Wireless Ad hoc Networks

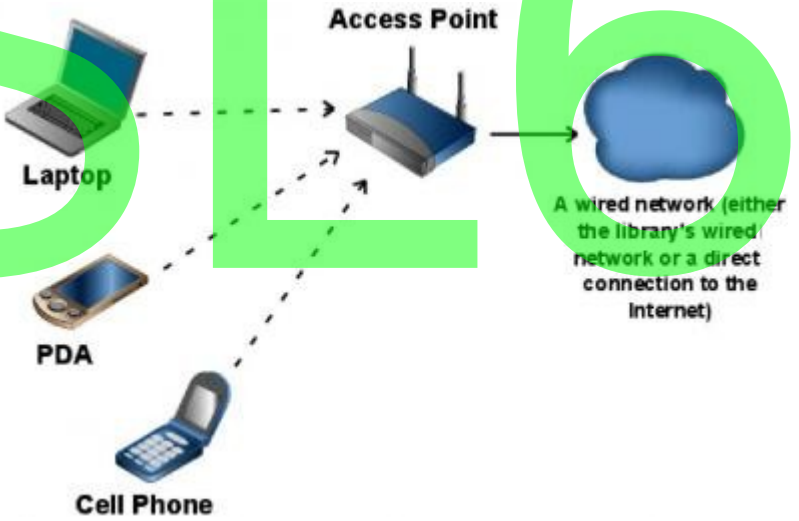
Prepared by

Sujata Pal, PhD
Assistant Professor
CSE IIT Ropar

Note: Some of the slides are directly copied from other sources.

Wireless Networks

- No cables
- Wireless access point connected to wired backbone
- Mobile nodes communicate wirelessly to base stations



Copied from http://www.techsoupforlibraries.org/planning-for-success/networking-and-security/tools/wired-for-success-a-tool-for-understanding-your-w

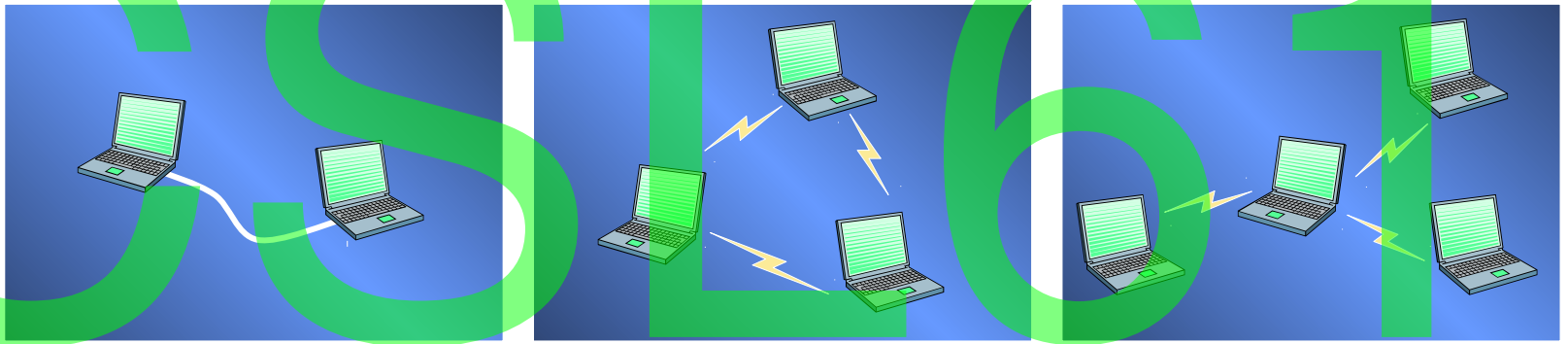
At a minimum, there are three pieces to a wireless network:

- First, there's the wireless access point. The center of a wireless network acts like the hub, or switch, of your wired network, though it also has many of the features of a standard router. On one side, it connects to the Internet, usually through a standard Ethernet cable, and on the other side, it broadcasts a wireless signal
- Also, there are "wireless devices." These are the computers and gadgets that use the access point in order to hook into your network and your Internet connection. The first wireless device that comes to mind for most people is a laptop computer. Library patrons use cell phones, smartphones, personal digital assistants (PDAs), personal gaming devices (like Playstation) and more to connect themselves to wireless networks.
- Each wireless device has a wireless network adapter — a specific piece of hardware that connects a computer to a WLAN. Wireless adapters come in all shapes and sizes. Some adapters are built into the computer. Others need to be purchased separately and then plugged into the Universal Serial Bus (USB) port or PC Card port.

Copied from http://keywordsuggest.org/gallery/41515.html

Ad hoc Networks

- Networks without pre-configured infrastructure
  - require no hubs, access points, base stations
  - are instantly deployable
  - can be wired or wireless

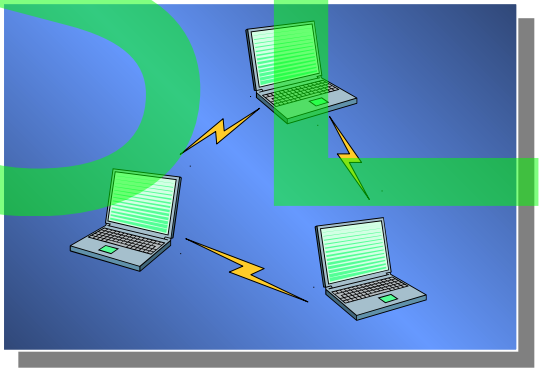


wired wireless multi-hop wireless

- Initially targeted for military and emergency applications

802.11 Ad hoc Mode

- IEEE 802.11 already provides support for ad hoc mode
- Computers can be connected without an access point
- Only work with single hop

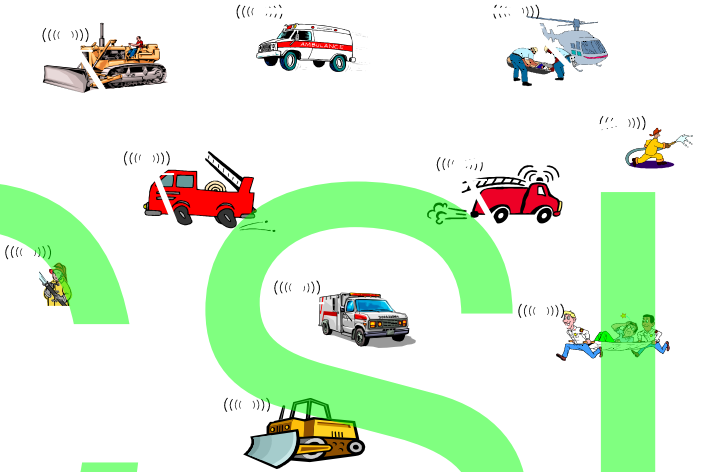


Ad hoc networking

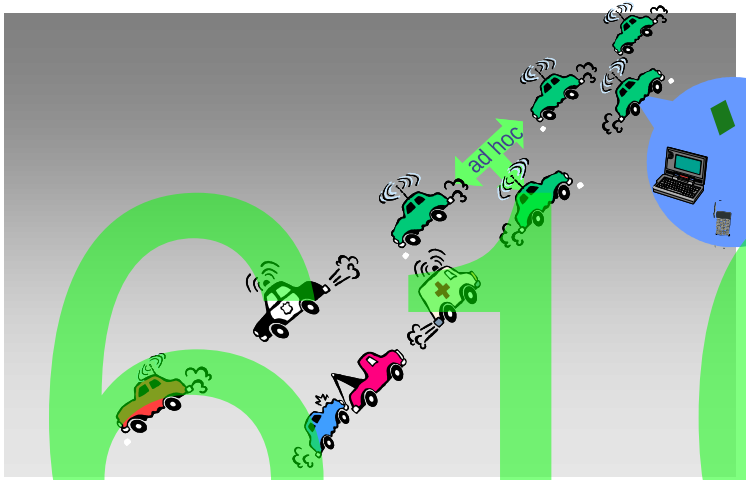
A mode of loosely connected networking characterized by the following qualities:

- lack of fixed infrastructure
- peer-to-peer (all nodes act as routers)
- multi-hop routing
- frequent connection / topology changes

Possible Applications for Ad hoc Networks



Disaster recovery



Car-to-car communication

Ad hoc networking

A mode of loosely connected networking characterized by the following qualities:

- lack of fixed infrastructure
- peer-to-peer (all nodes act as routers)
- multi-hop routing
- frequent connection / topology changes

Challenges in Ad hoc Networks

- Lack of central entity
- Limited range of wireless communication
- Mobility of participants
- Battery-operated entities

How?

Transmission Standards:

1. Piconet
2. HomeRF (Radio Frequency)
3. IEEE 802.11 Wireless LAN WG (Working Group)
4. Bluetooth SIG (Special Interest Group)
   - These above use radio waves from licence-exempt ISM (Industrial, Scientific and Medical) frequency band - around 2.4 GHz
5. IrDA (InfraRed Data Association)
   - which uses infrared instead of radio waves

Why we need Ad hoc networks?

- Microprocessor embedding trend in:

  cellular phones, car stereos, televisions, VCRs, watches, GPS (Global Positioning System) receivers, digital camera.

- Groups of computational devices used for:
  - environmental monitoring
  - personal area networks
  - geophysical measurement

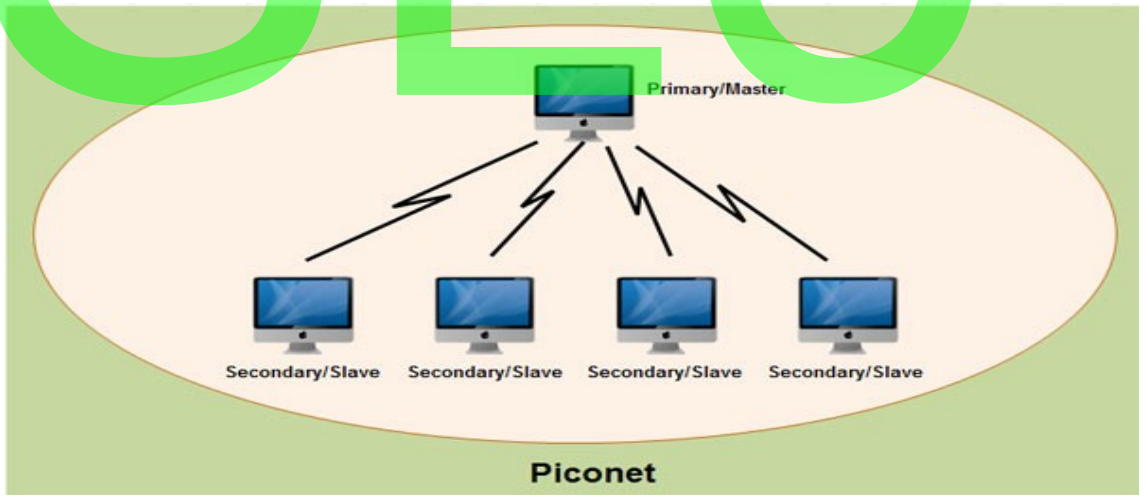
How?

Transmission Standards:

1. Piconet
2. HomeRF (Radio Frequency)
3. IEEE 802.11 Wireless LAN WG (Working Group)
4. Bluetooth SIG (Special Interest Group)
   - These above use radio waves from licence-exempt ISM (Industrial, Scientific and Medical) frequency band - around 2.4 GHz
5. IrDA (InfraRed Data Association)
   - which uses infrared instead of radio waves

Piconet

- A general purpose, low-powered, ad-hoc network
- It allows two devices near each other to inter-operate
- These devices can be either mobile or fixed
- The range is said to be reasonably short



Copied from http://ecomputernotes.com/computernetworkingnotes/communication-networks/bluetooth

HomeRF

Uses Shared Wireless Access Protocol (SWAP) system

- carries both voice and data traffic
- Inter-operate with the PSTN (Public Switched Telephone Network) and the Internet)
- the range covers typical home and yard
- Its nodes could travel within a 50-meter range of a wireless access point

Device Types

- Isochronous (I node)

  > minimum latency - telephones, etc
- Asynchronous (A node) > TCP/IP traffic
- S-node (Streaming node).

HomeRF Network Topology

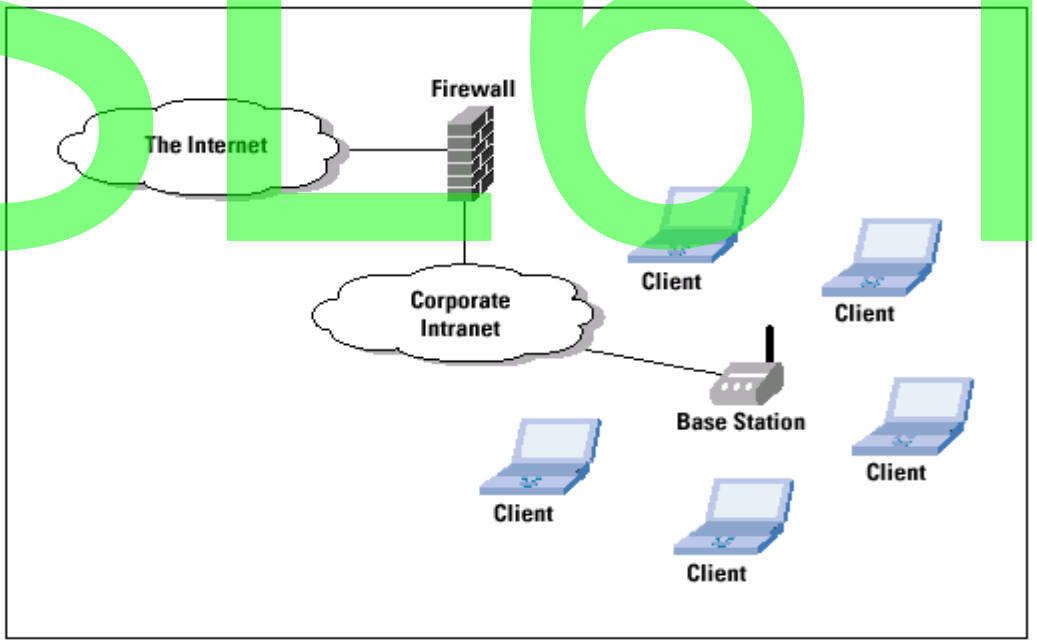
Comparing Home Networking Technologies

IEEE 802.11 Wireless LAN

The principles of Wireless Local Area Network (WLAN) are defined in IEEE 802.11 standard

- It defines two different topologies: ad-hoc network and infrastructure network
- This ad-hoc network is able to use only created wireless connection instead of fixed infrastructure

Figure 1: Typical IEEE 802.11 Configuration in Infrastructure Mode



Copied from https://www.cisco.com/c/en/us/about/press/internet-protocol-journal/back-issues/table-contents-21/ieee.html

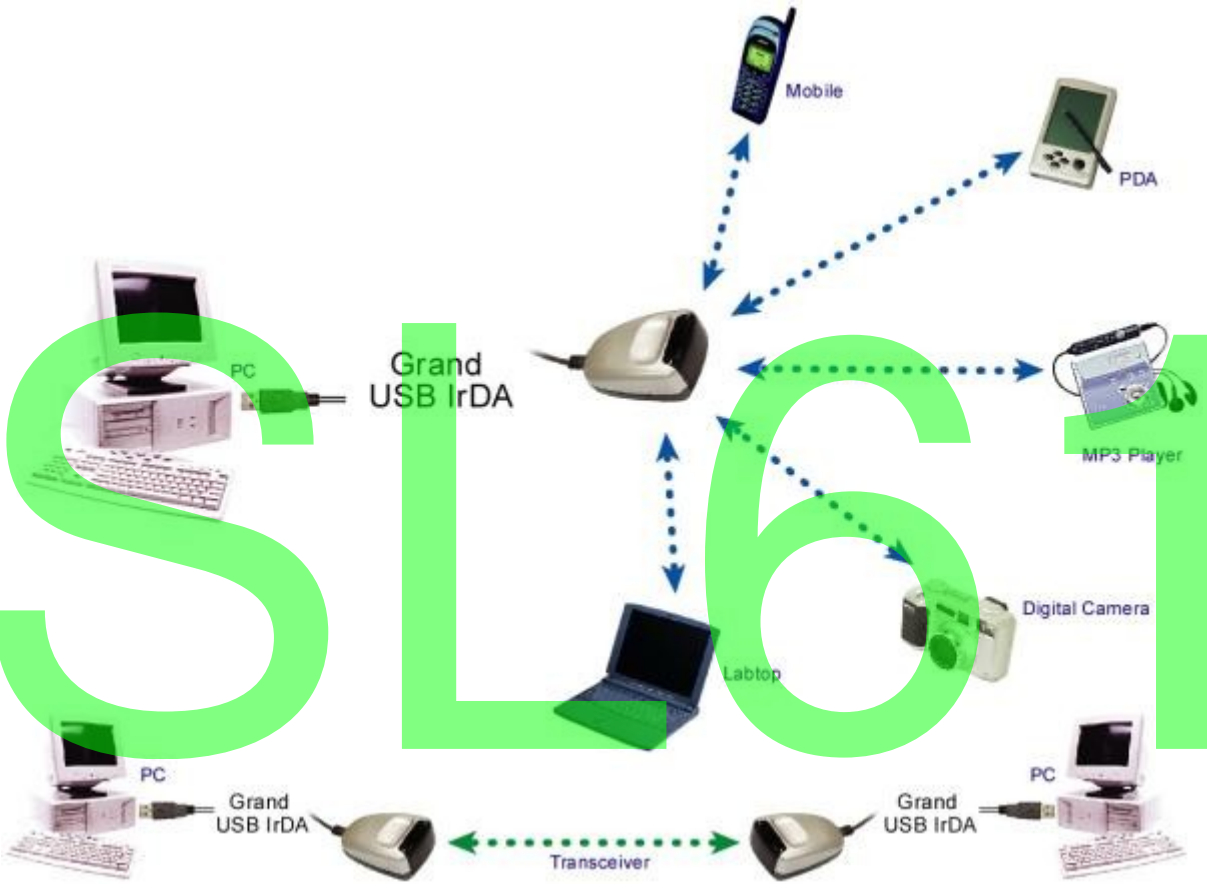
Bluetooth

- The code name for an open specification for short-range wireless connectivity
- Effortless, instant wireless connections between a wide range of communication devices in a small environment
- The BT range restricts the environment to about 10 meters

IrDA (Infrared device)

- based on technology similar to the remot control devices
- high-speed short range, point-to-point cordless data transfer
- in-room cordless peripherals to host-PC
- maturity and standardization activities advantage over radio
- line-of-sight requirement disadvantage

IrDA

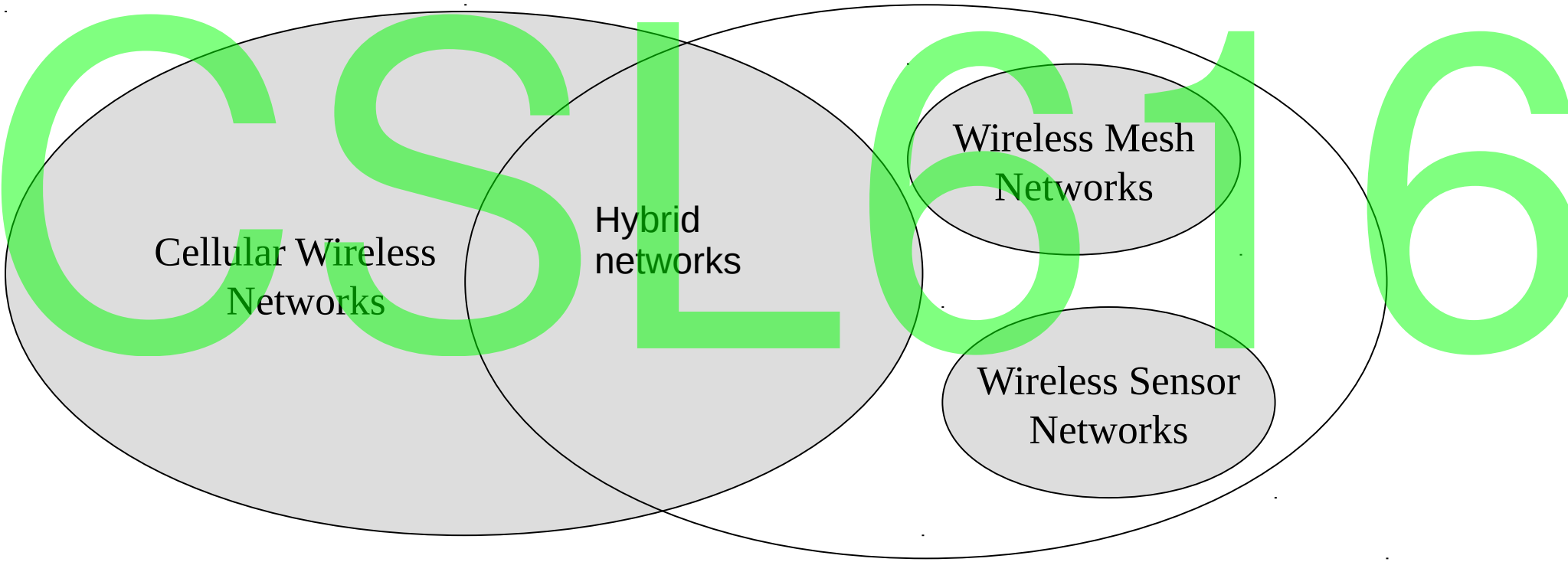

Mobile
PDA
PC
Grand
USB IrDA
MP3 Player
Digital Camera
Labtop
PC
Grand
USB IrDA
Transceiver
Grand
USB IrDA
PC

Comparison

	Bluetooth	HomeRF	IEEE 802.11	IrDA	Piconet
Range	40 feet	100 feet	100+ feet	Line of sight	Low range

Wireless ad hoc networks

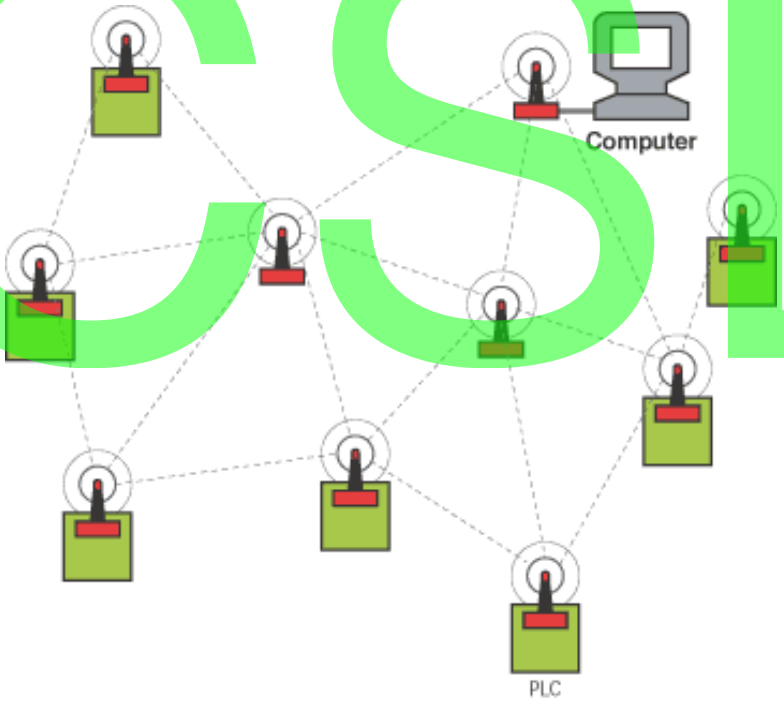
- Multi-hop relay in which messages are sent from the source to the destination by relaying through the intermediate hops (nodes).

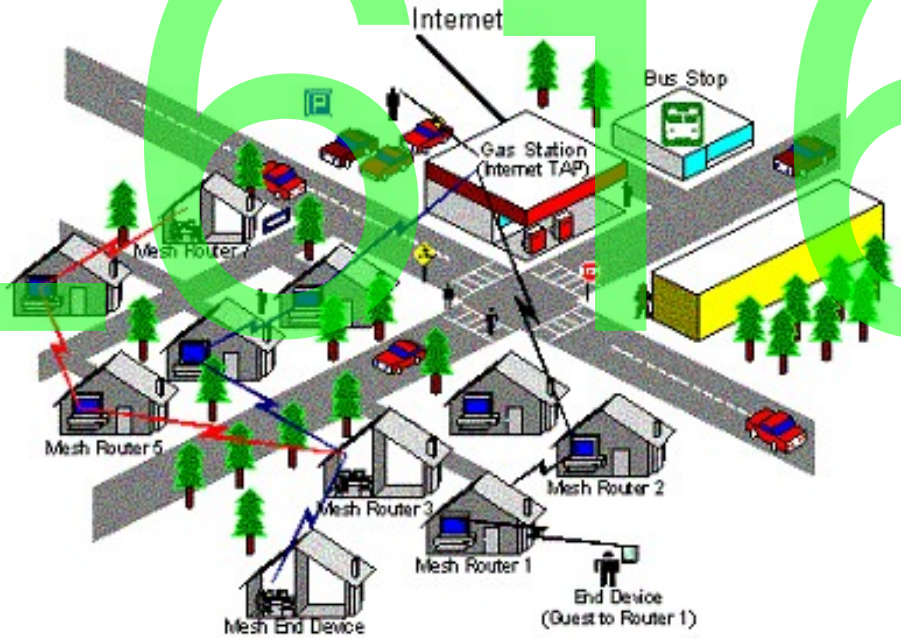


Cellular Networks	Ad Hoc Wireless Networks
Fixed infrastructure-based	Infrastructureless
Guaranteed bandwidth (designed for voice traffic)	Shared radio channel (more suitable for best-effort data traffic)
Centralized routing	Distributed routing
Circuit-switched (evolving toward packet switching)	Packet-switched (evolving toward emulation of circuit switching)
Seamless connectivity (low call drops during handoffs)	Frequent path breaks due to mobility
High cost and time of deployment	Quick and cost-effective deployment

Wireless Mesh Network

A **Wireless Mesh Network** is a mesh network that is built upon wireless communications and allows for continuous connections and reconfiguration around blocked paths by "hopping" from node to node until a connection can be established.





Wireless Mesh Networks

- The investment required in wireless mesh networks is much less than in the cellular network.
- Such networks are formed by placing wireless replaying equipment spread across the area to be covered by the network.
- The possible deployment scenarios include:
  - Residential zones (where broadband Internet connectivity is required)
  - Highways (where a communication facility for moving automobiles is required)
  - Business zones (where an alternate communication system to cellular networks is required)
  - Important civilian regions (where a high degree of service availability is required)
  - University campuses (where inexpensive campus-wide network coverage can be provided)

Wireless Mesh Networks

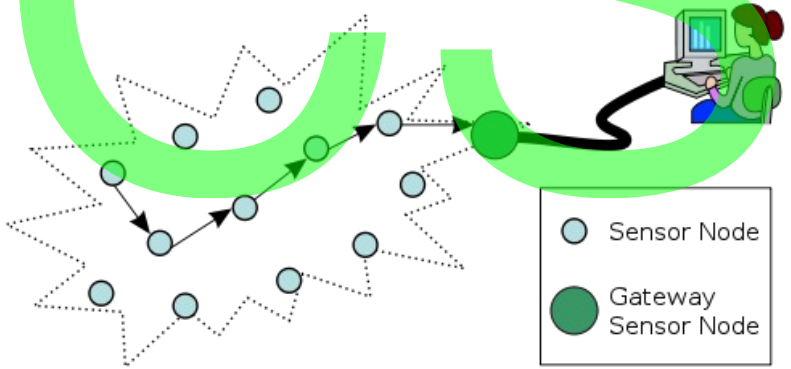
- Wireless mesh networks should be capable of self-organization and maintenance.
- Advantages
  - High data rate
  - Quick and low cost of deployment
  - Enhanced services
  - High scalability
  - Easy extendability
  - High availability
- It operates at 2.4 GHz or 5 GHz
- Data rates of 2 Mbps to 60 Mbps can be supported.

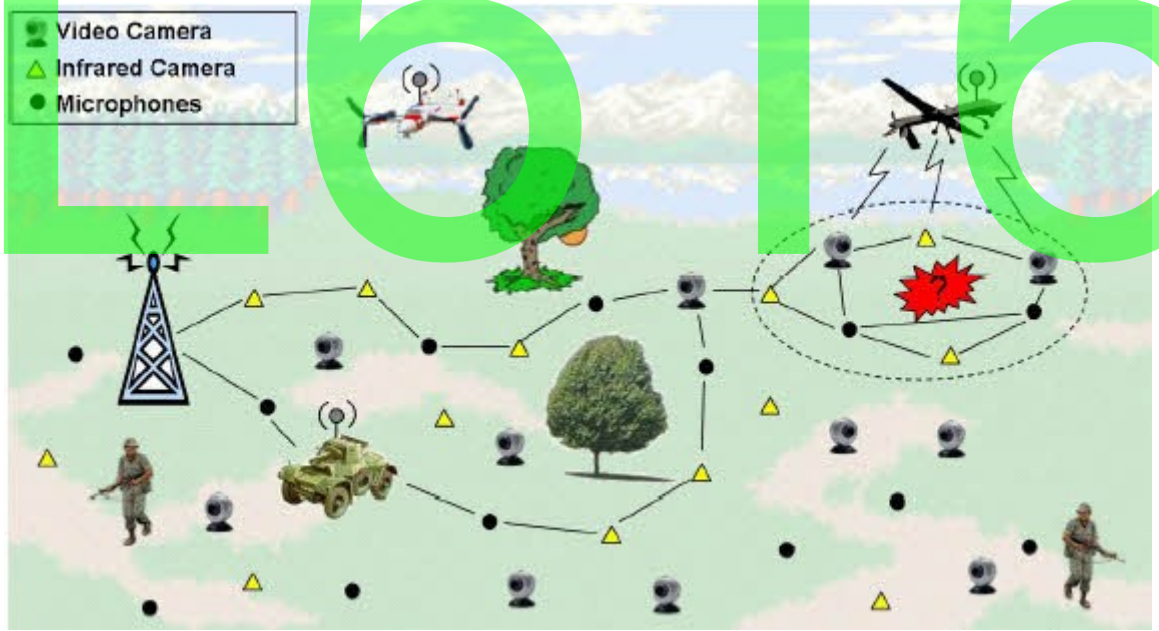
Wireless Sensor Networks

- Wireless Sensor Networks are a special category of ad hoc networks that are used to provide a wireless communication infrastructure among the sensors deployed in a specific application domain.
- A sensor network is a collection of a large number of sensor nodes that are deployed in a particular region.
- Distinct properties of wireless sensor networks:
  - Mobility of nodes are not needed in all cases in wireless sensor networks.
  - The size of the network is much larger than that in a typical ad hoc wireless network.
  - The density of nodes in a sensor network varies with the domain of application.
  - The power constraints in sensor networks are much more stringent than those in ad hoc wireless networks.

Wireless Sensor Networks

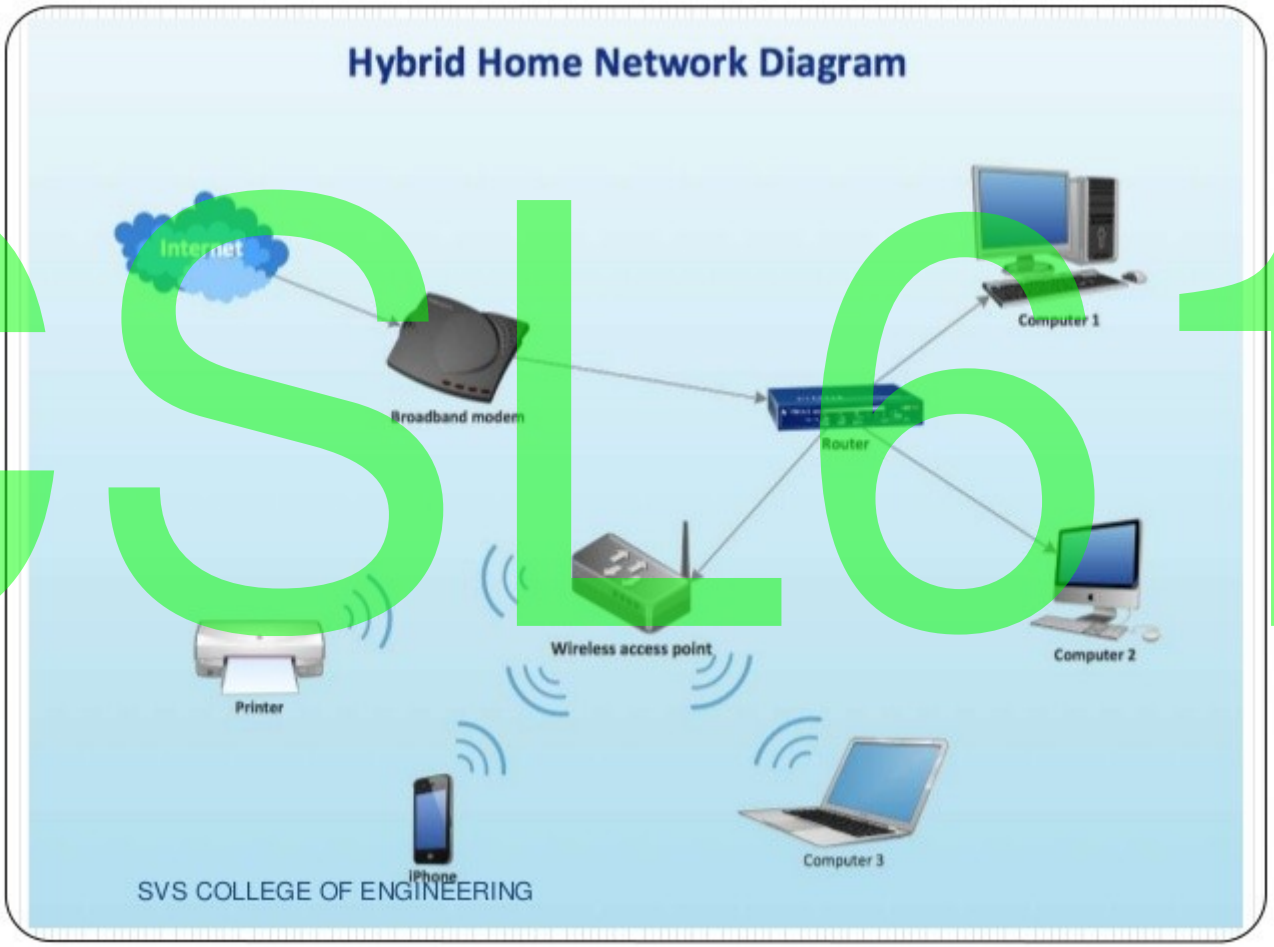
- Distinct properties of wireless sensor networks:
  - The power source can be classified into three categories:
    - Replenishable (renewable) power resource
    - Non- Replenishable power source
    - Regenerative power source
  - Data/information fusion aims at processing the sensed data at the intermediate nodes and relaying the outcome to the monitor node.





Hybrid Wireless Networks

- Hybrid Wireless Networks
  - Multi-hop cellular networks (MCNs) allows the transmission through the base stations or multi-hop of mobile nodes.
  - Integrated cellular ad hoc relay (iCAR) is a system that combines conventional cellular technology with Ad hoc Relay Station (ARS) technology. In this system cellular stations will relay or reroute calls from the congested cell to an adjacent one that is not congested.
- Advantages
  - Higher capacity than cellular networks
  - Increased flexibility and reliability in routing
  - Better coverage and connectivity


Hybrid Home Network Diagram
Internet
Broadband modem
Router
Computer 1
Computer 2
Wireless access point
Printer
IPhone
Computer 3
SVS COLLEGE OF ENGINEERING