e-ISSN : 2349-9745
p-ISSN : 2393-8161
Scientific Journal Impact Factor (SJIF): 1.711
International Journal of Modern Trends in Engineering and Research
www.ijmter.com

A SURVEY ON ROUTING PROTOCOLS IN WIRELESS SENSOR NETWORK

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Abstract— The applications of wireless sensor networks has wide varieties in which the network contains significant number of nodes for a particular area,where all the nodes are not connected directly.The data exchange is supported by multihop communications. Routing protocols are mainly used to discover the routes and maintain the routes in the network.Any particular routing protocol depends on the capability of its nodes and on the required applications. This paper presents the main routing protocols that are proposed for wireless sensor networks and their comparison for optamizing.
Keywords: WSN; TEEN; LEACH; BS; SPIN; SAR;GAF; GEAR

I. INTRODUCTION

Wireless Sensor Networks (WSN) supports for monitoring the environment. The aim of a wireless sensor node is to sense the data and collect it from a particular domain, process them and transmit it to the sink or source where the application is present. By the direct communication between a sensor and the sink or source, it may force the nodes to emit the messages with high power due to which the resources would be depleted quickly. Therefore, distant communication between the sensor and sink is required. Intermediate nodes are used for this distant communication, which also supports multiple hops.

By considering the reduced capabilities of sensors, initially the communication between the sink and sensor could be done without routing protocol. Flooding algorithm best suits for this type of communication. In this algorithm consecutive data is transmitted to its destination. Drawback in this algorithm is that different nodes receive same data.

Gossiping algorithm is another which transmits the data to a particular neighbor instead of sending to all as in flooding algorithm. Drawback in gossiping algorithm is overlapping of data. Hence in order to overcome all these drawbacks in algorithms, routing protocols are used in wireless sensor networks. The main limitation in this is identification of nodes. This can be overcome easily as it doesn't require any IP address of destination node. ones the nodes are identified, routing protocols discover the routes and maintain the routes in the network. There are plenty of proposed routing algorithms in wireless sensor networks. This paper explains about some attributed-based, geographic, hierarchical and multipath routing protocols.

Node deployment are of two types they are Manual deployment in which Sensors are manually deployed and Data is routed through predetermined path.In Random deployment Optimal clustering is necessary to allow connectivity & energy-efficiency and Multi-hop routing.

II. ROUTING CHALLENGES AND DESIGN ISSUES

Node deployment are of two types they are Manual deployment in which Sensors are manually deployed and Data is routed through predetermined path.In Random deployment Optimal clustering is necessary to allow connectivity & energy-efficiency and Multi-hop routing.

Data routing methods are Application-specific,Time-drivenwhich are Periodic monitoring, Event-driven which are Respond to sudden changes,Query-driven which are respond to query. Node/link heterogeneity are Homogeneous sensors and Heterogeneous nodes with different roles &

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capabilities,Diverse modalities.If cluster heads may have more energy & computational capability, they take care of transmissions to the base station (BS).

A. *Fault tolerance*

Some sensors may fail due to lack of power, physical damage, or environmental interference.Adjust transmission power, change sensing rate, reroute packets through regions with more power.

B. *Network dynamics*

Mobile nodes,Mobile events, e.g.,target tracking,If WSN is to sense a fixed event,networks can work in a reactive manner. A lot of applications require periodic reporting.Transmission media.They are Wireless channel with limited bandwidth is 1 to 100Kbps and MAC which are Contention-free, e.g., TDMA or CDMA and Contention-based, e.g., CSMA, MACA, or 802.11.

C. *Connectivity*

A High density which is high connectivity.Some sensors maydie after consuming their battery power.Connectivity depends on possibly random deploymen.In Coverage An individual sensor's view is limited.The Area coverage is an important design factor are Data aggregation,Quality of Service,Bounded delayEnergy efficiency for longer network lifetime.

III. ALGORITHM PARADIGMS FOR WIRELESS SENSOR NETWORKS

A wireless sensor network supports the execution of following algorithms. They are Centralized Algorithms: These are executed by that node which has the knowledge of the whole network. These algorithms are rare as it is cost effective in order to provide whole information to single node.

- Distributed Algorithms: The communication is done by message-passing.
- Local based Algorithms: The nodes use restricted data collected from a close area. The algorithm is executed in one node by using that node
- MCFA (Minimum Cost Forwarding Algorithm): Assume the direction of routing is always known, i.e., toward the fixed base station (BS), No need for a node to have a unique ID or routing table,Each node maintains the least cost estimate from itself to BS,Broadcast a message to neighbors,A neighbor checks if it's on the least cost path btwn the source and BS,If so, it re-broadcasts the message to its neighbors Repeat until BS is reached .In this Each node has to know the least cost path estimate to BS
- BS broadcasts a message with cost set to 0

Every node initially sets its cost to BS to ∞ When a node receives the msg from BS, it checks if the estimate in the packet + 1 < the node's current estimate to base station.

If yes, the current estimate & estimate in the msg are updated and present Else, delete the msg; Do nothing node far from BS may receive several msg's to a node will not send the updated msg until a * lc where a is a constant and lc is the link cost.Works well for fixed topologies.By using algorithm paradigm routing protocol for the network will be decided. Each node has to know the least cost path estimate to BS.

BS broadcasts a message with cost set to 0 Every node initially sets its cost to BS to ∞
When a node receives the msg from BS, it checks if the estimate in the packet + 1 < the node's current estimate to BS If yes, the current estimate & estimate in the msg are updated and resent,Else, delete the msg; Do nothing.A node far from BS may receive several msg's to a node will not send the updated msg until a * lc where a is a constant and lc is the link cost.Works well for fixed topologie.

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IV. CLASSIFICATION OF ROUTING PROTOCOLS IN WIRELESS SENSOR NETWORKS

Routing protocols are classified as:

- Flat
- Hierarchical
- Location-based
- QoS-based

A. *Flat*

In flat network, each node typically performs the same role and sensing task is performed by sensor nodes which are collaborate together.Because of more number of nodes,it is not feasible to assign a global identifier to each node. This consideration has leads to data centric routing, where the BS sends queries to certain regions and waits for data from the sensors located in the selected regions. Since data is being requested through queries, attribute-based naming is necessary to specify the properties of data. Prior works on data centric routing, e.g., SPIN and Directed Diffusion, were shown to save energy through data negotiation and elimination of redundant. Flooding is more so too much waste.Implosion and Overlap Use in a limited scope, if necessary. In data-centric routing there is no globally unique ID,Naming based on data attributes,SPIN, Directed diffusion.

Advantages of SPIN are Each node only needs to know its one-hop neighbors and Significantly reduce energy consumption compared to flooding.Disadvantages are data advertisement cannot guarantee the delivery of data if the node interested in the data are far from the source, data will not be delivered and not good for applications requiring reliable data delivery, e.g., intrusion detection In direct diffusion the motivation is on properties of Sensor Networks ,Data centric,No central authority,Resource constrained,Nodes are tied to physical locations,Nodes may not know the topology,Nodes are generally stationary.

It is different from SPIN in terms of on-demand data querying mechanism of Sink floods interests only if necessary.so A lot of energy saving.In SPIN, sensors advertise the availability of data

Advantages are data centric is all communications are neighbor to neighbor with no need for a node addressing mechanism and each node can do aggregation & caching

Disadvantages are on-demand, query-driven in which an Inappropriate for applications requiring continuous data delivery, e.g., environmental monitoring.It is attribute-based naming scheme is application dependent in which for each application it should be defined a priority and extra processing overhead at sensor nodes

B. *Herarchical*

In a hierarchical architecture, higher energy nodes are processing and sends information to low energy nodes can be used to perform the sensing of the target. Hierarchical routing is mainly two-layer routing where one layer is used to select cluster heads and the other layer is used for routing. Hierarchical routing (or cluster-based routing), e.g., LEACH, PEGASIS, TTDD, is an efficient way to lower energy consumption within a cluster and by performing data aggregation and fusion in order to decrease the number of transmitted messages to the base stations.

1) *Leach(Low Energy Adaptive Clustering Hierarchy)*

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In LEACH the the performance is based on the cluster head is periodically transferred between the nodes in the network in order to distribute the energy consumption. The performance of LEACH is based on rounds. In each round a cluster head is elected. The number of nodes that have not been cluster heads and the percentage of cluster heads are used for this election. Once the cluster head is defined in the setup phase, it forms a TDMA schedule for the transmissions in its cluster. Base on this scheduling allows nodes to switch off their interfaces when they are not going to be employed. The router acts as a cluster head to the sink and it is also responsible for the data aggregation. As the cluster head performs the job to controls the sensors located in a close area, the data aggregation performed

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by this leader permits to remove redundancy. A centralized version of this protocol is LEACH-C. This scheme is also based on time rounds which are divided into the set-up phase and the steady-phase. In the set-up phase, sensors inform the base station about their positions and about their energy level. With this information, the base station decides the structure of clusters and their corresponding cluster heads. Since the base station possess a complete knowledge of the status of the network, the cluster structure resulting from LEACH-C is considered an optimization of the results of LEACH.

It is Cluster-based protocol.Each node randomly decides to become a cluster heads (CH).Cluster head chooses the code to be used in its cluster using CDMA between clusters.Cluster head broadcasts Adv; Each node decides to which cluster it belongs based on the received signal strength.Cluster head creates a xmission schedule for TDMA in the cluster.Nodes can sleep when its not their turn to transmit.Cluster head compresses data received from the nodes in the cluster and sends the aggregated data to Base station.Cluster head is rotated randomly. Teen (Threshold Sensitive Energy Efficient Sensor Network Protocol)

Teen is the other hierarchical protocol that responds immediately when parameters are changed. The cluster head in this protocol has hard threshold and soft threshold values. When the parameter first reaches the hard threshold value, the node sends the data through transmitter. The data is then transmitted to the current cluster period. The main drawback is that when thresholds are not reached, nodes never communicate.Reactive, event-driven protocol for time-critical applications a node senses the environment continuously, but turns radio on and xmit only if the sensor value changes drastically.No periodic transmission.it Don't wait until the next period to xmit critical data.Save energy if data is not critical .It sends its members a hard & a soft threshold.Hard threshold is a member only sends data to CH only if data values are in the range of interest.Soft threshold is a member only sends data if its value changes by at least the soft threshold.Every node in a cluster takes turns to become the CH for a time interval called cluster period.Good for time-critical applications.Energy saving that is less energy than proactive approaches,Soft threshold can be adapted,Hard threshold could also be adapted depending on applications.Inappropriate for periodic monitoring, e.g., habitat monitoring.Ambiguity between packet loss and unimportant data (indicating no drastic change)

2) Rumor Routing

Variation of directed diffusion Don't flood interests (or queries),Flood events when the number of events is small but the number of queries large

Route the query to the nodes that have observed a particular event,Long-lived packets, called agents, flood events through the network,When a node detects an event, it adds the event to its events table, and generates an agent,Agents travel the network to propagate info about local events,An agent is associated with TTL (Time-To-Live).

When a node generates a query, a node knowing the route to a corresponding event can respond by looking up its events table.No need for query flooding ,Only one path between the source and sink,Rumor routing works well only when the number of events is small ,Cost of maintaining a large number of agents and large event tables will be prohibitive ,Heuristic for defining the route of an event agent highly affects the performance of next-hop selection.

3) Greedy Perimeter Stateless Routing(GPSR)

Greedy Perimeter Stateless Routing (GPSR) proposes the aggressive use of geography to achieve scalability. GEAR was compared to a similar non-energy-aware routing protocol GPSR, which is the one that uses planar graphs to solve the problem of holes.In case of GPSR, the perimeter of the planar graph are followed by the packet to find their routes. Although the GPSR approach reduces the number of states a node should keep, it has been designed for general mobile ad hoc networks and requires a location service to map locations and node identifiers.

4) Gradient-Based Routing (GBR)

Each Variation of directed diffusion,node memorizes the number of hops when the interest is diffused,Each node computes its height, i.e., the minimum number of hops to BS,Difference btwn a node's height & its neighbor's is the gradient on the link,Forward a packet on a link with the largest

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gradient data aggregation When multiple paths pass through a node, the node can combine dataTraffic spreading when Uniformly divide traffic over the network to increase network lifetime.Stochastic scheme: Randomly pick a gradient when two or more next hops have the same gradient.In energy-based scheme a node increases its height when its energy drops below a certain threshold.In stream-based scheme new streams are not routed through nodes that are part of the path for other streams Outperforms directed diffusion in terms of total energy.

C. *Location based*

Sensor nodes are addressed by means of their locations.On the basis of incoming signal strengths,the distance between neighboring nodes can be estimated.Neighboring nodes relative coordinates can be obtained by exchanging such information between neighbors. To save energy, some location based schemes demand that nodes should go to sleep if there is no activity. More energy savings can be obtained by having as many sleeping nodes in the network as possible. Hereby, two important location based routing protocols, GEAR and GPSR, are introduced.They are Geographical and Energy Aware Routing (GEAR) and Greedy Perimeter Stateless Routing (GPSR).

1) *GAF (Geographic Adaptive Fidelity)*

Energy-aware location-based protocol mainly designed for MANET.Each node knows its location via GPS.It is associate itself with a point in the virtual grid.Nodes associated with the same point on the grid are considered equivalent in terms of the cost of packet routing.as shown in figure Node 1 can reach any of nodes 2, 3 and 4 to 2,3, 4 are equivalent; Any of the two can sleep without affecting routing fidelity

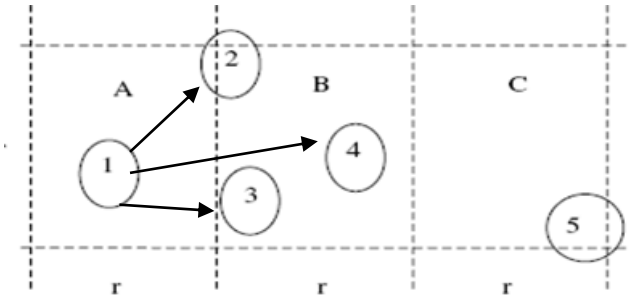

Fig 1.Exampleof virtual grid of GAF

2) *GEAR (Geographic and Energy Aware Routing)*

Restrict the number of interest floods in directed diffusion that is Consider only a certain region of the network rather than flooding the entire network.Each node keeps an estimated cost & a learning cost of reaching the sink through its neighbors

Estimated cost = f(residual energy, distance to the destination)

Learned cost is propagated one hop back every time a packet reaches the sink,so Route setup for the next packet can be adjusted.

In Phase 1 method Forwarding packets towards the region in which forward a packet to the neighbor minimizing the cost function *f.so forward data to the neighbor which is closest to the sink and has the highest level of remaining energy* .If all neighbors are further than itself, there is a hole to Pick one of the neighbors based on the learned cost.

In phase 2 the Forwarding the packet within the target region so apply either recursive forwarding Which divide the region into four subareas and send four copies of the packet and repeat this until regions with only one node are left.alternatively apply restricted flooding.Apply when the node density

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is low.GEAR successfully delivers significantly more packets than GPSR (Greedy Perimeter Stateless Routing).so GPSR will be covered in detail in another class.

D. Qos

QoS determines performance level of service offered by a network to the user.The goal of QoS is to achieve a more deterministic network behavior so that the information carried by the network can be better delivered and the resources can be better utilized.In QoS-based routing protocols, energy consumption and data quality must be balanced in a network. In particular, the network has to satisfy certain QoS metrics, e.g., delay, energy, bandwidth, etc. when delivering data to the Base Station.

1) SAR (Sequential Assignment Routing)

Table-driven multi-path approach to achieve energy efficiency & fault tolerance.Creates trees rooted at one hop neighbors of the sink it Form multiple paths from sink to sensors.As QoS metrics, energy resource, priority level of each packet.Local Failure Recovery,Select one of the paths according to the energy resources and QoS on the path,High overhead to maintain tables and states at each sensor

Basic settings are Base station,Gateways can communicate with each other,Sensor nodes in a cluster can only be accessed by the gateway managing the cluster,Focus on QoS routing in one cluster,Real-time & non-real-time traffic exist which Support timing constraints for RT and improve throughput of non-RT traffic.

2) Energy Aware QoS Routing Protocol

Finds least cost and energy efficient paths that meet the end-to-end delay during connection

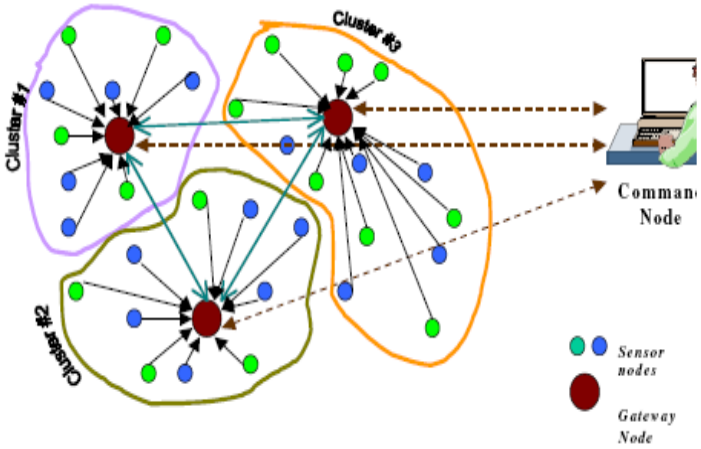

FIG .2. Energy Aware QoS Routing Protocol

Link cost = f(energy reserve, transmission energy, error rate) of nodes.Class-based queuing model used to support best-effort and real-time traffic generated by imaging sensors. It support bandwidth ratio *r* between real-time and best-effort traffics that is Properly adjust to support end-to-end delay without severely starving best-effort traffic.It is use extended Dijkstra's algorithm to list an ascending set of least cost path.

A gateway checks if E2E QoS can be met.It also, tries to find which r value maximizes the throughput of non-RT traffic

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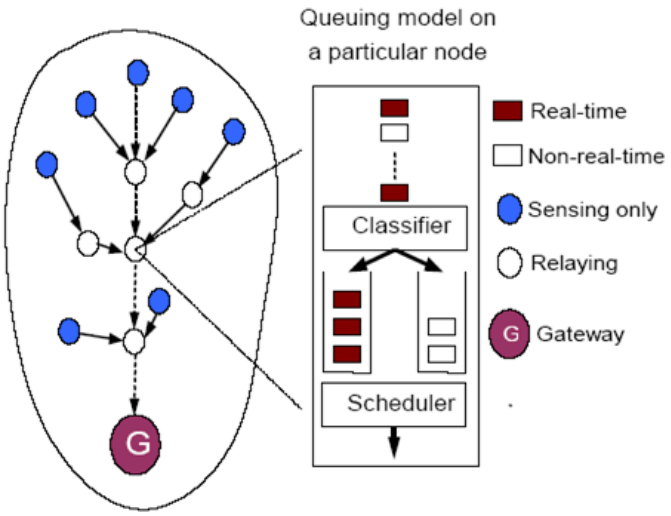

Fig. 3 .Queuing model in a particular sensor model

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Drawbacks inthis is transmission time is not considered to estimate delay.Usually, transmission delay propagation delay.Assumes more powerful gateways that is all communications are through gateways and gateways have to find paths and *r* to support QoS requirements.

3) SPEED

Each node maintains info about its neighbors and uses greedy geographic forwarding to find the paths.Tries to ensure a certain speed for each packet in the network.Congestion avoidance flat routing – Does not assume more powerful gateways or cluster heads.To be discussed in detail in another class

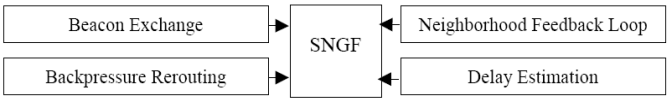

Fig. 5.Routing components in SPEED

4) Spin(Sensor Protocols for Information via Negotiation)

Spin belongs to adaptive protocol family which gathers the information in energy efficient way in wireless sensor network. Nodes in spin protocol uses high level protocol called meta data. In order to eliminate the redundant data, meta data negotiation is used throughout the network. Communication in spin nodes can be based on both application specific knowledge on data and the resources available to them. The following spin protocols were simulated and analyzed

SPIN-PP Point to point network
SPIN-EC Point to point network
SPIN-BC Broadcast network
SPIN-RL Broadcast network

In point to point network the source sends the information about the availability of new data in the form of message to the neighbor node.

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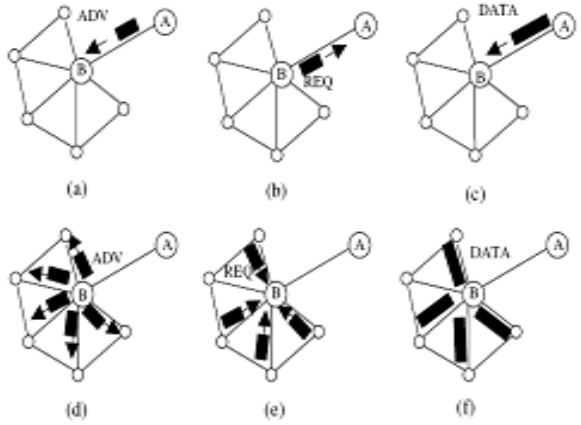

Fig.4. SPIN protocol

On receiving the message, the neighbor node checks the meta data. If the node requires the new data, it sends the request message to the source and gets the data. In broadcast network extension of algorithms will be done. Hence only one message is required for all the neighboring nodes.

5) Directed Diffusion

In data centric protocol, the data in sensors will be labeled using attribute-value pairs. A node generates request for interest of a message depending on the attribute-pair value. Source provides interest for each application task in the network. The node has a cache memory in which recent data will be stored. This helps to determine the data rate. On receiving the message the node provides reply link to the source that gives the intrest.This link is gradient link. This link is characterized by data rate, duration and expiration time. After receiving the message the node creates the multiple gradients to the sink. Positive and negative reinforcements are used to identify the optimum gradient.

IV. CONCLUSION

The combination of smart, light-weight sensors familiarized wireless sensor network. The constrained abilities of the devices should be taken into account for the development of applications for these networks. Concerning the routing protocols, the minimizes energy resources, the scalability and the resilience arise as the main limitations in wireless sensor networks. This paper presents a survey on how routing protocols are adapted to these characteristics.

The following table shown gives the comparison of all routing protocols for optimizing wireless sensor networks the complete analysis of routing protocols is require.

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Table 1.comparison of routing protocols

Routing protocol	Data centric	Hierarchical	Location based	Qos	Network flow	Data aggregation
SPIN	✓					✓
Directed Diffussion	✓					✓
Rumor routing	✓					✓
GBR	✓					✓
CADR	✓					
LEACH		✓				✓
TEEN	✓	✓				✓
SAR				✓		
SPEED			✓	✓		
GEAR			✓			
GAF		✓	✓			

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