Shortest Path Minimum Broadcast Energy Conserving Protocol for Asymmetric WSN

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ABSTRACT
Asymmetric Wireless sensor network is dynamic in nature and completely operates on infrastructure less environment. It discovers routes dynamically to reach the destination. Securing a dynamic route which is not known before communication is always a challenge. Energy conservation and finding the shortest path is a key challenge. In this paper propose a shortest path Minimum Broadcast Energy conserving (SME) Protocol for Asymmetric Wireless Sensor Network. It finds the shortest path in minimum broadcasts and conserves energy in asymmetric wireless network. The basic idea behind SME is to improve upon RP, Layhet, Egyhet from the state of the art and achieve performance enhancement with better delivery rate consuming minimum energy and slow sinking with reduction in energy during data routing process for data transmission to destination for the route selected in an asymmetric environment. Asymmetric indicates where two end nodes may not use the same path to communicate with each other.

Keywords
Asymmetric Wireless Sensor Network, RP, Layhet, Egyhet, SME.

1. INTRODUCTION
Wireless Sensor Network is one of the popular applications of wireless network. A Wireless Sensor Network typically consists of several base stations and thousands of sensor nodes, which are resource limited devices with low processing, energy, and storage capabilities. It is a collection of nodes organized into a cooperative network. In Wireless Sensor Networks asymmetric links uses different path for transmission and reception of packets. This consumes more energy as compared to symmetric links.

Asymmetric Wireless sensor offer unique benefits and versatility for wireless environments and its applications. The process of route discovery in ASN networks is different from that in symmetric networks. Because a path valid from base station to a node may not remain valid when reversed. Such a path can be discovered in bottom-up fashion only. So a node which needs to find a path to base station starts broadcasting to all its neighbor nodes. Other nodes on receiving packets put their node id and rebroadcast them until it reaches to base station. Base station replies directly to the requesting node with the identity of preferred neighbor [1][2][3].

Following figure shows the difference between symmetric and asymmetric link.

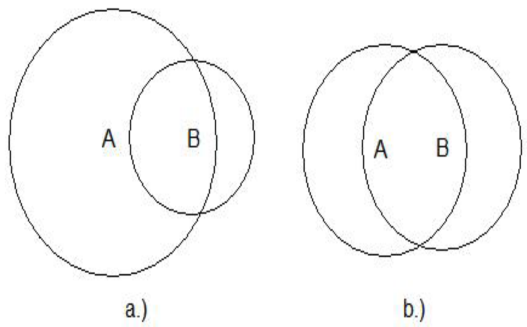

Fig.1. a) Asymmetric Link b) Symmetric Link

As shown in Fig 1(a) node B is in transmission range of A, but node A is not in transmission range of node B because both have different transmission range. Cause of ASN: Noise, power degradation, barriers and environmental conditions [4][5][6][7]. Challenges in Asymmetric Wireless Sensor Networks: No feedback from the neighboring node such as delivery probability, chances of network choke because of flooding with broadcast during route discovery [7].

In this paper, the focus is on designing a shortest path Minimum Broadcast Energy conserving (SME) Protocol for Asymmetric Wireless Sensor Network. It finds the shortest path in minimum broadcasts and conserves energy in asymmetric wireless network. The basic idea behind SME is to improve upon RP, Layhet, Egyhet from the state of the art and achieve performance enhancement with better delivery rate consuming minimum energy and slow sinking with reduction in energy during data routing process for data transmission to destination for the way route selected in an asymmetric environment. Asymmetric indicates where two end nodes may not use the same path to communicate with each other.

The rest of the paper organized in sections, Section-II, describes the related work which provides an overview on state-of-the-art routing protocols. In Section-III, describe the SME routing protocol architecture, Section-IV describes the algorithm, and Section-V shows the results obtained and Conclusion in Section-VI.

2. RELATED WORK

The process of route discovery in ASN networks is different from that in symmetric networks. Because a path valid from base station to a node may not remain valid when reversed. Such a path can be discovered in bottom-up fashion only. So a node which needs to find a path to base station starts broadcasting to all its neighbour nodes. Other nodes on receiving packets put their node id and rebroadcast them until it reaches to base station. Base station replies directly to the requesting node with the identity of preferred neighbour. [1][2][3]. In recent years, the research on design of routing protocol is done with an implicit assumption of links being symmetric [8]. The asymmetric nature leads to more overheads and less throughput. The need of the hour is designing protocols considering the asymmetric nature of links. Ramasubramanian et al proposed BRA protocol considering asymmetric nature of links. Their protocol design involved building reverse path for asymmetric links [7]. BRA maintains multihop reverse routes. Multihop protocols not only reduces the congestion but also leads to better utilization of energy resources as individual nodes can operate with low transmission power. Xio Chen et al. proposed reverse path protocol using source based routing [13][14].

Prohet is a reverse path protocol reactive algorithm which is suitable for large and dynamic networks. Their proposals are proactive algorithms for ASNs in static environment for efficient delivery routing. Few of the known routing protocols handling asymmetric links are: Proactive Link State protocols such as OLSR [9] having complete view of network at nodes but implement with partial view. Few maintain link and reverse route leading to reverse route leading to more overheads. Proactive distance vector protocols such as DSDV [10] are better than [9] but assume that links are bidirectional and fail in asymmetric links. Prakash's modified protocol of broadcasting unidirectional increases the worst case message size [11].On demand protocols such as AODV have the inherent limitation of not being able to resolve unidirectional link issues [12]. The IETF working group on Unidirectional Link Routing (UDLR) proposes a protocol [15] that invokes tunneling and encapsulation to send multi-hop acknowledgments a the link layer and Nesargi and Prakash propose a similar tunneling-based protocol where control packets are tunneled through multi-hop reverse routes to the upstream nodes of unidirectional links [16]. However, the protocols do not specify what routes are used for the multi-hop tunnels.

3. LAYHET ROUTING PROTOCOL

In this section, the LayHet protocol is proposed that is built on RP. The protocol has two parts: The preparation part which includes assigning layer numbers to the nodes and adjusting layer numbers periodically; And the routing part which includes the sender broadcasting *H* times and the receivers forwarding messages with probabilities estimated from link states with neighbours. The details are as follows:

Algorithm 1: LAYHET ROUTING PROTOCOL

1:Node *u* broadcasts an exploration packet *EP* containing sahop-count *c* D 0 and the source ID.
2: **if** a node *v* receives *EP* **then**
3: **if** it is the sink node **then**
4: it waits for a while for more copies of *EP* to arrive. Then it picks an *EP* with the smallest hop count. It increments the hop count by 1 and generates and Acknowledgement *EPack* containing the value of the Current hop count *c* and the path involving all the forwarding nodes on the path back to the source *u*. The later arrived copies of *EP* are dropped.
5: When an intermediate node *m* on the path receives *EPack*, it adjusts its own layer number according to hop count *c* and its location on the path.
6: **if** *m*'s previous node *t* is its in-out-neighbour **then**
7: it sends *EPack* directly to *t*;
8: **else if** *m* has a reverse path to *t* **then**
9: *m* sends *EPack* to *t* via the reverse path of the Asymmetric link *t! m*;
10: **else**
11: *m* simply drops *EPack*
12: **end if**
13: **else**
14: it increments the hop count by 1, appends its ID to *EP* and rebroadcasts *EP*
15: **end if**
16: **end if**
17: After *u* receives *EPack*, it knows its layer number to the sink is *c*.

Algorithm 2: Broadcasting H times

1: Except at the beginning when the packet loss rates are generated randomly, source node *u* _nds out the packet loss rates *p*1; *p*2; : : : ; *pK* with its *K* lower layer out-neighbours using Algorithm 5.
2: Node *u* calculates the number of times *H* it should broadcast using Formula (4) in Section VII.
3: Node *u* broadcasts the message plus its link packet loss rates *p*1; *p*2; : : : ; *pK H* times.

Algorithm 3: Forwarding Message

1: **repeat**
2: If a node *v* receives a message from a higher layer Neighbour *u* along with the packet loss rates of *u*'s Links, it uses Formula (5) in Section VII to decide its probability 0 to forward the message.
3: If it forwards, it becomes the new source and applies the algorithm 3.
4: If it does not forward, it will simply drop the message.
5: **until** the message reaches the sink.

Algorithm 4: Updating Packet Loss rate periodically

1: Each node *u* will update the packet loss rate of each of its links with its out-neighbours every *T* time period.
2: Suppose node *u* sends out *Ns* messages to node *v* during *T* time period. At the end of *T*, node *u* sends a message to *v* asking ``How many messages out of *Ns* have you received?''.
3: After *v* receives the inquiry, it replies directly or through the reverse path with the answer ``*Nd* ''. Also it attaches to the message its layer number for *u* to adjust its layer number.
4: After *u* receives the answer, it updates the packet loss rate of link *us* to 1-*Nd/Ns* Also if *u*'s layer number is at least 2 more than *v*'s layer number, *u* adjusts its layer number to *v*'s layer number C1.

4. SME ROUTING PROTOCOL ARCHITECTURE

The proposed protocol has four different stages.

1. Initialization of network
2. Asymmetric Route Discovery
3. Data Routing Mechanism
4. Metric measure for performance

1. Initialization of network

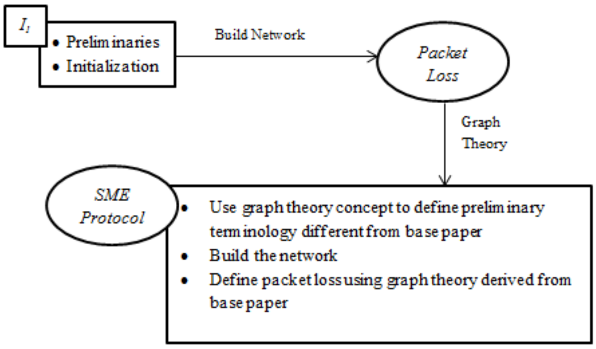

Fig. 2. Initialization of Network

2. Asymmetric Route Discovery

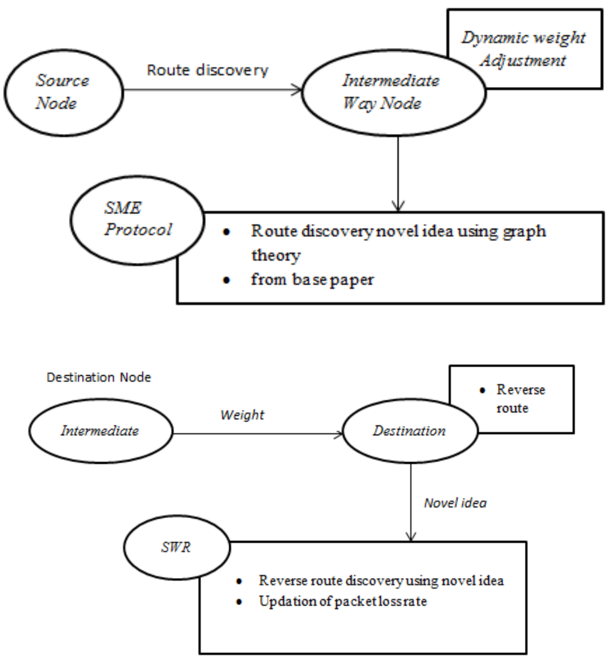

Fig. 3. Route Discovery

3. Data Routing Mechanism

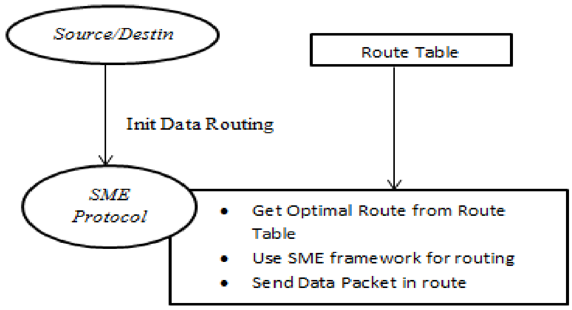

Fig.4. Data Routing Mechanism

4. Metric Measure Performance

The proposed protocol will be evaluated keeping all the performance measures in thought. It calculates delivery rate and energy consumption. The proposed protocol extends the RP routing protocol and we will compare the proposal with RP for evaluation.

Algorithm 5: Modified Reactive Reverse Path protocol (M (RP) ^{2}): Source Node *N*, Destination node S, "Hello", "ack", Nodes: A, B …

Modifications: Reactive algorithm instead of Proactive. Destination based instead of source based. Selective broadcast instead of broadcast. Incremental Hop count value2.

A. Initialization of network:

a. Source to destination optimal path identification using Conventional algorithms such as DVR or modified Version.
b. Store optimal path info in routing table of Sink S (Destination).
c. Sink selective broadcasts "hello" message to all its in Neighbours except through whom the optimal path exists.
d. All in-neighbours respond with a "hello" message.
e. If node A receives "hello" message but not the "ack" Then A knows that S is its in-neighbour. Then A will perform the next step to find a reverse routing path to S.

B. Finding Reverse route:

Node A tries to find a reverse routing path to each of its in-neighbours by broadcasting a ``Find" message containing the source ID (``S"), the destination ID (the ID of the in-neighbour to which it wants to find a reverse path (e.g. ``B")), and a hop count of 1. If some node C receives a ``Find" message, if it is the destination listed in the message, it will add the S to its out-neighbour list; increment the hop count, send the identified reverse routing path to S ``Path" message containing the reverse route.) if it is not the destination node and the hop count <= 2 it will rebroadcast the message after the following modifications: append its own ID to the message. in all other cases, it will drop the message.

5. SIMULATION RESULTS

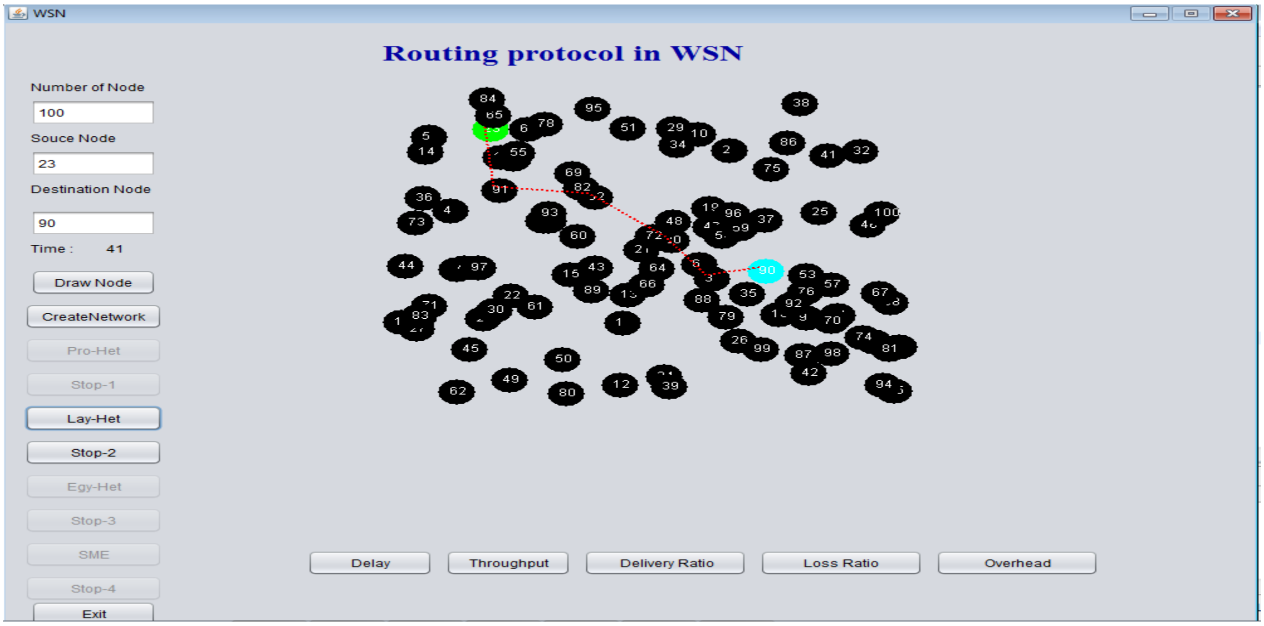

Fig. 5.1 Routing Protocol in WSN

Fig. 5.1 shows the Routing protocol in WSN, here network is created for 100 nodes out of that node 23 is selected as source which is shown by green color and node 90 is selected as destination node shown by blue color. When draw button is pressed the random network for 100 nodes is created with source node and destination node is appeared. After network is drawn the nodes are connected with their neighbour nodes by pressing createNetwork button shown the connected network. The results shown above are obtained by using the proposed routing algorithm. When the prohet button is clicked the timer will start and at the same time path will be shown by source to destination by red line. The same steps will be repeated when LayHet, EgyHet and SME buttons are pressed.

For experimental purpose the nodes were randomly deployed in a 500 m × 500 m area. There are three transmission ranges available: the minimum (40 m), the normal (50 m), and the maximum (60 m). A transmission range was selected randomly out of the three for a node in simulation. When the path is created between source node to destination node steps shown in above fig. 5.2 takes place. First the neighbours of the source node are found out then the nearest neighbour of source node is selected according to the specific range. After that next forwarder is selected and the neighbours of the forwarder is found out. This process repeats till the stop button is pressed. Finally the average number of hops required in the algorithm are displayed.

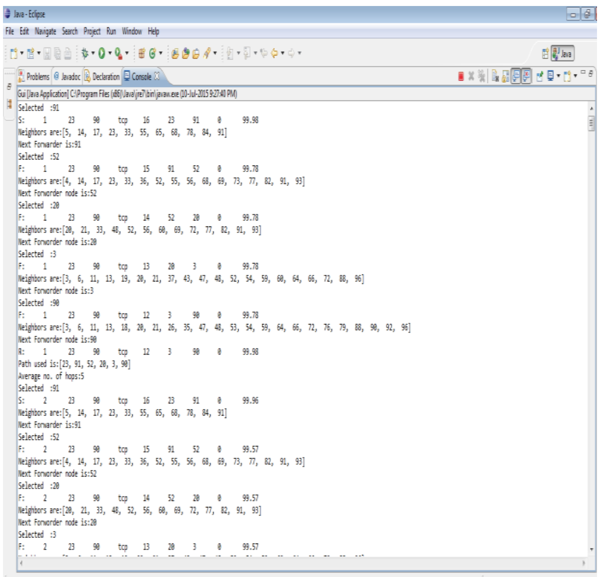

Fig. 5.2 Console Window

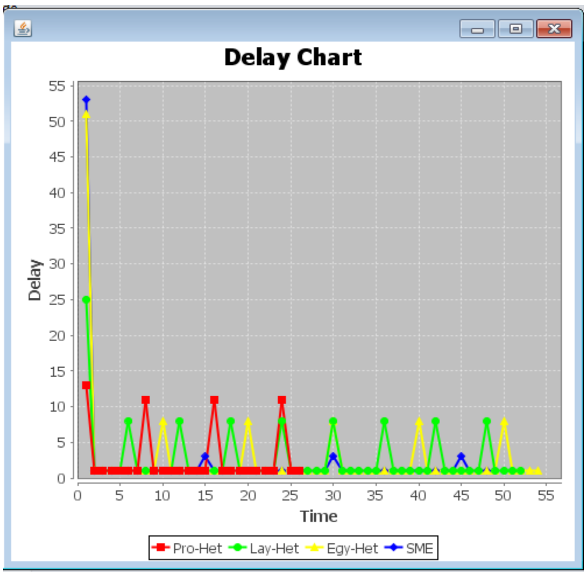

Fig. 5.3 Comparison of Delay Chart

In above fig. 5.3 delay for ProHet is shown by red color, LayHet by green color, EgyHet by Yellow color and SME by blue color. When the packets are send each protocol requires more time but as the time passed it can be observed that the SME protocol requires least delay among all the four protocols.

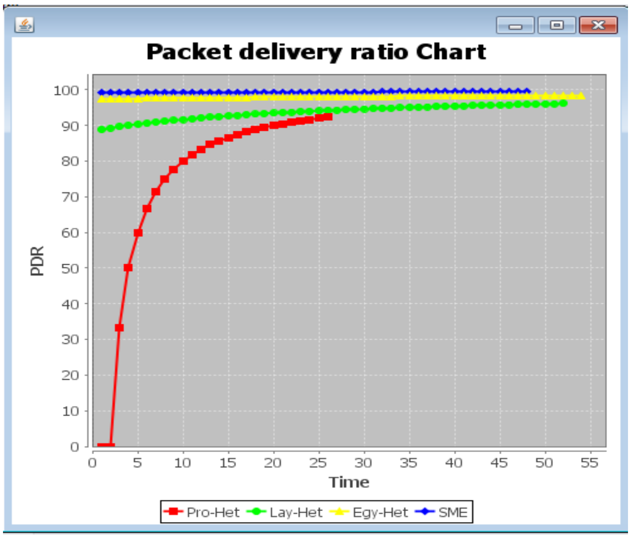

Fig. 5.4 Comparison of delivery ratio.

In above fig. 5.4 Packet delivery ratio for ProHet is shown by red color, LayHet by green color, EgyHet by Yellow color and SME by blue color. It is the ratio of the number of packets successfully delivered to the destination to the total number of packets. The packet delivery ratio of SME protocol is highest among all four protocols as shown in the above graph.

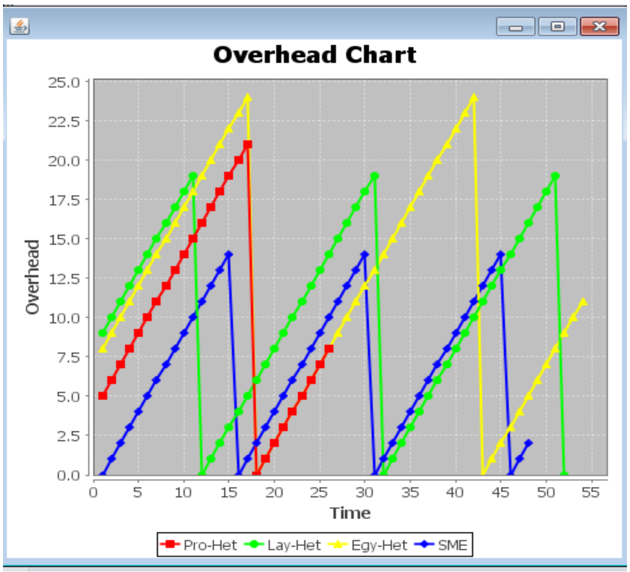

Fig. 5.5 Comparison of Overhead.

In above fig. 5.5 Comparison of overhead for ProHet is shown by red color, LayHet by green color, EgyHet by Yellow color and SME by blue color. It is the average number of packet replications used to successfully delivered a packet. The overhead of SME protocol is lowest among all four protocols as shown in the above graph.

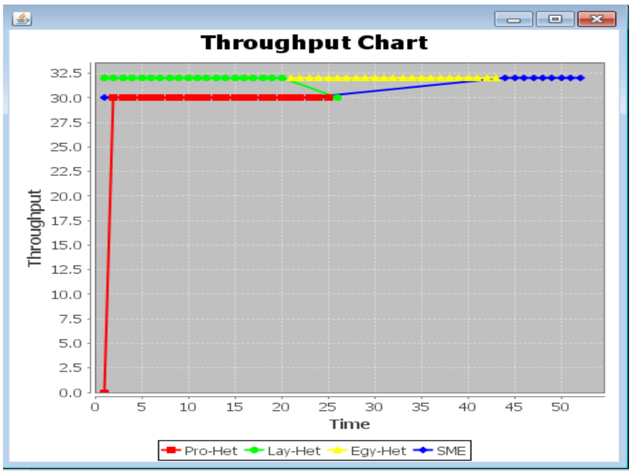

Fig. 5.6 Comparison of Throughput

In above fig. 5.6 Comparison of Throughput for ProHet is shown by red color, LayHet by green color, EgyHet by Yellow color and SME by blue color. Throughput is amount of data that has been forwarded in the network. The throughput of SME protocol is same as LayHet and EgyHet but higher than ProHet as shown in the above graph.

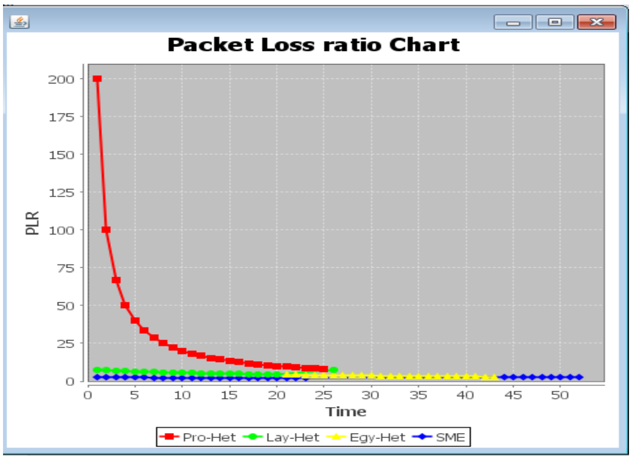

Fig. 5.7 Comparison of Packet Loss ratio.

In above fig. 5.7 Comparison of Packet loss ratio for ProHet is shown by red color, LayHet by green color, EgyHet by yellow color and SME by blue color. It is the ratio of drop packets to the total number of packets generated. The packet loss ratio of SME protocol is less as compared to LayHet and ProHet but same as EgyHet as shown in the above graph.

6. CONCLUSION AND FUTURE WORK

This paper presents a shortest path Minimum Broadcast Energy conserving (SME) Protocol for Asymmetric Wireless Sensor Network. It finds the shortest path in minimum broadcasts and conserves energy in asymmetric wireless network. The basic idea behind SME is to improve upon Reverse Path (RP), Layhet, Egyhet from the state of the art and achieve performance enhancement with better delivery rate consuming minimum energy and slow sinking with reduction in energy during data routing process for data transmission to destination for the way route selected in an asymmetric environment.

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