



**SURVEY ARTICLE**

# A Survey on Routing Protocols of MANET in Wireless Sensor Network

**Rashmi Gupta**, Department of Computer Science and Engineering, NIET, Greater Noida, India  
[rashmigupta2904@gmail.com](mailto:rashmigupta2904@gmail.com)

**Mr. Ramesh Chandra Sahoo**, Assistant Professor CSE Department, NIET, Greater Noida, India  
[rsahoo22@gmail.com](mailto:rsahoo22@gmail.com)

**Abstract—** *In Mobile ad hoc network (MANET) all nodes are battery operated, as battery power or batter energy is limited resource therefore it requires special attention to minimize energy consumption in MANET. For MANETs, optimization of energy consumption has greater impact as it directly corresponds to lifetime of networks. In WSN, sensor nodes have a limited storage capacity and limited transmission range. Maintenance of routes in wireless sensor network is the responsibility of the routing protocols. In this paper we discuss about the various routing protocols and study their behavior in MANET.*

## I. INTRODUCTION

Wireless sensor network (WSN) is widely considered as one of the most important technologies for the twenty-first century [1]. In the past decades, it has received tremendous attention from both academia and industry all over the world. A WSN typically consists of a large number of low-cost, low-power, and multifunctional wireless sensor nodes, with sensing, wireless communications and computation capabilities [2]. These sensor nodes communicate over short distance via a wireless medium and collaborate to accomplish a common task, for example, environment monitoring, military surveillance, and industrial process control [3]. The basic philosophy behind WSNs is that, while the capability of each individual sensor node is limited, the aggregate power of the entire network is sufficient for the required mission.

In many WSN applications, the deployment of sensor nodes is performed in an ad hoc fashion without careful planning and engineering. Once deployed, the sensor nodes must be able to autonomously organize themselves into a wireless communication network. Sensor nodes are battery-powered and are expected to operate without attendance for a relatively long period of time. In most cases it is very difficult and even impossible to change or recharge batteries for the sensor nodes. WSNs are characterized with denser levels of sensor node deployment, higher unreliability of sensor nodes, and sever power, computation, and memory constraints. Thus, the unique characteristics and constraints present many new challenges for the development and application of WSNs.

Due to the severe energy constraints of large number of densely deployed sensor nodes, it requires a suite of network protocols to implement various network control and management functions such as synchronization, node localization, and network security. The traditional routing protocols have several shortcomings when applied to WSNs, which are mainly due to the energy-constrained nature of such networks [4]. For example, flooding is a technique in which a given node broadcasts data and control packets that it has received to the rest of the nodes in the network. This process repeats until the destination node is reached. Note that this technique does not take into account the energy constraint imposed by WSNs. As a result, when used for data routing in WSNs, it leads to the problems such as implosion and overlap [5]. Given that flooding is a blind technique, duplicated packets may keep circulate in the network, and hence sensors will receive those duplicated

packets, causing an implosion problem. Also, when two sensors sense the same region and broadcast their sensed data at the same time, their neighbors will receive duplicated packets. To overcome the shortcomings of flooding, another technique known as gossiping can be applied [6]. In gossiping, upon receiving a packet, a sensor would select randomly one of its neighbors and send the packet to it. The same process repeats until all sensors receive this packet. Using gossiping, a given sensor would receive only one copy of a packet being sent. While gossiping tackles the implosion problem, there is a significant delay for a packet to reach all sensors in a network. Furthermore, these inconveniences are highlighted when the number of nodes in the network increases.

## II. IDEAL CHARACTERISTICS OF NETWORK

Wireless sensor networks have the following unique characteristics and constraints [4]:

- A. Sensor nodes are usually densely deployed and can be several orders of magnitude higher than that in a MANET.
- B. Sensor nodes are usually powered by battery and are deployed in a harsh environment where it is very difficult to change or recharge the batteries.
- C. Sensors nodes are having highly limited energy, computation, and storage capabilities.
- D. Sensor nodes are usually randomly deployed and autonomously configure themselves into a communication network.
- E. Since sensor nodes are prone to physical damages or failures due to its deployment in harsh or hostile environment.
- F. In most sensor network application, sensor nodes are densely deployed in a region of interest and collaborate to accomplish a common sensing task. Thus, the data sensed by multiple sensor nodes typically have a certain level of correlation or redundancy.
- G. A sensor network is usually designed and deployed for a specific application. The design requirements of a sensor network change with its application.
- H. In most sensor network applications, the data sensed by sensor nodes flow from multiple source sensor nodes to a particular sink, exhibiting a many-to-one traffic pattern.
- I. Network topology changes frequently due to the node failures, damage, addition, energy depletion, or channel fading.

## III. ROUTING CHALLENGES IN WIRELESS SENSOR NETWORK

The design of routing protocols for WSNs is challenging because of several network constraints. WSNs suffer from the limitations of several network resources, for example, energy, bandwidth, central processing unit, and storage [7].

A. Since sensor nodes are battery powered, they have limited energy capacity. Energy poses a big challenge for network designers in hostile environments, for example, a battlefield, where it is impossible to access the sensors and recharge their batteries. Furthermore, when the energy of a sensor reaches a certain threshold, the sensor will become faulty and will not be able to function properly, which will have a major impact on the network Performance. Thus, routing protocols designed for sensors should be as energy efficient as possible to extend their lifetime, and hence prolong the network lifetime while guaranteeing good performance overall.

B. Another challenge that faces the design of routing protocols is to manage the locations of the sensors. Most of the proposed protocols assume that the sensors either are equipped with global positioning system (GPS) receivers or use some localization technique to learn about their locations.

C. In addition to limited energy capacity, sensor nodes have also limited processing and storage capacities, and thus can only perform limited computational functionalities. These hardware constraints present many challenges in software development and network protocol design for sensor networks, which must consider not only the energy constraint in sensor nodes, but also the processing and storage capacities of sensor nodes.

D. Sensor node deployment in WSNs is application dependent and can be either manual or random which finally affects the performance of the routing protocol. In most applications, sensor nodes can be scattered randomly in an intended area or dropped massively over an inaccessible or hostile region. If the resultant distribution of nodes is not uniform, optimal clustering becomes necessary to allow connectivity and enable energy efficient network operation.

E. sensor network usually operates in a dynamic and unreliable environment. The topology of a network, which is defined by the sensors and the communication links between the sensors, changes frequently due to sensor addition, deletion, node failures, damages, or energy depletion. Also, the sensor nodes are linked by a wireless medium, which is noisy, error prone, and time varying. Therefore, routing paths should consider network topology dynamics due to limited energy and sensor

mobility as well as increasing the size of the network to maintain specific application requirements in terms of coverage and connectivity.

F. Since sensor nodes may generate significant redundant data, similar packets from multiple nodes can be aggregated so that the number of transmissions is reduced. Data aggregation technique has been used to achieve energy efficiency and data transfer optimization in a number of routing protocols.

G. Sensor networks have a wide range of diverse applications. No network protocol can meet the requirements of all applications. Therefore, the routing protocols should guarantee data delivery and its accuracy so that the sink can gather the required knowledge about the physical phenomenon on time.

H. Routing protocols should be able to scale with the network size. Also, sensors may not necessarily have the same capabilities in terms of energy, processing, sensing, and particularly communication. Hence, communication links between sensors may not be symmetric, that is, a pair of sensors may not be able to have communication in both directions. This should be taken care of in the routing protocols.

#### IV. ROUTING PROTOCOLS IN WIRELESS SENSOR NETWORK

Routing in wireless sensor networks differs from conventional routing in fixed networks in various ways. There is no infrastructure, wireless links are unreliable, sensor nodes may fail, and routing protocols have to meet strict energy saving requirements [8]. Many routing algorithms were developed for wireless networks in general. All major routing protocols proposed for WSNs may be divided into four categories as shown in Table 1. We review sample routing protocols in each of the categories in preceding sub-sections.

Category	Representative Protocols
Table Driven Routing	OLSR, Babel, DSDV
On Demand Routing	AODV, DSR, Power Aware DSR
Hybrid Routing	Zone Routing Protocol
Hierarchical Routing	CBRP, FSR

Table 1: Routing Protocols For WSN

#### V. TABLE DRIVEN ROUTING

##### A. Optimized Link State Routing Protocol (OLSR)

Optimized Link State Protocol (OLSR) is a proactive Routing protocol, so the routes are always immediately available when needed. OLSR is an optimization version of a pure link state protocol. So the topological changes cause the flooding of the topological information to all available hosts in the network. To reduce the possible overhead in the network protocol uses Multipoint Relays (MPR). The idea of MPR is to reduce flooding of broadcasts by reducing the same broadcast in some regions in the network, more details about MPR can be found later in this chapter. Another reduce is to provide the shortest path. The reducing the time interval for the control messages transmission can bring more reactivity to the topological changes. [26]

OLSR uses two kinds of the control messages: Hello and Topology Control (TC). Hello messages are used for finding the information about the link status and the host's neighbors. With the Hello message the Multipoint Relay (MPR) Selector set is constructed which describes which neighbors has chosen this host to act as MPR and from this information the host can calculate its own set of the MPRs. the Hello messages are sent only one hop away but the TC messages are broadcasted throughout the entire network. TC messages are used for broadcasting information about own advertised neighbors which includes at least the MPR Selector list. The TC messages are broadcasted periodically and only the MPR hosts can forward the TC messages. [27]

There is also Multiple Interface Declaration (MID) messages which are used for informing other host that the announcing host can have multiple OLSR interface addresses. The MID message is broadcasted throughout the entire network only by MPRs. There is also a "Host and Network Association" (HNA) message which provides the external routing information by

giving the possibility for routing to the external addresses. The HNA message provides information about the network- and the net mask addresses, so that OLSR host can consider that the announcing host can act as a gateway to the announcing set of addresses. The HNA is considered as a generalized version of the TC message with only difference that the TC message can inform about route cancelling while HNA message information is removed only after expiration time.

### *B. Babel Routing Protocol*

Babel is a loop-avoiding distance-vector routing protocol that is designed to be robust and efficient both in networks using prefix-based routing and in networks using flat routing ("mesh networks"), and both in relatively stable wired networks and in highly dynamic wireless networks. [9]

Babel was originally designed for wireless ad-hoc networks. Because of that, Babel is extremely robust in the presence of mobility: only under very exceptional situations circumstances will Babel cause a transient routing loop.

The Babel protocol variant is also able to take radio frequency into account in order to avoid interference. [10]

Unlike most routing protocols, which route either IPv4 or IPv6 but not both at the same time, Babel is a hybrid routing protocol, in the sense that a single update packet can carry routes for multiple network-layer protocols (both IPv6 and IPv4 routes). This makes Babel particularly efficient and simple to manage on dual (IPv6 and IPv4) networks.

Limitations. Babel has two limitations that make it unsuitable for use in some environments:

1) Babel relies on periodic routing table updates rather than using a reliable transport (hence, in large, stable networks it generates more traffic than protocols that only send updates when the network topology changes);

2) Babel does impose a hold time when a prefix is retracted. This makes Babel unsuitable for use in mobile networks that implement automatic prefix aggregation. [9]

### *C. Destination-Sequenced Distance Vector (DSDV)*

Destination sequenced distance vector routing (DSDV) is adapted from the conventional Routing Information Protocol (RIP) to ad hoc networks routing. It adds a new attribute, sequence number, to each route table entry of the conventional RIP. Using the newly added sequence number, the mobile nodes can distinguish stale route information from the new and thus prevent the formation of routing loops.

Packet Routing and Routing Table Management [11]

In DSDV, each mobile node of an ad hoc network maintains a routing table, which lists all available destinations, the metric and next hop to each destination and a sequence number generated by the destination node. Using such routing table stored in each mobile node, the packets are transmitted between the nodes of an ad hoc network. Each node of the ad hoc network updates the routing table with advertisement periodically or when significant new information is available to maintain the consistency of the routing table with the dynamically changing topology of the ad hoc network.

Periodically or immediately when network topology changes are detected, each mobile node advertises routing information using broadcasting or multicasting a routing table update packet. The update packet starts out with a metric of one to direct connected nodes. This indicates that each receiving neighbor is one metric (hop) away from the node. It is different from that of the conventional routing algorithms. After receiving the update packet, the neighbors update their routing table with incrementing the metric by one and retransmit the update packet to the corresponding neighbors of each of them. The process will be repeated until all the nodes in the ad hoc network have received a copy of the update packet with a corresponding metric. The update data is also kept for a while to wait for the arrival of the best route for each particular destination node in each node before updating its routing table and retransmitting the update packet. If a node receives multiple update packets for a same destination during the waiting time period, the routes with more recent sequence numbers are always preferred as the basis for packet forwarding decisions, but the routing information is not necessarily advertised immediately, if only the sequence numbers have been changed. If the update packets have the same sequence number with the same node, the update packet with the smallest metric will be used and the existing route will be discarded or stored as a less preferable route. In this case, the update packet will be propagated with the sequence number to all mobile nodes in the ad hoc network. The advertisement of routes that are about to change may be delayed until the best routes have been found. Delaying the advertisement of possibly unstable route can damp the fluctuations of the routing table and reduce the number of rebroadcasts of possible route entries that arrive with the same sequence number.

The elements in the routing table of each mobile node change dynamically to keep consistency with dynamically changing topology of an ad hoc network. To reach this consistency, the routing information advertisement must be frequent or quick enough to ensure that each mobile node can almost always locate all the other mobile nodes in the dynamic ad hoc network. Upon the updated routing information, each node has to relay data packet to other nodes upon request in the dynamically created ad hoc network.

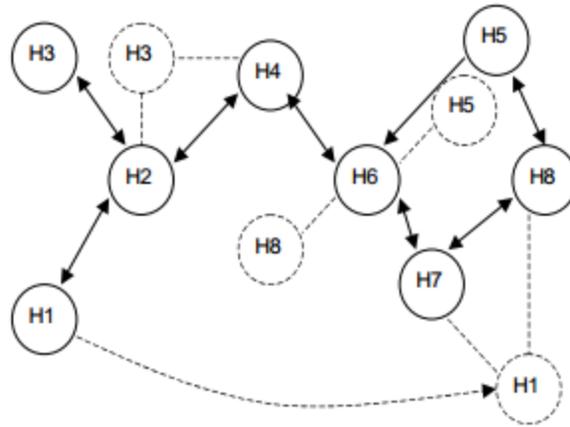


Fig1 : Example of an ad hoc network

Problems of DSDV: The main purpose of DSDV is to address the looping problem of the conventional distance vector routing protocol and to make the distance vector routing more suitable for ad hoc networks routing. However, DSDV arises route fluctuation because of its criteria of route updates. At the same time, DSDV does not solve the common problem of all distance vector routing protocols, the unidirectional links problem [12].

## VI. ON DEMAND ROUTING

### A. Ad hoc On-Demand Distance Vector (AODV) Routing

AODV enables “dynamic, self-starting, multi-hop routing between mobile nodes wishing to establish and maintain an ad hoc network”[13].

AODV allows for the construction of routes to specific destinations and does not require that nodes keep these routes when they are not in active communication.

AODV avoids the “counting to infinity” problem by using destination sequence numbers. This makes AODV loop free.

AODV defines 3 message types:

- Route Requests (RREQs)
- Route Replies (RREPs)
- Route Errors (RERRs)
- RREQ messages are used to initiate the route finding process.
- RREP messages are used to finalize the routes.
- RERR messages are used to notify the network of a link breakage in an active route.

The Path Discovery process is initiated whenever a source node needs to communicate with another node for which it has no routing information in its table Every node maintains two separate counters. a node sequence number and a broadcast id The source node initiates path discovery by broadcasting a route request (RREQ) packet to its neighbors.

The pair <source addr, broadcast id> uniquely identifies a RREQ broadcast id is incremented whenever the source issues a new RREQ Each neighbor either satisfies the RREQ by sending a route reply (RREP) back to the source. or rebroadcasts the RREQ to its own neighbors after increasing the hop cnt Notice that a node may receive multiple copies of the same route broadcast packet from various neighbors When an intermediate node receives a RREQ if it has already received a RREQ with the same broadcast id and source address it drops the redundant RREQ and does not rebroadcast it If a node cannot satisfy the RREQ it keeps track of the following information in order to implement the reverse path setup as well as the forward path setup that will accompany the transmission of the eventual (RREP).

There are two sequence numbers (in addition to the broadcast id) included in a RREQ: the source sequence number and the last destination sequence number known to the source The source sequence number is used to maintain freshness information about the reverse route to the source and the destination sequence number specifies how fresh a route to the destination must be before it can be accepted by the source.

As the RREQ travels from a source to various destinations it automatically sets up the reverse path from all nodes back to the source [14]. To set up a reverse path a node records the address of the neighbor from which it received the first copy of the RREQ These reverse path route entries are maintained for at least enough time for the RREQ to traverse the network and produce a reply to the sender.

Nodes can keep track of connectivity to neighbors using available data link or network layer mechanisms. RERR message processing is initiated when:

- Node detects a link break for the next hop of an active route, or
- Receives a data packet destined for a node for which it has no (active) route, or
- Receives a RERR message from a neighbor for at least one active route in its routing table.

Nodes must increment the destination sequence numbers of the routing entries contained in the RERR message before transmitting to nodes in precursor list. Nodes receiving RERR messages simply update their sequence numbers with those contained in the RERR message. Nodes must also mark these routing entries as invalid regardless of whether they are transmitting and/or receiving. This ensures that no predecessors may reply to a RREQ from a node on their successor path, thus providing loop freedom. RREQ messages are ultimately forwarded back to the originator who may initiate another RREQ message.

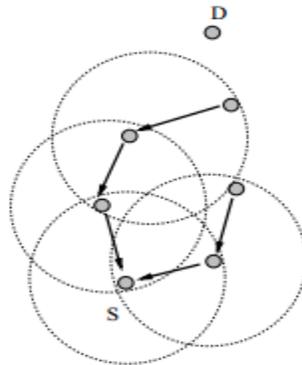


Fig 2: Reverse Path Formation

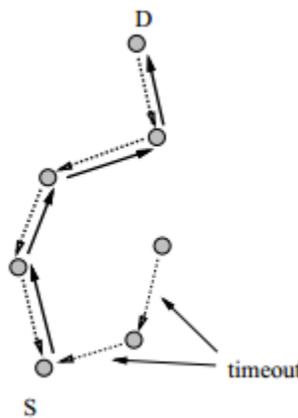


Fig 3 : Forward Path Formation

### B. Dynamic Source Routing (DSR)

To send a packet to another host, the sender constructs a source route in the packet's header, giving the address of each host in the network through which the packet should be forwarded in order to reach the destination host. The sender then transmits the packet over its wireless network interface to the first hop identified in the source route. When a host receives a packet, if this host is not the final destination of the packet, it simply transmits the packet to the next hop identified in the source route in the packet's header. Once the packet reaches its final destination, the packet is delivered to the network layer software on that host.

Each mobile host participating in the ad hoc network maintains a route cache in which it caches source routes that it has learned. When one host sends a packet to another host, the sender first checks its route cache for a source route to the destination. If a route is found, the sender uses this route to transmit the packet. If no route is found, the sender may attempt to discover one using the route discovery protocol. While waiting for the route discovery to complete, the host may continue normal processing and may send and receive packets with other hosts. The host may buffer the original packet in order to transmit it once the route is learned from route discovery, or it may discard the packet, relying on higher-layer protocol software to retransmit the packet if needed. Each entry in the route cache has associated with it an expiration period, after which the entry is deleted from the cache.

While a host is using any source route, it monitors the continued correct operation of that route. For example, if the sender, the destination, or any of the other hosts named as hops along a route move out of wireless transmission range of the next or

previous hop along the route, the route can no longer be used to reach the destination. A route will also no longer work if any of the hosts along the route should fail or be powered off. This monitoring of the correct operation of a route in use we call route maintenance. When route maintenance detects a problem with a route in use, route discovery may be used again to discover a new, correct route to the destination [15].

In DSR, when a mobile (source) needs a route to another mobile (destination), it initiates a route discovery process which is based on flooding. The source originates a RREQ packet that is flooded over the network. The RREQ packet contains a list of hops which is collected by the route request packet as it is propagated through the network. Once the RREQ reaches either the destination or a node that knows a route to the destination, it responds with a RREP along the reverse of the route collected by the RREQ [15]. This means that the source may receive several RREP messages corresponding, in general, to different routes to the destination. DSR selects one of these routes (for example the shortest), and it maintains the other routes in a cache. The routes in the cache can be used as substitutes to speed up the route discovery if the selected route gets disconnected. To avoid that RREQ packets travel forever in the network, nodes, that have already processed a RREQ, discard any further RREQ bearing the same identifier.

The main difference between DSR and AODV is in the way they keep the information about the routes: in DSR it is stored in the source while in AODV it is stored in the intermediate nodes. However, the route discovery phase of both is based on flooding. This means that all nodes in the network must participate in every discovery process, regardless of their potential in actually contributing to set up the route or not, thus increasing the network load [16].

## VII. HYBRID ROUTING PROTOCOL

### A. Zone Routing Protocol (ZRP)

As seen, proactive routing uses excess bandwidth to maintain routing information, while reactive routing involves long route request delays. Reactive routing also inefficiently floods the entire network for route determination. The Zone Routing Protocol (ZRP) aims to address the problems by combining the best properties of both approaches. ZRP can be classed as a hybrid reactive/proactive routing protocol. [17]

In an ad-hoc network, it can be assumed that the largest part of the traffic is directed to nearby nodes. Therefore, ZRP reduces the proactive scope to a zone centered on each node. In a limited zone, the maintenance of routing information is easier. Further, the amount of routing information that is never used is minimized. Still, nodes farther away can be reached with reactive routing. Since all nodes proactively store local routing information, route requests can be more efficiently performed without querying all the network nodes. [17]

Despite the use of zones, ZRP has a flat view over the network. In this way, the organizational overhead related to hierarchical protocols can be avoided. Hierarchical routing protocols depend on the strategic assignment of gateways or landmarks, so that every node can access all levels, especially the top level. Nodes belonging to different subnets must send their communication to a subnet that is common to both nodes. This may congest parts of the network. ZRP can be categorized as a flat protocol because the zones overlap. Hence, optimal routes can be detected and network congestion can be reduced. [18]

Further, the behavior of ZRP is adaptive. The behavior depends on the current configuration of the network and the behavior of the users. [17]

The Zone Routing Protocol, as its name implies, is based on the concept of zones. A routing zone is defined for each node separately, and the zones of neighboring nodes overlap. The routing zone has a radius  $\rho$  expressed in hops. The zone thus includes the nodes, whose distance from the node in question is at most  $\rho$  hops. where the routing zone of S includes the nodes A–I, but not K. In the illustrations, the radius is marked as a circle around the node in question. It should however be noted that the zone is defined in hops, not as a physical distance. [17]

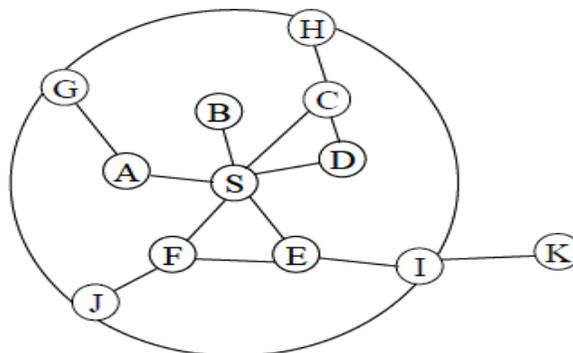


Fig 4: Example Routing Zone with  $p=2$

The nodes of a zone are divided into peripheral nodes and interior nodes. Peripheral nodes are nodes whose minimum distance to the central node is exactly equal to the zone radius  $\rho$ . The nodes whose minimum distance is less than  $\rho$  are interior nodes. In Figure 1, the nodes A–F are interior nodes, the nodes G–J are peripheral nodes and the node K is outside the routing zone. Note that node H can be reached by two paths, one with length 2 and one with length 3 hops. The node is however within the zone, since the shortest path is less than or equal to the zone radius. [19]

The number of nodes in the routing zone can be regulated by adjusting the transmission power of the nodes. Lowering the power reduces the number of nodes within direct reach and vice versa. The number of neighboring nodes should be sufficient to provide adequate reach ability and redundancy. On the other hand, a too large coverage results in many zone members and the update traffic becomes excessive. Further, large transmission coverage adds to the probability of local contention.

ZRP refers to the locally proactive routing component as the Intra-zone Routing Protocol (IARP). The globally reactive routing component is named Inter-zone Routing Protocol (IERP). IERP and IARP are not specific routing protocols. Instead, IARP is a family of limited-depth, proactive link-state routing protocols. IARP maintains routing information for nodes that are within the routing zone of the node. Correspondingly, IERP is a family of reactive routing protocols that offer enhanced route discovery and route maintenance services based on local connectivity monitored by IARP. [20]

The fact that the topology of the local zone of each node is known can be used to reduce traffic when global route discovery is needed. Instead of broadcasting packets, ZRP uses a concept called *bordercasting*. Border casting utilizes the topology information provided by IARP to direct query request to the border of the zone. The bordercast packet delivery service is provided by the Bordercast Resolution Protocol (BRP). BRP uses a map of an extended routing zone to construct bordercast trees for the query packets. Alternatively, it uses source routing based on the normal routing zone. By employing *query control* mechanisms, route requests can be directed away from areas of the network that already have been covered. [21]

In order to detect new neighbor nodes and link failures, the ZRP relies on a Neighbor Discovery Protocol (NDP) provided by the Media Access Control (MAC) layer. NDP transmits “HELLO” beacons at regular intervals. Upon receiving a beacon, the neighbor table is updated. Neighbors, for which no beacon has been received within a specified time, are removed from the table. If the MAC layer does not include a NDP, the functionality must be provided by IARP. [22]

The relationship between the components is illustrated in Figure 5. Route updates are triggered by NDP, which notifies IARP when the neighbor table is updated. IERP uses the routing table of IARP to respond to route queries. IERP forwards queries with BRP. BRP uses the routing table of IARP to guide route queries away from the query source. [18]

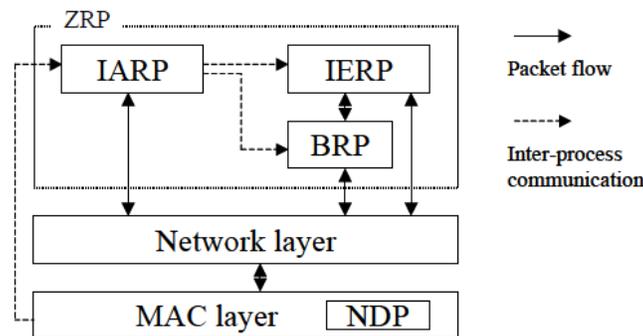


Fig 5: ZRP Architecture

## VIII. HIERARCHICAL ROUTING PROTOCOL

### A. Cluster Based Routing Protocol (CBRP)

CBRP (Cluster Based Routing Protocol) is an on-demand routing protocol, where the nodes are divided into clusters. It uses clustering's structure for routing protocol. Clustering is a process that divides the network into interconnected substructures, called clusters. Each cluster has a cluster head as coordinator within the substructure. Each cluster head acts as a temporary base station within its zone or cluster and communicates with other cluster heads.

CBRP is a routing protocol designed to be used in mobile ad hoc networks. The protocol divides the nodes of the ad hoc network into a number of overlapping or disjoint 2-hop diameter clusters in a distributed manner. Each cluster chooses a head to retain cluster membership information. There are four possible states for the node: NORMAL, ISOLATED, CLUSTERHEAD and GATEWAY. Initially all nodes are in the state of ISOLATED. Each node maintains the NEIGHBOR table wherein the information about the other neighbor nodes is stored. Cluster heads have another table (cluster heads NEIGHBOR) wherein the information about the other neighbor cluster heads is stored [23].

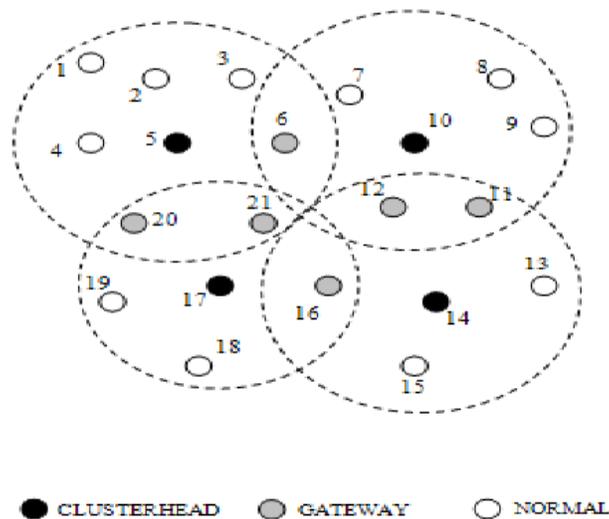


Fig 6: Cluster Formation

### B. Fisheye State Routing (FSR)

FSR is an implicit hierarchical routing protocol. It uses the “fisheye” technique proposed by Kleinrock and Stevens [24], where the technique was used to reduce the size of information required to represent graphical data. The eye of a fish captures with high detail the pixels near the focal point. The detail decreases as the distance from the focal point increases. In routing, the fisheye approach translates to maintaining accurate distance and path quality information about the immediate neighborhood of a node, with progressively less detail as the distance increases.

FSR is functionally similar to LS Routing in that it maintains a topology map at each node. The key difference is the way in which routing information is disseminated. In LS, link state packets are generated and flooded into the network whenever a node detects a topology change. In FSR, link state packets are not flooded. Instead, nodes maintain a link state table based on the up-to-date information received from neighboring nodes, and periodically exchange it with their local neighbors only (no flooding). Through this exchange process, the table entries with larger sequence numbers replace the ones with smaller sequence numbers. The FSR periodic table exchange resembles the vector exchange in Distributed Bellman-Ford (DBF) (or more precisely, DSDV [25]) where the distances are updated according to the time stamp or sequence number assigned by the node originating the update. However, in FSR link states rather than distance vectors are propagated. Moreover, like in LS, a full topology map is kept at each node and shortest paths are computed using this map.

In a wireless environment, a radio link between mobile nodes may experience frequent disconnects and reconnects. The LS protocol releases a link state update for each such change, which floods the network and causes excessive overhead. FSR avoids this problem by using periodic, instead of event driven, exchange of the topology map, greatly reducing the control message overhead. When network size grows large, the update message could consume considerable amount of bandwidth, which depends on the update period. In order to reduce the size of update messages without seriously affecting routing accuracy, FSR uses the Fisheye technique. The application of fisheye in a mobile, wireless network. The circles with different shades of grey define the fisheye scopes with respect to the center node (node 11). The scope is defined as the set of nodes that can be reached within a given number of hops. In our case, three scopes are shown for 1, 2 and 3 hops respectively. Nodes are color coded as black, grey and white accordingly. The number of levels and the radius of each scope will depend on the size of the network.

The reduction of routing update overhead is obtained by using different exchange periods for different entries in routing table. More precisely, entries corresponding to nodes within the smaller scope are propagated to the neighbors with the highest frequency. Entries in bold are exchanged most frequently. The rest of the entries are sent out at a lower frequency. As a result, a considerable fraction of link state entries are suppressed in a typical update, thus reducing the message size.

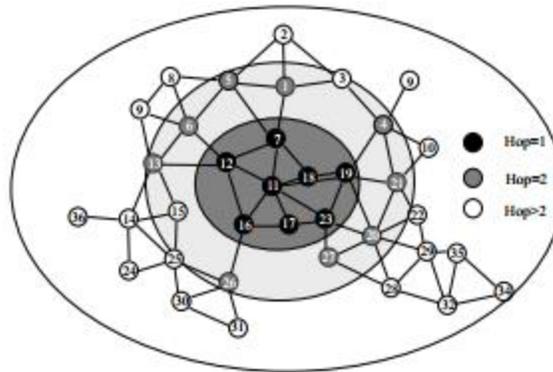


Fig 7: Architecture of Fisheye

This strategy produces timely updates from near stations, but creates large latencies from stations afar. However the imprecise knowledge of the best path to a distant destination is compensated by the fact that the route becomes progressively more accurate as the packet gets closer to destination. As the network size grows large, a “graded” frequency update plan must be used across multiple scopes to keep the overhead low.

## IX. CONCLUSION

One of the main challenges in the design of routing protocols for WSNs is energy efficiency due to the scarce energy resources of sensors. The ultimate objective behind the routing protocol design is to keep the sensors operating for as long as possible, thus extending the network lifetime. The energy consumption of the sensors is dominated by data transmission and reception. Therefore, routing protocols designed for WSNs should be as energy efficient as possible to prolong the lifetime of individual sensors, and hence the network lifetime.

In this paper, we have surveyed a sample of routing protocols by taking into account several classification criteria, including table driven routing, on demand routing, hybrid routing, hierarchical routing. For each of these categories, we have discussed a working pattern of these protocols.

Main aim of this paper is to explain all the routing protocols in a single paper for an easy understanding of all the MANET routing protocols.

## References

- [1] “21 ideas for the 21st century”, Business Week, Aug. 30 1999, pp. 78-167.
- [2] S.K. Singh, M.P. Singh, and D.K. Singh, “A survey of Energy-Efficient Hierarchical Cluster-based Routing in Wireless Sensor Networks”, *International Journal of Advanced Networking and Application (IJANA)*, Sept.–Oct. 2010, vol. 02, issue 02, pp. 570–580.
- [3] S . K. Singh , M .P . Singh , and D .K . Singh , " Energy – efficient Homogeneous Clustering Algorithm for Wireless Sensor Network", *International Journal of Wireless & Mobile Networks (IJWMN)*, Aug. 2010, vol. 2, no. 3, pp. 49-61.
- [4] Jun Zheng and Abbas Jamalipour, “Wireless Sensor Networks: A Networking Perspective”, a book
- [5] Luis Javier García Villalba, Ana Lucila Sandoval Orozco, Alicia Triviño Cabrera , and Cláudia Jacy Barenco Abbas , “ Routing Protocol in Wireless Sensor Networks”, *Sensors* 2009, vol. 9, pp. 8399- 8421.
- [6] E . Zanjaj , M . Baldi , and F . Chiaraluce , “ Efficiency of the Gossip Algorithm for Wireless Sensor Networks”, In *Proceedings of the 15<sup>th</sup> International Conference on Software, Telecommunications*
- [7] Jamal Al – Karaki , and Ahmed E. Kamal, “Routing Techniques in Wireless Sensor Networks : A Survey “ , *IEEE Communications Magazine*, vol 11, no. 6, Dec. 2004, pp. 6-28.
- [8] S . Misra et al. ( eds .), *Guide to Wireless Sensor Networks*, Computer Communications and Networks , DOI: 10.1007/978-1-84882-218-4 4, Springer-Verlag London Limited 2009.
- [9] J . Chroboczek , The Babel Routing Protocol, RFC 6126, ISSN 2070-1721, April 2011.
- [10] J . Chroboczek , Babel — a loop-avoiding distance-vector routing protocol, <http://www.pps.univ-parisdiderot.fr/~jch/software/babel>
- [11] Perkins Charles E . , Bhagwat Pravin : Highly Dynamic Destination Sequenced Distance - Vector Routing (DSDV) for Mobile Computers, London England UK, SIGCOMM 94-8/94.
- [12] Guoyou He , “ Destination – Sequenced Distance Vector ( DSDV ) Protocol” , Networking Laboratory , Helsinki University of Technology , ghe@cc.hut.fi
- [13] Perkins, et. al. “Ad hoc On-Demand Distance Vector (AODV) Routing”, RFC 3561, July 2003
- [14] M . S . Corson and A. Ephremides. A Distributed Routing Algorithm for Mobile Wireless Networks. *ACM J Wireless Networks*, 1(1), jan.1995.

- [15] David B . Johnson , David A . Maltz “Dynamic Source Routing in Ad Hoc Wireless Networks, Mobile Computing, Thomasz Imielinski and Hank Korth (Editors) ,” Vol . 353, Chapter 5, pp. 153- 181, Kluwer Academic Publishers, 1996.
- [16] Akshai Aggarwal , Savita Gandhi , Nirbhay Chaubey , “performance analysis of aodv , dsdv and dsr in manets” , International Journal of Distributed and Parallel Systems ( IJDPS ) Vol.2 , No.6, November 2011
- [17] Pearlman , Marc R ., Haas , Zygmunt J.: Determining the Optimal Configuration for the Zone Routing Protocol, August 1999, IEEE Journal on Selected Areas in Communications, Vol. 17, No. 8
- [18] Haas, Zygmunt J., Pearlman, Marc R.: The Performance of Query Control Schemes for the Zone Routing Protocol, August 2001, IEEE/ACM Transactions on Networking, Vol. 9, No. 4
- [19] Haas, Zygmunt J., Pearlman, Marc R., Samar, P.: Intrazone Routing Protocol (IARP), June 2001, IETF Internet Draft, draft-ietf-manet-iarp-01.txt
- [20] Haas, Zygmunt J., Pearlman, Marc R., Samar, P.: Interzone Routing Protocol (IERP), June 2001, IETF Internet Draft, draft-ietf-manet-ierp-01.txt
- [21] Haas, Zygmunt J., Pearlman, Marc R., Samar, P. : The Bordercast Resolution Protocol (BRP) for Ad Hoc Networks, June 2001, IETF Internet Draft, draft-ietf-manet-brp-01.txt
- [22] Haas , Zygmunt J., Pearlman, Marc R.: Providing Ad-hoc Connectivity With Reconfigurable Wireless Networks , Ithaca , New York, <http://www.ee.cornell.edu/~haas/wnl.html>
- [23] M . Jiang , J . Li , and Y . C . Tay. “Cluster Based Routing Protocol (CBRP)” , IETF MANET Working Group, Internet-Draft, 1999.
- [24] L. Kleinrock and K. Stevens, “Fisheye: A Lenslike Computer Display Transformation ,” Technical report , UCLA , Computer Science Department, 1971.
- [25] C . E . Perkins and P . Bhagwat , “Highly Dynamic Destination- Sequenced Distance – Vector Routing ( DSDV ) for Mobile Computers,” In Proceedings of ACM SIGCOMM’94, London, UK, Sep. 1994, pp. 234-244.
- [26] T. Clausen and P. Jacquet “Optimized Link State Routing Protocol (OLSR).” RFC 3626, IETF Network Working Group, October 2003.
- [27] Ying Ge , Thomas Kunz and Louise Lamont “ Quality of Service Routing in Ad-Hoc Networks Using OLSR.” Proceeding of the 36<sup>th</sup> Hawaii International Conference on System Science(HICSS’03)