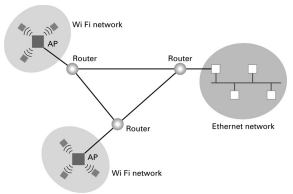
Routers connecting two WiFi networks and an Ethernet network to form an internet



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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

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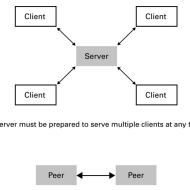
The client/server model compared to the peer-to-peer model



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Distributed Systems

- Systems with parts that run on different computers
  - Cluster computing
  - Grid computing
  - Cloud computing
    - Amazon's Elastic Compute Cloud
    - Google Drive

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The Internet

- The Internet: An internet that spans the world
  - Original goal was to develop a means of connecting networks that would not be disrupted by local disasters
  - Today a commercial undertaking that links a worldwide combination of PANs, LANs, MANs, and WANs involving millions of computers

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Internet Architecture

- Internet Service Provider (ISP)
  - Tier-1
  - Tier-2
- Access or tier-3 ISP: Provides connectivity to the Internet
  - Hot spot (wireless)
  - Telephone lines
  - Cable/Satellite systems DSL
  - Fiber optics

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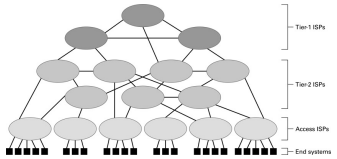
Figure 4.7 Internet Composition



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Internet Addressing

- IP address: pattern of 32 or 128 bits often represented in dotted decimal notation
- Mnemonic address:
  - Domain names
  - Top-Level Domains
- Domain name system (DNS)
  - Name servers
  - DNS lookup

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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.

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Early Internet Applications

- Network News Transfer Protocol (NNTP)
- File Transfer Protocol (FTP)
- Telnet and SSH
- Hypertext Transfer Protocol (HTTP)
- Electronic Mail (email)
  - Domain mail server collects incoming mail and transmits outing mail
  - Mail server delivers collected incoming mail to clients via POP3 or IMAP

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SMTP Simple Mail Transfer Protocol

```
220 mail.tardis.edu SMTP Sendmail Gallifrey-1.0; Fri, 23 Aug 2413 14:34:10
HELO mail.skaro.gov
250 mail.tardis.edu Hello mail.skaro.gov, pleased to meet you
MAIL From: dalek@skaro.gov
250 2.1.0 dalek@skaro.gov... Sender ok
RCPT To: doctor@tardis.edu
250 2.1.5 doctor@tardis.edu... Recipient ok
DATA
354 Enter mail, end with "." on a line by itself
Subject: Extermination.
EXTERMINATE!
Regards, Dalek
.
250 2.0.0 r7NJYAEl028071 Message accepted for delivery
QUIT
221 2.0.0 mail.tardis.edu closing connection
```


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More Recent Applications

- Voice Over IP (VoIP)
- Internet Multimedia Streaming
  - N-unicast
  - Multicast
  - On-demand streaming
  - Content delivery networks (CDNs)

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World Wide Web

- **Hypertext** combines internet technology with concept of linked-documents
  - Embeds **hyperlinks** to other documents
- **Browsers** present materials to the user
- **Webservers** provide access to documents
- Documents are identified by **URL**s and transferred using **HTTP**

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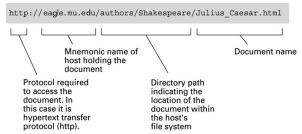
Figure 4.8 A typical URL



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Hypertext Markup Language (HTML)

- Encoded as text file
- Contains tags to communicate with browser
  - Appearance
    - <h1> to start a level one heading
    - <p> to start a new paragraph
  - Links to other documents and content
    - <a href = . . . >
  - Insert images
    - <img src = . . . >

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A simple webpage

a. The page encoded using HTML.

Tag indicating beginning of document
Preliminaries
The part of the document that will be displayed by a browser
Tag indicating end of document

```
<html>
<head>
<title>demonstration page</title>
</head>
<body>
<h1>My Web Page</h1>
<p>Click here for another page.</p>
</body>
</html>
```


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A simple webpage (continued)

b. The page as it would appear on a computer screen.

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An enhanced simple webpage

a. The page encoded using HTML.

Anchor tag containing parameter
Closing anchor tag

```
<html>
<head>
<title>demonstration page</title>
</head>
<body>
<h1>My Web Page</h1>
<p>Click
   <a href="http://crafty.com/demo.html">
   here
   </a>
   for another page.</p>
</body>
</html>
```


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An enhanced simple Web page (continued)

b. The page as it would appear on a computer screen.

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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

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Using XML

<staff clef = “treble”> <key>C minor</key>
<time> 2/4 </time>
<measure> < rest> egth </rest> <notes> egth G, egth G, egth G </notes></measure>
<measure> <notes> hlf E </notes></measure>
</staff>

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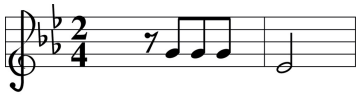
The first two bars of Beethoven’s Fifth Symphony



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Client Side Versus Server Side

- Client-side activities
  - Javascript
  - Macromedia Flash
- Server-side activities
  - Common Gateway Interface (CGI)
  - Servlets
  - JavaServer Pages (JSP) / Active Server Pages (ASP)
  - PHP

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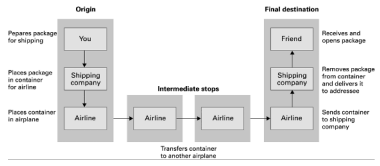
Package-shipping example



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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

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The Internet software layers

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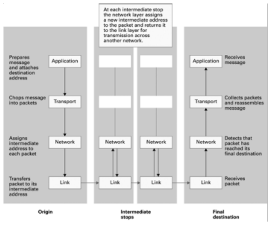
Following a message through the Internet



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TCP/IP Protocol Suite

- Transport Layer
  - Transmission Control Protocol (TCP)
  - User Datagram Protocol (UDP)
- Network Layer
  - Internet Protocol (IP)
    - IPv4
    - IPv6

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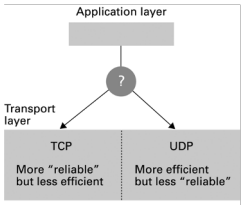
Choosing between TCP and UDP



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Security

- Attacks
  - Malware (viruses, worms, Trojan horses, spyware, phishing software)
  - Denial of service (DoS)
  - Spam
- Protection
  - Firewalls
  - Spam filters
  - Proxy Servers
  - Antivirus software

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Encryption

- HTTPS and SSL
- Public-key Encryption
  - Public key: Used to encrypt messages
  - Private key: Used to decrypt messages
- Certificates and Digital Signatures
  - Certificate authorities

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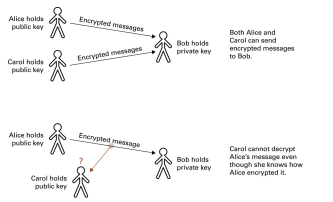
Figure 4.16 Public-key encryption



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