Hierarchical Routing Protocols In Wireless Sensor Networks : A Survey

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Abstract- *In recent years, wireless network sensor has received a lot of attention from Community research and real users. Also, so many improvements in micro-electro-mechanical system, digital electronics and wireless communication technologies are responsible for the development in the use of wireless sensor networks. Wireless sensor networks consist of a large number of inexpensive and small devices called sensory nodes. Wireless touch applications include a wide range of scenarios. The network consists of a significant number of nodes located in a large area where all nodes are not directly connected. The data exchange is then supported by multihop communication. Routing is a critical issue that needs to be considered because it has a direct impact on the efficiency of wireless sensor networks. The routing protocol is responsible for detecting and maintaining network paths. Several protocols have been proposed to address. this problem, as well as reduce energy consumption and extend the life of the sensor node in the wireless networks sensor. This document provides a detailed overview of the hierarchical routing protocol for Wireless sensor networks.*

I. INTRODUCTION

Wireless sensor network refers to a series of spatially special Sidetracking sensors for monitoring and recording the physical and environmental conditions and the Organization of the data collected in a central area. Wireless sensor networks measured environmental parameters such as temperature, pollution, humidity, sound, wind speed, direction and pressure and so on. WSN. It was originally designed to support military action, but its use has spread to health, transport and many other consumer and industrial areas. Wireless sensor networks include instead of hundreds of thousands of nodes. The device includes a sensor node radio transmitters and antennas, microcontroller, interface circuit and power supply (usually batteries). The size of the sensor nodes must be in the range of the size of a shoebox-sized dust particle. As a result, the prices vary according to the functional parameters of the sensor of the energy consumption, calculate the speed, bandwidth and memory [1].

Wireless sensor network is a wireless network that is configured and equipped to monitor physical or environmental conditions and cooperate in the transfer of data over the network to the location of the primary or the place where you can see and analyze the data received. Functions of the handset or the base station is similar to the interface between the user and the network. By injecting the results of the consultation and the collection of the receiver, you can retrieve the necessary information from the network. Wireless sensor networks typically contain hundreds of sensors. Nodes can communicate with each other using radio signals. Wireless sensor nodes are equipped with sensors and devices, radio transmitters and computer power components. Individual nodes in wireless sensor networks are inherently limited: the processing speed, memory capacity and bandwidth are limited. After you have deployed the sensor nodes are auto-organization of the proper network infrastructure, often with the help of multihope and its sensor communication on Board will begin to collect the information of interest. Wireless sensor devices also respond to queries sent from a Web server control to perform any specific instructions or provide examples of remote sensing. The operating mode of the device node is continuous or event-driven. Wireless device networks have new applications enabled and, thanks to varied limitations, need unconventional forms for the planning of the protocol. attributable to would like for lower complexness of the device and low energy consumption i.e. long network life, the right balance between communication and signal/data process capabilities should be found. This has contributed to important efforts over the past ten years in analysis activities, standardization processes and industrial investment within the space. Currently, most of the WSNS analysis focuses on coming up with algorithms and protocols for energy and computing potency, whereas the applying domain is restricted to easy chase and coverage knowledge.

Data collected by device nodes measure used for crucial choices, therefore it's necessary that knowledge is collected from every node within the network at the bottom station. Routing is one in every of the foremost necessary challenge challenges that directly have an effect on WSNs performance. numerous WSNs parameters embody packet size, per energy package, network life, energy and

responsibility, measurability, total range of nerve nodes, average packet latency, packet transfer quantitative relation, energy dissipation, distance and information measure, etc.

II. APPLICATION OF WIRELESS SENSORS NETWORK

Wireless device networks have dilated big discernibility attributable to their flexibility in finding issues in numerous applications and have the potential to alter human lives in many ways. WSNS has been with success applied to several totally different application domains, such as:

1. Military Application:-The original WSNs is intended for military use. Wireless device networks are a part of military command, police work, target systems, communication, computing, tract and intelligence activity.

2. Transport:-Real-time traffic data is collected by WSNs for later feed models of transportation and alarms-driven congestion and traffic issues.

3. Area Monitoring:-In regional watching, sensory nodes measure deployed in one space, within which case some phenomena are going to be monitored.

4. Health Applications:-Some of the health applications of sensing element networks square measure support disabled people's interfaces, integrate patient, Administration hospital remedy, diagnosis, observance of physiological knowledge, observance and observance of the patient's condition, also as doctors.

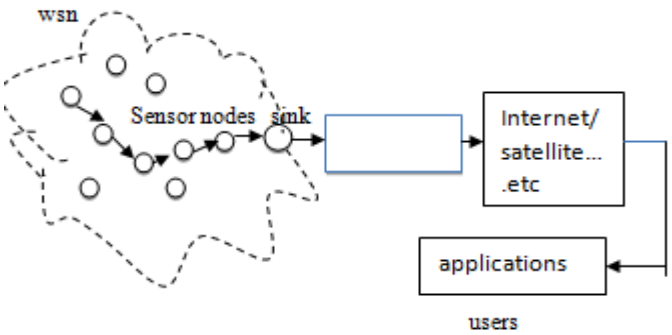

Fig.1. A Typical WSNs

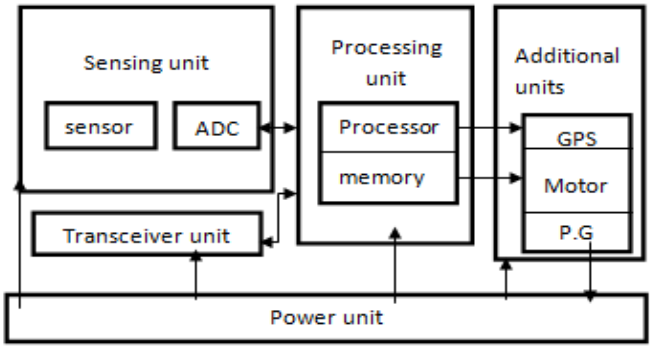

Fig.2.Structure of sensor node

5. Industrial Supervision:-WSNs is developed to take care of mechanical conditions as they supply nice savings and supply new options.

6. Structural Supervision:-Wireless sensors can even monitor movement inside buildings and infrastructure (such as bridges, overpasses, tunnels, etc.), sanction native engineering practices to remotely management the property while not having to access a group of internet sites.

7. Agriculture Industry:-Using wireless sensory networks to shield farmers from the setting in maintaining electrical installations. Irrigation automation makes it a lot of economical to use water and reduces waste.

8. Environment Research:-In environmental readings, volcanoes, forests, oceans, icebergs and different areas, as observance of pollution. inexperienced Housing observance hearth detection Country aspect review

III. ROUTING CHALLENGES AND DESIGN ISSUES IN WSNs

Many of the challenges of deploying sensory networks square measure those within the wireless network ad cluster. The sensing element node communicates via wireless. Losing lines while not infrastructure. Another challenge is with the energy that has node with restricted, sometimes non-renewable, sensors. for optimum lifetime of the network, the protocol should be designed from the terribly starting, progressing to with efficiency manage energy resources. Below, summarizes a number of the routing challenges and style problems which will have an effect on the WSNS producing method[6].

1. Fault Tolerance:-Sensor nodes measure vulnerable and infrequently applied in a very dangerous setting. The node fails for a few reason (such as a retardant with hardware or physical damage) or expend energy offer. Protocols within the sensing element network ought to be able to notice these

failures as shortly as attainable. Then, maintaining the perform of the network is strong enough to handle a comparatively massive failure.

2. Production. Price:-Since several readying models think about sensory nodes to be disposable devices, sensory networks is computed mistreatment ancient strategies of gathering data only if individual sensory nodes will turn out rock bottom.

3. Transmission Media:-Communication between nodes is typically meted out by mistreatment radio communication on a well-liked school of thought band. However, some network sensing element uses optical or infrared communications, that incorporates a large advantage and nearly no interference.

4. Scalability:-The size of the sensing element network varies from many nodes to probably thousands. The introduction of density is variable. so as to gather high-resolution knowledge, a density node will reach levels of nodes inside the vary of transmission with many thousand neighbours. Protocols within the sensing element network ought to be ascendible at these levels and maintain adequate performance.

5. Hardware Limitations:-Secondly, every sensing element node has these units, a transmitter, a process unit and an influence supply. Initially, nodes will have many units in a very sensing element of extra devices, love system localization, modify the situation of the routing. However, every extra feature comes with further prices and will increase the strength and physical size of the fixtures. As a result, extra functionalities ought to stay balanced against prices and low energy.

6. Power Consumption:-Many of the challenges of the sensory network revolve round the restricted power of resources. Limit size of the battery size node. computer code and hardware style need careful thought of the problem of effective use of energy. knowledge compression will scale back the number of power used for radio transmissions, however it is wont to calculate or filter extra energy. Energy policy additionally depends on the appliance.

7. Mobility Customization Option:-Different WSNs programs would like nodes to upset their quality, receiver quality or event quality. Routing protocols ought to offer adequate support for these moves.

8. sensing element configuration :-Although WSNs has evolved in some ways, it continues to be joined to a restricted network access in terms of energy, process power, memory and communication capabilities. Energy consumption is incredibly necessary, and this shows an oversized variety of technologies that reach the lifetime of the network. Maintenance topology is one in every of the necessary topics in reducing energy consumption in WSNS.

IV. ROUTING PROTOCOLS IN WSNs

The wireless sensing element network runs underneath a high resource restriction setting, and it desires effective potential. It appears terribly tough to determine a worldwide schema addressing all nodes within the network. this will result in extra overhead networks. additionally, every application has completely different topologies. Therefore, supported the topology application changes. every node collects nearly identical knowledge, the information redundancy is high, that the routing ought to be affected. This redundantion is intended to extend the energy and information measure use. For these reasons, several routine techniques are planned for sensory networks. These routing techniques take into consideration the characteristics of sensing element networks, and additionally bring some necessary ways into the WSNs routing. The routing protocol is the appropriate path for the procedure for selecting data from source to destination. If the routing is confirmed, the process encounters several difficulties, depending on the type of network, channel characteristics and performance pointers, and the data that the sensor perceived in WSNs usually forwards the base station that connects the sensor. Network and other network data collection, analysis, and take action accordingly. In very small sensory networks, base stations and sensory nodes are so close that they can communicate directly, but rather it is a single hop communication, but in most WSNs the area is so large that it takes thousands of sensors in a node, which requires multi-hop Distributed communication because most of the sensor nodes are away from the receiver node. One preferred communication is called the direct communication and multi-hop distributed communication called Indirect communication. Multi-Hop distributed sensor node not only produces and transmits data, but also serves as a path to the base station for other sensory nodes. The process of finding the appropriate path from the source node to the target node of the routing name. This is the primary responsibility of the network layer[7].

A.Network organization based routing protocols

Following protocols are based on the network organization of wireless sensor network.

1. Flat topology :- Flat topology treats all nodes equally. Flat topology is mainly for homogeneous networks where all nodes

are of same characteristics and have same functionality. Examples are:

• Gradient based routing (GBR)
• COUGAR
• Constrained anisotropic diffusion routing (CADR)
• Rumor routing (RR)

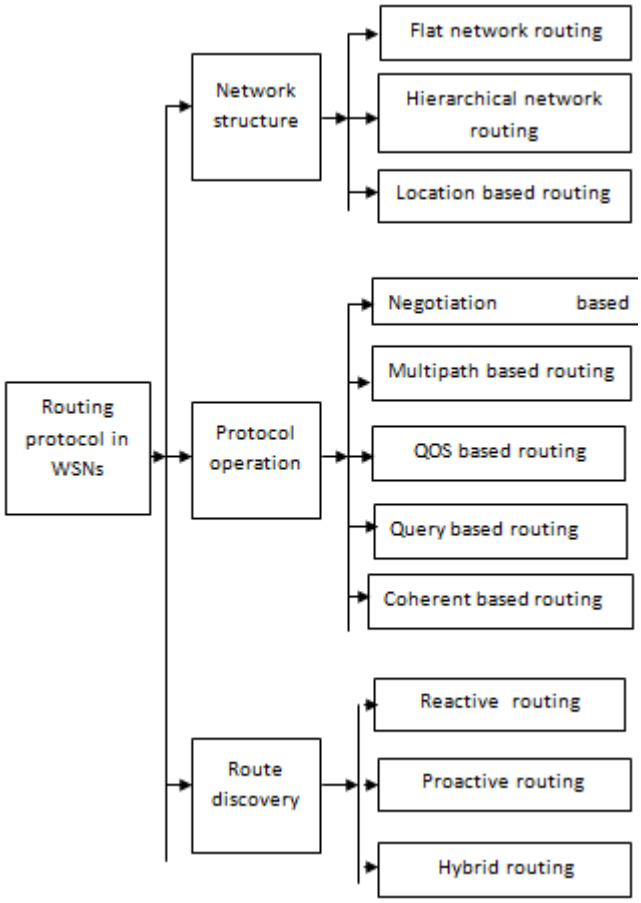

Fig.3.Categories of routing protocol

2. Hierarchical based routing :-Mostly heterogeneous networks apply hierarchical routing protocols where some nodes are more advance and powerful than the other nodes, but not always this is the case, sometimes in hierarchical (clustering) protocols sometimes the nodes are grouped together to form a cluster and the cluster head is assigned to every cluster, which after data aggregation from all the nodes, communicates with the base node .The clustering scheme is more energy efficient and more easily manageable. Examples are:

- Threshold sensitive energy efficient sensor network (TEEN)
- Adaptive threshold sensitive energy efficient sensor network (APTEEN)
- Low energy adaptive clustering hierarchy (LEACH)
- The power-efficient gathering in sensor information systems (PEGASIS)
- Virtual grid architecture routing (VGA)
- Self-organizing protocol (SOP)
- Geographic adaptive fidelity (GAF)

3.Location-based routing (geo-centric) :- In location based routing the nodes have capability to locate their present location using various localization protocols. Location information helps in improving the routing procedure and enables sensor networks to provide some extra services. Examples are:

- SPEED
- Geographical and energy aware routing (GEAR)
- SPAN

B. Operation based routing protocols

According to the operational basis the routing protocols are classified as:

1. Multi-path routing protocol :- Multi-path routing protocols provide multiple paths for data to reach the destination providing load balancing, low delay and improved network performance as a result. The multiple routing protocol also provide alternate path in case of failure of any path. Dense networks more interested in multiple path networks. To keep the paths alive some sort of periodic messages has to a send after some specific intervals hence multiple path routing is not more energy efficient. Multipath routing protocols are:
• Multi path and Multi SPEED (MMSPEED)
• Sensor protocols for information via negotiation (SPIN)

2. Query based routing protocol :- These type of routing protocols are mostly receiver-initiated. The sensor nodes will only send data in response to queries generated by the destination node. The destination node sends query of interest for receiving some information through the network and the target node sense the information and send back to the node that has initiated the request. The examples are:

- Sensor protocols for information via negotiation (SPIN)
- Directed diffusion (DD)
- COUGAR

3. Negotiation based routing protocols :-In these types of protocols to keep the redundant data transmission level at

minimum, the sensor nodes negotiate with the other nodes a and share their information with the neighbouring nodes about the resources available and data transmission decisions are made after the negotiation process. Examples are :

- Sensor protocols for information via negotiation (SPAN)
- Sequential assignment routing (SAR)
- Directed diffusion (DD)

4. QoS based routing protocols :- To get good Quality of Service these protocols are used. QoS aware protocols try to discover path from source to sink that satisfies the level of metrics related to good QoS like throughput, data delivery, energy and delay, but also making the optimum use of the network resources. Examples are:

- Sequential assignment routing (SAR)
- SPEED
- Multi path and Multi SPEED (MMSPEED)

5. Coherent data processing routing protocol :-In coherent data processing routing protocol the nodes perform minimum processing (time stamping, data compression etc.) on the data before transmitting it towards the other sensor nodes or aggregators. Aggregator performs aggregation of data from different nodes and then passes to the sink node.

C. Route discovery based routing protocols

Routing protocols are classified on the basis of process they used to discover the routes.

1. Reactive protocols :- Reactive routing protocols do not maintain the whole network topology they are activated just on demand when any node wants to send data to any other node. So, the routes are createdon demand when queries are initiated.

2. Proactive protocols :- They are also known as table driven routing protocols, because they maintain the routing tables for the complete network by passing the network information from node to node and the routes are pre-defined prior to their use and even when there is no traffic flow.

3. Hybrid routing protocols :- Hybrid Routing Protocols have the merits of proactive and reactive routing protocols by neglecting their demerits.

V. HIERARCHICAL ROUTING PROTOCOLS

The stratified routing supported agglomeration reduces the energy consumption in wireless device networks. The nodes unit classified into clusters. The cluster head selection relies on wide range of election algorithms. the higher level of communication is completed through these heads looking forward to application and area of coverage these, the agglomeration are usually extended to higher levels. among that the routing established between the availability and sink nodes relies on the routing table. The stratified routing in addition reduces the dimensions of routing table provides stability. as a result of agglomeration technique, the traffic overhead is in addition reduced. Low energy sensors are usually accustomed perform the sensing task and high energy sensors accustomed technique and send data to base station[11].

Characteristics of Hierarchical Based Routing Protocols

- Hierarchical primarily based routing protocol usually divided in to several cluster to chop back the energy consumption among the wireless device network.
- Hierarchical routing relies on the native topology information.
- Hierarchical primarily based routing protocol is use multi-hop communication mode for saving communication energy.
- It has data primarily based, minimize data transmission and reduce information redundancy through data fusion.
- This quite routing protocols uses distributed operation mode.
- The quite routing mechanism ought to have some fault tolerance.

Advantages of hierarchical routing protocols

- No mounted infrastructure is needed nodes are usually deployed in any manner.
- Non-Accessible Places like forests, mountains, crushed areas are usually fitly reached.
- Cheap and fewer wiring.
- New devices are usually extra instantaneously with versatile management because of multi-level protocols.
- A centralized system is usually accustomed management the data from the nodes in operation behind the sink node.

1.<u>Low Energy Adaptive Clustering Hierarchy(LEACH)</u> :-

Low-energy adaptive agglomeration hierarchy (LEACH) may be a routing rule designed to collect and deliver data to the data sink, typically a base station. the foremost objectives of LEACH are:

- Extension of the network period
- Reduced energy consumption by each network device node
- Use of information aggregation to chop back the quantity of communication messages

To achieve these objectives, LEACH adopts a stratified approach to rearrange the network into a gaggle of clusters. each cluster is managed by a selected cluster head. The cluster head assumes the responsibility to carry out multiple tasks. the first task consists of periodic assortment of information from the members of the cluster. Upon gathering the data, the cluster head aggregates it in a shot to induce obviate redundancy among involving values. The second main task of a cluster head is to transmit the mass data on to rock bottom station over single hop. The third main task of the cluster head is to create a TDMA-based schedule whereby each node of the cluster is appointed an interval that it'll use for transmission. The cluster head announces the schedule to its cluster members through broadcasting. to chop back the prospect of collisions among sensors within and out of doors the cluster, LEACH nodes use a code-division multiple access–based theme for communication. the essential operations of LEACH unit organized in a pair of distinct phases. the first section, the setup section, consists of two steps, cluster-head selection and cluster formation. The second section, the steady-state section, focuses on data assortment, aggregation, and delivery to rock bottom station. the amount of the setup is assumed to be relatively shorter than the steady state section to cut back the protocol overhead.

At the beginning of the setup section, a spherical of cluster-head selection starts. to create a choice whether a node to become cluster head or not a threshold T(s) is that's as follows:

$$T(n) = \begin{cases} \left[\frac{p}{1-p\left[r \bmod \left(\frac{1}{p}\right)\right]}\right] & if\ n \epsilon G \\ 0 & otherwise \end{cases}$$

--------(1)

Where r is the current round number and G is the set of nodes that have not become cluster head within the last 1/p rounds. At the beginning of each round, each node which belongs to the set G selects a random number 0 or 1. If the random number is less than the threshold T(n) then the node becomes a cluster head in the current round.

2. Threshold sensitive energy efficient sensor network (TEEN) :- TEEN protocol which stands for Threshold sensitive Energy Efficient sensor Network is a reactive protocol. In this type of sensor networks, the sensor nodes uninterruptedly sense the signal and identify the signal from the nature and communicate the data or value shortly to the receiving station whenever the data limitation surpasses the threshold value which was declared or specified by the user. With this type of feature, these sensor models and network models are used highly for critical applications which runs on the basis of time or time dependent applications in this scheme, at every cluster change time, in addition to the attributes, the CH broadcast the following message to its members:

- **Hard threshold (HT):** This is a threshold value for the attributes which were sensed and established for reactive networks. It is the absolute value of the attributes, from where the node senses the present particular value should switch on its transmitter and report the data to its CH.
- **Soft threshold (ST):** This is the value that was observed which is very small in the value attribute which triggers the node in the on mode of its transmitter and transmits the data.

The HT tries to reduce the number of transmission by allowing the nodes to transmit only when the sensed attribute is in the range of interest. The ST further reduces the number of transmissions by eliminating all the transmissions which have otherwise occurred when there is little or no change in the sensed attribute once the HT. Advantage of this scheme is it is eminently suited for time critical data sensing application. Energy consumption in this scheme can be much less than in proactive network because data transmission consumes more energy than data sensing and in this scheme data transmission is done less frequently[3].

3. Adaptive threshold sensitive energy efficient sensor network (APTEEN) :- A reactive network protocol known as APTEEN is reconciling periodic threshold sensitive energy economical detector network protocol. Hybrid Networks mix the simplest options of proactive and reactive networks, whereas minimizing their drawbacks. Nodes in such a network transmit information sporadically at comparatively longer intervals whereas at identical time transmitting information once the perceived worth goes on the far side its threshold. Thus, the detector energy is employed terribly with efficiency by reducing the quantity of transmissions of noncritical information. The user will modification the regularity,

threshold value(s) and therefore the parameter to be perceived in several regions. This network will emulate either the proactive or the reactive network by suitably dynamic the regularity or threshold values. Thus, this network is utilized in any style of application by fitly setting the varied parameters. However, this flexibility and flexibility will increase the complexity at the detector. Here a brand new protocol APTEEN (Adaptive Periodic Threshold-sensitive Energy economical sensor Network Protocol) is introduced for hybrid networks. There area unit applications during which the user needs time essential data and additionally needs to question the network for analysis of conditions although aggregation time essential information. APTEEN is ready to mix the simplest options of proactive and reactive networks whereas minimizing their limitations to make a new style of network known as a hybrid network. In this network, the nodes not solely send information periodically, they also respond to sharp changes in attribute values. during this manner it works as a proactive protocol further as reactive protocol. In APTEEN, once the CHs area unit determined, the following events ensue in every cluster amount. The CH first broadcasts the subsequent parameter as,

- **Attributes:** this is often a group of physical parameters that the user is inquisitive about. Thresholds: This parameter consists of a HT and a ST. HT may be a worth of associate attribute on the far side that a node can be triggered to transmit information. ST may be a hard currency within the value of associate attribute which will trigger a node to transmit.
- **Schedule:** this is often a TDMA schedule, assignment a slot to every node.
- **Count time:** This is the maximum time period between two successive reports sent by a node. It can be a multiple of the TDMA schedule length, and it introduces the proactive component in the protocol.

4.The Power Efficient Gathering In Sensor Information System (PEGASIS) :- PEGASIS, is the family of routing and information gathering Contract with WSNs. PEGASIS main purpose is Firstly, the aim of the Protocol To achieve high energy efficiency levels, to expand the lives and Unique energy in all nodes of the network. Second, the purpose of the Protocol is Reduce the wait until the data is generated by the recipient. Model Network by PEGASIS adopts a set of homogeneous nodes geographical area. Nodes are expected to have global knowledge of other the sensor position. In addition, the ability to control your power to cover at a distance. These nodes may also be equipped with CDMA wireless transceivers. The nodes responsibility is the collection and transfer of data from the receiver, usually the wireless base Stand. The aim is to develop the direction of the structure and redundancy plan to reduce to transfer energy consumption and aggregated data from minimum latency to key while balancing the power consumption between sensor nodes. In contrast to other agreements, It relies on a hierarchical organization or a grouped network Data collection and dissemination in the PEGASIS uses a chain structure.

5.Virtual Grid Architecture Routing(VGA): - This protocol employs a mixture of data gathering and in-network handling in pursuance of maximum energy and network lifetime. The overall process divides into phases, namely, clustering and data routing. During the clustering phase, the nodes are assumed to be deployed in a fixed topography. Each cluster has its CH. The CH which aggregates the data is termed as the Local Aggregator(LA). A set of this Local Aggregators (LA) is chosen to perform inter-cluster aggregation, and its members are termed as the Master Aggregators (MA). The routing energy cost includes routing from LAs to MAs and relaying the aggregated data over the shortest paths from MAs to BS. Some strategies can be adopted in the data aggregation phase to acquire a simple, efficient and near-optimal solution. VGA proves beneficial in attaining maximum energy efficiency and network lifetime with minimum delays. Nevertheless, the issue of the lesser number of the local aggregator as the master aggregator is a complex issue.

6.Geographic adaptive fidelity (GAF):- GAF is a routing protocol based on position and energy perception in wireless sensor networks direction. Nodes use global positioning information by any system, such as GPS, received radio signal strength, etc. to find themselves with their nearest neighbors. Nodes consume energy when they transmit data, i.e., when data is sent and received. In the idle state, a certain amount of energy is used, but it is less than the active state. The energy use in idle mode can be saved by turning off the radio. In, the entire network in a virtual grid. The appropriate size of the grid is important because it has direct influence on network connectivity. If the grid is large, it is difficult to connect the entire network by only one node in each grid. The size of the grid (r) is based on the idea that any node can communicate with any other node that exists in the adjacent grid. Grid size r is,

$r \leq R/\sqrt{5}$ ….where R is the radio range

The different transition states used in GAF are sleeping state, Discovery state and Active state . Only one node per grid is in the active state and all others are in sleeping state in order to save the energy. The selection of node to be active depends on the residual energy of the nodes.

7.Self-Organizing routing protocol(SOP): The main objective of the proposed approach is to achieve a longer network lifespan. In each turn, BS assigns a root node and shows its path, either through the transmission path information from the BS a sensor node, or the same tree structure, is generated dynamically and individually by each node. In both cases, the proposed scheme can change the root and reconstruct the routing tree with the map

Delayed low power consumption. The proposed approach assumes that the system model has the following Performance:

- Sensor nodes are randomly distributed across the earth Square, and only one BD is used away from the area.
- Sensor node is fixed, and power is limited. After placement, they will keep working until their power is exhausted.
- Sensor nodes are location-aware. Sensor nodes can be used as the region setting function of the auxiliary mechanism (such as GPS or locale algorithm).
- Each node has its own unique identifier (ID).

VI. CONCLUSION

In the survey of several routing algorithms, the advantages and disadvantages of the protocol are determined by the possibility of balance load, scalability, time delay, maneuverability, data transfer and aggregated data. This comparison works, the main problem identified is that the lifetime network is reduced due to increasing energy consumption in the data transfer process. Energy transfer is the energy required to transmit data successfully. All these protocols focus on increasing the network of life. Original complexity Needs analysis. We need to have a more mature model that consumes less energy in the transmission process. The adaptive power of control in data is one of the future field research, and the shortest route algorithm is used for routing. This increases the node of life and indirectly reduces energy consumption.

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