# Routing Protocols - based Clustering in WSN: An Overview


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***Abstract*— Wireless Sensor Network (WSN) is a group of small nodes that have small energy. WSN become important element of the new infrastructure of the communication. So, it has become key component of the public systems in many applications such as "agriculture", "factory monitoring", "health care" and "fire track". WSN has several benefits such as "low cost", "small size", "self-organized" and can be routed using routing protocols in WSNs. But, WSNs have several limitations that may effect on some applications such as "low battery", "short lifetime" and "sensor energy consumption". Energy is essential term in WSN. The design of WSN depend on "energy efficiency". The key aim is to enhance WSN's lifetime is a node energy consumption. There are many energy efficiency approaches are presented to reducing the "energy consumption", "improve network performance" and "increase network lifetime". This study focusing on the routing protocols for the WSN.**



***Keywords*— *LEACH protocol, clustering based Protocols WSN Life time, Energy Consumption, WSN.***


## I. INTRODUCTION

WSN has become a significant part of recent communication for the "21st century". Wireless sensor networks (WSNs) are becoming available by low-cost devices, advanced programming tools and energy efficient radio interfaces [1]. Wireless Sensor Networks (WSNs) involve large number of small that can be sense areas remotely. Then sensors gather data and send these data to base station (BS). WSNs can be used in many jobs due to capabilities to adaptability and low cost in different fields: such as weather predicting, smart traffics and commercial [2]. A sensor node (SN) is a node in a sensor network that is can executes several tasks such as processing, collecting main information and sending this sensitive information to base station through other nodes in the network. These nodes are employed randomly on specific area.

WSNs is important field for research due they are employed nowadays in many applications such as agriculture, environment, transport system, military systems, industry, healthcare and underwater. To allows larger monitoring with better accuracy may need big amount of sensors, but this case can be cause more cost because impossible to charge or replace batteries in particular environment [3]. Because SNs capable of gathering and transmitting data to other SNs or to BS, and these processes (sending and receiving) the information need more energy consumption by the nodes.

So, the good method to prolong the life of WSN is by selecting good paths to transfer the information. This leads to reduce the consumption of energy along the route. This results balance the load between the nodes. In WSNs, BS can be fixed or mobile node that the sensor network connects to it via existing infrastructure for communication or via the Internet. Critical parameters characteristic in WSNs are the power consumption and maximize lifetime of the network to get well deliver information to their destination. And the most important parameter is routing protocols [4].

Energy efficiency problems should be taking in the account with application specifications, and select the routing protocols determined by specifications of the application and depend on the network architecture. The clustering techniques applied for routing in WSNs [5-6]. A sink (BS) work as interface between "users and the network. SNs can connect using radio signals. And they are equipped with "sensing" and "computing devices", "radio transceivers" and "power components" [7].

## II. STRUCTURE & TYPES OF WSN

### A. Wireless Sensor Node

The components used to make a wireless sensor node are different units like sensing, processing, transceiver & power. It also includes additional components that depend on an application like a power generator, a location finding system & a mobilizer. Generally, sensing units include two subunits namely ADCs as well as sensors. Here sensors generate analog signals which can be changed to digital signals with the help of ADC, after that it transmits to the processing unit. Generally, this unit can be associated through a tiny storage unit to handle the actions to allows the "sensor node" work with the other nodes. The sensor node can be connected to the network with the help of a transceiver unit. In the sensor node, one of the essential components is a sensor node. The power-units are supported through power scavenge units like "solar cells" [8].

### B. WSNs Structure

The structure of WSN mainly comprises various topologies used for radio communications networks like a star, mesh, and hybrid star. These topologies are discussed below in brief [9].

***Star Network***: the communication topology like a star network is used wherever only the base station can transmit or receive a message toward remote nodes. The advantages of this network capable of keeping the power utilization of remote nodes to a minimum and less latency.

***Mesh Network***: this kind of network permits to the broadcast of the data from one node to another within the network that is in the range of "radio transmission". When a node needs to transmit an information to other node and that is out of the range of radio communications. Main benefit of a mesh network is scalability and redundancy. When an individual node stops working, a remote node may converse to other type of node within the range, then forwards the message toward the preferred location. The main drawback of these network is power consumption for the network nodes that execute the communications like multi-hop are usually higher than other nodes.

***Hybrid Network***: is a hybrid between two networks such as "star" and "mesh" which is give a strong and flexible communications network and give minimum "power consumption" of maintaining the of wireless sensor nodes. This is implemented topology through using standard mesh networking called ZigBee.

### C. Types of sensors

Sensor can be defined as a device which it can provides an output via sensing the alterations or change in quantities, sizes, amounts, events or measures. Sensors, in common, are called as the devices that create an electrical or optical signal as output equivalent to the differences in the input levels. Sensors do not similar, they are different as a sensor designed for temperature to produces voltage as output depend on the changes on the input temperature. There are different types of sensor can be sensing in several fields working with numerous applications. Sensors mostly can be categorized into analog and digital sensors. For examples for types of sensors that are often used in greatest applications are: pressure sensors, temperature sensors, IR sensors, ultrasonic sensors, proximity sensors and Smoke or Gas Sensors [13].

### D. Types of Wireless Sensor Network

Types of networks are decided determining on the environment and can be deployed: (terrestrial WSNs, underground WSNs, underwater WSNs, multimedia WSNs, mobile WSNs). Terrestrial WSNs can connecting efficiently to base stations (BSs). This type of these networks consist hundreds or thousands of sensor nodes (SNs). The "underground" WSNs are expensive than the terrestrial WSNs in deployment, maintenance, and planning. Underwater WSNs consist of several sensor nodes deployed underwater. Vehicles working underwater are used for collecting data from sensor nodes that are deployed underwater. Multimedia WSNs have been proposed to monitoring the actions such as imaging, video, and audio. Mobile WSNs (MWSNs) involve of a group of SNs that can be moved and can be interacted with the physical environment. The advantages of MWSNs compared with fixed WSNs include best coverage, good energy efficiency [10].

## III. WSN CHARACTERISTICS & TECHNOLOGIES

A protocol of a communication can be defining the rules of "how data are exchanged". Common protocols of a communication for WSNs are "Wi-Fi, Bluetooth, and ZigBee". Table 1 present these protocols. A good WSN design dependable range of communication that is essential to establish and maintain within the WSN [10-13].

Table 1. communication protocols of WSNs

| Communication Protocols | Description |
|---|---|
| **Wi-Fi** | Wi-Fi is good for exchange data.<br>Power supply is not a challenge, such as devices in household.<br>Operate at 2.4 GHz.<br>"Lower the radio frequency". |
| **Bluetooth** | "Operate at 2.4 GHz".<br>"Lower the radio frequency.<br>Bluetooth is a good option with low power consumption, short communication range, and high data rate. |
| **ZigBee** | ZigBee requires even less power than Bluetooth and has a longer communication range, but it is quite slow.<br>ZigBee is good suitable for communicating data from sensors in WSN field.<br>ZigBee radios can operate at 2.4 GHz, 900 MHz (US), and 868 MHz (Europe), |

### A. Characteristics of WSN

The characteristics of WSN are [14]:

- The sensor nodes work with batteries.
- "Mobility" of nodes.
- "Heterogeneity" of nodes
- Large scale of distribution (Scalability).

- Ease to use.

### *B. Benefits of Wireless Sensor Networks*

The benefits of WSN are [14]:

- Suitable for the places cannot be reached.
- Flexible (when need to add workstation).
- Inexpensive.
- It allows run new devices at any time.

### *C. Limitations of Wireless Sensor Networks*

WSNs have several limitations such as [16]:

- Limit storage capacity.
- Limit processing power.
- Working in short communication range.
- Needs minimal energy.
- Working based on batteries with a finite lifetime.

## IV. Application & Design Issues WSNs

WSNs allow novel applications and need advance models for protocol design because they have numerous challenges such as energy consumption, computational and a coverage [3],[15]. The applications of wireless sensor networks mainly include:

- "Military" Applications
- "Health" Applications
- "Environmental" Applications
- "Home" Applications
- "Commercial" Applications
- "Area monitoring"
- "Health care monitoring"
- "Environmental/Earth sensing"
- "Air pollution monitoring"
- "Forest fire detection"
- "Landslide detection"
- "Water quality monitoring"
- "Industrial monitoring"

Important issues for design of WSNs architecture include: Energy Consumption, Localization, Coverage, Clocks, Computation, Cost of Production, Design of Hardware, Quality of Service [16].

***Energy Consumption***: in WSN, power consumption is one of the main issues. The battery is used by equipping with sensor nodes. The energy consumption mainly depends on the sensor nodes' operations like communication, sensing & data processing. Throughout communication, the energy consumption is very high. So, energy consumption can be avoided at every layer by using efficient routing protocols.

***Localization****:* for the operation of the network, the basic, as well as critical problem, is sensor localization. So sensor nodes are arranged in an ad-hoc manner so they don't know about their location. The difficulty of determining the sensor's physical location once they have been arranged is known as localization. This difficulty can be resolved through GPS, beacon nodes, localization based on proximity.

***Coverage***: the sensor nodes in the wireless sensor network utilize a coverage algorithm for detecting data as well as transmit them to sink through the routing algorithm. To cover the whole network, the sensor nodes should be chosen. There efficient methods like least and highest exposure path algorithms as well as coverage design protocol are recommended.

***Clocks***: in WSN, clock synchronization is a serious service. The main function of this synchronization is to offer an ordinary timescale for the nodes of local clocks within sensor networks. These clocks must be synchronized within some applications like monitoring as well as tracking.

***Computation***: the computation can be defined as the sum of data that continues through each node. The main issue within computation is that it must reduce the utilization of resources. If the life span of the base station is more dangerous, then data processing will be completed at each node before data transmitting toward the base station. At every node, if we have some resources then the whole computation should be done at the sink.

***Production Cost***: in WSN, the large number of sensor nodes is arranged. So if the single node price is very high then the overall network price will also be high. Ultimately, the price of each sensor node has to be kept less. So the price of every sensor node within the wireless sensor network is a demanding problem.

***Hardware Design****:* when designing any sensor network's hardware like power control, micro-controller & communication unit must be energy-efficient. Its design can be done in such a way that it uses low-energy.

## V. Energy Consumption and Conservation with Routing for WSNs

The energy limitation due the small battery powered nodes consider main problem. More effort is present to decreasing the power consumption. Many applications depending WSNs need deploying thousands of sensor nodes in remote locations randomly, and this require replace the battery. So, energy conservation is very important for sensor networks. when all sensor nodes send packets to the BS directly, then the nodes that are more far from the BS will die quickly. But, when sending packets via multiple hops, sensors nearest to the BS may die quickly. "Energy efficiency" is a significant factor in the lifetime of WSNs. Therefore, design good algorithms with energy efficient is very important [17] - [20].

No infrastructure in WSNs and "wireless links" are unreliable. So, sensor nodes may fail. "Routing protocols" become more important to "energy saving requirements". Main routing protocols proposed for WSNs can be divided into several categories as shown in Table 2. [21] - [26].

Table 2: Routing Protocols in WSN

| Category | Description | Existing Protocols |
|---|---|---|
| **Flat Protocols** | Flat routing protocol executed by routers. All routers are as peers. The role of sensor nodes is same. | RIP, IGRP, OSPF, EGP, EIGRP, BGP, IS-IS [29] |
| **Hierarchical Protocols** | Clustering is an energy-efficient communication protocol. It enables the sensors to send their sensed data to BS. A network is divided into many clusters. Each cluster must have cluster head (CH). CH is responsible for data transmission of all sensors in its cluster to BS. | LEACH, PEGASIS, HEED, TEEN, APTEEN |
| **Location-Based Protocols** | Sensor nodes are addressed their locations. Location information obtained by calculate the distance between two particular nodes so that energy consumption can be estimated. | MECN, SMECN,GAF, Span |

WSNs are becoming one of the "demanding platforms", via sensor nodes are sensing and monitoring the environmental conditions and transfer the data to the BS via multi-hop routing. The "sensor nodes" have several energy problems. And these problems cause failure and delay in data transmission in the WSNs fields. To reduces total energy usage by applied clustering-based routing protocol that balance the load between the nodes in the network at various points in time. [27] Proposed "Low-Energy Adaptive Clustering Hierarchy" (LEACH). LEACH used randomized rounds of "cluster-heads" to balanceing the distribute the energy load among the sensors in the network. Lifetime of the network still as an important requirement in WSNs. Clustering is a main method to enhancing network lifetime [28-33].

## VI. Discussion & Future of WSN technology

Despite the many limitations and problems that wireless sensor networks suffer from, such as lack of memory, lack of processing and their dependence on battery as a source of energy, these networks continued to grow and develop rapidly in most areas of life, as they entered into industrial, medical, agricultural and military applications. The demand for this type of network has increased in recent times due to its small size, cheap price and ease of deployment. Many and varied solutions have emerged trying to address some of the problems of this type of network, the most prominent of which is reducing energy expenditure and reducing the delay in the arrival of information from the sender to the recipient. The most important way to reduce energy expenditure and the speed of information arrival is good routing of the baggage and choosing the best path. Quite a few set of routing protocols operating on wireless sensor networks appeared, including protocols that relied on direct transmission (one hop) between the sender and the recipient, but this type causes energy waste and the death of the node quickly, which leads to a reduction in network life. And protocols appeared that work on the principle of multiple jumps to reach the goal, and this greatly reduced energy expenditure and delay. One of the best and most popular routing protocols that improved energy expenditure, reduced delay and increased network life, are the protocols that have relied on clustering methods, where the network is divided into groups according to certain criteria, and each group is elected to a president who receives information from the members and processes it and then sends it to the base station. LEACH protocol is the first clustering algorithm adopted and has largely addressed the problem of power drainage. However, this protocol suffers from some problems. Many papers have appeared that tried to improve the functioning of this protocol and find solutions to the problems it suffers from.

1) This study provides a brief overview for researchers and those interested in the field and gives a complete perception of wireless sensor networks.

2)This search addresses the most important problems and provides the best solutions.

3)The study focuses on directing messages between the sender and the recipient. This study conceives of researchers on the importance of routing protocols and draws attention to the method of grouping and its importance in increasing the lifetime of the network.

4)This study considers guiding the use of aggregation a fertile area for researchers to work on improving energy consumption, reducing delay and increasing network life.

## VII. Conclusions and Future work

Numerous applications depending on WSNs, so, the issue of "power consumption" is important for WSNs particularly increase the lifetime of WSNs. In this study, we have brief and classified many approaches for classifying energy efficiency problem in WSNs. And try to present these methods which less energy consume. Routing is the important topic of the network, and the main problem to protocol design in WSNs is to get the better Protocols reliability and to minimize a delay time and the packet retransmission. we have survey on the hierarchical routing protocols for WSNs. The key challenge in designing algorithms for WSNs forwarding is a reliable transmission of packets with smallest delay, energy consumption, and maximum throughput. Numerous systems like ("LEACH, TEEN") are proposed.

Future studies should be focus on routing protocols to handle the quality of applications. Clustering algorithms are significant function of designing routing protocols in WSNs that are given good packet transformation with low energy consumption, "low communication overhead", "smallest delay" and "throughput". Future study should focus on protocols that target heterogeneous structures to handle applications with different requirements of quality of service. Clustering is a major task in designing forwarding algorithms in future. Sensors can enhance the world in multiple fields such as diagnostics in medical applications, improved health and safety and security for people. Sensors can use for travelling the space.

The main approaches now are being developing for "intelligent systems" that, self-correcting, and self-modifying. Suggests for future sensors ability for scheme to:

- See (photonic technology).
- Feel (physical measurements).
- Smell (electronic noses).
- Hear (ultrasonic).
- Think/communicate (smart electronics and wireless).
- Move (sensors integrated with actuators).

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