Comparative analysis of ETSEP with SEP and TSEP in WSNs

Madhusudan[1] Joykaran Singh[2]
[1,2]Department of Electronics and Communication Engineering
[1,2]CTITR, Jalandhar

Abstract— A wireless sensor networks (WSNs) consist of numerous power constrained nodes which collect data from the environment and then passes it to the base station through cluster heads for extracting desired information. The main requirement of the WSN is to enhance the lifetime of the nodes, increase throughput and reduces the delay and packet loss. So clustering is use to increase the lifetime as well as the stability of the network. In this paper ETSEP (Enhanced Threshold Sensitive Stable Election Protocol) has been analysed comparatively on the basis of parameters like delay, packet loss, and throughput with SEP (Stable Election Protocol), TSEP (Threshold Sensitive Stable Election Protocol). The simulation results show that the ETSEP performs far better than SEP and TSEP. The network consists of 100 nodes spread out in the area of 100*100 meters. The working of these protocols has also been described.

Key words: TSEP, SEP, ETSEP

I. INTRODUCTION

Wireless sensor network comprises of a numerous number of mobile nodes. These nodes communicate with each other directly or indirectly through the wireless links. The internet is outspreading its range to the real world through innovations cooperatively termed as the Internet of Things (IoT) [1]. As the important role of the IoT, wireless sensor networks (WSNs), have been drawing growing research interests due to their ability to collect data from the environment [16][17][2]. Wireless sensor networks are distributed autonomous sensors to monitor physical or environmental conditions, for instance, temperature, pressure, humidity, etc. and to supportively pass their data through the network to the main location [3][12][14]. Clustering is the method in which nodes are divided into sub-areas called clusters. Each cluster is having a cluster head (CH) which collects the data from the nodes of its cluster and then collectively passes it to the base station (BS). This ultimately saves the energy of the nodes, reduces packet loss and thereby improves the stability of the network [4] [13][15].ETSEP is a hierarchal, cluster based and reactive routing protocol for WSN. It consists of three types of nodes- normal, advanced and intermediate nodes, having different energy levels. Advanced nodes have energy higher than the normal nodes by a factor of 'a'. Intermediate nodes have more energy than Normal nodes by a factor of 'b', which is half of the value of 'a'. It consists of two types of threshold Soft and Hard threshold. The node which wants to become the cluster head chooses a number randomly between 0 and 1 and compared with the threshold. All nodes continuously sense the environment. When the parameter reaches the hard threshold value, the transmitter is turned on and the data is transmitted to the base station. Then this sensed value is stored in a variable in the node. For the next time, all the other nodes will transmit sensed data only if the currently sensed value is greater than the hard threshold or the difference between the sensed value and previously stored value in the variable is equal or greater than the soft threshold. In ETSEP, the threshold has been set on the basis of residual energy of node and an optimal number of cluster per round [5].

TSEP also comprises of nodes having three different energy levels, namely- normal, advanced and intermediate nodes. Cluster heads are formed by considering the threshold value and the number selected by nodes.

SEP assumes that nodes have the different energy in the real environment. So it takes two different types of nodes- Normal and Advanced nodes. Advanced nodes have an 'a' amount of more energy than normal nodes. SEP assigns a weighted probability to each node on the basis of its energy.

II. RELATED WORK

Sharma T. et al has studied and compared various routing protocols on the basis of parameters like data aggregation, multi-hoping, power usage, scalability. The conclusion derived from this work is that there is a need to develop a protocol that can overcome these challenges [2]. Kumar S. et al had compared ETSEP, SEP, TSEP on the basis of the number of alive nodes, the number of dead nodes. The result shows that ETSEP has improved the stability and lifetime of the network in comparison with the other two protocols [5]. Latif K., et al had selected four cluster based routing protocols namely Low Energy Adaptive Clustering Hierarchy (LEACH), Threshold Sensitive Energy Efficient sensor Network (TEEN), Stable Election Protocol (SEP), and Distributed Energy Efficient Clustering (DEEC). The authors had taken cluster head per round, number of alive nodes and packet send to base station as the parameters for comparison. The results had been concluded that SEP is good for an optimum number of CH selection, while DEEC is the most energy efficient protocol [4]. Heinzelman W. had analyzed a method for electing cluster heads by taking into account the energy left in each node. The drawback of this method is that this decision has to be made per round and assumed that the total energy left in the network was known. The assumption of global knowledge of the energy left in the whole network makes this method very difficult to implement [6]. Vibhuti P. et al has compared LEACH, SEP, and TEEN on the basis of first node dead. The results shows that there has been a significant improvement in the network lifetime by SEP as the first node dies at 834th round in comparison to the TEEN and Leach in which node dies at 726 and 802 respectively [7]. Jinpa T. et al had compared DEEC, MODLEACH and SEP on the basis of the number of alive nodes, number of dead nodes, and cluster formation in each round. The results had been concluded that the DEEC has performed far better than SEP and MODLEACH as it has more number of alive nodes in each round [8]. Sharma T. et al has proposed a new protocol namely ECC-SEP, which is an extension of SEP. It results in better stability in comparison with LEACH, SEP. The clusters merged into each other on the basis of the distance between them and

redundant information is removed [9]. GS has designed a protocol named SEP for a heterogeneous two-level hierarchal network, in which each and every sensor node can elect itself as cluster head on the basis of its residual energy [10].

III. SIMULATION SETUP

The network is designed using Network Simulator version 2.35 with IEEE standard 802.11. We implemented the network with respect to varying node energy. The network area has been taken as 100*100 meters in which 100 numbers of nodes are deployed. These nodes are further divided into clusters. Three different networks had been formed for SEP, TSEP, ETSEP. Simulation setup is described as follow:

Standard used	IEEE 802.11
Network size	100*100
Number of nodes	100
Number of CH	8
Node range	18 meters

Table 1: Network setup

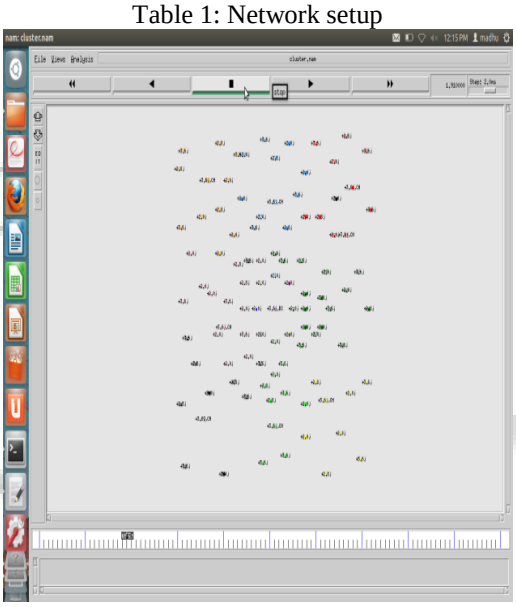

Fig. 1: Network scenario of ETSEP.

IV. RESULTS AND DISCUSSION

We analyzed the ETSEP, SEP, TSEP on the basis of parameters namely, packet loss, delay and throughput. The parameters taken for comparison are defined as follows:

Packet loss is defined as the number of packets received to the total number of packets sent.

Delay refers to the time taken by a packet to reach the destination after it leaves the source.

Throughput is defined as the amount of data moved successfully from source to destination in a given time period.

Figure 2, 3, 4 shows the graphical results taken for delay, packet loss and throughput respectively.

The ETSEP has a minimal delay in comparison to SEP and TSEP. The highest value of delay in ETSEP is 8 while it is 20 for SEP and 13 for TSEP.

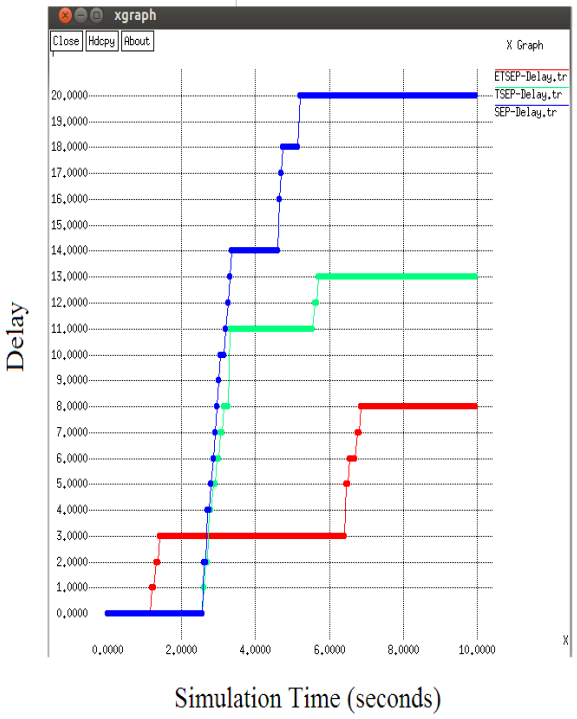

Fig. 2: Delay vs. Simulation Time

Simulation Time (seconds)	DELAY		
	SEP	TSEP	ETSEP
2	0	0	3
4	14	11	3
6	20	13	3
8	20	13	8
10	20	13	8

Table 2: Tabular comparison of Delay vs. Simulation time for SEP, TESP, and ETSEP

The packet loss is also very minimal in case of the ETSEP. The maximum value of packet loss is 11 for ETSEP at 10 seconds, while it is 24 for SEP and 15 for TSEP.

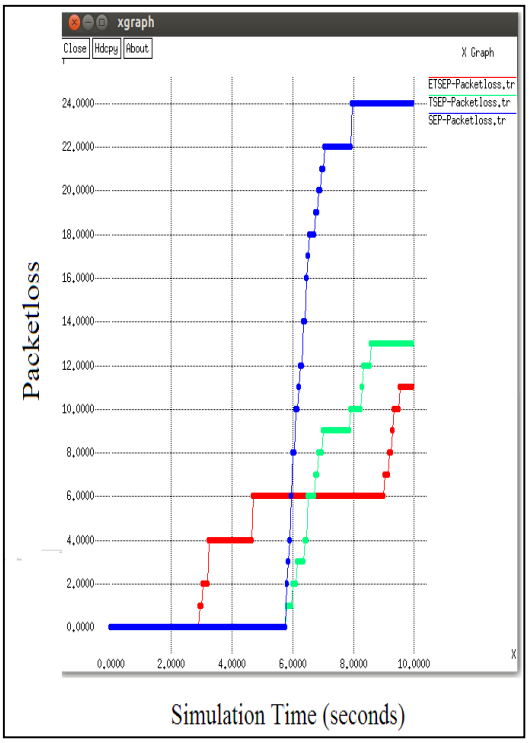

Fig. 3: Packet loss vs. Simulation Time

Simulation Time(seconds)	PACKET LOSS		
	SEP	TSEP	ETSEP
2	0	0	0
4	0	0	4
6	8	2	6
8	24	10	6
10	24	13	11

Table 3: Tabular comparison of Packet loss vs Simulation time for SEP, TESP, and ETSEP

Throughput value for ETSEP is 87 while it is 32, 25 for TSEP, SEP respectively at 10 seconds. Hence, ETSEP outperforms SEP and TSEP in improving the lifetime and stability of the network.

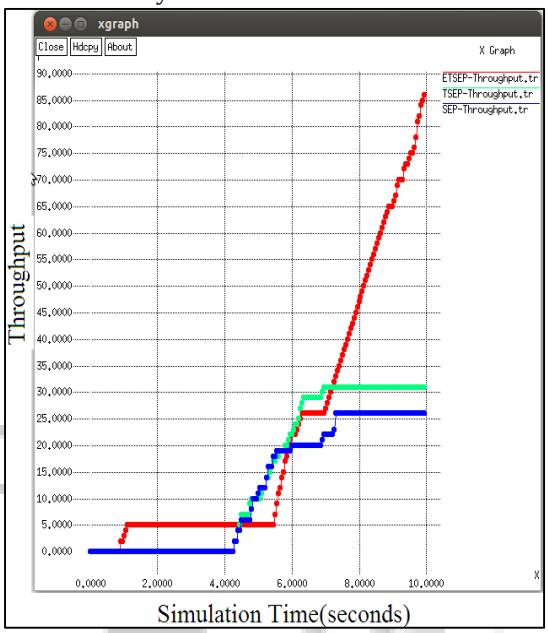

Fig. 4: Throughput vs. Simulation Time

Simulation Time (seconds)	THROUGHPUT		
	SEP	TSEP	ETSEP
2	0	0	5
4	0	0	5
6	20	22	22
8	21	31	48
10	21	31	86

Table 4: Tabular comparison of Throughput vs Simulation time for SEP, TESP, and ETSEP.

V. CONCLUSION

In this paper, our main focus is to improve the stability and lifetime of the network by increasing the throughput and decreasing the delay and packet loss to the minimum level possible. ETSEP perform far better in improving the stability and network lifetime of the network as compared to the SEP and TSEP as it has high throughput value and minimum delay and packet loss. Therefore, ETSEP is one of the best protocol for Wireless sensor networks. Furthermore, improvement can be done in ETSEP to make it even better.

REFERENCES

[1] Yongsheng Ding, Yifan Hu, Kuangrong Hao, Lijun Cheng, "MPSICA: An intelligent routing recovery scheme for heterogeneous wireless sensor networks," Information Sciences, pp 49–60, 2015.
[2] Sharma T.,Singh H., Sharma A., ''A Comparative Review on Routing Protocols in Wireless Sensor Networks, International Journal of Computer Applications, vol. 123, pp. 28-33, 2015.
[3] Ren F., Zhang J., He T., Lin C., Das S.,''EBRP: Energy-Balanced Routing Protocol for Data Gathering Wireless sensor network,'' Ieee transactions on parallel and distributed systems, Vol. 22, pp. 67.75,2011.
[4] K. Latif, M. Jaffar, N. Javaid, M. N. Saqib, U. Qasim‡, Z. A. Khan, "Performance Analysis of Hierarchical Routing Protocols in Wireless Sensor Networks", pp. 26-38, 2012.
[5] Kumar S., Verma S., Enhanced Threshold Sensitive Stable Election Protocol, IOSR Journal of Computer Engineering, Vol. 17, pp. 27-33, 2015.
[6] Heinzelman W., "Application-Specific Protocol Architectures for Wireless Networks," Ph.D. thesis, Massachusetts Institute of Technology, pp. 84-99, 2000.
[7] Vibhuti P., Jaiswal N., Garg A., " An Efficient Protocol for Reducing Energy Consumption in Wireless Sensor Networks," International Journal of Engineering Research and Applications, Vol. 2, pp. 530-533, 2012
[8] Jinpa T., Reddy B., "The Study of the Energy Efficient Protocols (MODLEACH, SEP and DEEC)", International Journal of Computer Science & Communication Networks, Vol 5(1), pp. 32-38, 2013.
[9] Sharma T., Kumar B., Tomar G., "An Efficient Condensed Cluster Stable Election Protocol in Wireless Sensor Networks," International Journal of SmartDevice and Appliance, Vol.1, pp. 26-34, 2013.
[10] Smaragdakis G., Matta I., Bestavros A. "SEP: A stable election protocol for clustered heterogeneous wireless sensor networks", Proc of the Internationa1 Workshop on SANPA 2004. pp. 251-261, 2004.
[11] Verma R., Dolly P., Kumar D., "A Novel Approach of Improved Stable Election Protocol (I-Sep) In Wsn", International Journal of Computer Science and Mobile Computing, Vol.4, pg. 701-711, 2015.
[12] Bakaraniya P., Mehta S., "Features of WSN and various routing techniques for wsn: a survey," International Journal of Research in Engineering and Technology, vol. 1, pp. 348-354, 2012.
[13] Verma D., Singh S., ''Quadrature Based Energy Efficient Hierarchical Routing Protocol for Heterogeneous Wireless Sensor Networks,'' International Journal of Current Engineering and Technology, vol.5, pp. 1921-1925, 2015.
[14] Tanwar S., Kumar N., Rodrigues J., ''A systematic review on heterogeneous routing protocols for wireless sensor network,'' Journal of Network and Computer Applications, pp. 39-56, 2015.
[15] Biradar V., Patil V., Sawant V., Mudholkar R., ''Classification and comparison of routing protocols in wireless sensor networks,'' Special Issue on Ubiquitous Computing Security System, vol. 4, pp. 704-711, 2011.
[16] Singh S., Singh M., Singh D., ''Routing Protocols in Wireless Sensor Networks–A Survey,'' International Journal of Computer Science & Engineering Survey, vol.1, no.2, pp. 63-83, 2010.
[17] KwaśniewskiP., ''Comparative Study of Wireless Sensor Networks Energy-Efficient Topologies and Power Save Protocols," Journal of Telecommunication and information technology, pp. 219-227, 2009.

