A Comparative Study of Routing Protocols in Wireless Sensor Network

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ABSTRACT

Wireless Sensor Networks plays vital role in applications such as Precision Agriculture, habitat Monitoring, Environmental sensing etc. Now-a-days, every electronic device contains sensor which are associated with human life. Sensor nodes are used to sense, monitor, and coordinate the whole sensing area. WSN is a collection of sensor nodes and sensor nodes are used to take and give the detailed data about the surrounding environment and obtained information then transferred to the distant base station. The detailed classification of sensor network routing protocols is discussed in the paper. Some WSN routing techniques discussed in paper are PEGASIS, SPIN, LEACH, Direct Diffusion any many more. The comparison table 5 of WSN routing techniques is also present in the paper.

Keywords : WSN, Leach, SPIN, Direct Diffusion.

1. INTRODUCTION

In present scenario, the advancement in the electronics as well as in software & telecommunication is growing up quickly. Technology is evolving day by today, switching from analog to digital mode, making electronic devices more and more cheap, smaller as well as mobile. This resulted in the arrival of wireless sensor networks. The Wireless sensor network has got lots of attentions and has been known as one of the most challenging, emerging and dynamic field. A sensor network usually comprises of numerous nodes. Basically, there is no as such pre-defined or pre-determined topology of such networks. In fact, these nodes in the sensor network construct and organize themselves, thus dynamically maintaining the network structure via wireless communication (Cordeiro *et al*., 2006; Kushwaha *et al*., 2015; Pantazis *et al*., 2012; Akkaya *et al*., 2005).

A wireless sensor network is a group of small devices which is known as sensor nodes; these nodes cooperate with other nodes in order to gather information from the environment. These tiny sensor nodes composed of some modules which are as follows: sensing module (for monitoring the environment), processing module (for performing data processing), communication module (for transmitting data between sensor nodes) and power supply (for energy). WSN is resource constraint. The network subsists of nodes which has low cost, low processing power, has limited energy, limited storage capacity and a base station (Cordeiro *et al*., 2006; Kushwaha *et al.*, 2015; Pantazis *et al.*, 2012; Akkaya *et al*., 2005).

1.1. ARCHITECTURE OF SENSOR

Figure 1 shows the sensor node block diagram. As can be seen, it comprised of five modules. The controller, used as CPU for collecting & processing data and data path searching.it basically consist of following parts:

Microcontroller–Fully operationable for request of sensor node.

FPGA–Reprogrammable due to which hardware is flexible to rearrange.

ASIC–Application specific design.

Memory Module–Used for storage of data.

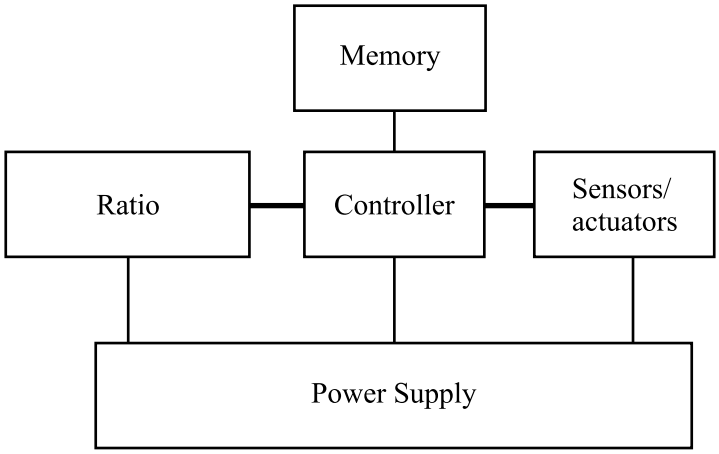

Figure 1: Architecture of Sensor

It can be either of ROM, RAM or flash memory. Power supply which is mostly battery is the source of energy for sensor nodes. Communication module (RF) used for transmission of signals. Actuator/Sensor modules which can be of any of below given kinds: Active Sensor and Passive Sensors (Akkaya *et al*., 2005).

1.2. ROUTING CHALLENGES IN WSN

Routing in WSN has many challenges due to its unique characteristics. Many factors can affect the routing protocol design in WSNs and provide efficient communication in WSNs. So, here are some challenging factors that can affect the routing protocol design as:

- Nodes are homogeneous or heterogeneous
- Node failure
- Energy efficiency
- Different topology
- Redundancy

The main objective of the routing protocol is (i) to minimize the utilization of energy of the node, (ii) improves the life of the node in WSN. When the routing protocol is design it considers the following factors (Gangwar *et al.*, 2016):

- Node deployment: Node deployment depends upon different type of application where the sensors are arranged in deterministic or randomized. The sensors are deployed and dependent on what

happened in the past or randomly placed in the application environment.

- Node heterogeneity: There are different types of sensors are used in different type of application of WSN. So it causes difficulty in routing of wireless sensor network.
- Energy: The sensor node has limitation of energy due to limited battery sources.
- Scalability: If the routing protocol work in small number of sensor network is also behave in same manner in large number of sensor network.
- Mobility: WSN is dynamic due to the movement of sensors. Node movement causes frequent path breaks.
- Data Delivery: WSN protocols has affected by time, event, and data driven reporting method.
- Fault tolerance: In order to reduce energy consumption between nodes WSN calibrate transmission powers on the link, if any nodes is failed.
- Transmission Media: Generally, the bandwidth is used in sensor for transmitting the data is less (1-100 kb/s). MAC is designed by the according to transmission media.
- Converge cast: Combination of data from different sources and collecting information "upwards" from the spanning tree after a broadcast.

2. CLASSIFICATION OF ROUTING PROTOCOL IN WSN

In wireless sensor network there is a source node which want to transmit the date to a node in network that node is called sink node or destination node. The base station is the movable or static where the user can collect the data from the networks. The challenge is to find the optimal routes between source and destination because there is a many constraints like:

- Nodes are homogeneous or heterogeneous
- Node failure
- Energy efficiency
- Different topology
- Redundancy
- Nodes are static or dynamic

The main objective of the routing protocol is to minimize the energy consumption of the node and improve the lifetime of the sensor node in networks. When the routing protocol is design it considers the factors which is mentioned above (Muruganathan *et al*., 2005; Ghiasi *et al*., 2002). Figure 2 represent the classification of protocol in WSN. Table 5 shows Comparison between different category of routing protocol in WSN.

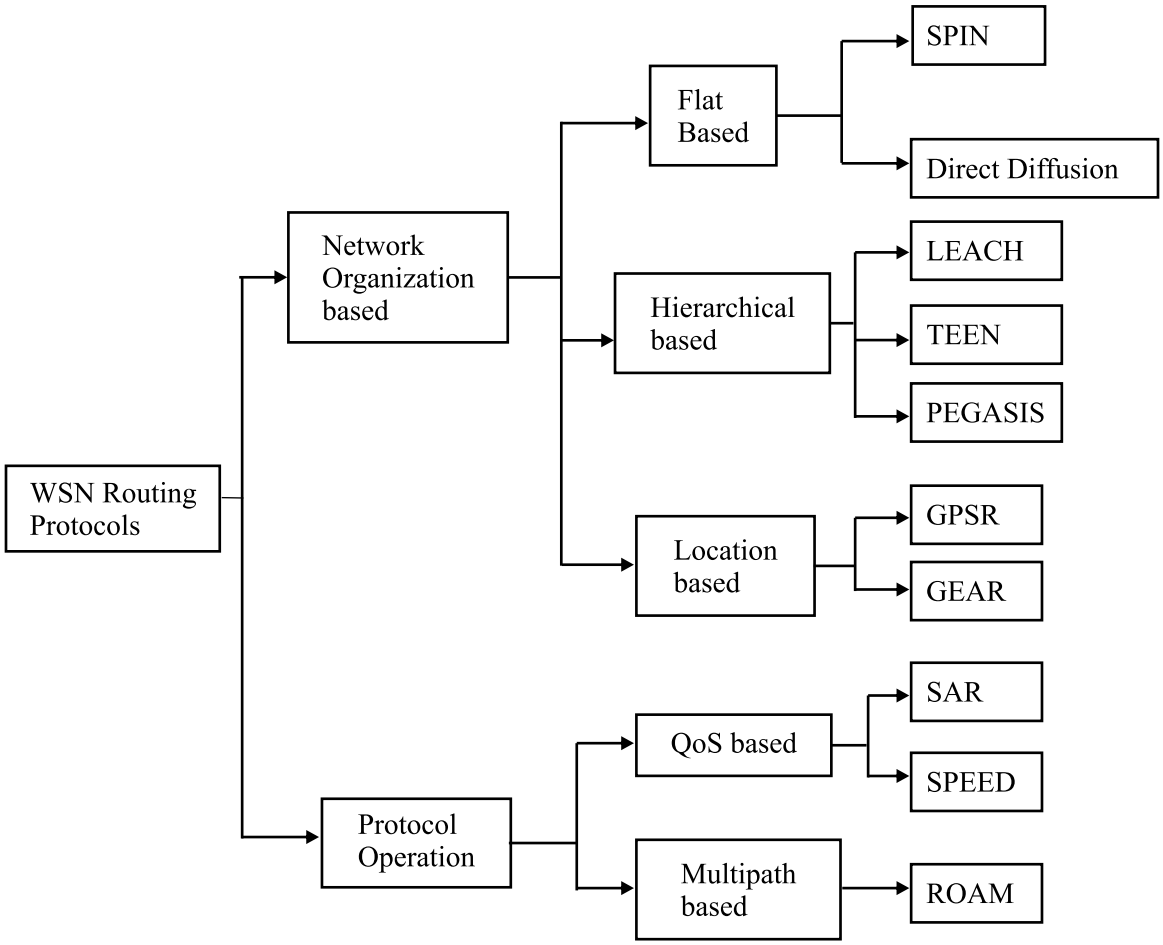

Figure 2: Classification of routing protocol in WSN

2.1 FLAT ROUTING PROTOCOL

The Flat based network protocol all the nodes plays the same role and responsibility toward the network. Due the large numbers of node it is not possible to assign special responsibility to any special node. Here the base station sends the special queries for data in any specific region and wait for data from the requested sensor node of that region. So there are some early data centric routing protocol SPIN and Directed Diffusion which are save energy and remove redundant data (Al-Karaki *et al.*, 2004). These two protocols motivate to other protocol which in terms to make more energy efficient routing through data negotiation and removing redundancy. The table 1 shows the comparative study of Flat based routing protocols. The explanation of these protocols is as follows:

SPIN: SPIN is the family of sensors protocols for information via negotiations. It is using the resources and the negotiations to overcome the problem of flooding. Sensor protocols for Information via Negotiation; SPIN is a negotiation-Based Protocol for Disseminating Information in Wireless Sensor Networks where dissemination is the process of distributing individual sensor observations to over the network where all sensors nodes treat as a sink node. The SPIN replicates complete view of the environment and enhance fault tolerance and Broadcast critical piece of information.

The SPIN uses three types of message First is ADV, it is containing meta-data which is describe actual

data. REQ is the message send by sensors to request any information. And the third is DATA which is actual data sends by the sensor. Here it actually works by a sensor nodes broadcasts to all the nodes to ADV message, if any neighbor sensor nodes interested to this data it sends the REQ message to the sensor After that the neighbor send actual DATA to the neighbor sensor nodes. The neighbor sensor again sends the ADV message to throughout the network. The following are some Successor of the SPIN (Kulik *et al.*, 2002).

SPIN-PP (Three-stage handshake protocol): This protocol works for a point to point communication, i.e., hop-by-hop routing. SPIN-PP: Three-stage handshake protocols for peer-to-peer media where three type of messages are used. ADV – it is called data advertisement, node that has data to broadcast and share this by broadcasting an ADV and it also attached with meta-data. REQ – this type of message sent when node want to actual data. DATA – It is actual data which ha meta data as header and it is much bigger than ADV or REQ messages (Manjeshwar *et al*., 2003). Figure 3 shows the three-way handshake protocol for each node.

SPIN-EC (Energy-Conserve): It is a combination of SPIN-PP and simple energy-conservation heuristic method. It reduces the energy loss of sensors due to not allow to participation of nodes when approaching low-energy-threshold. When node receives data, it only initiates protocol if it can participate in all three stages with all neighbor nodes.

SPIN-BC: It is designed for broadcast channels, so it has the multiplicity of communication is one to many communication models. By this method the Broadcast network is 1/p times cheaper than point to point network where p is the numbers of neighbors of each node.

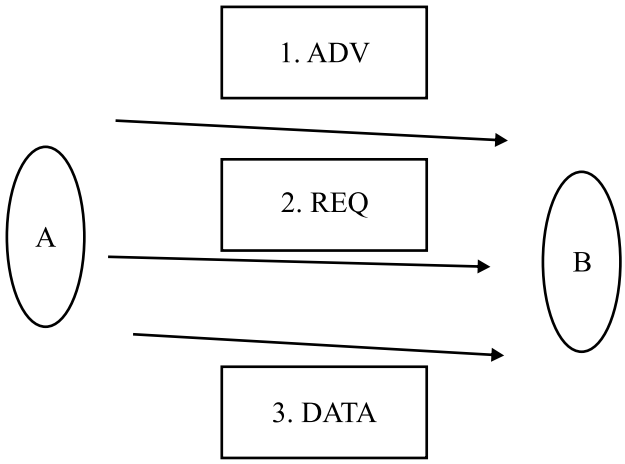

Figure 3: SPIN-PP

SPIN-RL: This is protocol, which is used in a lossy channel, named called SPIN-RL. It is used after the adjustments are added to the SPIN-PP protocol especially for the lossy channel. Also included the features of SPIN-BC where it tracks the entire transmitted message. When it does not get the acknowledgment message it resends the message.

DIRECT DIFFUSION: Direct Diffusion is a data centric protocol which main work is to diffuse the data by naming scheme of the data among the sensor nodes. This protocol main aims to save energy to avoid the unnecessary operations on routing of network layer. It uses the attribute value pairs by on demand basis for the queries and data to the sensors node. The figure 4 shows that route finding of Direct

Diffusion. Directed diffusion consists of query by the user called Interest, the collected information called data, gradient which is direction, data rate and events start flowing towards the originators of interests. Reinforcement, after the sink starts receiving events it reinforces at least one neighbor to draw down higher quality events.Each sensor node collects the interest which is broadcast by the sink through its neighbors and compare the interests with received data and the value of interest. The interest field contains several gradient fields. So, by comparing interest with gradients the path will be decided between the sink node and the source. The reinforcement helps to select path among several paths. Path repairs feature also available in Directed Diffusion. When path will break between source and sink then Directed Diffusion repairs the broken path (Intanagonwiwat *et al.*, 2003; Kemal *et al.*, 2005).

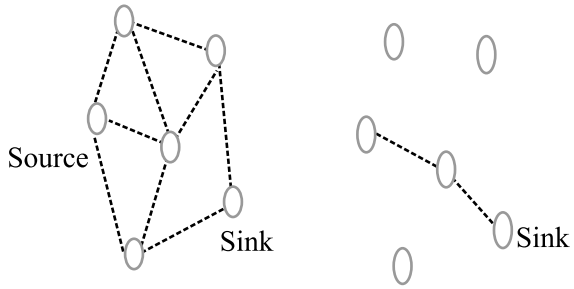

Figure 4: Direct Diffusion Protocol

Table 1: Comparison table for flat based routing protocol

Parameters	**SPIN**	**SPIN-PP**	**SPIN-EC**	**SPIN-BC**	**SPIN-RL**	**DD**
Scalability	Medium	Medium	Medium	Medium	Medium	Low
Network Lifetime	Good	Good	Good	Good	Good	Good
Resource awareness	Yes	Yes	Yes	Yes	Yes	Yes
Routing Structure	Flat and data centric	Flat and data centric	Flat and data centric	Flat and data centric	Flat and data centric	Flat and data centric
Energy Consumption	High	Medium	Low	Medium	Medium	Low
Meta Data Used	Yes	Yes	Yes	Yes	Yes	Yes
Reliability	Low	Low	Low	Low	High	High

2.2. HIERARCHICAL ROUTING PROTOCOL

In hierarchical routing protocol all the sensor node make a group called cluster. In each cluster every node has some specific task with different roles and also have unique id. In every cluster there is a special node called Cluster Head (CH). The Cluster head (CH) has chosen on different parameter like energy of the node, degree of the node, residual energy etc. In each cluster all the sensor node collects the data and send to the Cluster head (CH). The Cluster head (CH) remove the redundant data and send to the Base station (BS). The hierarchical routing protocol is more energy efficient because to rotate the responsibility of Cluster Head (CH). In our subsection we summarize the LEACH], PEGASIS and HEED protocol which motivates to researchers to develop more energy efficient protocol.

LEACH: WSN has LEACH as it's first and foremost hierarchical self-organizing clustering algorithm. This algorithm divides the network into clusters or groups virtually. There are certain numbers of nodes in every cluster. In every cluster there is a special node called Cluster Head (CH). It has extra information for scheduling TDMA slots, takes the data from its other nodes, performing some operations or computation on the accumulated data and transmits the information to the sink node. Leach continuously transferring the responsibility of CH among the nodes, so not a single node facing the drain of battery. Leach protocol has two phases

(a) Set-up Phase
- Advertisement Phase
- Cluster Set-up Phase

(b) Steady Phase
- Schedule Creation
- Data Transmission

In setup phase, The LEACH selects the cluster Head (CH) and random number is opted between 0 and 1. The node assigned to be CH, if the threshold T(I) transcends the chosen number. The T(i) is given as:

$$T(i) = \begin{cases} \dfrac{P}{1 - P\left(r \bmod \frac{1}{p}\right)}, & \text{if } i \in G \\ O, & \text{otherwise} \end{cases}$$

Where r represents as current round, p represents the probability of node to be a Cluster Head and G is number of nodes which do not get the chance to be Cluster Head since last 1/P rounds (Muruganathan *et al*., 2005;Handy *et al*., 2002). In During the steady phase, each sensor nodes that are distributed in the network start sensing environment and start the sending and receiving data to the cluster heads. After receiving the data from each node the cluster heads collects and send data to the sink node or base station. LEACH is a low energy, which has small delay, adhoc with distributed clustering routing protocol (Al-Karaki *et al.*, 2004). Cluster heads suffers from high expenditure of power when the sink node or base station is situated very far.

There are many successor protocols of LEACH. Here we are given the introductory information about some of the successor of LEACH (Singh *et al.*, 2003). Figure 5 shows the flowchart of LEACH Protocol.

LEACH-C (LEACH-Centralized): In LEACH-C is the base station is responsible to select the cluster head form all nodes, so it is called centralized protocol. LEACH-C is the improvised and advancement of LEACH protocol. The base station also decides formation of clusters and information distribution into network. LEACH-C produces very efficient clusters by broadcasting the CH throughout the sensor network compare to LEACH.

LEACH-DCHS (LEACH-Deterministic Cluster Head Selection): In this paper Handy et al. increases the lifetime of network by changing the threshold T(n) value for CH selection by multiplying the remaining energy factor which can be shown in Equation 4 and using a new approach to define the network lifetime in LEACH protocol. In this method they reduced the energy consumption during the cluster head selection.

SLEACH (Security based LEACH): SLEACH is first protocol which used security features using SPINS protocol in LEACH. This protocol uses lightweight cryptographic techniques. This protocol provided the security from attackers and think that base station is trusted. The SLEACH used authentication technique which authenticate the source of message and also identify that the data are old or new in WSN.

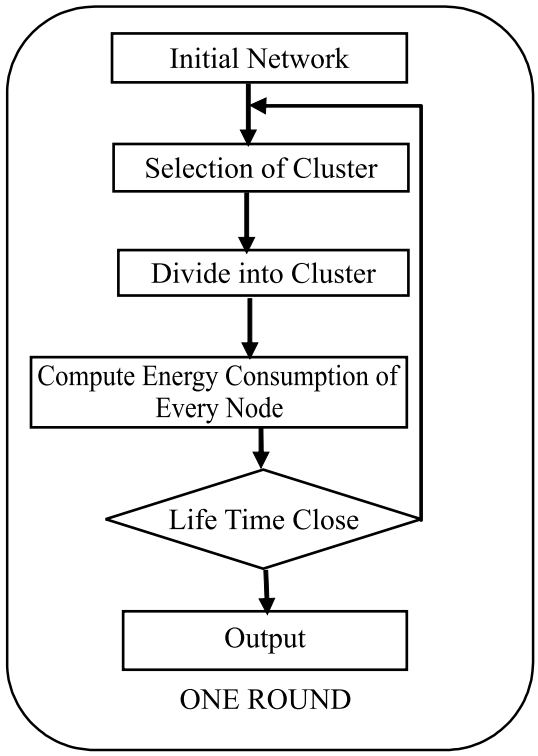

Figure 5: Flow chart of LEACH protocol

Q-LEACH (Quadrant Cluster based LEACH): In this enhancement of LEACH proposed a Q-DIR routing techniques and LEACH protocol protocol-DIR routing is the combination of location-based routing and restricted flooding. In this protocol the area of sensors divided into four parts and every cluster belongs to each part. The communication between CHs of each cluster using route request packets (RREQ) and also determine the smallest distance or path between source or start node and destination and or sink node. This protocol improves the efficiency of LEACH. The Enhanced Q-LEACH is also proposed by some researchers to remove the limitation of Q-LEACH.

LEACH-H (LEACH-Hybrid): In this paper the uses the combination of LEACH and LEACH-C protocol to improve its lifetime of network. This paper used the simulated annealing technique to choose the best cluster head among all nodes. LEACH-H routing protocol ensures a more even distribution of CH than LEACH and LEACH-C routing protocol.

MOD-LEACH (Modified-LEACH): This protocol uses the signal amplification technique to communicate with other cluster sensors and inside cluster sensors. The high amplified signal is used to communicate within the clusters and low amplified signal are used to communicate with other cluster sensors. Mod LEACH always check the new cluster head in every round by checking that the current cluster head's remaining energy is from threshold limit then the cluster head remains same for the next round and if more than the threshold limit the new cluster head is selected by the LEACH.

MH-LEACH (Multi-hop-LEACH): In the multi-hop leach protocol work as basic leach algorithm. The communication with cluster head and sink node depend upon the distance, if the distance is less than the threshold then it transmits data as a LEACH protocol and if the distance is not less than threshold, it will use the other nodes for data communication. So, it is called Multi-hop- LEACH protocol.

TEEN: The TEEN is the reactive Hierarchical structure-based protocol which is used in the reactive networks. This protocol is efficiently used in time variant environment. In this scheme there are two important features are used, first is Hard Threshold, the value of hard threshold is set and when the data read by any sensor node is beyond this threshold value the node will be activate the transmitter to inform the cluster head. Second is Soft Threshold which any small or sudden changes in data sensed by the sensor it activates the transmitter to transmit the data (Manjeshwar et al., 2001). Table 2 shows the comparison of various successor of LEACH protocol.

Table 2: Comparison of successor of LEACH protocol

Parameters	LEACH	LEACH -C	LEACH -DCHS	SL -LEACH	Q - LEACH	LEACH -H	MOD - LEACH	Multi hop- LEACH	LEACH -L
Scalability	Low	Low	Low	Medium	High	Medium	Medium	High	High
Clustering Nature	Distributed	Centralized	Distributed	Distributed	Distributed	Hybrid	Distributed	Distributed	Distributed
Energy efficiency	Medium	High	High	High	High	High	High	High	Medium
Load Balancing	Low	Medium	Medium	Medium	Medium	Medium	Medium	High	High
Delay in packet Delivery	Small	Small	Small	Small	Small	High	Small	High	High
Overhead	High	Low	High	High	High	High	Low	Medium	High

The cluster Head broadcast this soft threshold and hard threshold to the networks. The sensor nodes read the environment continuously. The data sensed by the sensor nodes stored in internal variable When the data sense by the sensor node is more from the hard threshold and the sensed data by the sensors are variable from the soft threshold then node transmitter is on and it transfer the data to the next cluster head. So, by this protocol the sensor nodes send data only when the data is more than the hard threshold value and when any sudden changes in the sense data which is equal or more than the current value. So, it reduces the unnecessary transmission of data and reduces the energy consumption. The APTEEN is the improved version of TEEN protocol. Figure 6 shows the cluster level of sensor use in TEEN and APTEEN [10]. In this scheme the APTEEN capture the data in periodically and only react when events are time critical.

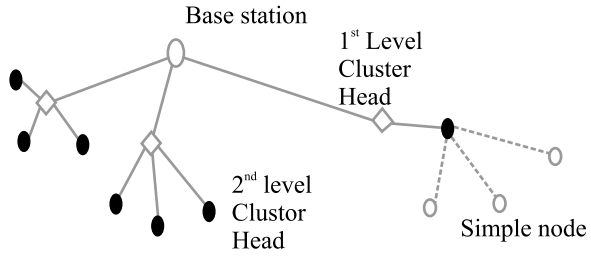

Figure 6: TEEN

This protocol provides overall structure of network in power efficient way. So in this type of network, the nodes have able to give response of historical data, current data and persistent queries. The performance

of this protocol is good in compare with in term of energy dissipation.

PEGASIS: It is the chain based methodology followed by the PEGASIS which is proposed by C. Raghavendra *et al*. (2002) (Gangwar *et al*., 2016; Lindsey *et al*., 2002). There are two main objectives of PEGASIS. First the life time of node is increased by collaboration technique and second reduced the bandwidth of communication by which only local nodes can be communicated. The working of this protocol is that if any node wants to communicate with the base station it is used closest neighboring node for the communication. When all sensor nodes finish its communication for the current round then the new round starts and the process continues. The approach is use by PEGASIS called chain-based approach where it will spread the energy load equally in the sensors of the network. At the start, all nodes are distributed randomly in the network in the application environment, so they are in random order. The nodes maintain the way like a chain, which can maintain by sensor node itself otherwise using a greedy algorithm starting from some node. In the PEGASIS protocol the sensor nodes forms a chain by using greedy algorithm. This algorithm starts with farthest to sink node and it send to the data to its neighbor node and in next round this will continue to select another neighbor node and send data. This process continues until all nodes are cover. The PEGASIS is energy efficient protocol where each sensor node communicates with their neighbor node to receive and send the data in network. The PEGASIS forms the chain of nodes rather than cluster. This approach uniformly spread the load of data and energy to among the sensor nodes of the network. Due to which the energy required to transmit data per round is reduced.

The main approach of this protocol is when any sensor node wants to sends the data to base station then it uses the neighbor nodes to make a chain formation. When the current round completes the then the next round will start. The PEGASIS utilizes the strength of signal to compute the distance between the neighbor nodes and select the path between sensor nodes to base station PEGASIS routing protocol for WSN introduce excessive delay Because of the use of chain based approach by the distant node in the network. They did not select the location of the sink node or base station in respect of the sensor nodes energy level when one cluster head is choosing among them.

HEED: Hybrid Energy Efficient Distributed Clustering Protocol (HEED) is proposed by O. Younis and S. Fahmy. The HEED protocol uses the residual energy as a first parameter and the topology features like node degree and the distance to neighbors are used as second parameter which is use to select cluster heads and metric of cluster to energy balancing There is the n iteration divided by the cluster and in every iteration their probability that any node becomes a cluster head of that node which is not get the chance to be cluster head is double. So, HEED protocols enables energy-efficient clustering where every node is probabilistically deciding the role and responsibility in the cluster based network and not give any guarantee to optimal selected a set of cluster heads (Younis et al., 2004). Table 3 shows the comparison between the protocols which belongs to hierarchical clustering category.

Table 3: Comparison between Hierarchical clustering protocols

Parameters	LEACH	TEEN & APTEEN	PEGASIS	HEED
Scalability	Good	Good	Good	Medium
Network Lifetime	Good	Good	Good	Good
Resource Awareness	Yes	Yes	Yes	Yes
Routing Structure	Hierarchical	Hierarchical	Hierarchical	Hierarchical
Energy Consumption	Low	Medium	Low	Medium
Data Delivery Model	Cluster based	Active threshold	Chain based	Cluster based
Reliability	High	High	High	Good

2.3. *LOCATION BASED ROUTING PROTOCOL*

In location-based routing protocol, all nodes maintain the information of position about other nodes. In this category energy can be saved by using sleeping nodes in the network. The location-based protocol broadcast the message to find the location of source and location of destination nodes and other message broadcast to find the distance between other nodes. In this protocol category each node transmits the message at regular interval to update the distance between neighbour nodes and other nodes. In this paper we summarize the two basic protocol GEAR and GPSR which explain the location-based routing protocol beautifully and motivate to develop other routing protocol (Yu *et al.*, 2001). Table 4 represents the comparison between protocol.

GPSR: Greedy Perimeter Stateless Routing (GPSR) uses the geography to achieve scalability. GPSR is one of the older protocol which works in the area of geographic routing by using planner graph to give solution for routing problem. In this algorithm, the data packets follow the path of the planner graph perimeter. The nodes should keep reduced number of states by this approach; this algorithm is designed for MANET which requires locations and node identifiers. In GPSR there are following two approaches. Greedy forwarding + Perimeter forwarding: Greedy forwarding method to transmit the forwarded packet to its closer neighbor node which is nearest to its destination node. Perimeter forwarding is used where the greedy method is not possible that means the other nodes are temporarily far from the destination node. So, it is recover from the perimeter forwarding. through perimeter forwarding method the packet moves over the planner subgraph of which is close to the destination node until the greedy forwarding method applied (Yu *et al.*, 2001).

GEAR: It is the location based protocol uses to route discovery towards the sink by using Energy Aware Routing (GEAR) protocol which is use uses energy aware and geographically-informed selection of neighbor which is avoid flooding. The GEAR save more energy than direct Diffusion. The main aims to this protocol to broadcast all the data and the information to the any specified region rather than all network nodes. The main idea of this protocol incorporates of two important parts. First target the area by energy efficient neighbor selection and geographically where packets route towards this region. Second the packet is distributed in this selected region. The learned cost to region R of each node N has state h(N, R), Each sensor periodically updates to it neighbor node by this cost in the region R. If any node decides to send the data to other nodes then it verifies that the learned cost of the particular region. The cost of that region of every neighbor node is:

$$c(Ni, R) = \alpha d(Ni, R) + (1-\alpha)\, e(Ni) \quad \ldots (1)$$

where α - tunable weight which is vary from 0 to 1.
d (Ni, R) - normalized the largest distance among neighbours of N,
e(Ni) - normalized the largest consumed energy among neighbours of N

If any sensor node sends the data to destination node then it wants to check that any neighbour node is closer than the destination node

$$h(N, R) - h(N_{min}, R) + c(N, N_{min}) \quad \ldots (2)$$

$c(N, N_{min})$ - the transmission cost from N and N_{min}

So GEAR reduces the energy consumption of the sensor node and extends the lifetime of network and also performs better connectivity after initial partition (Karp *et al.*, 2000).

2.4. QOS-BASED PROTOCOLS

In this category QoS-Based Protocols the network compromise with as energy is consuming, the network reduces the quality of data to save the energy and extend the life time of network. In our paper we

highlight the SAR and SPEED protocol which is the basic QoS-Based Protocols.

Table 4: Comparison between location based protocol

Parameters	GEAR	GPSR
Mobility	High	Medium
Data Aggregation	Good	Good
Routing Structure	Location Based	Location Based
Energy Usage	Limited	Good
Scalability	Limited	Good

2.5 SEQUENTIAL ASSIGNMENT ROUTING (SAR):

In Sequential assignment routing (SAR) (Akyildiz *et al.*, 2002) protocol is the earliest protocol which is based on the QoS in routing of Wireless sensor network. This protocol SAR uses the table-driven approach to minimize fault tolerance and route recovery. The SAR uses mainly energy resource, local recovery of path and priority of packet. There is multiple path generated from source to sink node and one path is selected according to energy of sensor nodes. It maintains the consistency of routing table if any path is fail it locally recover and restore the path. It uses minimum energy algorithm to for less power consumption. This protocol has many effective ways to reduce the average weighted metric of QoS in the lifetime of sensor network.

SPEED: This protocol provides the avoidance of congestion and provides surety to source to destination in soft real time. This protocol uses Stateless Geographic Non-Deterministic forwarding (SNFG) and information about all its neighbors to find the routes between source node and the destination nodes. When there is congestion in network it diverts the packet at network layer and repair locally regulating packet at MAC layer (He *et al*., 2003). Stateless Geographic Non-Deterministic forwarding (SNFG) has working with four other modules, first the beacon exchange which has the responsibility of collect the information about nodes, Second the delay ratio measures the elapsed time when ACK come back from the neighbor node third The neighborhood feedback loop module calculates the relay ratio by using the miss ratio of the neighbor's nodes and fourth module is Backpressure rerouting which is responsible to find the new route depend upon the relay ratio which is smaller than the generated random number then that route is dropped.

2.5 MULTIPATH BASED ROUTING PROTOCOL

Multipath based routing protocol provides fault tolerance, reliability, traffic free network and receives data from multiple routes. It increases the lifetime of the network. It recovers from any route failure and provides load balancing by handling multiple paths to distant sink. Here we explain the ROAM a multipath based routing protocol (Raju *et al*., 1999).

Routing on-Demand Acyclic Multipath: In ROAM algorithm, which uses feasible distance intermodal using directed acyclic subgraphs which is use in routers from source to sink node. In ROAM uses demand on diffusing computation to find and maintain the routes. ROAM has information about state which informs to routers when the sink is unreachable, so it stops sending packet to destination. Here every router perpetuates a table of distance called distance table. In this table the entries are distance between the neighbors and routers. ROAM also maintain routing table and link cost table. The routing table having

the following information like distance between each node, feasible distance between destination and router and the timestamp. The link-cost table is maintaining the information of cost of each link of neighbor nodes. Here three types of control packet are used which is queries, replies and update. Control packet having the information about destination which is shared between routers. A flag is used to inform about the message which is control, replies and update. ROAM exchanges the information of state between nodes. The advantage of this protocol is that it is more useful in static networks with or limited mobility networks.

2.6. HETEROGENEOUS ROUTING PROTOCOL

Usually, in the wireless network, nodes differ on the energy level i.e. each node have energy which is different from the other nodes in the network. This becomes the source for heterogeneous network. So any time new nodes can be added to the existing network, thus old nodes have lesser energy then the new ones, thereby varying on the level of energy content. It may be (like in the ideal case) that in the beginning, after some time all the nodes having same energy level, nodes start differing in their energy due to energy expenditure which is caused by radio communication. Thereby the WSN probability is more of being heterogeneous than being homogeneous (Gupta *et al.*, 2012).

Probability based Energy Efficient Clustering Protocol: This is the probabilistic approach which is work on heterogeneous environment. Heterogeneity defines as a different energy. In this method, presume that nodes vary by different level of their energies. So, this method needs to effectively choose cluster-heads (CH). In each round the cluster heads are different but choosing that cluster heads from cluster is different from homogeneous environment in the network. While selecting a CH, parameters to be considered other than network energy is initial energy of each node plus left-over energy [28]. Consider these energies and choose the Cluster Head for each cluster. So, the cluster head are select on the basis of left over energy and initial energy of the nodes. So, by this method the weaker nodes or low energy nodes do not die earlier because s cluster-heads is selected on the basis of left energy. The node becomes a cluster head if and only if it is having the sufficient energy. So, we calculate the probability becomes a cluster head on the basis of left-over energies. So, the nodes are chosen cluster head if it has left energy is more than threshold energy (Agarwal *et al*., 2012).

Table 5: Comparison between different category of routing protocol in WSN

Parameters	Flat Routing	Hierarchal Routing	Location Based Routing	QoS-Based Protocols	Multipath based routing protocol	Heterogeneous routing protocol
Mobility	Yes	Fixed base station(BS)	Limited	No	No	Fixed base station(BS)
Power Usage	Limited	Maximum	Limited	Limited	Not Available	Maximum
Data Aggregation	Yes	Limited	No	Limited	Limited	Limited
Localization	Limited	Yes	No	No	No	Yes
Energy	Low Energy Consumption	High Energy Consumption	Energy Efficient	Less Energy Efficient	Energy Efficient	High Energy Consumption
Scalability	Limited	Good	Limited	Limited	Limited	Good
Reliability	Medium	High	Good	High	High	High
Robust	Good	Good	Limited	Low	Limited	Good
Route Metric	Best Path	Shortest path and best route	Shortest path and best route	Any path	Any path	Shortest path and best route
Overhead	Low	High	Medium	Low	Low	High
Data Delivery Model	Meta Data Based	Cluster Based model	Geo cast Based	Re-routing based	Multi path based	Cluster Based model

3. CONCLUSION AND FUTURE WORK

To overcome above challenges many researches had been done on the various issues in sensor networks like energy efficiency, routing and localization and the various schemes were proposed related to these issues. In this paper we give a detailed survey and comparative study on routing protocol in WSN. In this paper highlight the working of protocol on the basis of extension of lifetime, data delivery, reducing energy, optimal route selection, scalability etc.

The routing protocol in WSN is divided on the basis of network organization and protocol operation. The Network Organization based protocol further classified in Flat, hierarchical and location-based routing techniques. The protocol operation-based routing is divided into QoS based routing and Multipath based routing. These routing protocols mainly focus on some limitations such as power constraint, storage constraint; bandwidth is also limited for communication. Here we give the comparative study of some protocol which provides the motivation in protocol design. There are various opportunities of research in the future on the way in area of wireless sensor networks. Recently the WSN and MANET are focused to develop according to their applications. So, the routing plays the vital role for transmission the data between the sources and sink node through the other nodes. There are many open issues for researchers which mainly focus on contention issue, traffic management, scalability, topology management, new internetworking schemes.

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