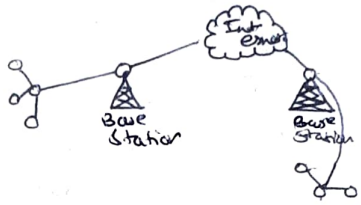
WIRELESS SENSOR NETWORK - QUICK NOTES

* Sensor : Device that measures physical quantity or quality and converts into an observable quantity.

* Wireless Sensor Networks: Sensor networks are highly distributed, lightweight nodes, deployed in large number to monitor the environment or system.
  - This combination is distributed on Adhoc manner.

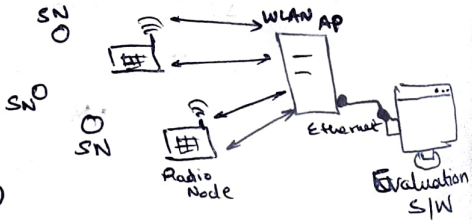
- Sensor Node → Sensor subsystem
  → Processing System
  → Communication System.



Applications:
(i) Surveillance and Monitoring in Military
(ii) Air Pressure, Temp., Humidity
(iii) Noise Level.
(iv) Patient diagnosis and Monitoring
(v) Agriculture
(vi) IoT (Internet of Things).

Challenges:
(i) Scalability → N/W Area ↑ Throughput ↓
(ii) QoS (quality of service)
(iii) Energy efficiency
(iv) Security.

Components (of WSNetwork)
(i) Sensors
(ii) Wireless Sensor Nodes or Radio Nodes.
(iii) WLAN Access Point
(iv) Evaluation Software



Components of (Wireless Sensor Node)
(i) Microcontroller → Microprocessor
  → RAM
  → Associated Peripherals
(ii) Transreceiver.
(iv) External Memory → Small in size
  → Reasonable Storage Capacity
(v) Power Source

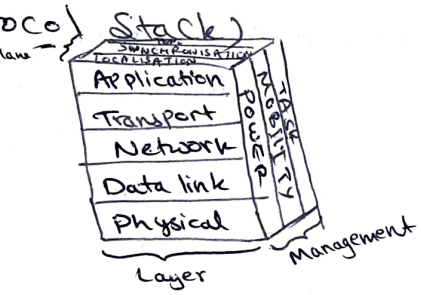
* Adhoc wireless N/W vs. Sensor N/W

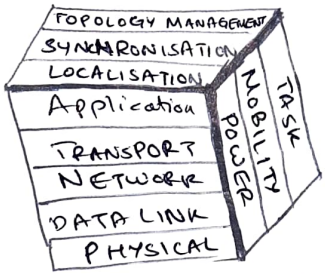
Adhoc wireless N/W	Sensor N/W
1. Comparatively less numbers of nodes.	1. Comparatively more number of nodes.
2. Less prone to failure and energy drain.	2. More prone to failure and energy drain
3. Address centric.	3. Data centric
4. Most of the adhoc N/W routing protocols cannot be implemented to sensor network.	4. Many of sensor N/W routing protocol can be implemented to adhoc N/W.

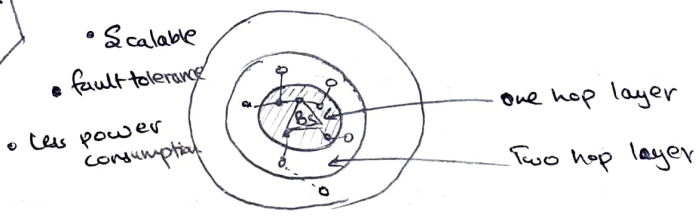
- Issues and Challenges in designing Sensor Network.
  - i) No Regular topology
  - ii) Infrastructureless
  - iii) Resource constraints → Energy, Bandwidth
  - iv) Hardward (e.g. Microcontroller) should be energy efficient
  - v) Security issue (no central tower)
  - vi) Adaptible to changing connectivity synchronisation.

* [redacted] Sensor Network Architecture.

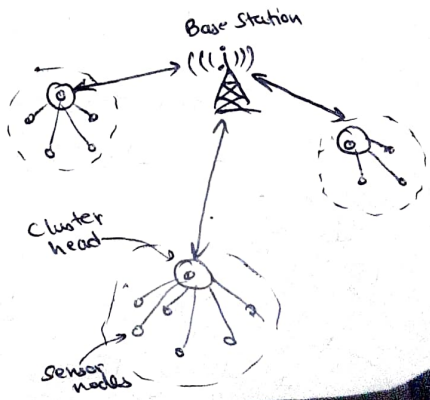
(1) Layered N/W Architecture: (Protocol Stack)
- 5 layers
- 3 cross layers







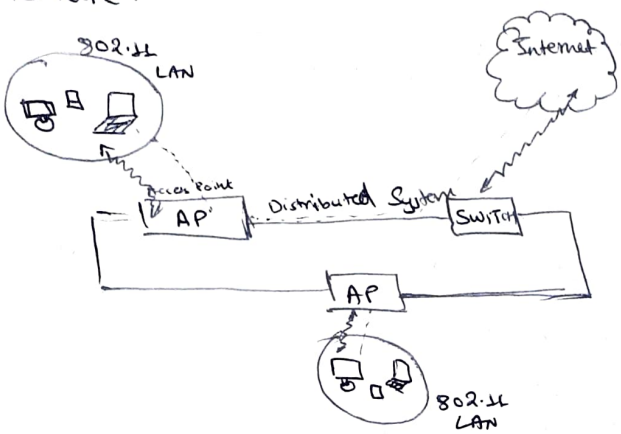
(2) Clustered N/W Architecture
- LEACH Protocol:
  - 2-tier hierarchy clustering architecture
  - distributed algo. - to organise the sensor nodes into cluster
  - Cluster head nodes create TDMA modules
  - Energy efficiency = data fusion



✱ Wireless Local Area Networks (WLANs)

- Standards: 802.11, 802.15
- Components:
  1) Access Point – Radio receiver/transmitter (Transreceiver)
  2) Wireless LAN Card. – (WLAN Adapters)
  3) BRIDGE – (used for connecting two LANs)

- Architecture:

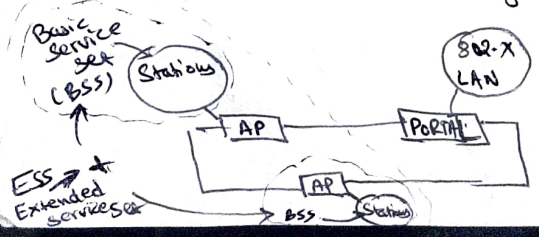


- Application:
  - Campus Wireless LAN
  - Almost automatic inventory management
  - Providing internet access to difficult to wire areas (hilly areas)
  - WLAN connectivity to geographically diversed system.
- Advantages over wired LAN:
  - Mobility : users can get into any place.
  - Simple and fast to deploy
  - flexible
  - Cost effective

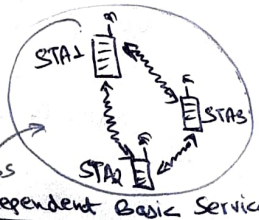
✱ IEEE 802.11

- family of WLANs.
- Standards that specifies the physical or MAC Layer adapted.
- Defines separate standard for infrastructure based and adhoc N/W.

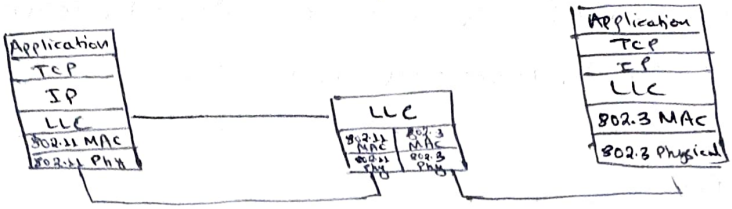
- Infrastructure-based (ESS & BSS)
  - Distribution System (DCF) Distribution Coordination Function



- Infrastructure less
  - Adhoc Network (PCF) Point coordination function



- Wireless (802.11) to Wired (802.3) data transfer/communication operation in IEEE 802.11.



* IEEE 802.15 :

- Short distance wireless n/w used for networking of portable devices such as cellphone, PDA etc.
- E.g.: Bluetooth (802.15.1), WPAN+WLAN (802.15.2) etc.
- Requirement :
  1. Power Manggement : Low Current Consumption.
  2. Range → 0 to 10 m
  3. Speed → 19.2 to 100 Kbps
  4. Size → 0.5 cubic inches without antenna.
  5. Cost → cheap.

* IEEE 802.15.4 :

- features : Lower Rate, Lower Power
- 802.15.4 → LP-WPAN (Low rate wireless personal area network)
- basis for Zigbee, WirelessHART, MiWi, 6LoWPAN etc.
  WiMAX, RFID,

* Zigbee :

- Low Cost, Low power wireless network standard.
- Used to create PAN (personal area network)
- Wireless technology based on 802.15.4 IEEE.
- Chips integrated with radios of microcontroller.
- Supported network topologies → P2P, Mesh.
- Low Duty Cycle : Long Battery life.
- Low Latency
- Encryption 128 bit.
- Bandwidth [redacted] range : 868 – 900 MHz

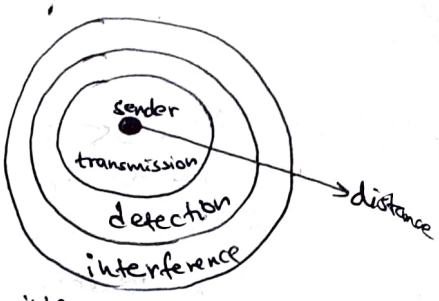
Application Layer	
Network Layer	→ Setup Routing
MAC Layer	→ CSMA (Becon frames for sync)
Physical layer	→ MODEM

* Antennas:

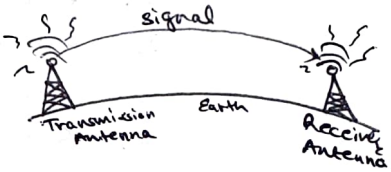
- Electrical conductor to send/receive Radio frequency (RF) signal
- Transmission Antenna and Reception Antenna.
- Omnidirectional Antenna and Directional Antenna

* Propogation:

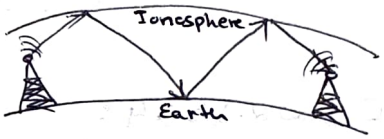
- Signal Propagation Ranges:
  - Transmission range: comm possible, low error rate
  - Detection range: comm not possible, signal detection possible
  - Interference range: signal detection not possible, signal adds to background noise.



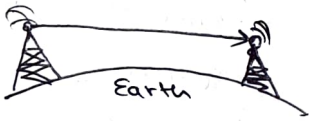
- Signal Propagation modes:
  1. Ground Wave Propagation



  2. Sky Wave Propagation



  3. Line of Sight (LOS) Propagation



- Signal Propagation: Receiving power influenced/affected by:
  1) fading (frequency dependent)
  2) Shadowing
  3) Refraction (depending on density of medium)
  4) Reflection (at large obstacle)
  5) Scattering (at small obstacles)
  6) Diffraction (at edges like hills)

- Five basic propagation mechanisms:
  1. Free-space propagation
  2. Transmission (Refraction) through medium
  3. Reflection
  4. Diffraction
  5. Scattering

* Free Path Loss: $L_{dB} = 20\log(f) + 20\log(d) - 147.56\,dB$

- Two Ray Model Path Loss: $P_r = P_t P_o \left(\frac{d_o}{d}\right)^{\alpha}$

where,
α → Pathloss exponent
d_o → 1 m
P_o → Received Power at d_o

Modulation:

1. Digital Modulation: • Digital data translated into Analog Signal.
   • ASK, FSK, PSK
2. Analog Modulation: • Transferring low frequency analog baseband signal over higher frequency signal like RF (Radio frequency) band.

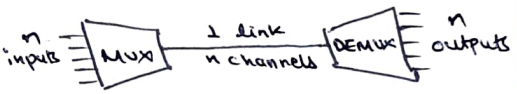
• Basic Schemes: 1. Amplitude Modulation (AM)
2. Frequency Modulation (FM)
3. Phase Modulation (PM)

Digital Modulation (Digital to Analog Signal) Encoding Technique:

1. ASK (Amplitude-Shift keying)
2. FSK (Frequency-Shift keying)
3. PSK (Phase-shift keying)
4. Many other advanced variants

} See Assignment.

Multiplexing: Carrying multiple signals on a single medium



• 4 Dimensions: (i) Space (ii) time
(iii) Frequency (iv) Code

• Types: 1. Frequency Multiplexing
2. Time Multiplexing
3. Time & Frequency Multiplexing
4. Code Multiplex
5. Orthogonal Frequency Division Multiplexing (OFDM)

Channel correction mechanism →

Spread Spectrum → Direct Sequence Spread spectrum (DSSS)
Frequency Hopping Spread spectrum (FHSS)

Channel Correction Mechanism: Forward Error Correction: 1) Bit level Error detection/correction
↳ Parity Check
↳ CRC
↳ Checksum

2) ARQ (Automatic Repeat Request)
↳ Stop and Wait ARQ
↳ Go-Back-N ARQ
↳ HYBRID ARQ