**STUDY ON WIRELESS SENSOR NETWORK & CHALLENGES & ITS APPLICATIONS**

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**ABSTRACT**

Sensing technology used in the world is undergoing a huge upheaval thanks in large part to wireless sensor networks (WSNs). In recent years, wireless sensor networks have emerged as a powerful technology with numerous uses, the use of intelligent transportation systems (ITS), surveillance technologies, and military operations. WSN's sensor nodes collect data from their surroundings and monitor the external environment as well. Sensor networks are being researched to make them operate with minimal energy consumption so that they can last for longer periods. It has been primarily The main worry in the direction of energy conservation has been the draining of batteries on which sensor nodes function. WSNs are also exploited for their security aspects, so that they can be used in some confidential areas such as military battlefields. A brief overview of WSNs is presented here, including applications, routing and data collection, security aspects, and a brief description of the simulation platforms available for WSNs. A contribution to this chapter focuses on introducing and reflecting the significance of WSNs in different sectors of their operation.

* 1. **INTRODUCTION**

Sensor nodes are devices that make up wireless sensor networks thanks to advances in wireless communication. Small, inexpensive, low-power sensor nodes can do computation, wireless communication, and sensing. When deployed, the sensors set themselves up and establish connections with one another to start gathering data and transmitting it to the base station.

**Figure 1.1 WSN Architecture & Network**

It can also be defined as a network made up of devices that are relatively small and low-complexity, known as nodes that can sense the environment and communicate the information it gathers. Through gateway nodes, Data can be sent directly or through multiple hops to sinks, which can use it locally or connect it to other networks (like the Internet) for further usage.

Four major parts make up a sensor node: a transceiver, a processing unit, a sensing unit, and a power source. Physical quantities are sensed in the sensor unit and then transformed to digital values using an ADC, or an A/D converter. Data is then processed by the processor and transmitted to and received from other nodes or the base station using the transceiver. The most noticeable part of a sensor node is its power unit. Once a battery is depleted, an unattended application cannot function without one. Other units, such Mobilise, Power Generator, and Location Finding System, are application-dependent units.

**Figure 1.2 Component of Sensor Role**

**1.2 MOTIVATION FOR WSN**

* + New sensor designs, information technologies, and wireless systems have been made possible by recent advancements in engineering, communication, and networking.
	+ Such sophisticated sensors can act as a link between the physical and digital worlds.
	+ The use of distributed sensor networks was made possible by technological advancements in VLSI, MEMS, and wireless communication. Sensors are used in a wide variety of devices, industries, and machines and aid in preventing infrastructure failures, accidents, conservation of natural resources, preservation of wildlife, and increase in productivity, and provide security, among other things.
	+ Modern semi conducting technology has enabled the development of powerful microprocessors that are more compact than those of earlier generations.
	+ Tiny, low-cost, and low-power sensors, controllers, and actuators have been produced as a result of the miniaturisation of processing, computing, and sensing technologies.
	1. **WORLDWIDE SENSOR NETWORK CHALLENGES**

One of the main design goals of WSNs is to communicate data while prolonging the lifetime of the network. This is done aggressive energy management strategies are used. There are several difficult issues that affect how topology control in WSNs is managed. Before WSNs can achieve effective communication, several obstacles must be removed. The following provides a summary of some of the problems and design considerations that have an impact on the WSNs' construction and maintenance topology [2].

**Node deployment:** In WSNs, the placement of node depends on the application and has an impact on topology control algorithms. The deployment can be deterministic or random. In deterministic deployment, sensors are manually placed and data is routed through pre-determined paths. However, in random node deployment, sensor nodes are scattered randomly, creating an ad hoc infrastructure.

**B. 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 communication and computation are essential. There is a strong correlation between the battery lifetime and the sensor node lifetime.

**C. Data Reporting Model:** The application and the degree of time criticality determine the data sensing and reporting in WSNs. There are several types of data reporting, including time-driven (continuous), event-based, query-based, and hybrid. The time-driven delivery model is appropriate for applications that need to check data on a regular basis. As a result, sensor nodes will regularly turn on their transmitters and sensors, sense the surrounding environment, and send the relevant data. This occurs at regular intervals of time.

**D. Node/Link Heterogeneity:** In several research, it was believed that all sensor nodes were homogeneous, i.e., that they had equivalent computing, communication, and power capacities. However, a sensor node may have a distinct function or role depending on the application.

**E. Fault Tolerance:** Due to a lack of power, physical harm, or interference from the environment, some sensor nodes may break or become blocked. The overall task of the sensor network shouldn't be failed by sensor nodes. The development of new links and routes to the data collection base stations must be accommodated by MAC and topology control algorithms if several nodes fail.

**F. Scalability:** In the sensing region, there may be tens of thousands or more sensor nodes placed. This enormous number of sensor nodes requires compatibility with any topology control mechanism. Algorithms for routing and controlling sensor networks must also be scalable enough to react to environmental changes. Most sensors can remain in a sleep state until an event happens, with data from the few remaining sensors having coarse quality.

**G. Security:** For some applications, communication between nodes needs to be sufficiently protected to preserve confidentiality. It is mostly needed in military applications, such as battlefield monitoring or military operations.

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**Figure 3.1 Challenges of WSN’s**

**1.4 APPLICATIONS OF WIRELESS SENSOR NETWOR**K

1. Military applications
* Military Command
* Control
* Communications
* Computing
* Intelligence
* Battlefield Surveillance
* Reconnaissance
* Targeting Systems
1. Area monitoring
* In area monitoring, sensor nodes are placed over an area that needs to have a certain occurrence observed.
* When the sensors pick up the monitored event (heat, pressure, etc.), one of the base stations reports it and subsequently performs the necessary action.
1. Transportation
* In order to feed transport models and warn drivers of congestion and traffic issues, real-time traffic information is being gathered.
1. Health applications
* Integrated patient monitoring, diagnostics, drug administration in hospitals, tele-monitoring of human physiological data, and tracking and monitoring of doctors or patients inside a hospital are a few of the health applications for sensor networks.
1. Environmental sensing
* Oceans
* Glaciers
* Forests Etc.
* Air Pollution Monitoring
* Forest Fires Detection
* Greenhouse Monitoring
* Landslide Detection
1. Structural monitoring
* Wireless sensors are useful for monitoring infrastructure like bridges, flyovers, embankments, tunnels, and more. They also make it possible for engineering practises to remotely monitor assets.
1. Industrial monitoring
* For machine condition-based maintenance (CBM), wireless sensor networks have been created because they provide significant cost reductions and allow for additional functionality.
1. Agricultural sector
* Irrigation automation provides more efficient water use and decreases waste, freeing the farmer from the maintenance of wiring in a challenging setting.

**CONCLUSION**

Many aspects of human life have benefited from WSNs. Sensor nodes are able to communicate and react too many attributes because of sensing technology. The purpose of this Chapter is to provide an overview of several WSN-related topics. The WSN has been briefly introduced, and special issues covered. Applications and security concerns in WSN have both been identified. Following that, a table comparison of the various simulation software was provided. The research conducted for this paper concludes that WSN has revolutionised practically every industry in the modern period. It offers tremendous potential for investigation into many facets of human life.

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