WSN and Concerns: A Review

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Abstract- For the last few years, wireless sensor networks have been taken extreme attention of researchers. WSNs are basically used for gathering information from the unattended and hostile environment .However, sensor nodes in Wireless Sensor Networks (WSNs) are usually battery-powered sensor nodes (BPSNs) and which is the reason of its unreliability in most cases. Therefore, five important key features are needed to be considered when developing any WSN which are scalability, security, reliability, self-healing and robustness. But, energy efficiency and failure are extremely rigorous factors which are considered while developing any network. This paper will through light on types of WSNs, its applications, services, architecture, characteristics and review challenges associated with designing a WSN.

Keywords – ***Wireless Sensor Networks; WSNs; BS; Sink***

I. INTRODUCTION

Wireless Sensor Networks (WSNs) contain numerous sensors of different types. They include sinks and base stations. Those sensors are known as nodes or sinks and can perform various functions like event sensing, data transmission, processing of information, etc. The number of nodes can be from hundreds to thousands. Base stations (BSs) handle underlying sinks for collecting and forwarding the data to the outside world. A sink node is a veritable embedded system with a wireless communication function, and that is capable to collect physical quantities such as heat, humidity, temperature, vibration, radiation, sound, light, movement, etc. It converts them into digital values which are sent as sensed data to a remote processing station or base station. Sink node and Base station differs in memory, processing and computation capabilities, where base stations or gateways are more powerful. WSNs include low-cost sensors, which are intelligent in nature and this is the most prominent reason that WSNs are replacing traditional networks in many scenarios. There are numerous other reasons like deployment easiness, self- organization behavior, increased range of data transmission, etc. which are making WSNs more popular.

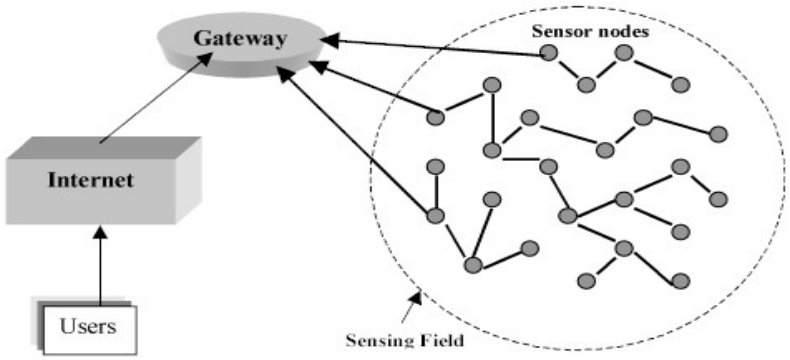

Fig 1: Wireless Sensor Network

(A) STRUCTURE OF A SENSOR NODE

The sensor node comprises of a sensor, microcontroller, and RF transceiver. It is often driven by a battery or energy harvesting system. The sensor generates analogue signals, and an ADC converts the signals. The microcontroller executes a series of algorithms to process the data. All data will be stored in the microcontroller and transmit through an integrated RF transceiver.

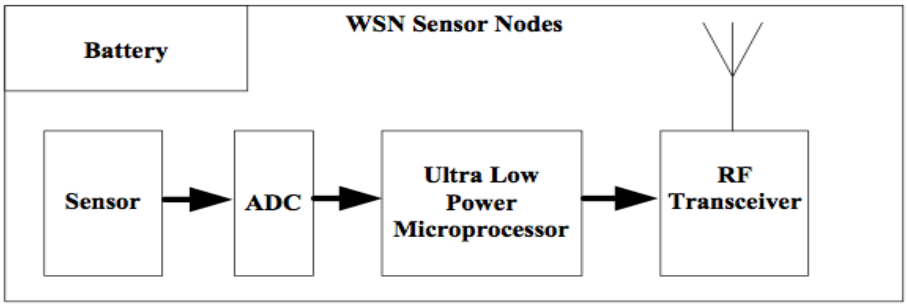

Fig 2: Sensor Node Structure

The nodes in a WSN can be connected in a Mesh Topology, Peer to Peer, Tree or Star topology depending upon the requirements. The size of a node is as small as a coin. The wireless sensor nodes do not communicate with a central node directly but rather through their surrounding local nodes. The nodes have an embedded processor which has to implement complex networking protocols with a memory of few kilobytes. As the size of the device grows smaller and so does the power source. The nodes include both hardware and an operating system such as TinyOS (a widely used operating system for WSN). The most advanced hardware platform used is single chip CMOS device.

(B) CHARACTERISTICS OF WSN

The main characteristics of a WSN are:

- *Power consumption*: It is always a major constraint in the deployment of sensor nodes since they are deployed in an inaccessible areas and need function accurately. So the only source of power to them is through battery which is obviously non-rechargeable.
- *Heterogeneity* : Mostly the type of nodes deployed differ by the type of operation, and hence homogeneity or heterogeneity also depends upon the type of operations and area in which they are deployed
- *Scalability*: Usually the performance of the network depends upon energy levels of the nodes, apart from that the network performance doesn't depend upon the size of the network
- *Nodal mobility*: If the nodes are mobile, then they need different algorithms for functioning
- *Communication failures*: It occurs due to lack of battery power and if a node goes out of transmission range
- *Ability to withstand harsh environmental conditions*: It should be able to operate in harsh conditions where human reachability is less.

(C) BASIC ARCHITECTURE OF WSN NODE

Architecture of sensor network depends upon the expected service and the implemented application. Sensor node has a sensor unit which plays a vital role to fetch a physical quantity and covert into the digital value. In application some modules are added such as GPS, solar cell etc. WSNs architecture are mainly of the following types:

Flat architecture: Here all nodes have same capability in terms of energy and computations. The major point is that it is easiest architecture and enables low communication latency. Nodes can directly communicate with each other.

Hierarchical architecture: In the hierarchical architecture network is broken down into many groups which are organized units of the network. It is more expensive but more powerful. It provides more latency as compared to the flat architecture and in this way we can say that it consumes more energy.

II. WSN APPLICATIONS

In the previous period, wireless sensor networks and its applications are developing quickly and playing a vital role in the research field. Initially, the WSN development was encouraged by military applications but now a

days it have numerous applications in these areas such as in environmental, ecological, agricultural, military and medical treatment .
Some of the main applications are given below:
Area Monitoring: It is used in the military area to detect the enemy intrusion which is the best example of the area monitoring.
Health care Monitoring: It is used to gather the information related the body which can be of two types wearable and implantable where either the device is touching the body or putting inside the body.
Environmental Sensing: It is used to monitor the dangerous gases which exist in the environment.
Forest fire Detection: Sensors nodes are installed in the forest so that fire brigades easily know that when fire is started and how much it is spreading.
Water Monitoring: It is used to check the status of the water like in dams, oceans etc.
Natural Disaster Prevention: It has the main purpose to prevent the consequences of the natural disaster such as floods, earthquakes.
Telematics: Nowadays telematics plays a vital role in our daily life because traffic is increasing day by day so to control the traffic telematics is used.
Data logging: WSNs are used to control the level of water.

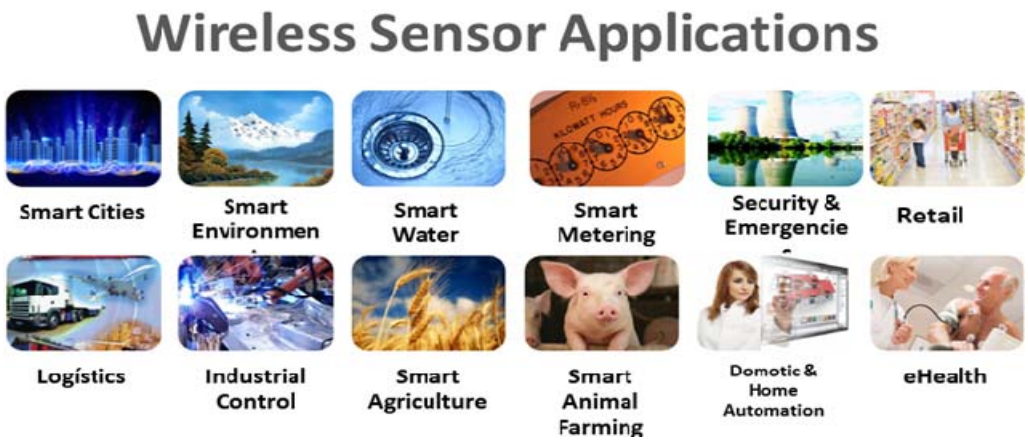

Fig 3: Wireless Sensor Network Applications

Table -1: Uses of WSNs

Sr. No.	Applications	Use
1.	Area Monitoring	• Used in military area to detect enemy intrusion • Security detections
2.	Health Care Monitoring	• It can collect information by body care network. • Condition based Maintenance(CBM)
2.1	Wearable	▪ It is used on the body surface
2.2	Implanted	▪ Inserted inside human body
3.	Environmental Sensing	• Air Pollution Monitoring • Monitor the concentration of dangerous gases

4.	Forest fire Detection	• Sensor nodes are installed to detect fire in a forest • Fire Brigades will know when a fire is started and how much is spreading
5.	Water Monitoring	• Monitor the water properties in dams, lakes and oceans • Create the accurate map of water status
6.	Natural Disaster Prevention	• Prevent the consequences of natural disaster like floods
7.	Telematics	• Control the traffic
8.	Data logging	• Monitor the temperature of fridge • Control level of water in power plants

III. SERVICES OF WSNS

WSN provides services which are categorized into provisioning and control nodes management.

1. Coverage: Coverage comes under the provisioning services. It covers the placement of nodes in deployment area to ensure the coverage of inside area. It depends upon the application, the number of nodes and localization of these nodes.

2. Localization: It also comes under the provisioning services .It is used to find the position of a node in the network. Localization is used in three ways in wireless sensor network which are:

- GPS (Global Positioning System): It is the easiest method in WSN but its main drawback is that it consumes more energy and cost so that is why it cannot work in dense environment like forest.
- Anchor node approach: It consists of node which is sometimes called as the anchor who knows its position and helps to evaluate the neighboring nodes.
- Close Localization: It consists of a node that uses the neighboring nodes to find their positions and then become an anchor point for the rest of all nodes.

3. Synchronization: It is used for the control and management of a node. It uses two approaches:

- Data Compression: Here the data is first compressed and then send onto the network and at the destination node the data is decompressed to get the original content. Its main advantage is that it reduces the cost of communications and in this way it increases the reliability of the transfer of the data.
- Data aggregation: Here the data is aggregated using the algorithms and then it is sent onto the network. It is used to conserve the scarce energy resources by eliminating the redundant data and in this way it increases the lifetime of the network.

IV. PARAMETERS INVOLVED IN WSN

The performance of wireless sensor networks is based on the following factors.

Latency: Latency is defined by how much time a node takes to sense, or monitor and communicate the activity. It also depends on the application at hand. Sensor nodes collect information, process it and send it to the destination. Latency in a network is calculated based on these activities as well as how much time a sensor takes to forward the data in heavy load traffic or in a low density network.

Scalability: Scalability is an important factor in wireless sensor networks. A network area is not always static, it changes depending upon the user requirements. All the nodes in the network area must be scalable or able to adjust themselves to the changes in the network structure depending upon the user.

Energy Awareness: Every node uses some energy for activities like sensing, processing, storage and transmission. A node in the network should know how much energy will be utilized to perform a new task that is submitted, the amount of energy that is dissipated can vary from high, moderate to low depending upon the type of functionality or activity it has to perform.

Node Processing Time: It refers to the time taken by the node in the network for performing all the operation starting from the sensing activity to processing the data or storing data within the buffers and transmitting or receiving it over the network.

Transmission Scheme: Sensor nodes which collect the data transmit it to the sink or the base station either using the flat or in multi hop routing schemes.

Network Power Usage: All the sensor nodes in the network use a certain amount of network power which helps them to perform certain activities like sensing or processing or even forming groups within the network area. The amount of energy or power utilized by the sensor nodes or a group of sensors within the network is known as network power usage.

V. DESIGN ISSUES IN WSN

Despite the innumerable applications of WSNs, these networks have several restrictions, e.g., limited energy supply, limited computing power, and limited bandwidth of the wireless links connecting sensor nodes. One of the main design goals of WSNs is to carry out data communication while trying to prolong the lifetime of the network and prevent connectivity degradation by employing aggressive energy management techniques. The design of routing protocols in WSNs is influenced by many challenging factors. These factors must be overcome before efficient communication can be achieved in WSNs. In the following, we summarize some of the routing challenges and design issues that affect routing process in WSNs.

Node deployment: Node deployment in WSNs is application dependent and affects the performance of the routing protocol. The deployment can be either deterministic or randomized. In *deterministic deployment*, the sensors are manually placed and data is routed through pre-determined paths.

Energy consumption without losing accuracy: Sensor nodes can use up their limited supply of energy performing computations and transmitting information in a wireless environment. As such, energy conserving forms of communication and computation are essential. Sensor node lifetime shows a strong dependence on the battery lifetime.

Data Reporting Model: Data sensing and reporting in WSNs is dependent on the application and the time criticality of the data reporting. Data reporting can be categorized as either time-driven (continuous), event-driven, query-driven, and hybrid.

Node/Link Heterogeneity: In many studies, all sensor nodes were assumed to be homogeneous, i.e., having equal capacity in terms of computation, communication, and power. However, depending on the application a sensor node can have different role or capability. The existence of heterogeneous set of sensors raises many technical issues related to data routing.

Fault Tolerance: Some sensor nodes may fail or be blocked due to lack of power, physical damage, or environmental interference. The failure of sensor nodes should not affect the overall task of the sensor network. If many nodes fail, MAC and routing protocols must accommodate formation of new links and routes to the data collection base stations.

Network Dynamics: Most of the network architectures assume that sensor nodes are stationary. However, mobility of both BS's and sensor nodes is sometimes necessary in many applications.

VI. FAULTS IN WSN

To comprehend fault tolerance mechanisms, it is important to point out the difference between faults, errors, and failures. Various definitions of these terms have been used.
• *A fault is any kind of defect that leads to an error*.
• *An error corresponds to an incorrect system state. Such a state may lead to a failure.*
•*A failure is the (observable) manifestation of an error, which occurs when the system deviates from its specification and cannot deliver its intended functionality*.

- ***Types of Faults***

Based on persistence, faults are categorized into the following types:
Soft faults: These faults occur very less frequently or rarely and get removed without any external intervention. These are mostly caused due to noise.
Permanent faults: The permanent fault is permanent for a node. The intermittently faulty node gradually becomes a permanent faulty node in due course of time. They are caused mainly due to power failure in the node.

- ***Causes of Faults***

Due to the fragile nature of sensor nodes and also because of the depletion of their limited power source, faults may occur. Due to harsh environments where nodes are being deployed, the nodes may receive and transmit incorrect sensor readings. In WSN, the links are also prone to faults. Also when nodes are embedded or mobile nodes sometimes go out of range of communication. Faults are also caused due to multi-hop communication as it takes several hops to deliver the data to sink. Failure of single intermediate node may lead to a total erroneous data being collected. Congestion, which occurs due to large number of nodes transmitting the same time may also lead to packet loss.

- ***Fault Detection***

Detection of faulty sensor nodes can be achieved by two mechanisms i.e. *self-detection (or passive-detection*) and *active-detection*. In self-detection, sensor nodes are required to periodically monitor their residual energy, and identify the potential failure. In this scheme, we consider the battery depletion as a main cause of node sudden death. A node is termed as failing when its energy drops below the threshold value. When a common node is failing due to energy depletion, it sends a message to its cell manager that it is going to sleep mode due to energy below the threshold value. This requires no recovery steps. Self-detection is considered as a local computational process of sensor nodes, and requires less in-network communication to conserve the node energy. In addition, it also reduces the response delay of the management system towards the potential failure of sensor nodes.

VII. CONCLUSION

The WSN operates in harsh conditions and deployed nodes are prone to failure in these circumstances. Failure is either a single node failure or multi-node failure and the techniques suitable for single node failure are not applicable to multi-node failure. To get the reliable output in either homogeneous or heterogeneous environment or in mobile or stable WSNs, fault detection and its recovery is a serious challenge in future. Thus it is prime essential to consider the issue of faults in WSN and try to work on overcoming the same for WSN in future by studying the behavior of source node with its neighbors.

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