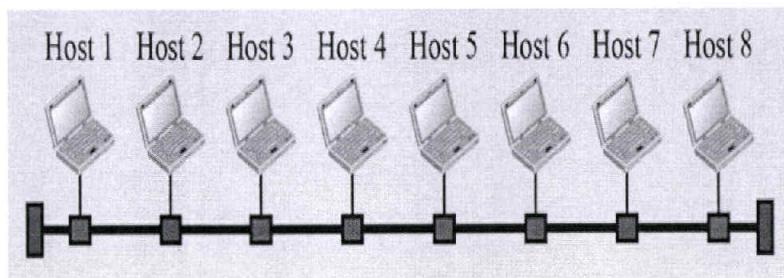


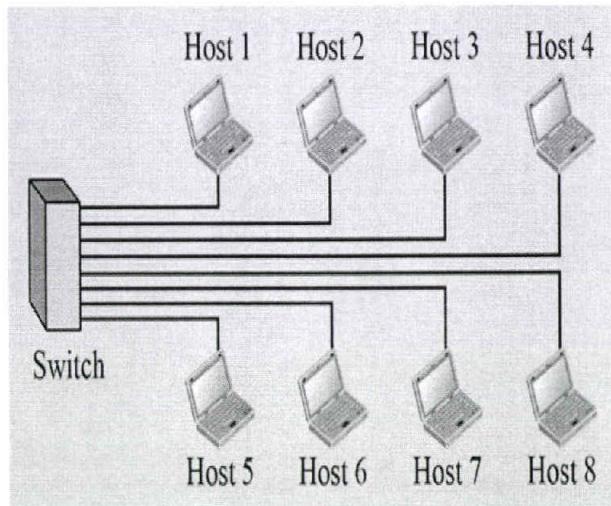
Network Classifications

- Networks can be classified based on Coverage into
 - LANs: Local Area Networks
 - WANs: Wide Area Networks
 - Others including MAN (Metropolitan Area Networks), PAN (Personal Area Networks), Home Networks, etc...
- Networks could also be classified as Switched or Shared (Broadcast) networks
- Networks could also be classified based on their functionalities for example Backbone Networks, Content Delivery Networks, Overlay Networks, etc..

Switched vs. Broadcast Networks

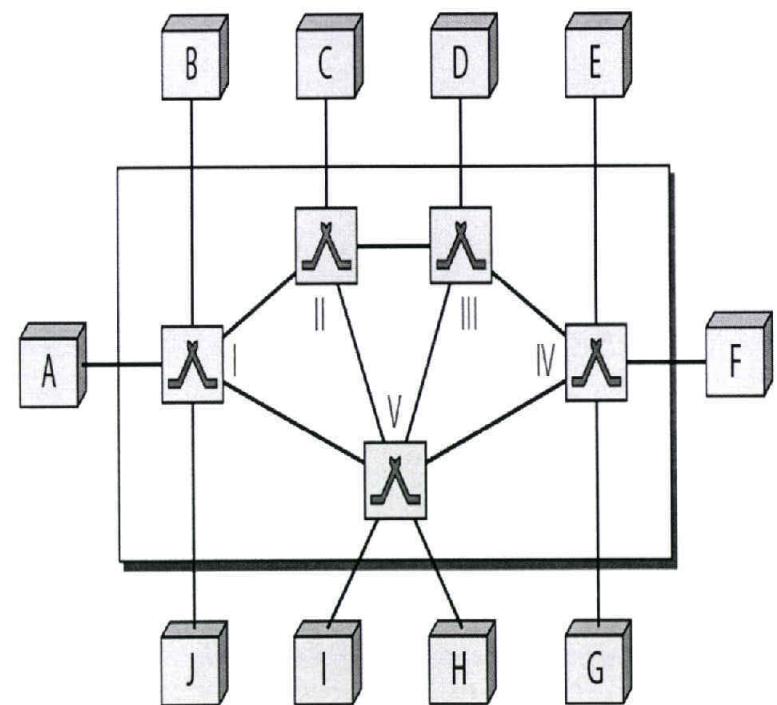
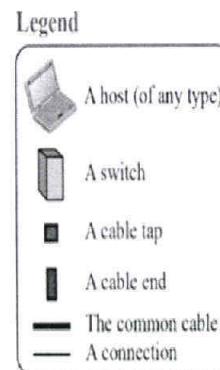


a. LAN with a common cable (past)

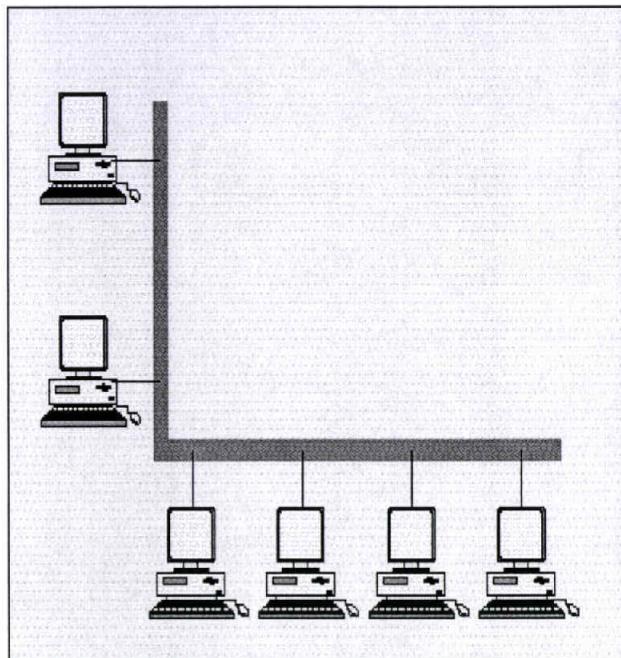


b. LAN with a switch (today)

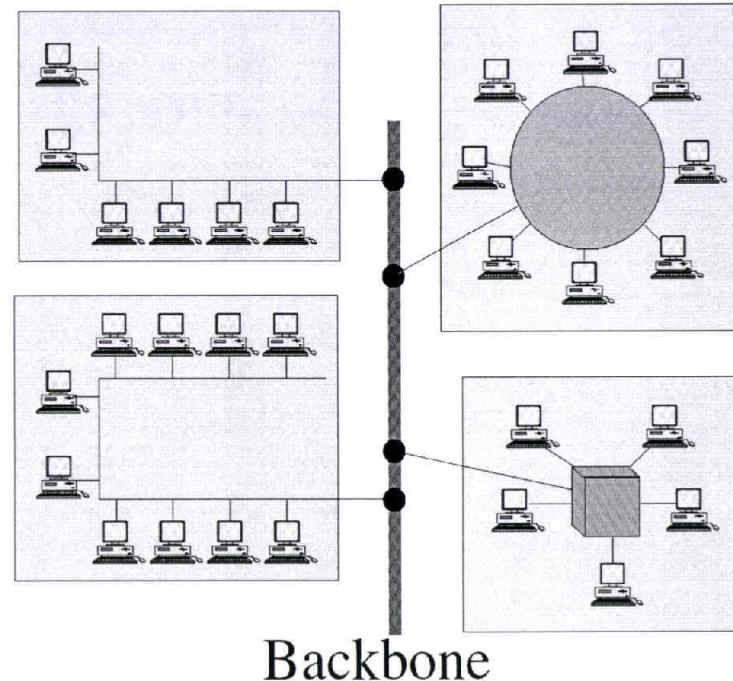
Broadcast



Local Area Networks (I)

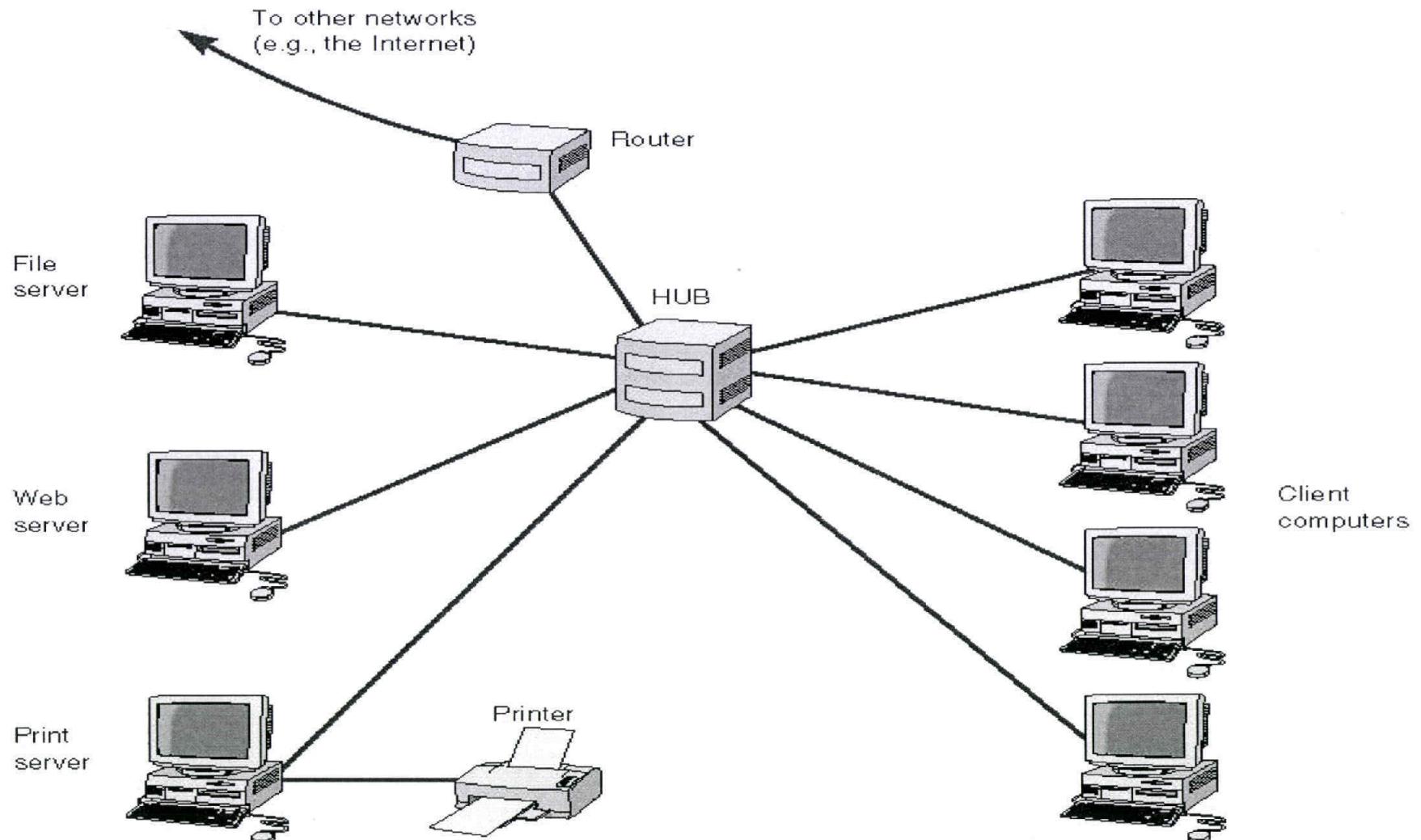


Single building LAN

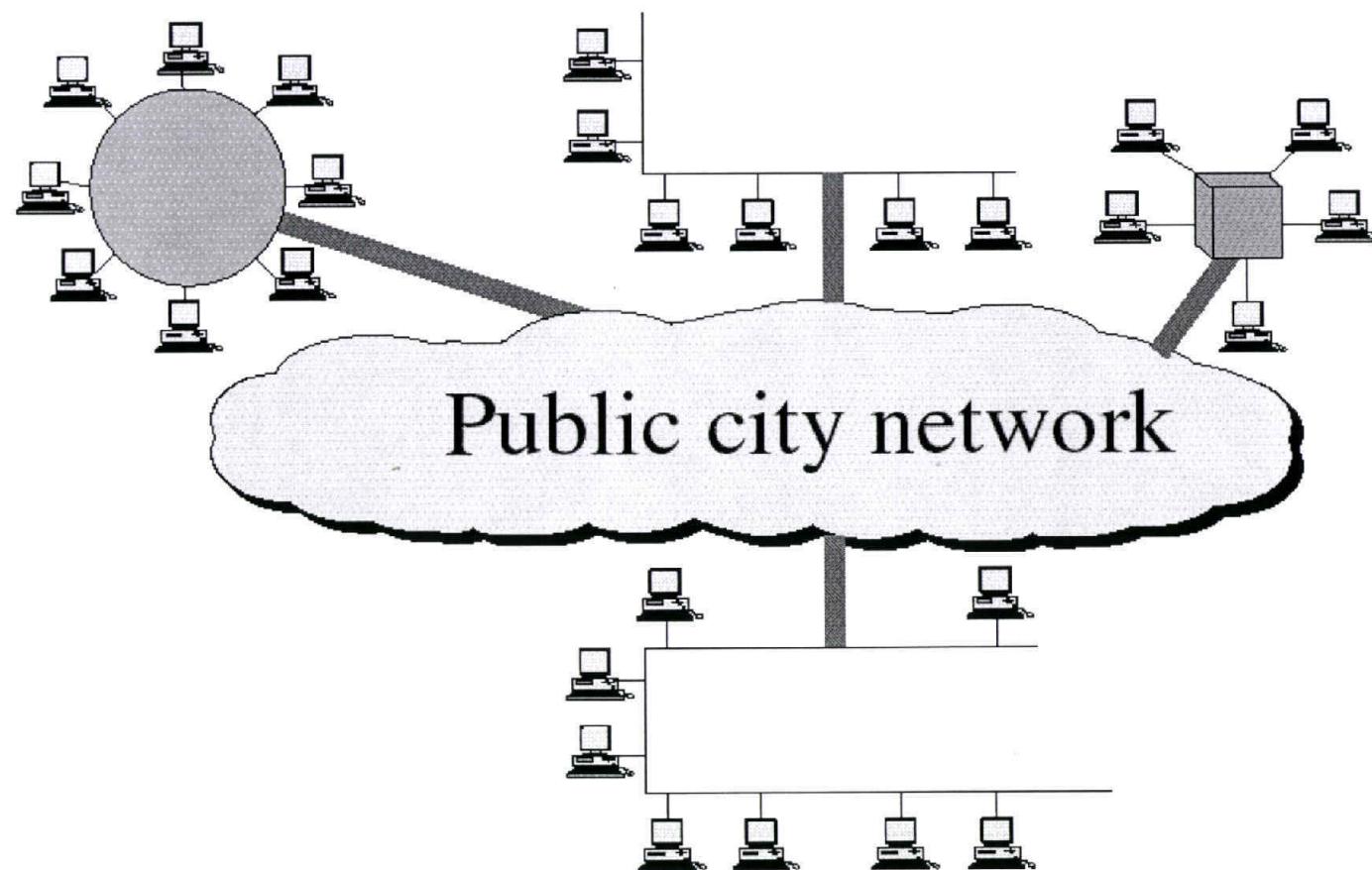


Multiple building LAN

Local Area Networks (II)



Metropolitan Area Network



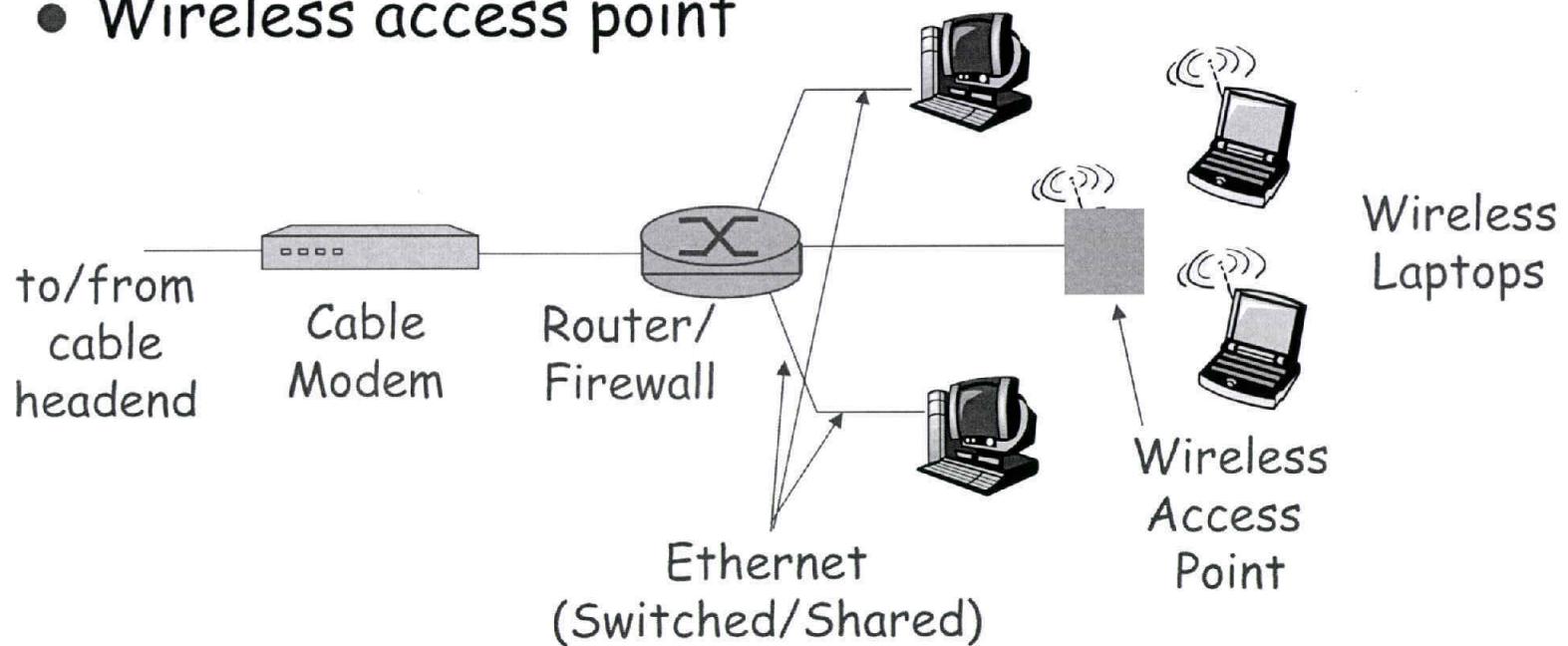
Wide Area Networks



Home Networks

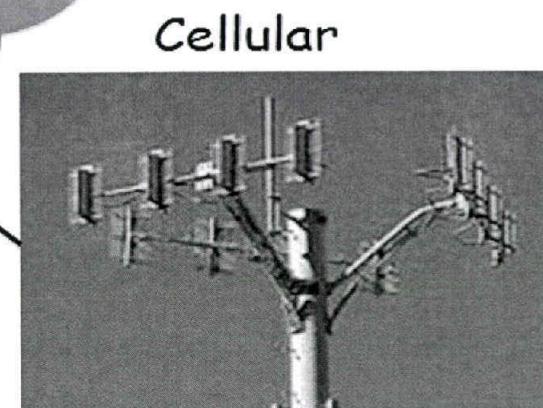
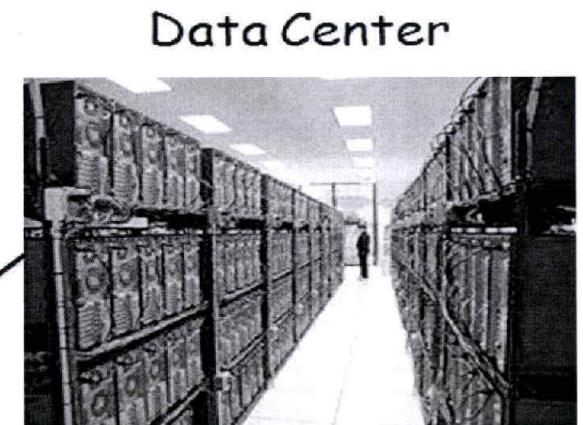
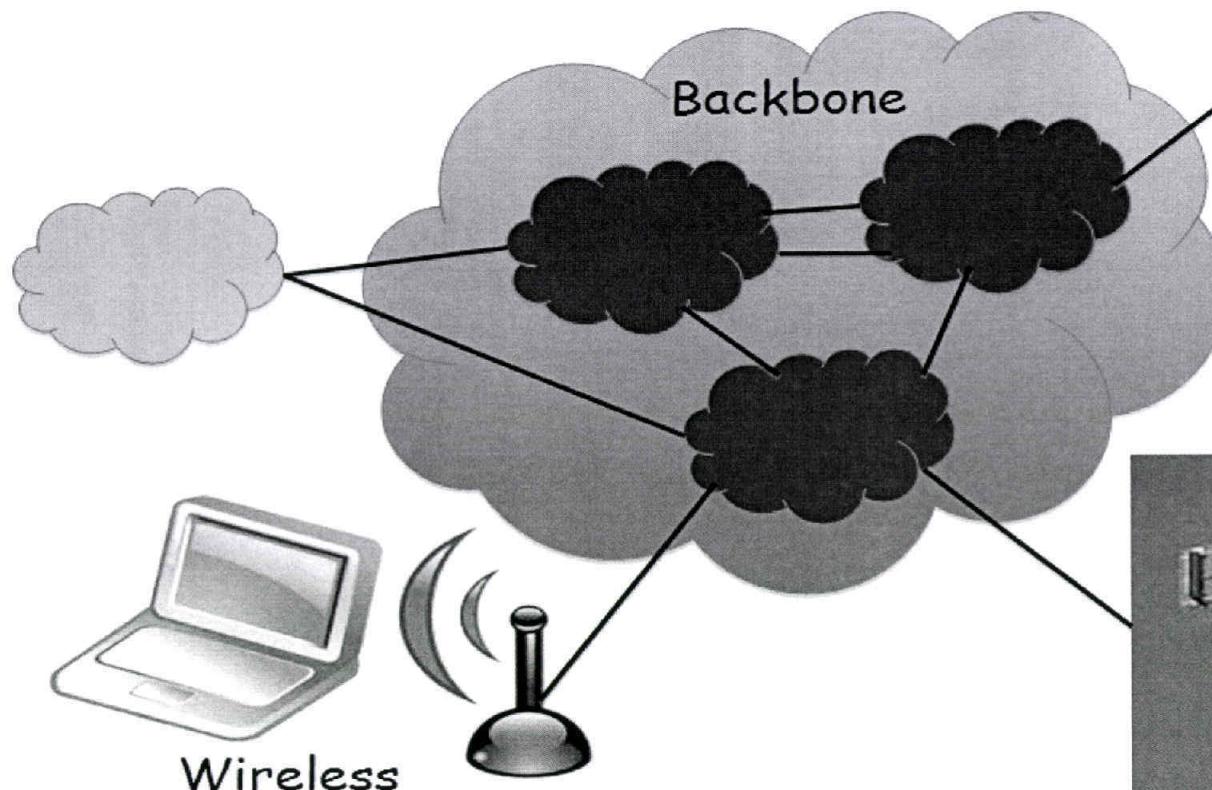
Typical home network components

- ADSL or cable modem
- Router/firewall/NAT
- Ethernet
- Wireless access point



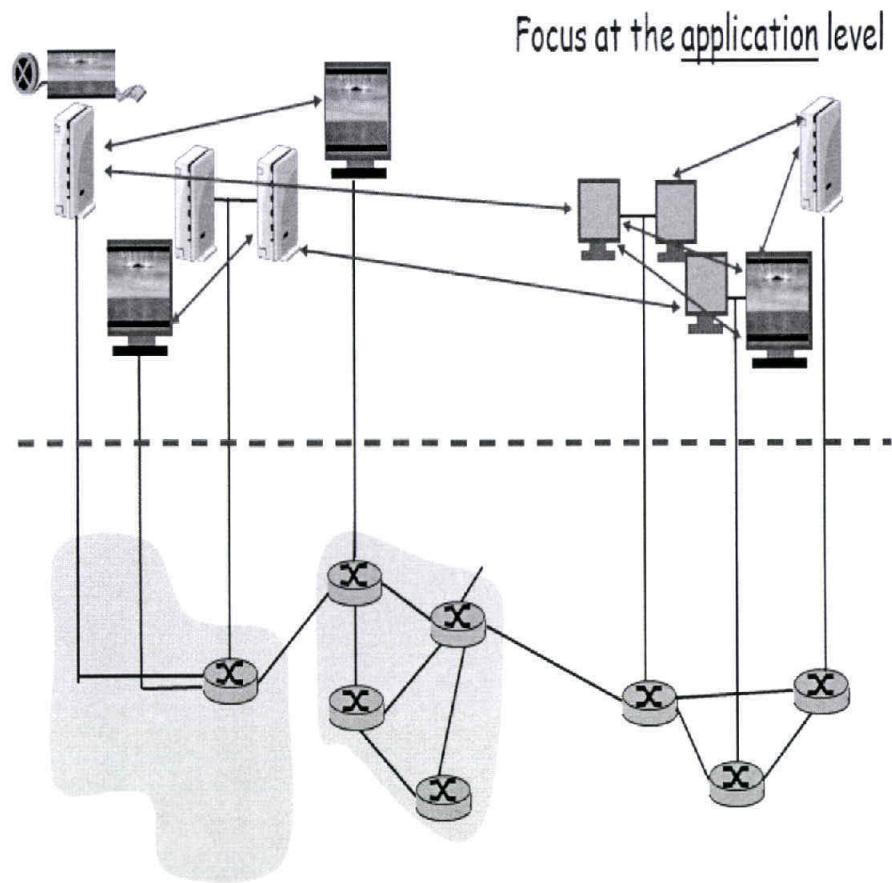
Backbone Networks

Provide Transit Service for customers
Glue that holds the Internet together

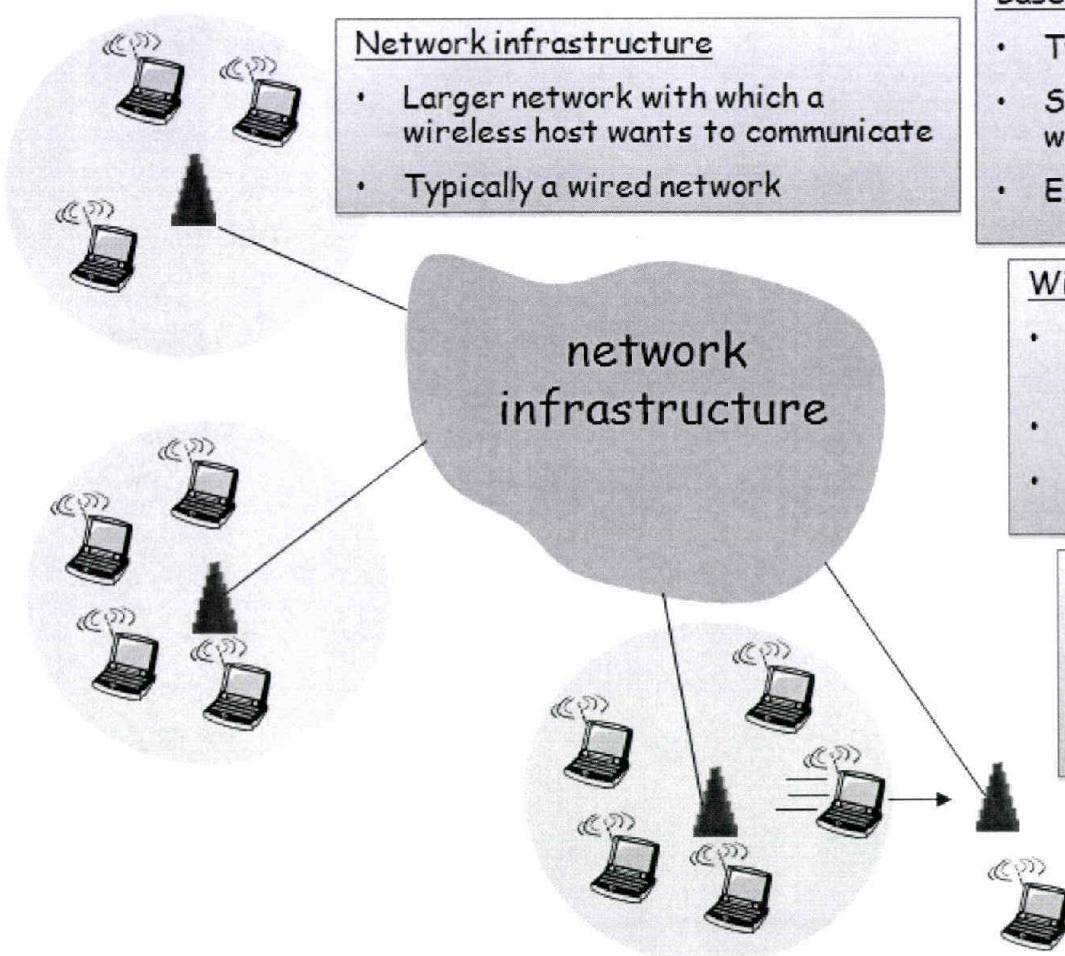


Overlay Networks

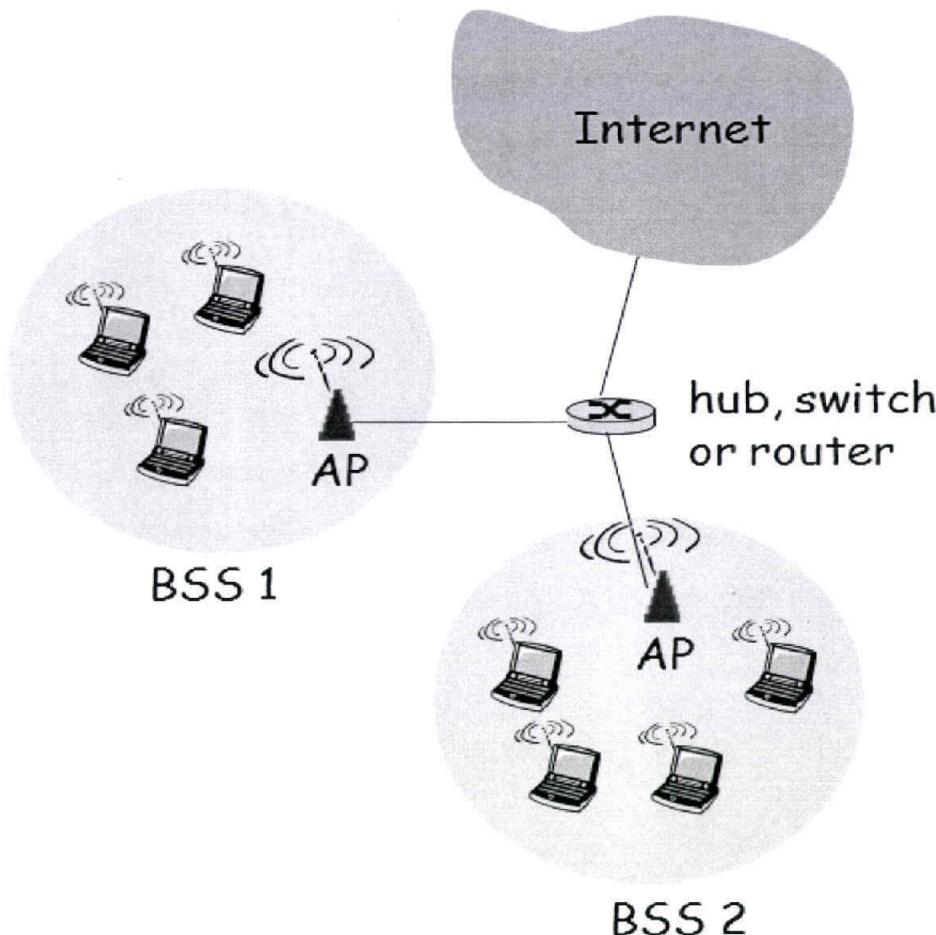
- Logical network built on top of physical network
 - Overlay link is tunnel through underlying network
- Many logical networks may coexist at once
 - Over the same underlying network
- Nodes are often end hosts
 - Acting as intermediate nodes that forward traffic
- Who controls the nodes providing service?
 - The party providing the service
 - Distributed collection of end users



Wireless Networks



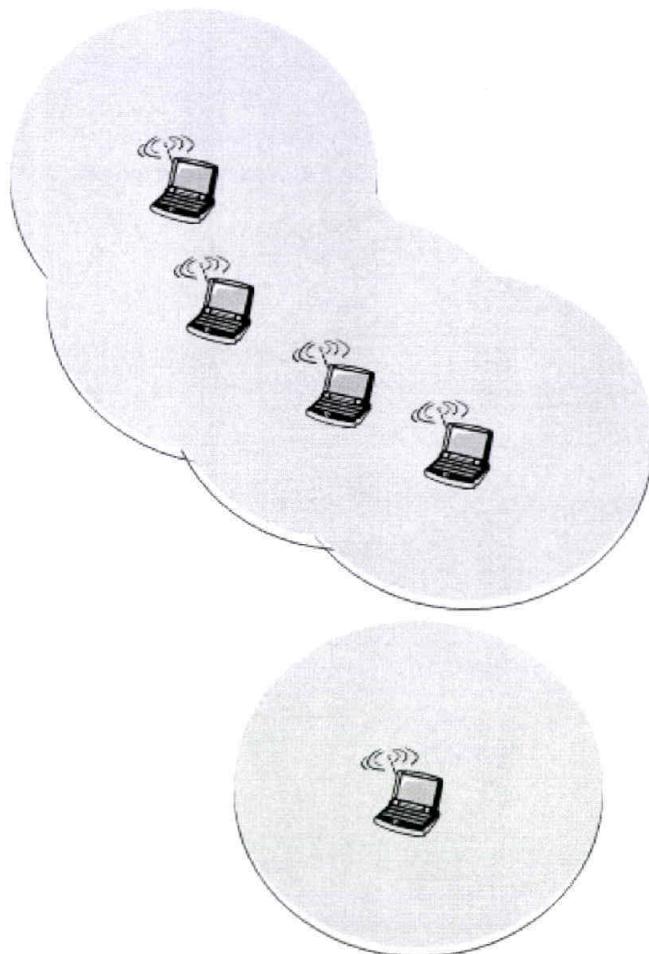
Wireless LANs (802.11)



- **Access Point (AP)**
 - Base station that communicates with the wireless hosts
- **Basic Service Set (BSS)**
 - Coverage of one AP
 - AP acts as the master
 - Identified by an “network name” known as an SSID

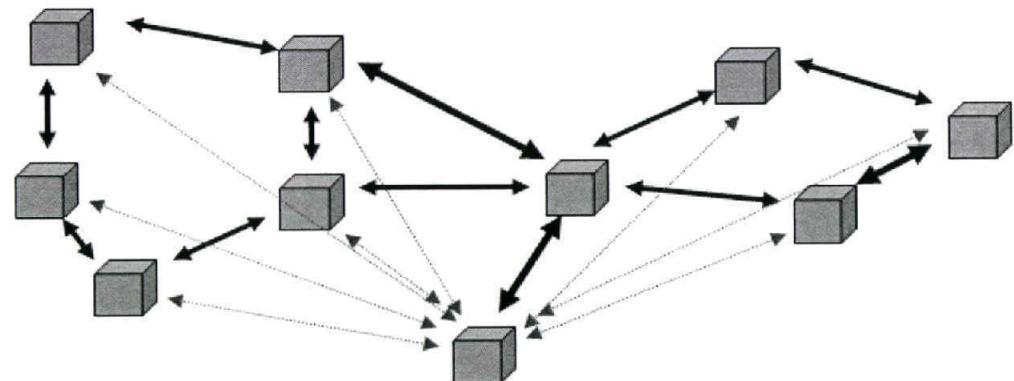
SSID: Service Set Identifier

Ad-Hoc Wireless Mesh

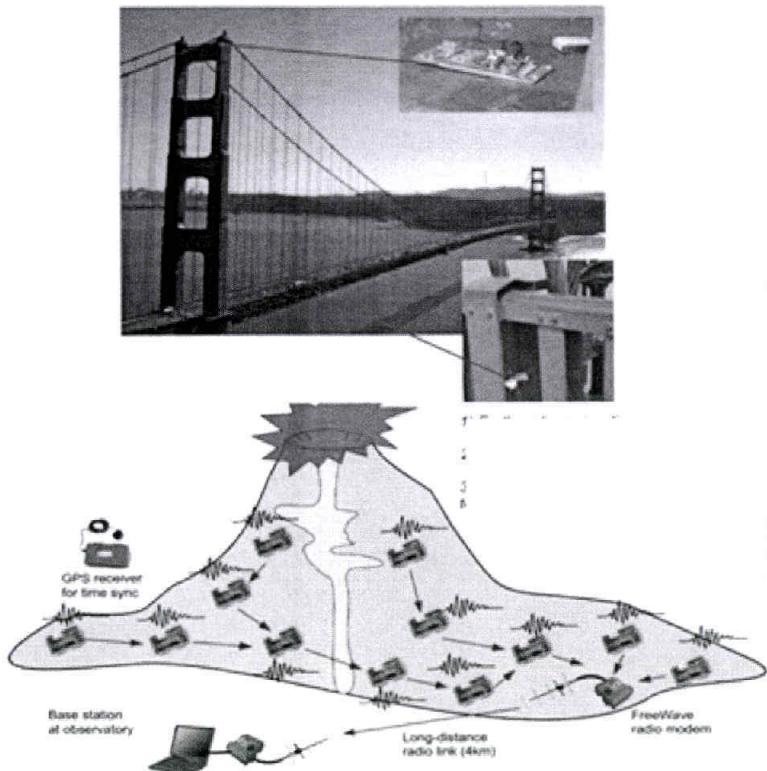


Ad hoc mode

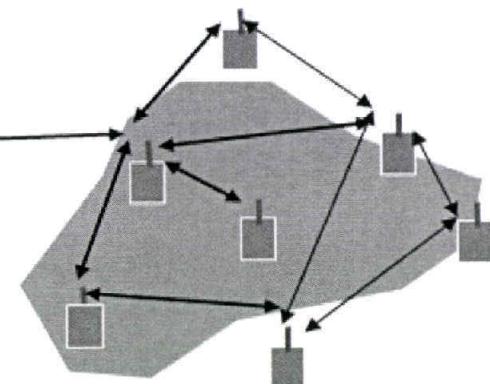
- No base stations
- Nodes can only transmit to other nodes within link coverage
- Nodes self-organize and route among themselves
- Can create multi-hop wireless networks, instead of a wired backend



Sensor Networks (EE652)

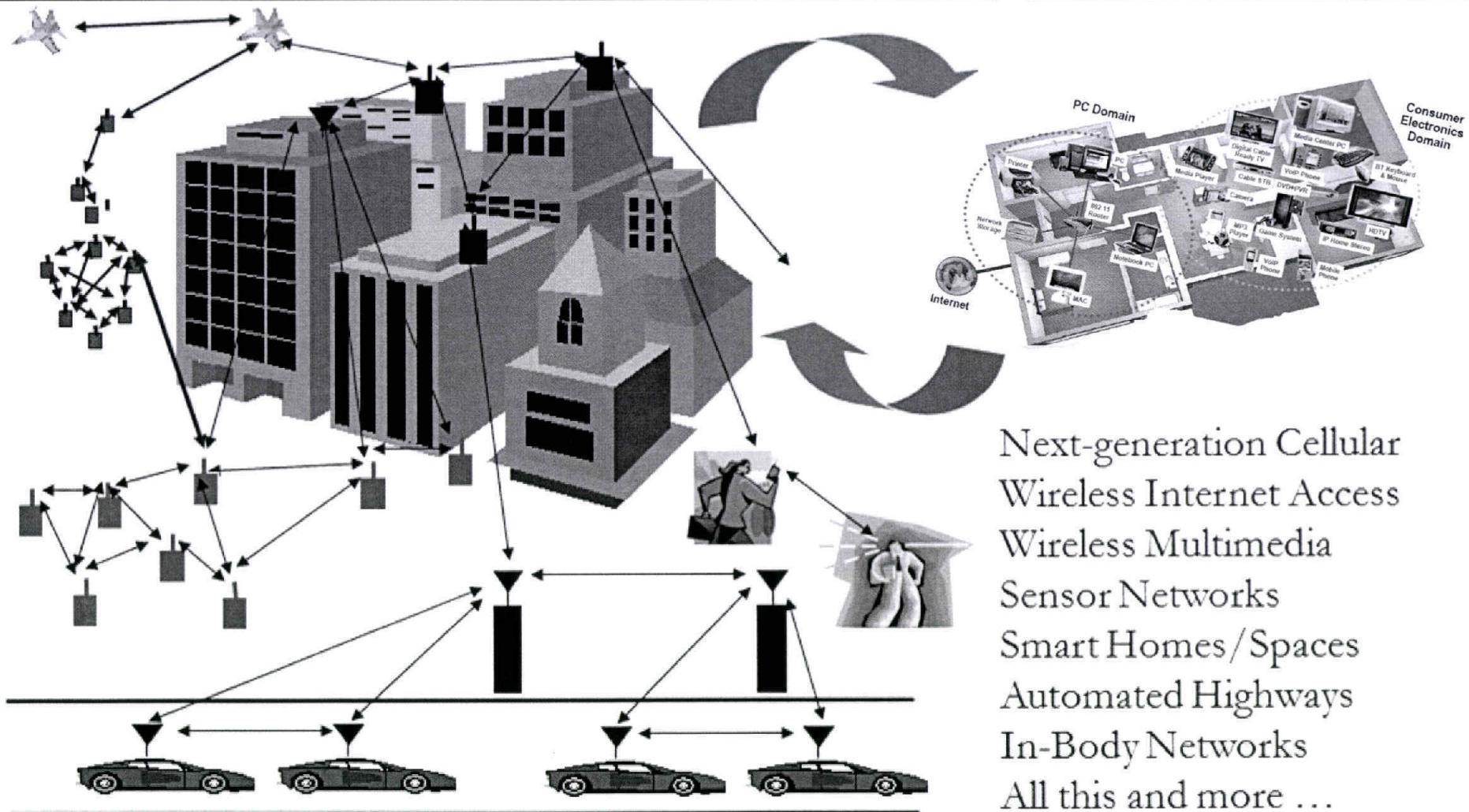


- Smart homes/buildings
- Smart structures
- Search and rescue
- Homeland security
- Event detection
- Battlefield surveillance



- Energy (transmit and processing) is driving constraint
- Data flows to centralized location
- Low per-node rates but tens to thousands of nodes
- Intelligence is in the network rather than in the device

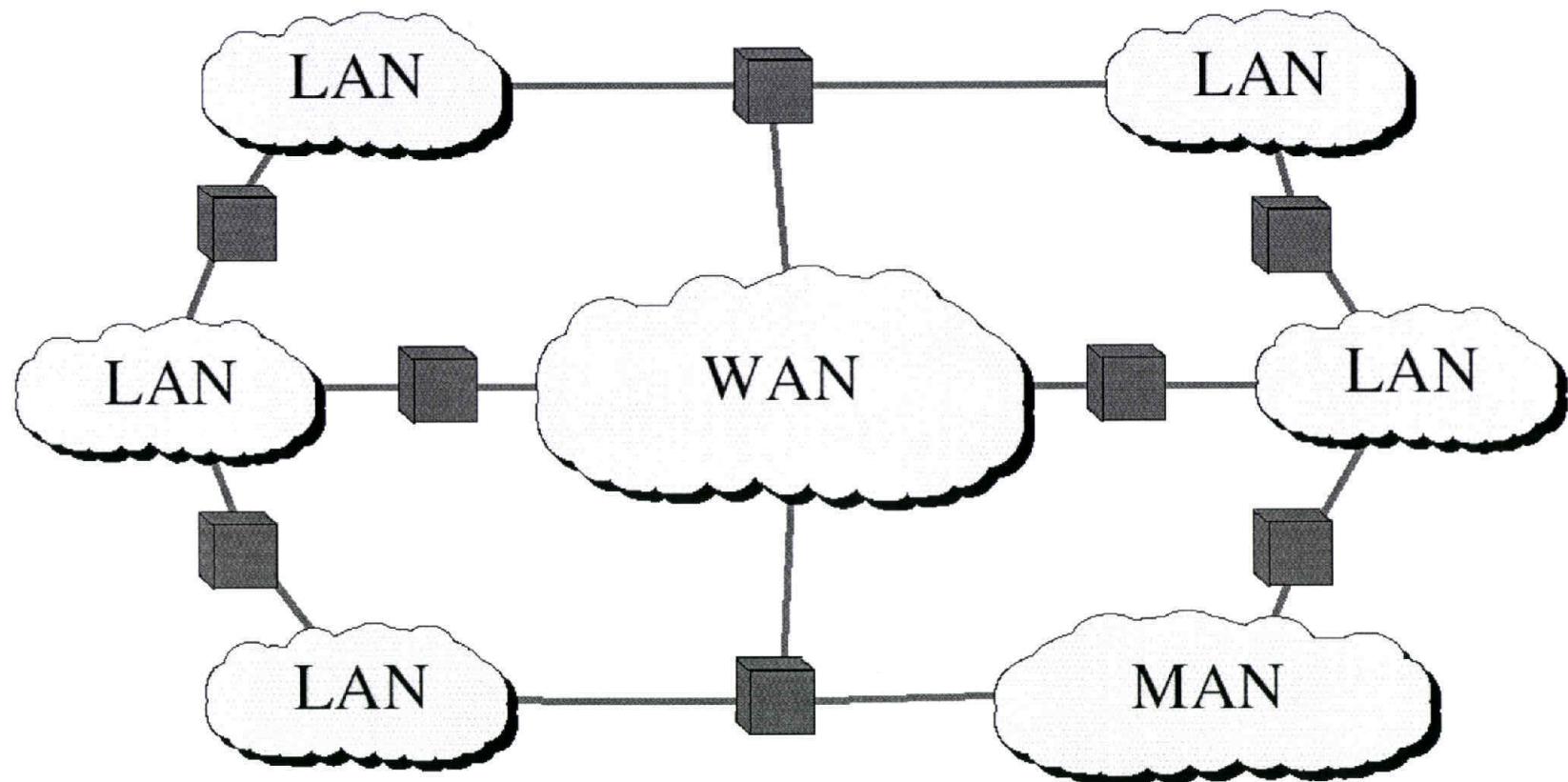
Future Wireless Networks



Ubiquitous Communication Among
People and Devices

EE450, USC, Zahid

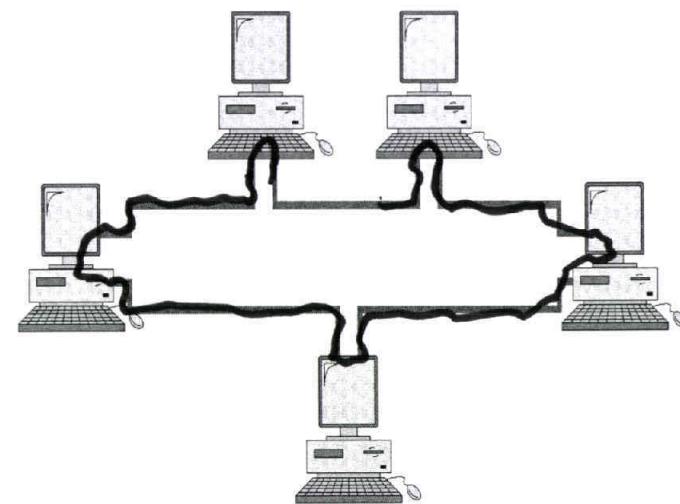
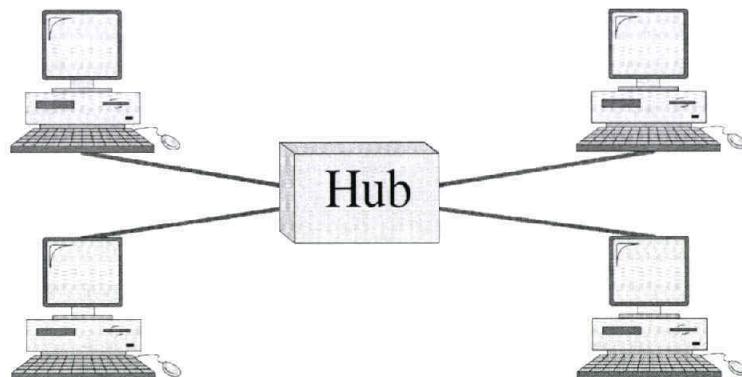
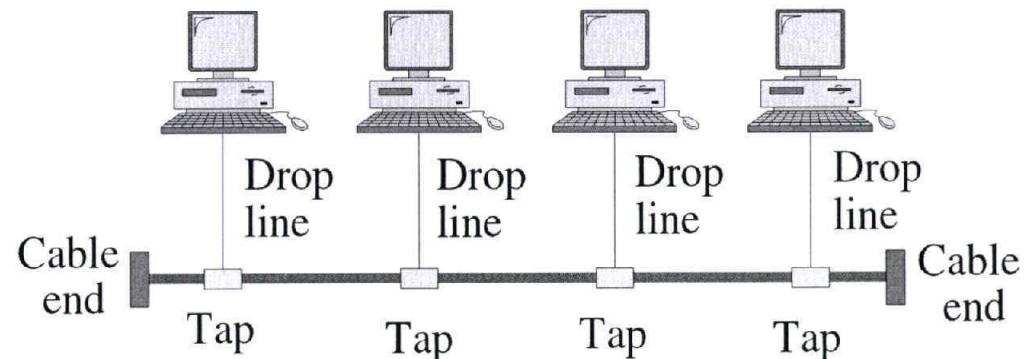
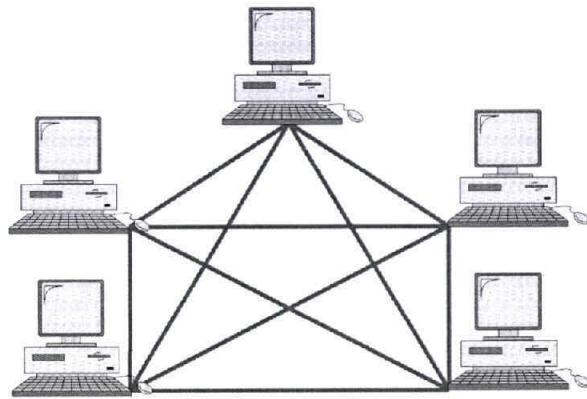
Internetworking



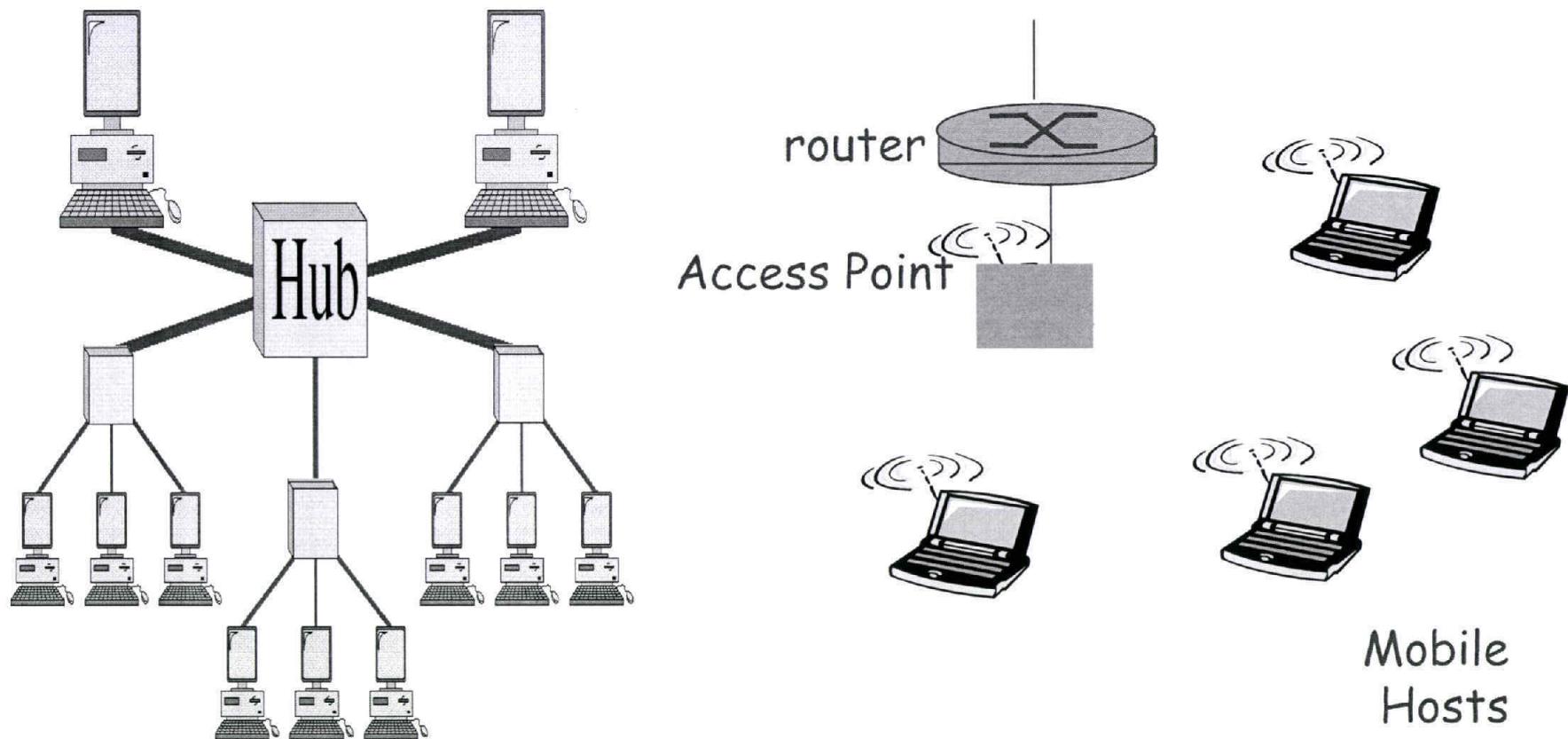
Network Topologies

- Network topology is the physical arrangement (Layout) of the network nodes and the links interconnecting them
 - Mesh topology
 - Star/Hub topology
 - Bus topology
 - Tree Topology
 - Ring topology
- A fully connected network is one in which every node is connected to every other node

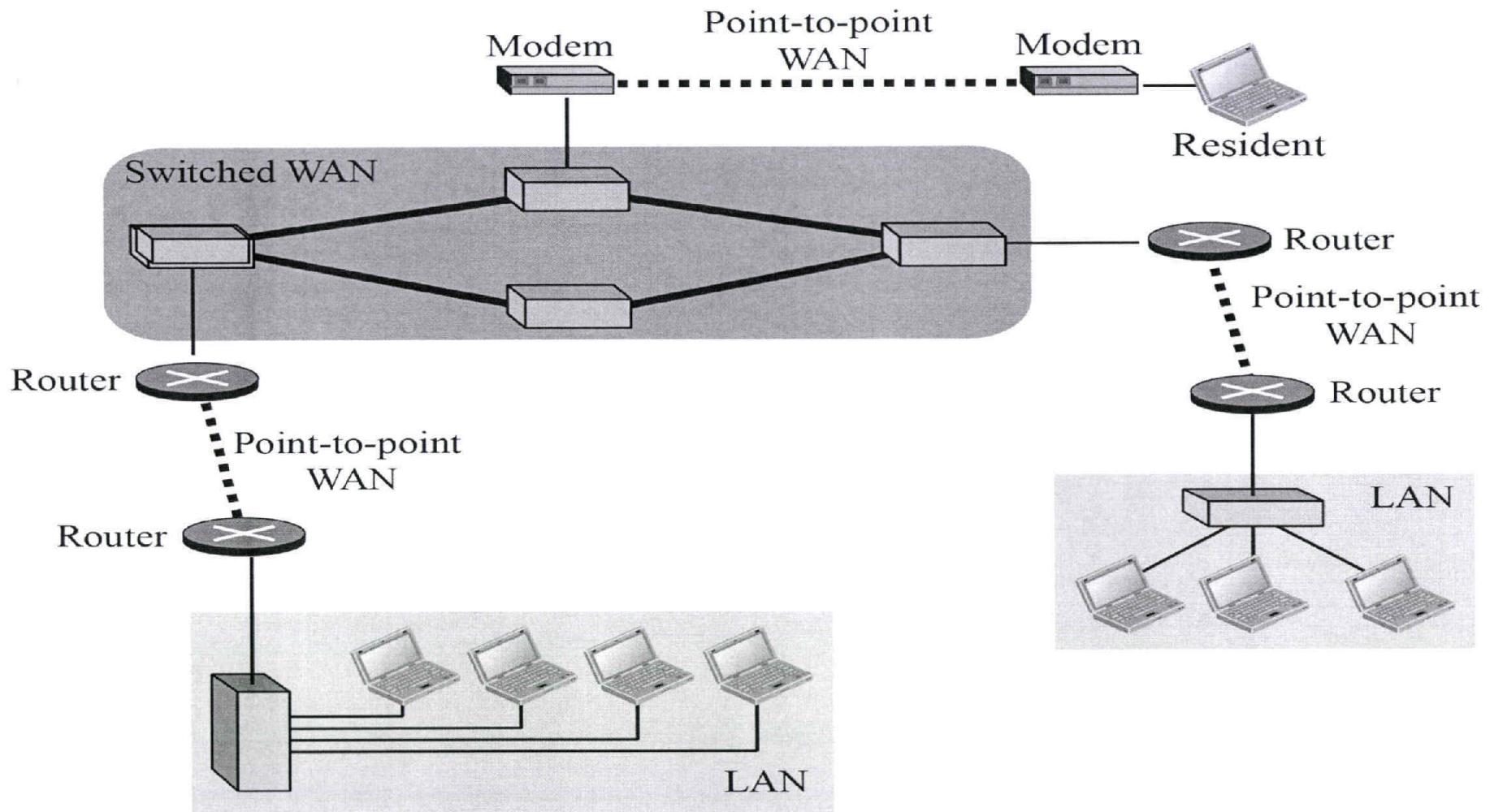
Mesh, Hub, Bus and Rings (I)



Tree and Wireless (II)



A heterogeneous Internetwork



Link Topologies

- Point-to-point

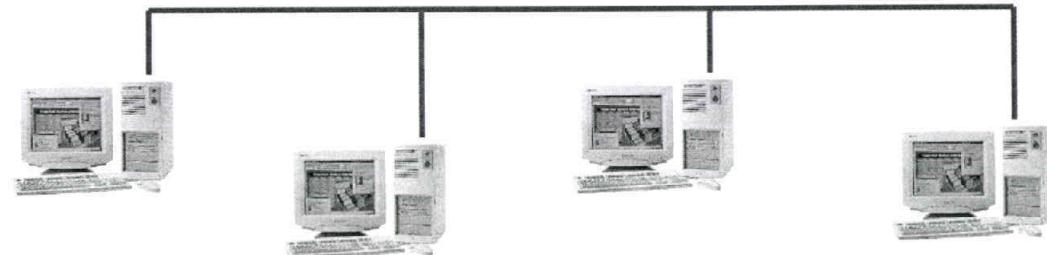
- Direct link

- Only 2 devices share link



- Multipoint

- More than two devices share the link



Link Duplicity

- Simplex

- One direction

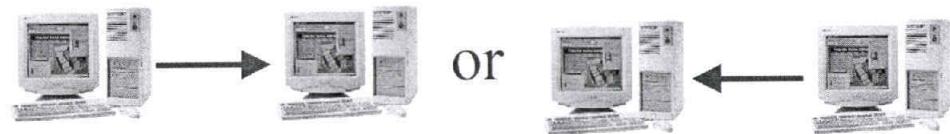


- e.g. Radio/Television broadcasting

- Half duplex (HDX)

- Either direction, but only one way at a time

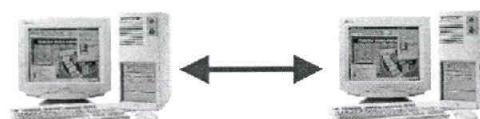
- e.g. Police radio



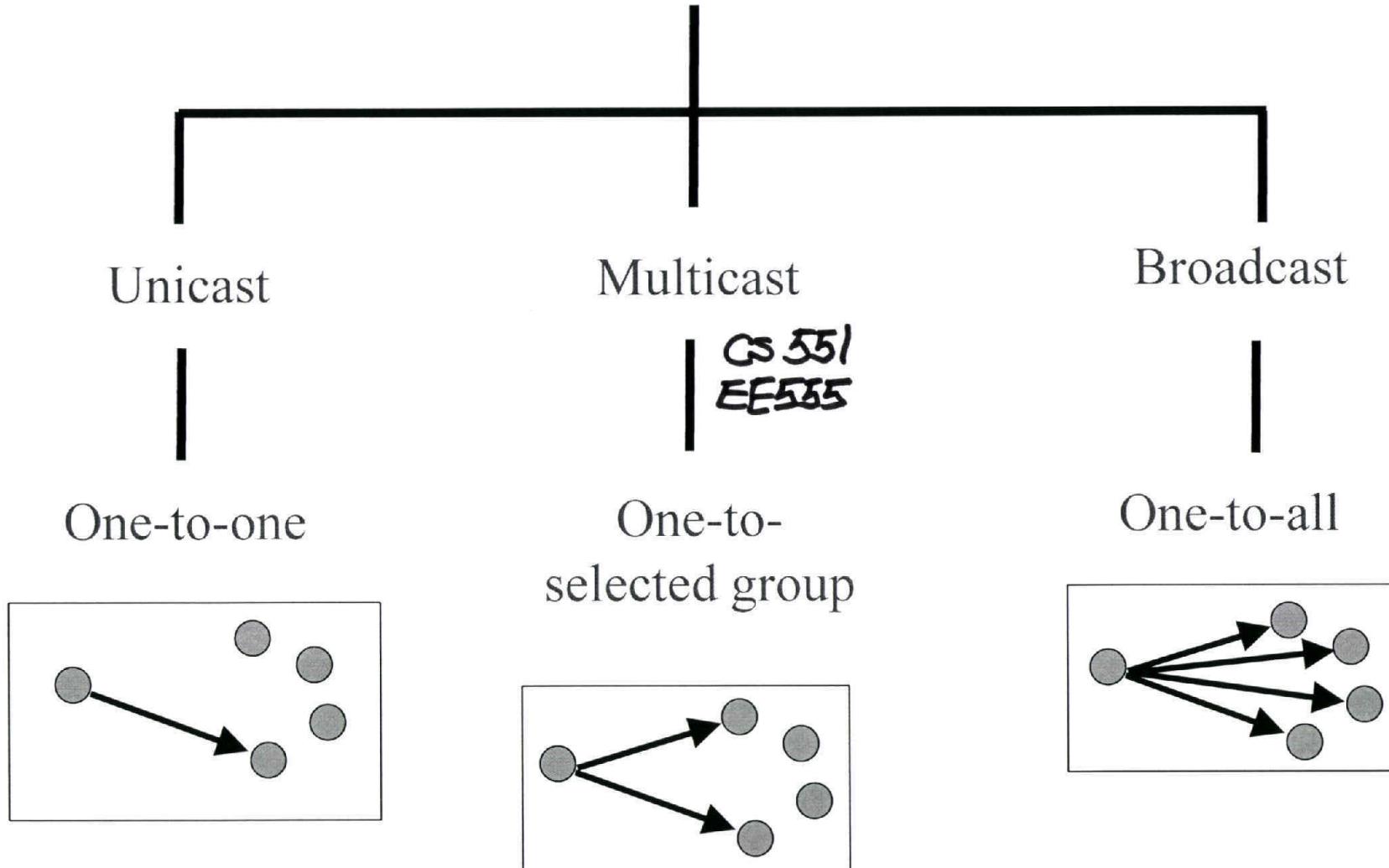
- Full duplex (FDX)

- Both directions at the same time

- e.g. Telephony



Transmission Modes



Physical Media (I): Copper

- Bit: propagates between transmitter/rcvr pairs
- Physical link: what lies between transmitter & receiver
- Guided media:
 - signals propagate in solid media: copper, fiber, coax
- Unguided media:
 - signals propagate freely, e.g., radio

Twisted Pair (TP)

- two insulated copper wires
 - Category 3: traditional phone wires, 10 Mbps Ethernet
 - Category 5/6: 100Mbps ~ 10Gbps Ethernet



Physical Media (II): Cable

Coaxial Cable:

- Two concentric copper conductors
- Bi-directional
- Baseband:
 - single channel on cable
 - legacy Ethernet
- Broadband:
 - Multiple channels on cable
 - CATV, Cable Access



Fiber Optic Cable:

- Glass fiber carrying light pulses, each pulse a bit
- High-speed operation:
 - high-speed point-to-point transmission (e.g., 10's-100's Gps)
- Low error rate: repeaters spaced far apart ; immune to electromagnetic noise



$$10^9 \sim 10^{-12}$$

Physical Media (III): Radio

- Signal carried in electromagnetic spectrum
- No physical "wire"
- Bi-directional
- Propagation environment effects:
 - Reflection
 - Obstruction by objects
 - Interference

Radio link types:

- Terrestrial Microwave
 - e.g. up to 45 Mbps channels
- WLAN (e.g., Wi-Fi)
 - 2Mbps, 11Mbps, 54 Mbps
- Wide-area (e.g., cellular)
 - e.g. 3G: few Mbps
- Satellite
 - Kbps to 45Mbps channel (or multiple smaller channels)
 - 270 msec end-end delay
 - GEO/LEO

The Internet (Wikipedia)

The Internet is the worldwide, publicly accessible network of interconnected computer networks that transmit data by packet switching using the standard Internet Protocol (IP). It is a "network of networks" that consists of millions of smaller domestic, academic, business, and government networks, which together carry various information and services, such as electronic mail, online chat, file transfer, and the interlinked Web pages and other documents of the World Wide Web.