Chapter 1

1.1 Introduction to WSN

A Wireless Sensor Network (WSN) is a remote network comprising of spatially appropriated self-ruling devices utilizing sensors to agreeably monitor physical or ecological conditions for example temperature, sound, vibration, weight, motion or contaminations, at diverse location. A WSN is a gathering of extensive number battery powered, ease detecting devices, normally known as sensors shown in figure 1.1, which work together to perform some disseminated sensing undertaking in a domain. These sensors have detecting types of gear, central preparing unit, power supply unit and radio transceiver to correspond with different sensors. A sensor node detects an occasion or measures an encompassing state of the earth (Ex, temperature, pressure, moistness). The situational condition information is gathered and is transmitted to a remote Base Station (BS) that makes fast endearing of the information from the remote situational condition.

Figure 1.1: Sensor node communication

In spite of the fact that individual sensors can do very small work of their undertaking, substantial number of sensors can be facilitated into a sorted out network to perform a major detecting assignment. Sensors are typically battery controlled and when conveyed they stay in the branch of knowledge unattended for long time. Battery power reduced below its threshold than battery can barely be revived or supplanted because sensors are placed in remote places. So sensors are conceived obliged by energy source. To point of confinement energy, they do not transmit signal to a distant placed sensors to access a remote sink, rather they frame a multihop correspondence situation with their short range radio types of node, transmitting information every time to the prompt neighbors and in this manner melding it into the whole network. WSN innovation is
characterized by IEEE 802.15.4 wireless innovation which is a short extend correspondence framework planned to give applications throughput and idleness necessities in WPAN. The key components of IEEE802.15.4 remote innovation are to be less complex, minimal effort, low power utilization, low information rate transmissions, to be upheld by low cost that are fixed or moving devices. The primary field of use of this innovation is the usage of WSN’s. The 802.15.4 physical layer works in three diverse unlicensed groups (and with distinctive modalities) as per the topographical territory where the deployment of system is done. IEEE 802.15.4 determines a sum of 27 half-duplex channels over the three frequency bands. IEEE 802.15.4 MAC layer uses a protocol in view of the CSMA calculation, which obliges listening to the channel before transmitting to lessen the likelihood of impacts with other progressing transmissions. IEEE 802.15.4 characterizes two diverse operational modes, that are beacon and non beacon enabled, which relate to two distinctive channel access components.

1.2 WSN Architecture

The principle parts of remote sensor network are given underneath and figure 1.2 showing individual components of sensor network.

![Figure 1.2: WSN architecture](image)

**Sensing Unit**

The sensing unit contains principle part of the node. It will have the application particular sensor. In the event that of the application such as sensing temperature,
moisture detection, medical appliance etc, so as to sense the data and further sending the data to processing unit.

**Processing Unit**

The processing unit will collect raw data from individual sensor node with different measuring parameters for different applications then that data is processed into readable data so as to convert into a form that can be received by neighboring node or BS, basically the assimilation and dissemination of data takes place.

**Transceiver Unit**

The transceiver unit is used for wired and wireless transmission, where in wired transceiver unit will transmit data through wire as electrical voltage. In wireless communication the transceiver will send and receive the data through radio waves.

**Power Unit**

The Power unit offers life to the sensor node. This unit suits a battery, usually with rechargeable choice. Progression in force unit can prompt sunlight based charging. A long life power reinforcement with clever force mindful, which empowers reviving naturally by sunlight based furthermore with ordinary electrical plug is been provided. This will empower the use of sensor network in a colossal application.

**Network Channels**

Network channels can be wired and wireless channels. When it is wireless channel then microwave frequency is used for communication, when it is wired the internet media is used for communication.

**Sensor Channels**

The sensor channels are a communication channel among the sensor nodes (Monitor prompt environment), target nodes (Generates different boosts for sensor nodes) and user nodes (Client and administration of sensor networks). The characteristics of this channel will be very different from network channel with respect to bandwidth, latency, delay.
1.3 Protocols layers of WSN

The protocol stack for WSN consists of five protocol layers as shown in figure 1.3.

![WSN protocol layer stack](image)

**Figure 1.3: WSN protocol layer stack**

**Physical Layer**

The physical layer is in charge of changing over bit streams from the data link layer to flags that are suitable for transmission over the correspondence medium. For this reason, it must manage different related issues, for instance, transmission medium, frequency choice, signal modulation, signal discovery, information encryption, it should likewise manage the configuration of the fundamental equipment, different electrical and mechanical interfaces.

**Data Link Layer**

The data link layer handles information stream multiplexing, information frame creation and recognition, medium access, error control with a specific end goal to give solid point to direct and indicate multipoint transmissions. A standout amongst most imperative elements of the data link layer is Medium Access Control (MAC). The essential goal of MAC is to productively share the common correspondence assets or medium among various sensor nodes with a specific end goal to accomplish great system execution as far as energy utilization, network throughput and delivery latency.

**Network Layer**

The network layer is responsible for routing the information detected by source sensor nodes to the information sink. Since sensor nodes are thickly conveyed and neighbor nodes are near one another, it is conceivable to utilize multihop short range correspondence in sensor systems. For this situation, to send the detected information to
the sink, a source node must utilize a routing protocol to choose energy productive multihop way from the node itself to the sink.

**Transport Layer**

Transport layer does reliable end to end information conveyance between sensor nodes and the sink due to energy, calculation and capacity requirements of sensor nodes, conventional transport protocols cannot be connected specifically to sensor systems without adjustment.

**Application Layer**

Application layer performs query dissemination, node restriction, time synchronization and system security. For instance, the Sensor Management Protocol (SMP) is an application layer administration protocol that gives programming operations to perform many tasks like exchange of area related information, synchronizing sensor nodes, moving sensor nodes and detection of status of every node.

**Power Management Plane**

Manages how a sensor node uses its power. It is responsible for managing power level of sensor nodes for processing, sensing and communication. For example, the sensor node may turn off its receiver after receiving a message from one of its neighbors. This is to avoid getting duplicated messages.

**Connection Management Plane**

It is responsible for configuration or reconfiguration of sensor nodes in attempt to establish or maintain network connectivity.

**Task Management Plane**

It is responsible for distribution of tasks among sensor nodes to prolong network lifetime and improve energy efficiency, balances and schedules the sensing tasks given to a specific region.

### 1.4 Network characteristics of WSN

When contrasted with the conventional wireless communication networks with (MANET) and cell networks. WSN have the accompanying interesting attributes and limitations.

**Network Structure**

A sensor network can be non various leveled or level as every sensor has the same part and usefulness. Such progressive networks are regularly grouped and situated in which cluster heads have a more conspicuous part than others.
**Self Configurable**

Vast or small number of nodes per unit area should be with application dependent or different node patterns like circular, square, triangular placement and be applicable for efficient communication per unit area in the network. Usually sensor nodes deployed in a network with multicast routing involved, over a period of time, any node failure due to energy does not affect the network function as sensor nodes are generally self configurable and arrange themselves into a correspondence network.

**Topology Change**

WSN encourages different types of network topology and network topology changes habitually because of the node failure, harm, expansion, vitality exhaustion or channel blurring. Basic topologies that presently exist are tree, star, circular, square, hexagonal.

**Quality of Service**

Quality of service guarantee in WSN is difficult and more challenging due to the fact that resources available of sensors and the various applications running over these networks have different constraints in their nature and requirements. The basic parameters of QOS for WSN that are considered are delay, jitter, bandwidth, energy and lifetime.

**Lifetime**

Since the sensor nodes have constrained capacity in force, processing and communication, amplifying network lifetime is surely a standout amongst the most vital outline targets for all the sensor networks that need to keep running for quite a long while. Network lifetime has been characterized in different ways. In the least difficult case, a network may be viewed as alive when any of the sensors is alive. Network lifetime can likewise be calculated as the span of time when the rate of sensors that have exhausted their energy is underneath a limit. Current topology control instruments utilize the accompanying systems to minimize energy utilization, for example, minimizing correspondence power, diminishing message trade overhead and lessening state support cost.

**Maintainability**

The WSN is always continuously monitored and maintained, because each individual node is energy vulnerable. When network functions, then each individual node energy decreases, hence it is required to maintain nodes in this network, where routing path and packet delivery are automatically maintained in this network without monitory and maintaining. WSN has to adapt to changes, self monitoring, adapt operation and incorporate possible additional resources, like newly deployed nodes.
1.5 Design issues of WSN

Sensing Coverage

Since sensing is the essential capacity of a sensor network, sensing scope is a critical QoS estimation of the network and is additionally the outline target of topology control calculations. If whole field is secured by a network, network gives 1-coverage. Along with this each point in the field is checked by any event of K sensors, the network is said to accomplish K-coverage. A network might likewise give incomplete 1-scope or K-scope.

Network Connectivity

In the event that sensor information need to travel large distance to reach the base station, it is vital to keep up the integration among the sensors. A few components can design the network to a particular level of integration needed by the application, given an adequately high sensor thickness.

Data Delivery Ratio

A high information delivery proportion is another objective for topology control calculations. It can be measured by the normal measure of information conveyed from a source to a sink amid the interval. In any case, this measure is not suitable when there is in network information aggregation.

Balanced Energy Consumption

Since the sensor node is inclined to fail, if the energy of specific nodes is exhausted before the others, openings may show up in the detecting scope or the sensor network may get to be disengaged rashly. A few instruments endeavor is used to adjust the energy utilization among the sensors by round robin operation.

Arrangement of Node

Node arrangement is application particular and it specifically impacts the ability of protocol. The arrangement of stations may be in predefined or it can be arbitrary in nature. In the event of predefined execution, routing is done through officially characterized ways. In arbitrary execution, the sensor stations are set without system and by cognizant choice, it makes framework in specially appointed way. Energy usage specifically is influenced by this procedure.

Energy Efficiency of Node

Sensor nodes have just restricted supply of energy for transmitting and calculations of data in a remote network. Lifetime of the node uniquely relies on upon its battery lifetime. In the event that a specific node fails because of power disappointment
then there will be critical topological changes and this will lessen dependability and information exactness of the network.

**Heterogeneity of Nodes**

Sensor node in ordinarily are considered as homogeneous in terms of energy utilization, information handling and correspondence foundation. Contingent upon applications, it may have diverse different architecture or capacity. For samples certain application obliges constant checking, some are security alerts, some need to withstand the ecological compelling conditions and due heterogeneity of nodes outline complexity increments.

**Fault Tolerance**

Amid operation few of the nodes may get fall flat because of great natural conditions, physical harm or outer obstruction. This specific disappointment fail not be because of failure of network. Along these lines routing strategies ought to deal with this failure node and recovery of the network after such failure. In the event of node failure routing calculation ought to be ready to build up new paths or connections and information rate must be kept up.

**Network Scalability**

The remote sensor nodes may be all together from few to thousands or significantly more. So the routing procedure ought to be equipped for working with such enormous number of stations, it ought to be versatile adequate for reacting occasions happening in environment.

**Routing**

Numerous network structural planning considers sensor nodes to be stationary, yet application may request portability of nodes. Routing with paths development and updating such routing tree is real test while outlining. In altered structural engineering routing can be static however element routing is essential if there should be an occurrence of portable nodes.

**Connectivity**

Nodes in sensor network blocks themselves, structures complete disengagement from others. Therefore, sensor nodes are normal integration on vast scale. Network relies on upon distribution of nodes.

**Coverage**

In remote sensor networks, each node registers certain data from environment. Each node has restricted extent of vision or reach. It is for the most part that covers just
certain restricted zone. Subsequently while planning of WSN, scope is additionally one of the real parameter needed to be considered as well.

**Attacks**

A WSN is conveyed and managed by single power. Every one of the nodes in the network can be seen as legit and agreeable substances, while attackers are blocked from the network and have no privilege to get to the network. Those outer aggressors can dispatch attacks from outside the extent of the network and the effect of attack is constrained. If an aggressor can get into the network, it turns into an inside attack. For this situation, the aggressor can bring about more extreme with the fact that it is seen as a genuine entity. For the most part, an attacker can turn into an inward one by behaving as an authentic node or by conveying malicious nodes that can pass the network access control component.

### 1.6 Issues of WSN

**Security**

Security provides confidentiality with fundamental administration to keep up the privacy of vital information transmitted between sensor nodes. Generally, basic parts of a packet are encoded before the packet is transmitted from the sending node and afterward, the packets are unscrambled at the accepting node. Without relating unscrambling keys, attackers are kept from getting to the basic data. The sort of data that must be encoded relies on upon the applications. Usually only the information of a packet is scrambled and in alternate cases, the packet header additionally is encoded to secure node entities, with authenticity discriminating to give the affirmation of the personalities of communicating nodes. Each node ought to check whether a got message originates from a genuine sender. Without validation, aggressors effectively can hack node characters to spread false data into the WSN. Ordinarily, a joined Message Confirmation Code (MAC) can be utilized to validate the source of a message and integrity ought to be given to ensure that the transmitted messages are not altered by assailants. Attacker can acquire obstruction with a few bits of transmitted packets to change their polarities. A malicious routing node can likewise change vital information in packets before sending them. Like a Cyclic Redundancy Checksum (CRC) used to distinguish arbitrary mistakes during packet transmissions and a keyed checksum like MAC can secure packets against change.

**Topology Control**

Suppressing a few nodes does not influence the framework as long as there are sufficient working nodes to guarantee it. On the other hand that all the sensor nodes at
same time worked in the dynamic mode, an unnecessary measure of energy would be squandered and information that gathered would be very corresponded and repetitive, additionally the top packet crash would happen. Consequently, it turns into one of the critical issues to improve the topology of network and minimize energy utilization to drag out the framework lifetime for remote sensor networks.

To start with, topology control is the essential procedure of energy sparing and energy sparing is likewise a standout amongst the most critical targets in topology control. Second, topology control ought to guarantee the nature of network scope and integration. Scope and integration are the precondition for powerful monitoring and information gathering in remote sensor networks. Third, topology control can decrease the sign obstruction of radio and enhance the productivity of MAC and routing conventions. Finally, topology control can build the network execution, for example heartiness, dependability and versatility. Diverse applications have distinctive necessities, so they receive the diverse network models and presumptions. Some of the feasible topology to improve the effectiveness is as shown in figure 1.4 where nodes of WSN can be connected as bus, fully connected, mesh, ring, star, tree, random, depending on the stated application. Network connectivity with uniform node patterns contributes as an additional attribute for various performance patterns this can be a simple and value added approach to improve efficiency of WSN.

![Figure 1.4: Different pattern of nodes](image)

**Fault Tolerance**

Fault tolerance is the ability of a system to deliver a desired level of functionality in the presence of faults. Since the sensor nodes are prone to failure, fault tolerance should be seriously considered in many sensor network applications. In WSN it is often
the case that not every sensor node needs to be active at the same time for sensing and communication. To reduce unnecessary power consumption, only a minimum number of sensor nodes operate in active mode while the others are kept in sleep mode. In such case, however the network service can be easily unreliable if any active node is unable to perform its sensing or communication function because of an unexpected failure. Thus, it is important to maintain the original sensing level even when some sensor nodes fail. Designing a fault tolerant network for WSN is a challenging task due to the limited resources in the nodes. Most fault tolerant approaches applied in WSN demand high resources and require offline regeneration of the detection model. Some researchers attempt to improve the network availability and reliability through redundancy or by detecting the fault with limited automated recover. It is sometimes necessary to determine the cause of the fault online and rectify the problem quickly and effectively to reduce networks downtime.

**Energy Efficiency**

Energy is a very scarce resource for WSN systems and has to be managed wisely in order to extend the life of the sensor nodes for the duration of a particular mission. Energy consumption in a sensor node could be due to either useful or wasteful sources. Useful energy consumption can be due to transmitting or receiving data, processing query requests, forwarding queries and data to neighboring nodes. Wasteful energy consumption can be due to one or more of the following facts. Major sources of energy waste is idle listening (listening to an idle channel in order to receive possible traffic) and reason for energy waste is collision (When a node receives more than one packet at the same time, these packets are termed collided), even when they coincide only partially. All packets that causes the collision have to be discarded and retransmissions of these packets are required which increases in energy consumption. The next reason for energy waste is overhearing (a node receives packets that are destined to other nodes) and for energy waste is over emitting, which is caused by the transmission of a message when the destination node is not ready. Considering the above mentioned facts, a correctly designed protocol must be considered to prevent these energy wastes. Most importantly the reason of usage of energy would be the non uniform distribution of node in the network that takes additional energy for data transmission causing early death of node as well network, effective placement of node extend the life of network be it with different pattern of nodes like square, grid, circular etc.
Routing Protocols

Routing in WSN is exceptionally difficult because of the inalienable qualities that recognize these systems from different remote systems like versatile specially appointed systems or cell systems.

Hierarchical cluster based routing systems is fundamental for sensor system applications where an extensive number of sensors are sent for detecting purposes. In the event that every sensor begins to convey and take part in information transmission in system, an incredible system blockage and information impacts will be experienced, which brings about emptying of the restricted energy out of the system. Node clustering will address these issues. In clustered systems, nodes can be apportioned into various little gatherings called cluster. Every cluster has a facilitator as a Cluster Head (CH) and various Sensor Nodes (SN). Clustering results in a two level order in which CH’s structure the higher level while SN’s structure the lower level. Figure 1.5 represents information stream in a clustered system. The SN’s transmit their information to the separate CH’s. The CH’s gathers the information and forward them to a focal BS specifically or through different CH’s. Clustering through making a various leveled WSN encourages effective usage of constrained energy of sensor nodes and thus amplifies system lifetime. The routing protocols are classified based the way they are positioned, that depends on the types of applications to be used. Different routing protocols can be classified, that are discussed in the following section.

A. Attribute Based or Data Centric Routing Protocols

The information is normally transmitted with huge repetition. This is exceptionally wasteful regarding energy utilization, routing conventions that have the
capacity to choose an arrangement of sensor nodes and use information gathering during transferring of data.

i. **SPIN**

Sensor Protocols for Information by means of Negotiation (SPIN) convention in which like in SPIN, information transaction among the nodes is considered. It can disseminate information between sensors by considering the constrained energy assets of the nodes viably. This convention starts when a node accomplishes new information and chooses to transmit it. In this manner, it picks a name for the new information and sends a notice message ADV to its neighbors. While accepting the ADV message, the neighbor node verifies whether it has got or asked for such information earlier. If not, the neighbor node transmits a solicitation message (REQ) to the sender node and requests that it sends its new information. At last, the DATA message will be sent from the sender node and the procedure will be done which is as demonstrated in figure 1.6.

![Figure 1.6: SPIN routing pattern for WSN](image)

ii. **Directed Diffusion (DD)**

In DD, beneficiary node remembers the senders. Along these lines, a slope which exhibits the bearing of information stream and the status of solicitation (which can be dynamic, latent or requiring update) is made.

Suppose a node can predicate the following bounce from the past angles or land data, it sends the request just to the nodes which have the capacity to respond to the request, else it ought to show the solicitation to its entire neighboring node. At the point when a node gets a request which is good with its information, it enacts sensors for gathering the obliged data and transmits the data toward the requester.

In DD, information is put away as shown in figure 1.7 to the intermediate nodes (1) during the sending procedure toward the destination, when the sink node gets
information from various paths (2), as per the quality of every paths, it chooses the best path and fortifies the source to send its information through this path (3).

![Directed diffusion routing pattern for WSN](image)

**Figure 1.7: Directed diffusion routing pattern for WSN**

Besides, when a failure happens in the active path or the rate of information delivery is diminished, the sink chooses another best path for information transmission.

**B. Geographical Routing Protocols**

These algorithms explore the location data to make routing strategies more productive. In particular, neighbor trade data about their area, so when a node needs to forward a packet, it sends it to the neighbor which is thought to be nearest to the last destination.

**i. Greedy Algorithms**

Under this approach, a node chooses about the transmission path in light of the position of its neighbors. To continue, the source contrasts the confinement of the destination and the directions of its neighbors. At that point, it transfers the message to the neighbor which is nearest to the last destination.

![Greedy routing pattern for WSN](image)

**Figure 1.8: Greedy routing pattern for WSN**
The procedure is continued until packet achieves the planned destination, the greedy calculation with most data forwarding inside of radius ‘R’, where forwarding strategy picks to choose the most far off neighbor for the packet transfer which is closer to the last destination as the next hop. Conversely, the closest forward procedure picks the closest neighbor that is closer to the expected destination for intended destination of next relaying node.

In greedy routing, indicated in figure 1.8 a node passes data to the neighboring node that is nearest to the last destination in a conceptual space called concealed metric space. This space underlies the real network and separations in this space indicate the similarities between the nodes. This relationship between a nodes separation to the destination in metric space, the nodes general reach and its degree is the thing that makes the greedy routing technique proficient at deciding the shortest paths. By and large of exchanging data with greedy routing, data first goes to node with high degrees, when the separation to the destination diminishes, the deployment changes so that the data achieves its destination in a couple of little hops, regardless of the node degree. Here the data is sent from ‘v’ to ‘W_t’ and to ‘t’.

ii. GAF

Nodes here are in one of three states: sleeping, discovery and active. A state move pattern is indicated in Figure 1.9. At first node begin in the discovery state, in which a node turns on its radio and trades disclosure message to discover different nodes inside of the same cell.

![Figure 1.9: GAF routing pattern for WSN](image)

The revelation message is a tuple of node ID, cell ID, evaluated node active time, node state and a node utilizes its area and cell size to focus the cell ID. At the point when
a node enters disclosure state, it sets a clock for ‘$T_d$’ seconds. At the point when the timer fires, the node show its revelation message and enters state of active. The timer can likewise be smothered by other revelation messages.

This timer diminishes the likelihood of disclosure message collision. At the point when a node enters active state, it sets timeout esteem ‘$T_a$’ to characterize to what extent this node can stay in active state. After ‘$T_a$’, the node will come back to the disclosure state. While active, the node intermittently re-telescast its disclosure messages at an interval of ‘$T_d$’. A node in disclosure or active states can change state to sleeping when it is in a position to focus some other comparable nodes while handling routing. At the point when transitioning to sleep, a node wipes out every timer and shuts down its radio. A node in the sleeping state awakens after an application dependent sleep time ‘$T_s$’ and moves back to discovery.

C. Hierarchical Routing Protocols

The fundamental goal of hierarchical routing is to decrease vitality utilization of nodes into groups. In every cluster, a node is chosen as CH or leader. The diverse plans for various leveled hierarchical routings for the most part vary in how the cluster head is chosen and how the nodes act in inter and intra cluster communication.

i. LEACH (Low Energy Adaptive Clustering Hierarchy)

In LEACH as indicated in figure 1.10, the function of the cluster head is occasionally exchanged among the nodes in the system with a specific end goal to circulate the energy utilization. At that point, a cluster head is chosen in every round. For this decision, the number of nodes that have not been cluster heads are utilized. When the cluster head is characterized in the setup stage, it sets up a TDMA plan for the transmissions in its cluster. This planning permits nodes to switch off their interfaces when they are not going to be utilized.

![Figure 1.10: LEACH routing pattern for WSN](image)
The cluster head is the route to the sink and it is additionally in charge of the information accumulation. The cluster head controls the sensors situated in a nearby range, the information accumulation performed by this cluster grants to remove redundancy.

**ii. PEGASIS (Power Efficient Gathering in Sensor Information Systems)**

PEGASIS demonstrated in figure 1.11 is a streamlining of LEACH, as opposed to arranging nodes in cluster, the algorithm structures chains of the sensor nodes. With this structure, every node transmits to and gets from nearest node of its neighbors. With this reason, the nodes alter the force of their transmissions. The node performs information accumulation and advances it to the node in the chain that corresponds with the sink. In every cycle, one node in the chain is chosen to communicate with the sink. The chain is developed with greedy based scheme.

![PEGASIS routing pattern for WSN](image)

**Figure 1.11: PEGASIS routing pattern for WSN**

**D. Multipath Routing Protocols**

In these protocols, a source knows various routes to a destination. The routes can be at the same time utilized or one of them can be active while the others are kept up for future needs.

**i. SAR (Sequential Assignment Routing)**

An arrangement of algorithm which performs association and portability administration in sensor systems is proposed. The SAR calculation makes numerous trees, where foundation of every tree is a one hop neighbor for the sink. Every tree becomes outward from the sink and evades nodes with low throughput or high delay. On the end of the technique, most nodes have a place with multiple trees. An occasion of tree arrangement is delineated in Figure 1.12.

The trees established at A and B, two of the one hop neighbors of the sink, is indicated. Node C has a place with both trees and has path lengths of 3 and 5, individually to the sink utilizing two trees. Every sensor node records two parameters
about every path through it, the accessible energy assets on the path and an added substance QoS metric like delay.

![SAR routing pattern for WSN](image)

**Figure 1.12: SAR routing pattern for WSN**

### 1.7 Challenges of WSN

- One of the biggest disadvantages of large scale WSN lies on the complexity of logistics involving selective replacement of sensors that have ran out of energy
- More complex to configure and lower speed compared to wired network, it does not allow us to do more than can be done with a wired system
- Less secure because hacker’s system can act as Access Point (AP). If a hacker connects a laptop or desktop is able to read all user application data that has been collected
- Affected by surroundings of the environment like walls (blocking), microwave oven (interference), far distance (attenuation) which can cause more of fading with the signals
- Gets distracted by various elements like Blue-tooth, Zigbee
- It does not make sensing quantities in buildings easier and still costly at large network too with no reduction in costs for installation of sensors.

### 1.8 Applications of WSN

WSN being used as in most of the recent application from miniature to major application, figure 1.13 shows the various applications of WSN being used in variety of fields. WSN is utilized as a part of the vast majority of the applications for instance military, wellbeing, backwoods, monitoring different gadgets, catastrophes which have
turned out to be generally productive. In a military application circumstance mindfulness can be discovered utilizing sensors by detecting interlopers and discovery of adversary unit developments ashore or ocean and it is in this way for war zone reconnaissance.

In therapeutic application sensors for blood stream estimation can be utilized or to locate the respiratory rate of an organ and application like, ECG (electrocardiogram), beat oxymeter, circulatory strain and oxygen estimation are all done utilizing sensors. The most vital application can be remote checking of a patient, here sensor nodes are conveyed on human body, all the data like circulatory strain, status of medication are all sent consequently to the healing facility to make important move.

![Figure 1.13: Different application of WSN](image)

Sensors are utilized as a part of debacle help operations like out of control bonfire identification, where nodes are furnished with sensors to quantify temperature, moistness and gasses which are principle substance of a flame in the trees or vegetation, sensors can be set to identify any such fire at the early. Sensor nodes can be utilized to identify land sliding of dirt, sensors can be put to screen dampness of soil and through the information assembled it might be conceivable to know the event of avalanches much sooner than it really happens. WSN have been utilized as a part of the mechanical application for instance in machine well being observing where, sensors are produced for apparatus condition based giving expense reserve funds and empowering another usefulness. Sensors are utilized for the accumulation of information for checking of natural data, this factual data can then be utilized to indicate how frameworks have been functioning giving live information. Optical sensors to identify human vicinity through the IR range are the
latest sensors now. Horticulture applications, where the daylight radiation and bright sensors are needed, so as to gauge the aggregate sum of vitality and light which is consumed by the plants, in view of this data measure of water, pesticides can be sustained to the plants. Canny structures can be developed to decrease vitality wastage by legitimate moistness, ventilation, cooling control. Sensors additionally can be utilized to screen mechanical push after seismic tremors, machine reconnaissance and can be utilized to anticipate upkeep, install detecting or control capacities into spots, where there is no vicinity of link.

The following are the different scenarios of WSN with respect to different applications.

a. **General Scenario of WSN**

![Figure 1.14: Wireless Sensor Network Scenario](image)

WSN contains hundreds or a huge number of these sensor nodes and these sensors can convey either among one another or specifically to an outside BS. A more prominent number of sensors take into account detecting over bigger land areas with more prominent exactness. Figure 1.14 demonstrates a part of WSN. Essentially, every sensor node contains detecting, preparing, transmission, mobilizer, position discovering framework and power units (some of these parts are discretionary like the mobilizer). Sensor nodes are typically scattered in a sensor field, which is a territory where the sensor nodes are conveyed. Sensor nodes coordinate among themselves to deliver complete data about the physical environment. Each of these scattered sensor nodes has the capacity to gather and course information either to different sensors or back to an outer BS. A BS may be a settled or portable node fit for joining the sensor network to a current interchanges foundation or to the internet where a client can have entry to the reported information. In the past decades concentration exploration that addresses the capability of
joint effort among sensors in information assembling, preparing, coordination and administration of the detecting movement was directed. In many applications sensor nodes are obliged in energy supply and correspondence data transmission.

b. Underwater scenario of WSN

Sensor nodes are deployed vertically under the sea surface in a 3D display, typically anchored to the sea bottom (Figure 1.15), hence the network nodes are located at different depths or horizontal planes in shallow water.

Figure 1.15: Scenario of WSN underwater

Sensor nodes may be clustered around a sink node (UW-sink in Figure 1.15) that is capable of aggregating the data collected by the sensors (UW-sensors in Figure 1.15). The sink node communicates the collected data to a processing center that is either located under the sea surface (example a submarine), a surface ship or a command center which also can send reprogramming commands to UW sensors through UW sinks. The sink node acts in addition to its role within the sensor network, as a gateway to external endpoints or networks. In this kind of network deployments it is conceivable to expect either multi hop or single hop communications between each sensor node and the sink.

c. Agriculture Scenario of WSN

The agriculture system shown in figure 1.16 is considered to be a complex interaction of seed, soil, water, fertilizer and pesticides.
Exploitation of agricultural resources to bridge the gap in supply or demand is leading to the resource degradation and subsequent decline in crop yields. This calls for optimal utilization of the resources for managing agricultural system. Precision farming an information and technology based farm management system is to identify analyze and manage variability within field for optimum profitability, sustainability and protection of the resources. WSN one among many technologies i.e. (Remote Sensing, Global Positioning System (GPS) and Geographical Information System (GIS)) practiced for precision farming is found to be suitable for collecting the real time data of different parameters pertaining to weather, crop and soil thereby helpful in developing solutions for majority of the agricultural processes related to application of water, fertilizer, pesticides etc.

d. Military Application Scenario of WSN

The unique characteristics of WSN which are very useful in military application as shown in figure 1.17, such as limited power they can harvest or store, ability to withstand harsh environmental condition, ability to cope with node failures, mobility of nodes, dynamic network topology, communication failures, heterogeneity of nodes, large scale of deployment, unattended operation etc.
1.17: Scenario of WSN for military

1.9 Objective of Research

Considering WSN to be one of the recent trends in today world, most researchers discusses many issues on WSN, the main motivation for choosing WSN as a research would be to look forward in the area of agricultural. To increase the productivity there is also a need for e-agricultural, more specifically to involve technology in the growth of crop. Although not considering they are the direct reason for the growth, but sensors can be used in sensing various parameters of a crop to take suitable action against necessary changes. As a preparation to this two objectives are stated earlier to this.

- First objective is discussed with the placement of node problems, any application with WSN directly depends how the nodes are placed and usually it is random. Effective node placement with energy efficiency usage of network would be considered to increase the life and save the energy of network
- Second objective stating the faults of WSN, there is always problem with node of faults and different types of faults have been considered and worked out for the same
- These two objectives will add to effective utilization of e-agriculture by proper placement with identification of faults with source node, sink node, link failure, thus finding a way to increase the productivity of agriculture through WSN technology.
1.10 Organization of the Report

Till now the discussion about wireless sensor network in terms their structure, features, characteristics, limitations, application, issues and many other factors related to WSN have been discussed. Further in chapter 2, a related work about the introduction of WSN is discussed. The work done by existing researchers has been collected and made use for the various proposed chapter, these papers are each related to the objectives of the research. Chapter 3 provides the proposed approach for energy based node placement algorithms, been discussed with algorithms, modeling and simulation to show the graph obtained for proposed work. Chapter 4 provides the proposed approach for second objective discussing the faults commonly occurring with WSN, the simulation finds a way to identify these faults showing the comparison of results with and without failures. Chapter 5 discusses on e-agriculture, finding a way to include the WSN technology in a typical agriculture system, thus increasing the productivity. Finally chapter 6 provides overall conclusion of research work carried out with future work.