RESEARCH ARTICLE OPEN ACCESS

A Study on Wireless Sensor Network Protocols

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ABSTRACT

Advance in wireless sensor network (WSN) technology has provided the availability of small and inexpensive sensor node with capability of sensing various types of physical and environmental conditions, data processing, and wireless communication .Variety of sensing capabilities result in the large amount of application areas. However, the kind of wireless sensor networks require the effective method for data forwarding and processing. In WSN, The sensor nodes have a partial transmission range, and their procession and storage capabilities, as well as their energy resources, are also limited. Routing protocols for wireless sensor networks are accountable for maintaining the routes in the network and have to ensure reliable multi-hop communication under these conditions. In this study, the Routing protocols for Wireless Sensor Network is analyzed and compared with performance values. The best WSN protocol is found with its performance value.

Keywords:- WSN, Network Protocols

I. INTRODUCTION

Wireless sensor network (**WSN**) refers to a group of spatially dispersed and dedicated sensors for monitoring and recording the physical conditions of the environment and organizing the collected data at a central location. WSNs measure environmental conditions like temperature, sound, pollution levels, humidity, wind, and so on.[1].

These are similar to **wireless ad hoc networks** in the sense that they rely on wireless connectivity and spontaneous formation of networks so that sensor data can be transported wirelessly. Sometimes they are called **dust networks**, referring to minute sensors as small as dust. **Smart dust** is a U C Berkeley project sponsored by DARPA. Dust Networks Inc., is one of the early companies that produced wireless sensor network products. WSNs are spatially distributed autonomous sensors to *monitor* physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to the main location.[2]

1.1. Wireless sensor protocol:[3]

Networked micro-sensor technology is a key technology for the future. It has been identified as one of the most important technologies for the 21st century and is regarded to revolutionize information gathering and processing in applications. Advances in Micro-Electro-Mechanical Systems (MEMS) and low-power integrated digital electronics have inspired the development of micro-sensors). Such sensors are generally equipped with data processing, communication, and information collecting capabilities. They can detect the variation of ambient conditions in the environment surrounding the sensors and transform them into electric signals. Interests in sensor networks have motivated intensive research in the past few years emphasizing the potential of cooperation among sensors in data collecting and processing, coordination and management of the sensing activity, and data flow to the sink. Wireless Sensor Networks (WSNs) is one of the structural architectures of sensor networks.

II. WSN PROTOCOLS CLASSIFICATIONS

Different routing protocols are planned for WSN taking into account the challenges that have an effect on the performance of routing protocols resulting in overall WSN performance squalor. These protocols can be classified according to different parameters as depicted with the classification tree in Figure-1.

The wireless sensor protocol is classified into three types. They are,

1. **Data-centric protocol**
2. **Hierarchical based protocol**
3. **Location-based protocol**

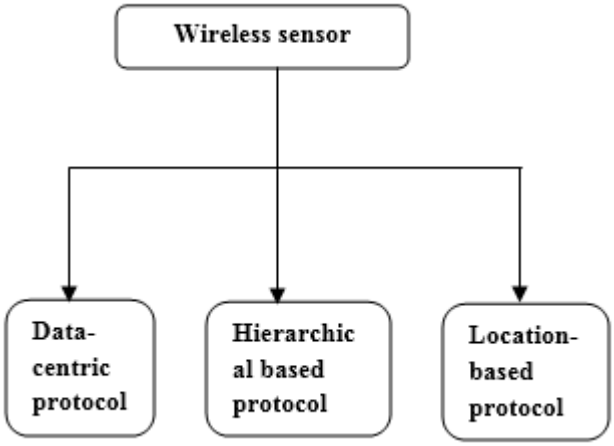

Figure-1: WSN protocols

2.1. Data-centric protocol:[4]

Outstanding to a large number of nodes exits in the network and their accidental position they do not have of global identification. Owing to many such wireless sensor network applications it faces difficulty in querying a particular set of sensors. Mainly it would lead to repeated transmission of data from all sensor nodes with inefficient energy acquisition. A precious solution is the definition of routing protocols which are capable of selecting particular sets of forwarding sensor nodes and to make use of data aggregation in the broadcast of data. This routing technique is recognized as data-centric routing. It varies from traditional address based routing in which routes are based on addressable nodes. Inside the data-centric method, the sink sends queries to exacting regions and then looks for data from the sensors located in the particular regions. Attribute-based naming is mandatory to describe the characteristics of data requested in the queries. SPIN and Directed Diffusion are the initial two data-centric protocols planned and they motivate other data-centric techniques as well.

SPIN (Sensor protocol for information via negotiation)[5]

It fulfills the problems of classic flooding move towards by implementing two innovative aspects negotiation and resource version.

To complete the deficiencies of implosion and overlapping, SPIN states that nodes have to negotiate each other previous to exchanging their data because of which only wanted data will be transmitted in the network. It saves our energy. To negotiate properly, nodes must be able to specify the information that they have to get together. The maximum-level explanation of data also called Metadata according to their idea.

2.2. Hierarchical based protocol:[6]

Hierarchical routing protocol has to turn into the center of attention of the routing technology with the recompense of suitable topology management, high-efficiency energy utilizes, and trouble-free data combination. Based on its architecture, a number of hierarchical routing protocols have been residential to deal with the scalability and energy consumption challenges of WSNs. Some of the hierarchical protocols intended for sensor networks are classified as Low-Energy Adaptive Clustering Hierarchy (LEACH protocol), Power-Efficient assembly in Sensor Information Systems (PEGASIS), Threshold-Sensitive Energy-Efficient Sensor Network (TEEN protocol), Adaptive Threshold-sensitive Energy-Efficient sensor Network (APTEEN), and Hybrid, Energy-Efficient Distributed Clustering (HEED). Low energy adaptive cluster hierarchy (LEACH).The Hierarchical based protocol construction is shown in fig 2

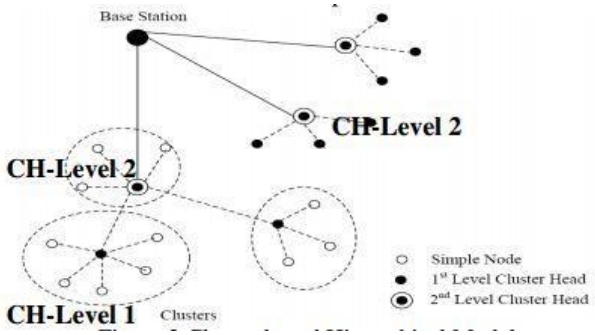

Figure-2: Hierarchical based protocol

Low energy adaptive cluster hierarchy (LEACH): [6]

LEACH is a first energy efficient routing protocol which is avoided an energy consumption and enhanced network lifetime. LEACH algorithm considers homogenous wireless sensor network where the base station is positioned in the middle of the simulation area and bounded by multiple clusters. The assortment of the cluster head is forever done depending on the maximum residual energy. The cluster top uses TDMA scheduling to merge the physical data from the member nodes on the single cluster. The entire operation of the LEACH is voted for using set up phase and stable phase, In the setup phase each node creates the

random number between 0 and 1 evaluate this random value with the threshold value if the random number is lesser than the threshold value than for the present round node becomes a cluster head (CH). There is an equation for calculated the entrance value are as follows:

(s)= P/ 1−P n mod 1/ P $if\ s \in G$

$otherwise$ Where,

P = The desired percentage of CH

r = count of present round

G = group of sensor nodes that are not CHs in the previous 1/p round.

The cluster head node broadcasts the message of it appropriate cluster head to the whole network, every node decides to close together which cluster based on the power of information received, and act in response to the equivalent cluster head. Then in the then phase, every node uses the technique TDMA to transmit data to the cluster head node, the cluster head sent the union data to the sink node. Stuck between the clusters, every cluster completes communication channel from side to side CDMA protocol. After a phase of steady phase, the network enters the then round of the cycle again, nonstop cycle. The technique of cluster top selected aimlessly avoids too much expenditure of energy, improves the network lifetime, data fusion reduce the traffic successfully, but the protocol silently uses the hop communication, even though the transmission interruption is small, nodes require a high power communications, expansion is poor, it is not appropriate for major networks; even in minor networks, the nodes out of away from the go under node communicating with each previous in high power can lead to a shorter staying power time; frequent selecting cluster head will direct to the traffic costing of energy .the structure of LEACH is known bellow Figure-3.

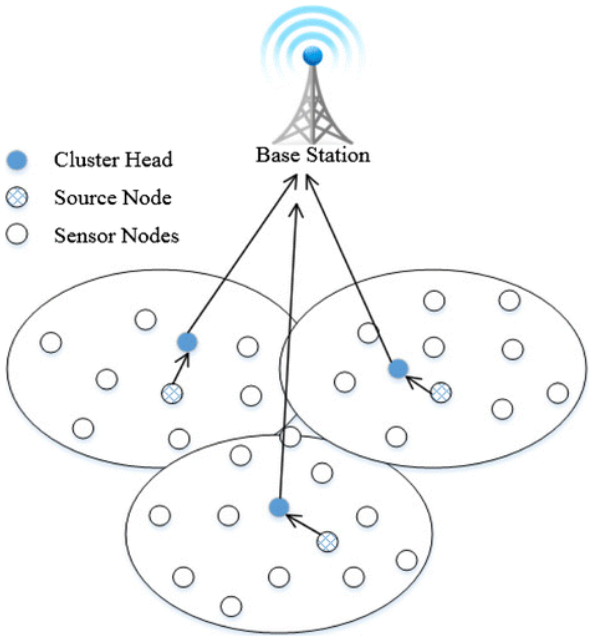

Figure- 3: Structure of LEACH protocol.

Power-Efficient Gathering in Sensor Information Systems (PEGASIS):[7]

It is, in addition, a superior version of LEACH routing protocol where the result shows that energy efficiencies capabilities are doubled up even compared to traditional LEACH. The aggregated data are not forwarded to stand station indirect manner, in unkindness; the aggregated data are transmitted throughout communication channel to the chap citizen networks, at last, which is forwarded to the base station. The happening of cluster formation is evaded in PEGASIS and considers that every sensor nodes have preceding information about the wireless sensor network by means of a greedy algorithm. Figure-4 shows the chain construction is performed according to a greedy algorithm, where nodes choose their adjoining neighbours as next hops in the chain. It is understood that the nodes have an in general knowledge of the network and the chain construction starts as of the nodes that are furthest away from the sink. As a result of the chain process, in its place of maintaining cluster formation and partisanship, every one node only keeps the path of it is preceding and next to fellow citizen in the chain

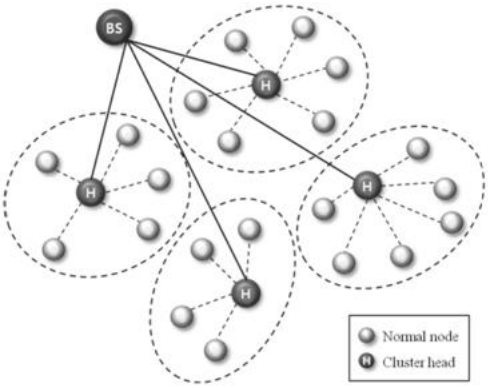

Figure-4: PEGIASIS construction

2.3. Location based protocol:[8]

The Wireless sensor network consists of multiple low-cost sensor nodes deployed in an ad-hoc method. These nodes are able to intelligence and communicate with each other over a short coldness. Sensor networks are used in dissimilar applications such as battlefield surveillance, locale monitoring, home appliances, and thing tracks. Routing in sensor networks is a most challenging task because of an active environment and some other constraints such as incomplete power and limited memory. WSNs are battery operated and a lot of applications cannot support the battery recharge facility. So it is must to develop such a technique in which the obtainable battery is used for a long period.

There are various types of geographic routing protocols in wireless sensor networks. Each within a different feature. Some of them are listed below in the order of their publication:

- MECN - Minimum Energy Communication Network. (1999)
- GPSR - Greedy Perimeter Stateless Routing Protocol. (2000)
- SMECN - Small Minimum Energy Communication Network. (2001)
- GEAR - Geographic Energy Aware Routing. (2001)
- GAF - Geographic Adaptive Fidelity. (2001)
- GOAFR - The Greedy Other Adaptive Face Routing. (2003)

- TBF - Trajectory Based Forwarding. (2003) from the above-mentioned location-based routing protocols.

GPSR - Greedy Perimeter Stateless Routing Protocol:[9]

In networks comprised entirely of wireless stations, communication between base and purpose nodes may need traversal of many hops, as radio ranges are finite. An area of ad hoc network researchers has wished-for, implemented, and measured a diversity of routing algorithms for such networks. The surveillance that topology changes more rapidly on a mobile, wireless network than on wired networks, where the use of Distance Vector (DV), Link State (LS), and Path Vector routing algorithms is well-established, motivates this body of work. DV and LS algorithms require continual distribution of a current map of the whole network's topology to all routers. DV's Bellman-Ford move towards constructs this global picture transitively; each router includes its detachment from all network destinations in each of its episodic beacons

Small Minimum-Energy Communication Network (SMECN):[10]

SMECN is a routing protocol proposed to get better MECN, in which a minimal graph is characterized with regard to the smallest number of amount energy property. This property implies that for any duo of sensors in a graph associated with a network, there is a smallest amount energy-efficient pathway between them; that is, a pathway that has the smallest cost in circumstances of energy consumption overall likely paths between this pair of sensors. Their classification of a graph with respect to the smallest amount energy property is intuitive. In SMECN protocol, each sensor discovers its immediate neighbours by broadcasting a neighbour detection message using some initial power that is efficient incrementally.

GAF (Geographic Adaptive Fidelity): [11]

GAF is a location-based and an energy-conscious routing protocol in WSN. Nodes use location information from side to side any system like GPS, inward radio signal strength etc to locate itself along with its adjacent neighbours. Nodes consume energy while transmitting data i.e. at the time of sending as well as receiving data. In the idle condition, some amount of energy is used but it is fewer in comparison to the active state. Energy used in the inoperative mode can be saved by turning off the radios.

III. METHODOLOGY

The various technologies followed in different Wireless Sensor Network protocol. This Section deals with those techniques.

3.1. CHIRON:[11]

Without defeat of generality, in our research, also consider a WSN of n energy-constrained sensor nodes, which are arbitrarily deployed over a sensing field. The BS is located at a corner of the sensing area and equipped with a directional antenna and infinite power. As a result, the BS can adaptively adjust its transmission power level and aerial direction to transmit control packets to all nodes in the WSN. Besides, for easy discussion, describe some notations as follows

1. R: the transmission range of the BS. For simplicity, use distinct integers (1 … n) to represent various ranges.
2. θ: the beam width (covering angle) of the directional antenna. Also, similar to the definition of R, different integers (1 … n) are used to indicate distinct angles.
3. Gθ, R : the group id. Theoretically, by changing different values of θ and R, the sensing area can be divided into n * n groups. Those are G1, 1, G1, 2, …, G1, n, …, Gn, 1, …, Gn,, n.
4. ni: the node i; the node set N={n1, n2, n3, …, ni}, where 1≦i≦|N|.
5. cx,y: the id of a chain which was formed in group Gx,y. the chain set C={c1,1, c1,2, ….}.
6. lx,y: the leader node id of chain cx,y. The leader set L={l1,1, l1,2, ….}.
7. neighbour (ni): the neighbouring nodes of ni. The neighbouring nodes mean the nodes which are locating in the transmission range of a specific node.
8. Res(ni): the residual energy of the node ni.
9. dis(x, y): the distance between nodes x and y. The BS can be deemed as a special sensor node.

The details of the competing algorithm are shown in Fig-5

3.2. GBR protocol:[12]

Reliable Communication Model:

This implies so as to the communication is such that the messages are definite to reach their destination complete and unspoiled. Some special method is taken to resend information that did not reach your destination the first time. For example, transmission is made reliable via the use of sequence numbers and acknowledgments.

DATA: This refers in the direction of the data packet which needs to be transmitted through the network.

ACK&DACK: These are the transmission control characters used to point to that a transmitted communication was received unspoiled or without errors. The receiver sends an ACK or DACK in the direction of the sender depending on the destination nodes number of the received message. If the message only has one destination node, after that the receiver sends an ACK. Otherwise, it sends a DACK.

TOGO: This is a signal that asks a node to broadcast the data message forward. In WSNs, the messages are delivered through the network by multi-hop and dependable communication is very important for each hop transmission. Hence, in this paper, wireless sensor networks which work with dependable communication model are determined on.

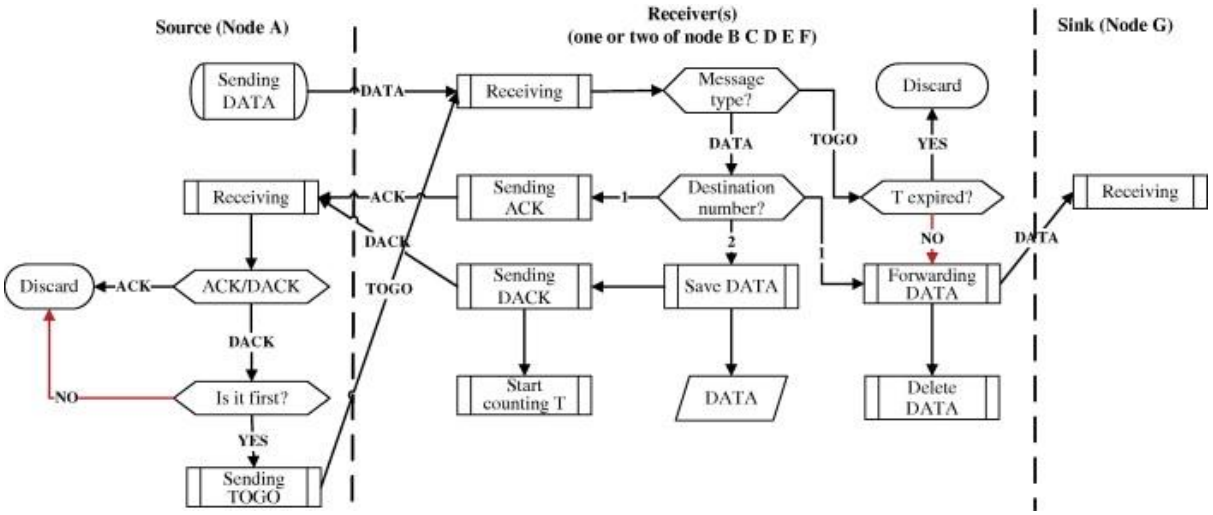

Figure-5:GBR flow chat

3.3. LEACH:[13]

1. The parameters on top of which the network performance depends are to be initialized in the primary step.
2. Then the energy parameters which encompass initial energy of sensor nodes, energy to run transmitter and receiver, data aggregation and amplification energy are initialized in the instant step.
3. The early population for the cluster head selection is generated. The cluster heads are selected from some number of nodes there in the network.
4. In after that step, after the generation of the initial population, the fitness of every node is evaluated for the better results consequently that the best nodes can be selected as a cluster head. Our fitness function includes force parameters, the distance of CH with associated nodes and distance of BS from CH's. Fitness function used is as follows: *Fitness function* = [(0 . 3 ∗*F* 1) + (0 . 35 ∗*F* 2) + (0 . 35 ∗*F* 3)] *F* 1 = *Energy of all nodes Energy of Cluster heads F* 2 = *Euclidean Distance of CH with its associated nodes Number of nodes in cluster F* 3 = *Euclidian Distance of BS from all CH _ s Number of CH _ s formed*
5. as of the fitness evaluated, the best individuals from the population are chosen using the Roulette Wheel selection.
6. The intersect and mutation operations are applied for selecting efficient CHs.
7. After applying to GA operations, the fitness of each person is evaluated again and is compared with the first one.

3.4. GAF:[14]

In GAF protocol, nodes use their GPS-indicated location to associate itself with a direct in the virtual grid. The whole area is troubled into several four-sided figure grids, and the node with the highest remaining energy within each grid becomes the master of that grid. Two nodes are considered to be equivalent when they preserve the same set of neighbour nodes. Basis and destination in the application are barred from this characterization. inside each zone, nodes collaborate with each other to play different roles. For example, nodes will elect one sensor node to stay awake for a convinced period of time and then they go to sleep. This lump is accountable for monitoring and reporting data to the sink on behalf of the nodes in the zone and is known as the master node. Previous nodes in the same grid can be regarded as redundant with respect to forwarding packets, and therefore they can be safely put to sleep without sacrificing the routing fidelity. The slave nodes switch sandwiched between off and listening with the assurance that one master node in each grid will stay awake to route packets.

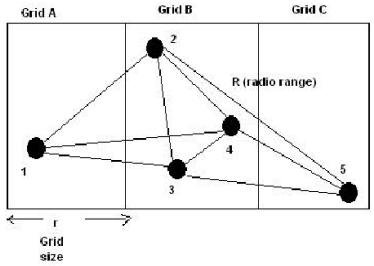

Figure-6: Virtual grid structure in the GAF protocol

For example, in figure-6 nodes, 2, 3 and 4 in the virtual grid B are equivalent in the sense that one of them can forward packets between nodes 1 and 5 while the other two can go to sleep in order to conserve energy. Therefore, the proposed GAF conserves energy by turning off pointless nodes in the network without affecting the level of routing fidelity.

IV. RESULT&DISCUSSION

The following table-1 shows the comparative performance of the above-discussed protocols.

Classifications	**protocols**	**Energy Efficiency**	**Delivery Delay**	**Algorithm complexity**
Chin-based	PEGASIS	very low	very high	High
	CCS	very low	High	Moderate
	CHIRON	moderate	Low	Moderate
Tree-based	TRP	moderate	Low	High
	LEACH	Low	High	Low
Grid-based	GAF	moderate	Very high	High
	GEERP	High	Low	Moderate
	GBR	Low	High	Moderate
Locations-based	GEAR	Very low	Low	High
	MECN	Low	High	Moderate

Table-1: Comparative performance

The following table-3 is prepared by assigning the value as bellow.

Parameter	**Value**
Very low	1
Low	2
Moderate	3
High	4
Very high	5

Table-2: Performance Value

Classifications	Protocols	Energy Efficiency	Delivery Delay	Algorithm complexity	Total performance value
Chin-based	PEGASIS	1	5	4	10
	CCS	1	4	3	8
	CHIRON	3	2	3	8
Tree-based	TRP	3	2	4	9
	LEACH	2	4	2	8
Grid-based	GAF	3	5	4	12
	GEERP	4	2	3	9
	GBR	2	4	3	9
Location-based	GEAR	1	2	4	7
	MECN	2	4	3	9

Table-3: Performance analysis

The following figure-7 shows the graphical representation of the above table-3

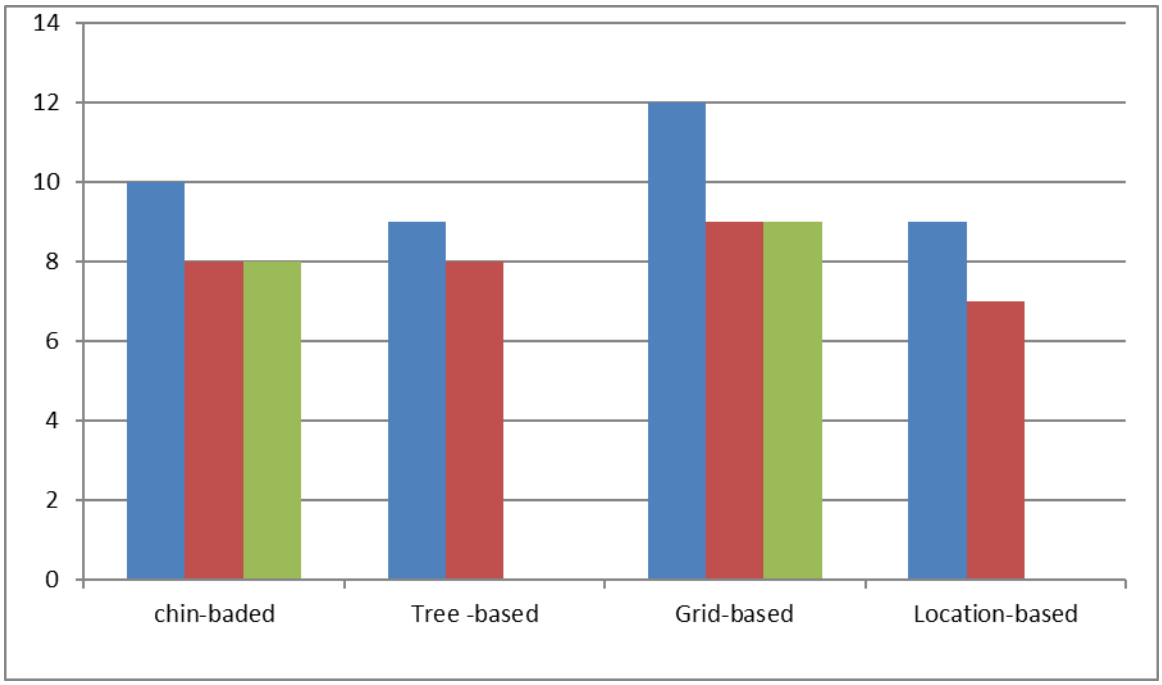

Figure-7. Performance analysis

In this study the grid-based algorithm GAF (Geographic Adaptive Fidelity) having more performance value 12. So this protocol is an optimized protocol used in wireless sensor protocol.

V. CONCLUSION

In Wireless Sensor Network lot of algorithms are used to optimize the transactions. Each and every algorithm has its own advantages and disadvantages. In this study, the performance of various algorithms such as energy efficiency, delivery delay, and algorithm complexity is analyzed and found that Grid-based protocol GAF (Geographic Adaptive Fidelity) is an optimal protocol which gives more performance value. So, the algorithm GAF gives better performance compared with other algorithms.

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