

**Computer Networks**

Chapter 12

Topics:

- Communication links
  - LAN / WAN
  - Internet / WWW

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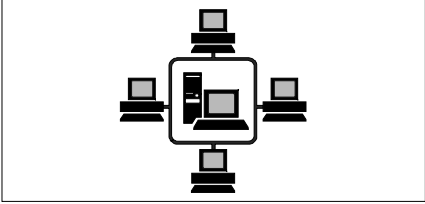
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**Computer Networks**

- A computer network is a set of independent computer systems interconnected by telecommunication links.



The diagram shows a central server computer with a monitor and keyboard. It is connected to four other computer systems (two desktops and two laptops) arranged around it, representing a network topology.

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**Telecommunication Links**

- The connection links:
  - Are used to transmit data between the computers on the network.
  - The links could be:
    - wires (cables, telephone-lines), or even
    - wireless (radio transmitters, satellites).
- The transmission rate or bandwidth of a link:
  - Is the amount of data that can be transmitted over a connection in a given period of time.
  - Is typically measure in bps (bits-per-second).

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### Connecting

- In a local network (office, building, campus), computers are usually connected via dedicated links, such as:
  - Twisted pair wire
  - Coaxial cable
  - Fiber-optic cable
- But what if we want to connect from home?
  - Telephone-lines
  - Cable TV



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### Connecting via Telephone Lines

- Problem:
  - Telephone systems were built to carry voice as analog data, but computers use digital (binary) data.
- Solution:
  - At the sending end the data is converted to analog signal (modulate).
  - At the receiving end: the analog signal is converted back to digital data (demodulate).
- The device that does this is called a modem.
- Bandwidth: up to 56 Kbps

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### ISDN

- Telephone companies are now also offering ISDN connections (Integrated Services Digital Network)
  - Communications links capable of handling digital signals.
  - Can also be used for normal telephone calls, a device called Terminal Adaptor (TA) converts the analog telephone signal to/from a digital signal.
- Need:
  - ISDN adapter in your computer
- Bandwidth: 128Kbps

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### Cable Modem

- A device called a cable modem allows to transmit data via a cable TV connection:
  - Does modulate the digital signals so can be transmitted (but without interfering with the TV picture).
- Needs
  - Cable TV outlet
  - A cable modem (rental included in monthly fee)
  - A network card in your computer.
- Advantages:
  - Dedicated connection (don't have to dial in).
  - Bandwidth: up to 45 Mbps (but shared by all users on cable)

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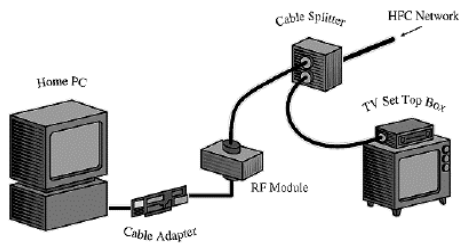
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### Cable Modem Setup



Taken from "The Emergence of Cable Modem Access"

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### Computer Networks

- We distinguish between two different type of networks:
- LAN (Local Area Networks)
  - Used to connect computers in close physical proximity (office, building, campus)
- WAN (Wide Area Networks)
  - Used to connect computers across cities, countries, continents.
- The two type of networks use totally different:
  - Network topology
  - Communication protocols

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### Local Area Networks (LANs)

- Many different types of LANs, but (by far) the most widely used are Ethernets.
  - Bandwidth: 10mbps-100mbps
  - Each computer on the network has installed an Ethernet adapter.
- Ethernet LAN's can be constructed in two different ways, either using
  - a shared cable
  - a HUB

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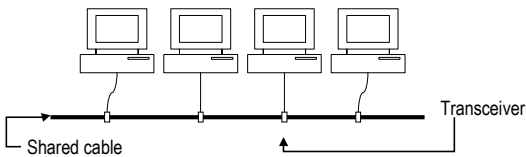
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### Ethernet LAN using a Shared Cable

- A shared (coaxial) cable is stretched around the area (a home, office, building, campus, ...).
- The computers connect to the cable via sockets called transceivers.



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11

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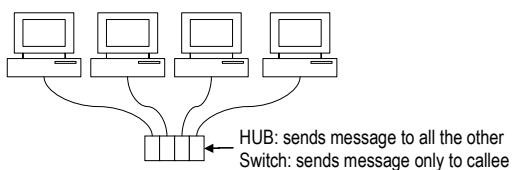
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### Ethernet LAN using a HUB

- No shared cable.
- All computers connect directly to a central device called a HUB (or a device called a Switch).



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12

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### Ethernet Communication Protocol

- The rules of how data is transferred over the network is called:
  - a communication protocol (same protocol used regardless of how the network is constructed).
- Communication technique (no central control):
  - Each computer on the network has a unique address.
  - A message to address is broadcasted over the network. Every computer receives the message, but only the computer with a matching address stores the message.
  - Contention-based transmission:
    - Listens to line and wait until free, then send.
    - If collision (two or more computers send at same time), wait a random amount of time, then retry.

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### Wide Area Networks (WANs)

- Used to connect computer systems that are far apart, e.g. across a city, country, continent.
- Network topology different from LAN's:
  - Point-to-Point communications links (one computer connects directly to another computer)
- Communication protocols different from LAN's:
  - Send a fixed maximum size packages instead of whole messages.
  - Use store-and-forward, package-switching protocol

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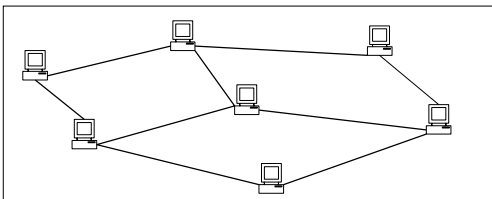
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### Network Topology WAN

- Point-to-Point communication lines, that is, a link directly connects two computers.
- Not all computers directly connected (but there exists a path between any two).



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### Communication Protocols WAN

- Messages transmitted via store-and-forward packet switching:
  - A message is split into packages (1000-1500 bytes).
  - A router determines best path to send the packages.
  - Packages are forwarded from a node-to-node
    - When receiving a package a node (computer) sends an acknowledge to sending node, which can then delete local copy of package.
  - At receiving end the message is reconstructed

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16

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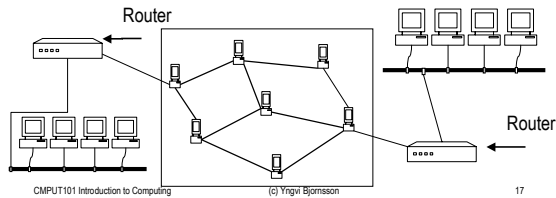
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### Mixing LAN/WAN

- LAN's connect to WAN's via routers.
- Routers:
  - Determine the path to take in the WAN
  - Reconfigure messages between LAN/WAN communication protocols



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17

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18

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### The Internet

- The first computer-to-computer message was sent in 1969.
- Today the Internet consists of estimated
  - 30 million interconnected computers
  - hundred of millions of users
  - in over 150 countries.
- The World Wide Web is the most popular component of the internet.

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19

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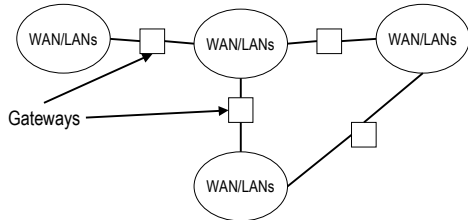
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### Internet - A network of networks



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20

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### Internet Infrastructure

- The Internet is a network of networks.
- Is based on an internetworking concept:
  - each network can do whatever it wants internally, but
  - much speak a standard protocol externally, and
  - use a standard addressing scheme
- A device called a gateway interconnects the networks
  - basically same as a router

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21

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### Standard Addressing/Protocols

- Addressing:
  - Each computer has a unique address
    - IP address
    - 128.129.4.29
  - Domain Name System
    - easier to remember names than numbers
    - Can refer to address as: www.cs.ualberta.ca
- Protocols:
  - TCP/IP (Transmission Control Protocol/Internet Protocol)
  - More or less the “common language” spoken by networks

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22

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### Usage of internet

- Web-browsing (World Wide Web)
- E-mail
- Telnet (log onto and work on another computer)
- FTP (transfer files from one computer to another)
- Newsgroups / Chat rooms
- E-Commerce
- ...

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23

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### World Wide Web

- The World Wide Web (WWW) is an information sharing system based on
  - inter-linked documents (web-pages)
  - that can be accessed over the internet and
  - viewed graphically (using a web-browser)
- Located via a URL (Uniform Resource Locator):
  - <protocol>://<internet address>/page
    - http://www.cs.ualberta.ca/~yngvi/cmp101
    - ftp://www.cs.ualberta.ca

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24

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### Web pages

- A web-page is a hypertext document
  - can have links to another web-pages
  - written in a language called HTML
- The web-pages
  - are stored on a computer running a web-server
  - can be accessed from any computer on the internet via a web-browser (Netscape, Internet Explorer).
- The HTTP protocol specifies
  - how the Web-browser (client) gets the page from the web-server.

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25

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### Summary

- Computer networks
  - computers connected using telecommunication links
  - Local Area Networks (LAN)
  - Wide Area Networks (WAN)
- Internet
  - Network of networks
  - Standard addressing scheme/inter network protocols
- WWW

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26

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