Analysis of Packet Dropping and End to End Delay in WSN using Routing Algorithm

Sunita[1], O. S. Khanna[2], Amandeep Kaur[3]

[1]M.E Student (ECE)
National Institute of Technical Teachers Training and Research
Sector- 26, Chandigarh, India
sunitanitttr@gmail.com

[2]Associate Professor (ECE)
National Institute of Technical Teachers Training and Research
Sector- 26, Chandigarh, India
oskhanna@gmail.com

[3]M.E Student (ECE)
National Institute of Technical Teachers Training and Research
Sector- 26, Chandigarh, India
aman.dhaliwal18@gmail.com

Abstract: ***The major attack on wireless sensor network is Denial–of-service (DoS). DoS attacks like packet dropping, collisions, interference, false route, flooding and buffer overload can destroy the network. One of the most important factors of DoS attacks is packet dropping. Packet dropping means drop packets to interrupt the packet transmission process which make the communication diminish. This paper proposed EQSR (energy Efficient and QoS multipath routing) in which drop packets and end-to-end delay is concluded using two pass algorithms which firstly examine drop packets and then the attack of packet loss. In this algorithm also reduced the dropping packets by decreasing the end –to- delay in wireless sensor network.***

Keywords: Wireless Senor Network (WSN), Denial–of-service (DoS), EQSR (energy Efficient and QoS multipath routing), and End – to-End delay

1. Introduction

A wireless sensor network is a network which consists of a number of sensor nodes that are wirelessly connected to each other. Each sensor node consists of sensing, data processing, and communication components. A large number of these sensor nodes collaborate to form wireless sensor networks [1]. To ensure scalability and to increase the efficiency of the network operation, sensor nodes are often grouped into clusters [2] [3]. A sensor node is battery powered and is equipped with integrated sensors, data processing capabilities, and short-range radio communications [4]. WSNs have a wide variety of applications such as environmental monitoring and tracking. The particular applications are tracking of object, monitoring of health, fire detection and control of nuclear reactor. Deployment of sensor nodes in an area for collection of data is a typical application of WSN. This paper computes the dropping packets in EQSR (energy Efficient and QoS multipath routing). There are many reasons of packet dropping are like congestion, interference, buffer overflows, collisions and delay. It is very important to find the solution of this problem.

The remaining paper is organized as follows: In section II, literature survey is addressed. Section III, Previous work is explained. In section IV, Problem definition is discussed. In section V, methodology is explained. In section VI, Results and Discussion is held. In section VI, paper is concluded. In section VII, future scope is written.

2. Literature Survey

Existing work has been done to detect the packet dropping in ad hoc networks by using the sleep – wake up schedules. But this approach is impractical [5]. A simulated environment is designed to examine the disconnected nodes using H- algorithm because the disconnected nodes destroy the data transmission and F – algorithm is used to detect the packets dropping [6]. Lightweight solution DPDSN is proposed to detect the drop packets of malicious nodes in [7]. A data province based mechanism is used to detect the packet loss [8]. Shan Zhu et.al [9] proposes optical routing algorithm (ORT) to reduce the drop packets in high speed networks like ATM networks. When packets sent to destination, they may be lost in way. A Had Based Two Pass algorithm used to compute the optimum solution for ORP with great speed. Zheng Jian-Li et.al [10] proposes a new scheme called MPSSF (Multi-Path Single Stream Forwarding) to reduce the extra consuming of network resources. This scheme is a combination of single stream is used to create the out-of-sequence packets. Single stream scheme consume extra network resources if out-of-sequence packets are not created. Bai, H. et.al [11] proposes a model explicit congestion notification (ECN) used with random early detection (RED) the buffer size and RED parameters to minimize the packet losses at RED gateway. Kaur et.al. [12] Proposes a scheme to reduce the packets loss by optimize the link weights using online simulation in OSPF networks. They use packet loss rate as the optimization metric. To compute the packet drop probability, they use GI/M/1/K queuing model. Priya et.al [13] proposed fast handoff scheme to improve the handoff latency during the transmission if signals. During handoff, packet loss ratio and delay are considered as QoS parameters.

3. Previous Work

Previous paper works on the packet delivery ratio and energy consumption using EQSR protocol. In that paper, the author proposed Energy Efficient and QoS aware multipath routing protocol, in which they use the concept of service differentiation to increase the lifetime of the network and to reduce the end-to end delay. The existing work is based on the analysis of drop packets and end –to-end delay [14].

Energy Efficent and QoS multipath routing (EQSR)

In wireless sensor network, the sensor nodes are randomly deployed. A network consists of a sink node, and other sensor nodes. The sensor nodes have limited energy, limited power and limited storage. The sensor nodes remain at their locations for sensing, once they are deployed. Depending on the available energy and signal strength of a node, it is selected to forward the data. The energy cost is calculated by data packet size, and radius of the transmission and energy cost model of transmitter and receiver. The energy cost for Sending k-bit packet to a node with distance‘d’ and receiving k-bit packet is shown as:

ETx(k, d) = ETx-elect (k) + ETx-amp (k, d)
ERx (k) = ERx-elect (k)

The Energy efficient QoS multipath routing protocol consists of two phases; Path construction phase and Data transmission phase. The path discovery phase consists of RREQ, RREP, and Second path discovery.

Path Construction Phase

During the first path discovery, the nodes discover the neighbor nodes to send the data packets and establish a route to sink node by transmitting the Route Request message and when the route is discovered, then the source node initiate the Route Reply message and create a new entry in neighbor routing table. In the second path discovery, the nodes participating in first path are not included in the second path routing. So, that there is establishment of second path between the source and the destination node [15].

Routing Request of the First Path

The source node sense the Surroundings area, collect the data and transmit the data to sink node by setting the transmit radius‘d’. If the nodes with omni directional antennas are interested to find the sink node; the source node send flooded RREQ data packet to the surrounding nodes. RREQ packet consists of node ID, remaining energy of node and message ID of RREQ. The node firstly checks the message ID and searches the task table after receiving RREQ sent by other nodes, to ensure whether this RREQ is first received or not. When the first time, RREQ packet is received, the node sets the reception time T and starts the timer. The frame format of Route Request Message is shown as Fig 1

Source ID	SeqNumber	HopCount	Energy Threshold	Signal Strength Threshold	Sink ID

Figure 1: Route Request Message frame format

The reception time T is calculated as

$$T = \frac{k}{Energy_{node}}$$

Where k is constant and Energy node is the remaining energy of node. After setting the reception time T, the node process the RREQ packet and record the remaining energy, ID and message ID of sending node in the recei-node list. The receiver node’s remaining energy and its ID replace the remaining energy and ID in this RREQ packet. RREQ packet is sent to its neighbors during the arrival of the reception time [16]. The node checks the arrival of the timer setting of message ID, if the RREQ packet is received after the first time as shown in Fig 2. If the reception time T has not arrived, then the node will record the whole information along with the remaining energy of the RREQ packet.

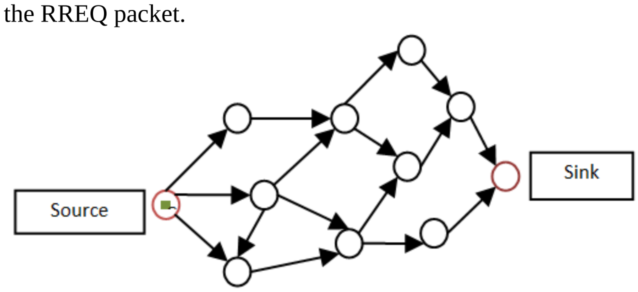


Figure 2: Source node path discover

If the reception time is T has arrived, then the node will discards the RREQ packet. RREQ packets are sent in flood to the destination by this manner. When the sink node receives the RREQ packet, it will examine the message ID number of RREQ packet. The sink node at the same time records the whole information like node remaining energy, and node ID of RREQ packet.

Routing Reply of the First Path

After the selection of the routing table for the path, the destination node sets the transmit radius and send the RREP packet. The RREP packet contains receiver node ID number, sender node ID number, message ID number, and RREP signs so on. The packet format of the RREP is shown in Fig 3.

RREP	RecvID	SelfID	MessageID

Figure 3: Packet format of RREP

After receiving the RREP packet, the node first checks the data packet type whether it is RREP packet or not. If it is RREP packet, It checks the receiver node ID number, to check whether it is receiver node or not. If it is receiver node ID in the RREP, the node will check and records the message ID number, node ID and other node information and for next hop node, it will set the sender node ID [16]. After setting the transmit radius, the RREP packet is transmitted [17]. This process is shown in Fig 4.

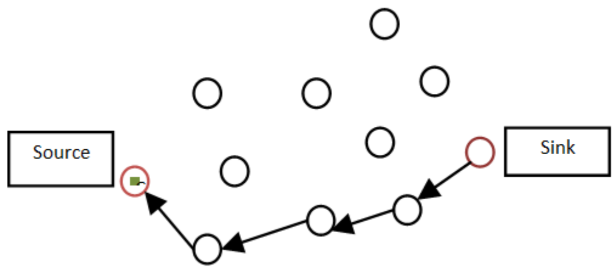


Figure 4: Route Establishing

Establishing the Second Path Discovery

The method of establishing the second discovery path is same as establishing the first path. The nodes which have participated in discovering the route will not participate in second discovering path. After the completion of routing, the source node sends data to the sink node through the established paths. The source node sets the time of transmitted data every time. When the source node sends data to the sink node, it will set the same time interval as in case of first path discovery, and sends the next packet.

Data Transmission Phase

After the discovering of paths, the source node starts sending data packets to the sink node. Each time a data packet arrived, the routing table is updated at the sink and the format of packet includes Seq_Number, Source ID, Sink ID, Data_len, Paylaod. The Seq_Number field is the sequence number of the data packet. The Source ID and Sink ID are the source and sink node of the packets. Data_len field denotes the length of the data packet. Paylaod field is that carry information [18]. The updating of values in routing table helps the sink node in finding that how many routes have been used. To detect the path failures, the sink node monitors the delay of data packets on each path. A threshold value is assumed. If the delay is above the threshold value, the sink supposes that the path is not broken. This protocol avoids the path failures and data packets the data is stored in the sender side unless an ACK is not received from the receiver side. If the ACK is not received within the reception time, an error report is generated and data will be sending back to the source for retransmission [19]. In order to save the energy of whole network, the data aggregation method is introduced in EQSR protocol. All the nodes will aggregate and send the data. When the node receives the data from different nodes, it will firstly rearrange the data by the sink ID field of data packet. The node will aggregate the packets by merging the payload and other fields. So, only one data packet is send to the sink node.

4. Problem Definition

In a Wireless Sensor Network (WSN for short), individual sensor nodes, or sensors, are constrained in energy, computing, and communication capabilities. Typically, sensors are mass-produced anonymous commodity devices that are initially unaware of their location. Once deployed, sensors should self-organize into a network that works unattended. The packet delivery should be reliable and scalable for the wireless sensor network for performing and better point of view.

5. Methodology

In a Wireless Sensor Network (WSN for short), individual sensor nodes, or sensors, are constrained in energy, computing, and communication capabilities. Typically, sensors are mass-produced anonymous commodity devices that are initially unaware of their location. Once deployed, sensors should self-organize into a network that works unattended. Power consumption is always a problem in wireless sensor network. There must be less energy consumption to improve the quality of service of sensor network. The packet delivery should be reliable and scalable for the wireless sensor network for performing and better point of view.

6. Objectives of the Research

The end to end delay is the main issues in the wireless sensor network. So these papers focus on main parameters; drop packets and end –to- end delay. The main steps included to get the required objectives are as follow:

- Develop a simulated environment of Wireless Sensor Network.
- Develop an energy aware EQSR routing protocol based on Quality of Service.
- Implement two pass Algorithm in EQSR routing protocol.
- Evaluate and analyze performance in terms of send packets, drop packets, receive packets and end to end delay.

7. Proposed Algorithm

Two Pass Algorithm:

This algorithm is used for finding variance; first it computes the sample mean,

Mean = $$A = \sum_{j=1}^{n} \frac{x_j}{n},$$

And then computes the sum of the squares of the differences from the mean,

Variance = $$\partial^2 = \sum_{i=1}^{n} \frac{(x_i - A)^2}{n-1}$$

as given by the following pseudo code :

```
def two_pass_variance(data):
   m  = 0
   count up 1 = 0
   count up 2 = 0

   for y in data:
      m    = m + 1
      count up 1 = count up 1 + y
```

$$mean = \frac{count\ up\ 1}{m}$$

```
 for y in data:
      count up 2 =  count up 2 + (y - mean)*(y - mean)
```

$$Variance = \frac{count\ up\ 2}{m-1}$$

```
   return variance
```

To find the drop packets

drop [k] = send [k] – rec [k]

Where k is the number of packets.

This algorithm is often more numerically reliable for large sets of data, although it can be worse if much of the data is very close to but not precisely equal to the mean and some are quite far away from it.

8. Results and Discussion

It deals with the simulation study of the routing protocol in Wireless Sensor Networks for said problem statement. The procedure used for simulations is explained and the scenarios for which simulations are carried out are described below. The observations of the simulation study are plotted as graphs and conclusions are carried out on the basis of these graphs. Simulation is the research tool of choice for majority of researchers. The simulation carried out with NS-2.The Network Simulator, ns-2.35 is a networking event simulator, which simulates such events as sending, receiving, forwarding and dropping packets, etc. The events are sorted by time (measure in seconds) in ascending order [20]. For simulation scenario and network topology creation it uses TCL (Tool Command Language).

For analyze, the simulations have been performed using Network Simulator 2 version 2.34. It is scalable and open source used for the simulation behaviors of wired or wireless network functions and protocols. Our simulation network consists of 200 sensor nodes that are randomly scattered in the square field of 1000 * 1000. All nodes have same transmission range of 25m.The following are the result analysis.

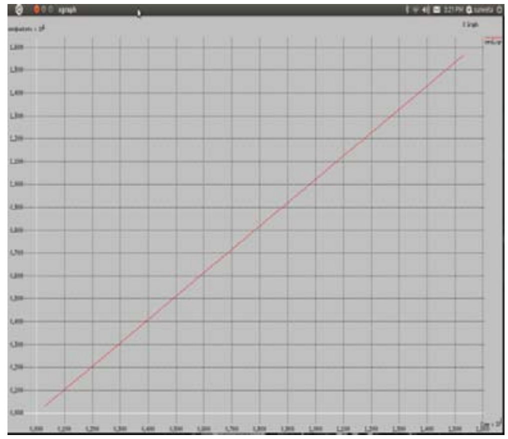
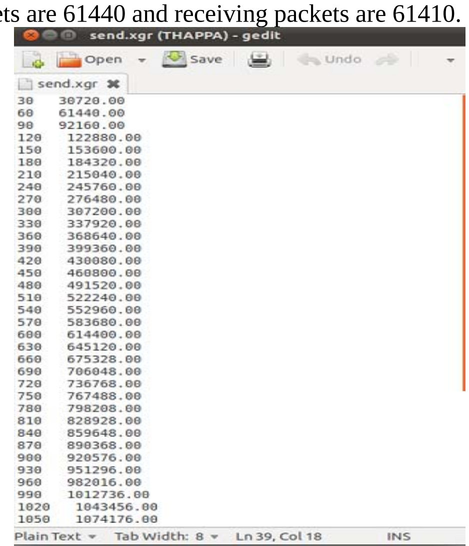


Figure 5: Send packets

In fig 5, at time 30 sec, the no of send packets are 30,720. At 60 sec, the no of send packets are 61440. At 90 sec, the no. of receive packets are 92160 and so on. The graph of send packets is increasing gradually. And the values calculated in NS-2 are in Fig 6.

In fig 7, at time 30 sec, the no of receive packets are 30,720. At 60 sec, the no of receive packets are 61410. At 90 sec, the no. of receive packets are 92070 and so on. The values of receive packets are simulated by NS-2 shown in fig 8. At 30 sec, the no of sending packets are 30 720, and at the receiving side, the no of received packets are same as send packets of 30,720. But at 60 sec, sending packets are 61440 and receiving packets are 61410.



send.xgr (THAPPA) - gedit

Open Save Undo

send.xgr

30	30720.00
60	61440.00
90	92160.00
120	122880.00
150	153600.00
180	184320.00
210	215040.00
240	245760.00
270	276480.00
300	307200.00
330	337920.00
360	368640.00
390	399360.00
420	430080.00
450	460800.00
480	491520.00
510	522240.00
540	552960.00
570	583680.00
600	614400.00
630	645120.00
660	675328.00
690	706048.00
720	736768.00
750	767488.00
780	798208.00
810	828928.00
840	859648.00
870	890368.00
900	920576.00
930	951296.00
960	982016.00
990	1012736.00
1020	1043456.00
1050	1074176.00

Plain Text Tab Width: 8 Ln 39, Col 18 INS

Figure 6: Send packet values

It means there are some drops of packets. These graphs of drop of packets are shown in fig 9.

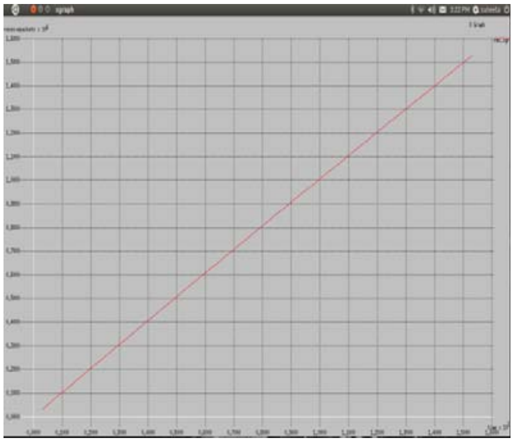
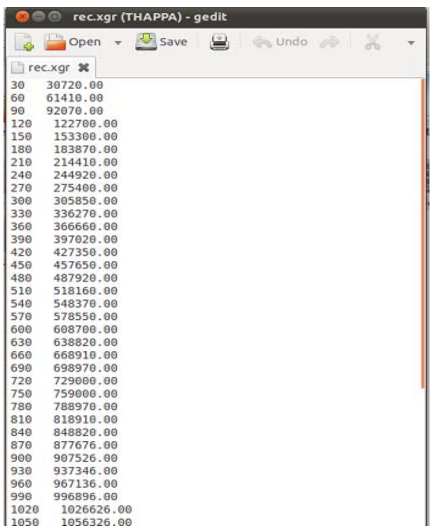


Figure 7: receive packets

In fig 8, at time 30 sec, the no of drop packet are 0.00. At 60 sec, the no of drop packets are 30.00. At 90 sec, the no. of drop packets is 90.00 and so on. The values of drop packets are simulated by NS-2 shown in fig 10.
At 30 sec, the no of sending packets are 30 720 and the no of received packets are also 30,720.



rec.xgr (THAPPA) - gedit

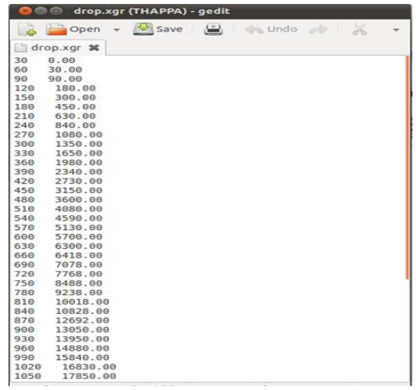
30	30720.00
60	61410.00
90	92070.00
120	122700.00
150	153300.00
180	183870.00
210	214410.00
240	244920.00
270	275400.00
300	305850.00
330	336270.00
360	366660.00
390	397020.00
420	427350.00
450	457650.00
480	487920.00
510	518160.00
540	548370.00
570	578550.00
600	608700.00
630	638820.00
660	668910.00
690	698970.00
720	729000.00
750	759000.00
780	788970.00
810	818910.00
840	848820.00
870	877676.00
900	907526.00
930	937346.00
960	967136.00
990	996896.00
1020	1026626.00
1050	1056326.00

Figure 8: receive packets values

So there is no drop of packets. But at 60 sec, sending packets are 61440 and receiving packets are 61410.

Figure 9: drop packets

It means there are some drops of packets. The no of drop packets are 30. At 90 and 120 secs, the packets dropped are 90 and 180.



drop.xgr (THAPPA) - gedit

30	0.00
60	30.00
90	90.00
120	180.00
150	300.00
180	450.00
210	630.00
240	840.00
270	1080.00
300	1350.00
330	1650.00
360	1980.00
390	2340.00
420	2730.00
450	3150.00
480	3600.00
510	4080.00
540	4590.00
570	5130.00
600	5700.00
630	6300.00
660	6418.00
690	7078.00
720	7768.00
750	8488.00
780	9238.00
810	10018.00
840	10828.00
870	12692.00
900	13050.00
930	13950.00
960	14880.00
990	15840.00
1020	16830.00
1050	17850.00

Figure 10: drop packets values

These graphs of drop of packets are shown in fig 9. The end-to delay in fig 11, the delay is analyzed using the NS-2 simulator. The delay in y- co-coordinately is within the red lines.

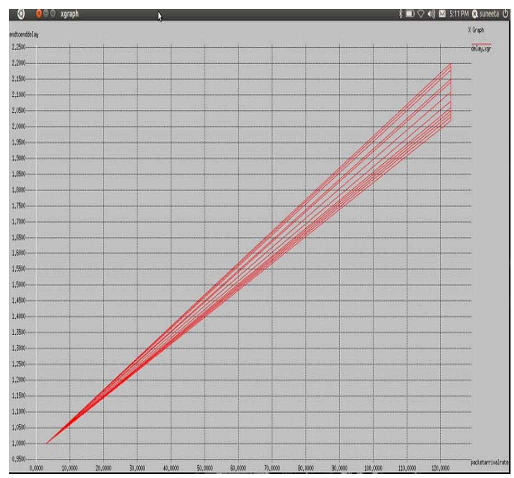


Figure 11: end- to-end delay

The delay is increasing gradually from co-ordinates (0.02, 100) to co- ordinates (120, 220). But implementing two pass algorithms the delay is decreased from the previous work. The reasons of drop packets are many like interference, collisions, delay and buffer overflows.

So this work is done on end –to –end delay. When the end –to-end delay is decreased, the no of received packets received successful and there is no drop of packets.

9. Conclusion

This paper analyzes EQSR protocol; An Energy efficient and quality of service aware multi-path routing protocol. The performance of EQSR is analyzed using NS2 simulator in terms of send packets, recive packets, drop packets and end – to-end delay. Analyze the drop packets and decrease the end – to-end delay. This improves the packet delivery ratio that prolong the lifetime of network.

10. Future Scope

In today's context, wireless sensors are now getting connected using internet backbone. We have wearable sensor which need to communicate with central server who process the received data to give some meaningful information. For future work, it is suggested that more simulation based experiments must be done to know the drop packets and end –to-end delay.

References

[1] F. Akyildiz, Weilian Su, Yogesh Sankarasubramaniam, and Erdal Cayirci, "A Survey on Sensor Networks", IEEE Communication Magazine, vol. 38, pp. 393-422, 2002.

[2] Yang Yu, Viktor K Prasanna, and Bhaskar Krishnamachari , " Information Processing and routing in Wireless Sensor Networks" , World Scientific Publishing Co. Pte. Ltd, 2006.

[3] Boujelben, Youssef, H.,Abid, and M., " Survey on Pre Shared Key in WSN" , International Conference on Wireless and Mobile Computing, pp. 532 – 537, 2008.

[4] Hongjun Dai; Huabo Liu; Zhiping Jia; Tianzhou Chen, "A Multivariate Classification Algorithmfor MaliciousNode Detection in Large-Scale WSNs", IEEE 11th International Conference on Trust, Security and Privacy in Computing and Communications (TrustCom), pp. 239 – 245, 2012.

[5] Ye, W., Heidemann, J., and Estrin, D., "An Energy Efficient MAC Protocol for Wireless Sensor Networks", IEEE Conference on Computer Communications (INFOCOM), pp. 1567-1576, 2002.

[6] Reddy, Y.; Durand, J., Kafle, "Detection of Packet Dropping in Wireless Sensor Networks", International Conference on Information Technology and New Generations (ITNG), pp. 879 – 884, 2010.

[7] Vijay Bhuse, Ajay Gupta, and Leszek Lilien, "DPDSN: Detection of packet-dropping attacks for wireless sensor networks" , International Conference on High Performance Computing, 2005.

[8] Sultana, S.; Bertino, E.; Shehab, M., "A Provenance Based Mechanism to Identify Malicious Packet Dropping Adversaries in Sensor Networks", International Conference on Distributed Computing Systems Workshops (ICDCSW), pp. 332 – 338, 2011.

[9] Shan Zhu; Huang, G.M., "A new packet-loss minimization routing algorithm for ATM high-speed data networks", IEEE conference on Decision and Control", vol 1, pp. 287-292, 1996.

[10] Zheng Jian-Li; Wang Xue-Ping; Zhang Gen-Du, "MPSSF: a buffering & forwarding handover scheme reducing out-of-sequence packets", International Conference on Computer Networks and Mobile Computing, pp. 478-482, 2003.

[11] Bai, H.; Lilja, D., "Buffer requirements at ECN-capable RED gateways to minimize packet losses", IEEE International Conference on Electro Information Technology, pp. 4, 2005.

[12] Kaur, H.T.; Ye, T.; Kalyanaraman, S.; Vastola, K.S., "Minimizing packet loss by optimizing OSPF weights using online simulation", IEEE/ACM International Symposium on Modeling, Analysis and Simulation of Computer Telecommunication Systems, pp. 79-86, 2003

[13] Priya, K.; Raja, G., "QoS enhancement in future generation network by handoff delay minimization", International Conference on Recent Trends in Information Technology (ICRTIT), pp. 287-291, 2012.

[14] Jalel Ben-Othman, Bashir Yahya, "Energy efficient and QoS based routing protocol for wireless sensor network", IEEE Journals of parallel and Distributed computing, vol. 70, pp. 849-857, 2010.

[15] Yash Pall, Lalit K. Awasthi, A. J. Singh, "Maximize the Lifetime of Object Tracking Sensor Network with Node-to-Node Activation Scheme", IEEE International Advance Computing Conference (IACC), 2009.

[16] S M Lambor, S M Joshi, "Performance Analysis of Network Lifetime and Energy Consumption in a Multi-Hop Wireless Sensor Network", International Conference and workshop on Emerging Trends in Technology (ICWET), 2011.

[17] Onur Soysal, Sami Ayyorgun, Murat Demirbas, PowerNap: An Energy Efficient MAC Layer for Random Routing in Wireless Sensor Networks", IEEE Communications Society Conference on Sensor, Mesh and Ad Hoc Communications and Networks, 2011.

[18] Sandip Kumar Chaurasiya, Tumpa Pal, Sipra Das Bit, "An Enhanced Energy-Efficient Protocol with Static Clustering for WSN", International Conference on Information Networking (ICOIN), 2011.

[19] Mustapha Reda Senouci, Abdelhamid mellouk, Amar AissanI, Hadj Senouci, "Performance Evaluation of the Network Lifetime for Routing Protocols in WSN", International Conference on Wireless Communications and Mobile Computing (IWCMC), 2011.

[20] Kumar M.K.Jeya and R.S.Rajesh, "Performance Analysis of MANET Routing Protocols in Different Mobility Models", International Journal of Computer Science and Network Security (IJCSNS), vol.9, pp.22-29, 2009.

Author Profile

Sunita is native of Gurdaspur, Punjab India. She received her B.Tech from BCET, Gurdaspur. She is pursing ME from NITTTR, CHD. Presently, she is a ME student.

Mr. O.S. Khanna is a native of Chandigarh, India. He received Degree from University of Roorkee (Now IITR), Roorkee, India. Currently he is pursuing his PhD from Punjab Technical University, Jalandhar, India. Presently he is servings as Associate Professor in the department of ECE at NITTTR, CHD. His areas of interests are Computer Networks, Wireless Sensor Networks, and Data Communications.

Amandeep Kaur is native of Mansa, Punjab, India. She received her B.Tech from CEC, Landran, and Punjab. She is pursing ME from NITTTR, CHD. Presently, she is a ME student.