

Analysis of Optimization of Quality of Service Parameters in Wireless Sensor Network by Clustering Approach

¹Kanchan Dhote, ²G.M.Asutkar, ³Supratim Saha, ⁴Tapas Pramanik

¹Department of Electronics Engineering. SRCOEM, Nagpur, India

²Department of Electronics Engineering. PIET, Nagpur, India

³Department of ECE. SITE, SVSU, Meerut, India

⁴Department of Electronics Engineering. TGPCET, Nagpur, India

Email: dhotek@rknc.edu, g_m_asutkar@gmail.com

Received: 20th September 2018, Accepted: 11th October 2018, Published: 31st October 2018

Abstract

Wireless Sensor Network is a very keen area for research. The factors that plays important role in affecting the performance of Wireless Sensor network are the quality of service parameters. The quality of service parameters plays the important role to judge the performance of Wireless Sensor Network. The important Quality of Service parameters are delay, jitter, throughput, packet delivery ratio and energy consumption. The problems and limitations existing in WSN in terms of Quality of Service parameters are like energy consumption by the routing protocols is very high further if we consider time related issues delay and jitter are high. In terms of security also they are not much secure. This paper proposes to overcome the problems and the limitations present in the existing routing protocols by improving the QOS parameters. This can be achieved by applying Clustering. This paper also presents the mathematical analysis of different routing protocols before and after applying the Clustering. Hence optimization of Quality of Service parameters leads to minimization of energy consumption, delay and jitters and hence enhanced the performance of WSN.

Keywords

Delay, Jitter, Energy Consumption, QOS.

Introduction

Wireless sensor networks (WSN) are scattered independent sensors to supervise environmental conditions, for example humidity, pressure, temperature etc. and to readily transfer their data from beginning to end to the network to a most important location. The recent networks are bi-directional, they also enables control of sensor activity. The military applications motivated the development of wireless sensor networks to a greater extent by battlefield surveillance; nowadays such networks are used in almost every field such as industrial and consumer applications, machine health monitoring, and so on. Typically, a wireless sensor node consists of sensors, computing unit, communication unit, and actuation unit and power components. A WSN usually comprises of ten to thousands of such nodes that correspond through wireless channels for information distribution and supportive processing. WSNs can be deployed on a large-scale scale for environmental monitoring and environment study, over a battle for military surveillance and investigation, in emergent environments for search and rescue, in factories for condition based protection, in buildings for transportation health monitoring, in homes to realize smart homes, or even in bodies for patient monitoring.

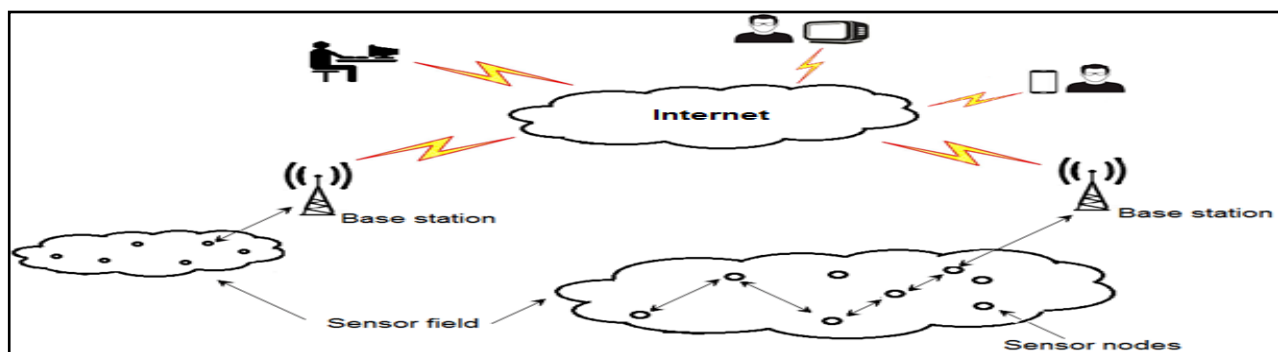


Figure 1: Wireless Sensor Network

Materials and Methods

Quality of Service Parameters

In this paper, the analysis of 4 protocols AODV, DSDV, DSR & AOMDV is done on the basis of Quality of Service Parameters – Delay, Jitter and Energy Consumption. For simulation NS-2, Network Simulator software version 2 is used.

Delay - Delay is the time taken from the exit of a data packet from the source node to the arrival at the destination node. Delay application usually require Wireless Sensor Adhoc Networks to deliver the data packets in real-time. The real-time does not mean fast communication in this context [3]. A real-time system needs to execute at a speed that fulfill the timing requirements. Delay is a scale used to calculate the performance with time take by a data packet to travel across a network from a source node to the destination node. Each sensor node with sensed data waits for the neighbor sensor node to turn it to active mode.

Average End-to-End Delay = n(Transmission delay + Processing Delay + Propagation Delay)

Jitter - Jitter is generally referred to as variation in delay. It is often caused by the difference in queuing delays experienced by subsequent packets. Jitter is a performance parameter used to measure deviation from true periodicity eventually of immobility in packet across exact network [11]. Network congestion results in route changes that causes jitter. Due to improper queuing techniques, average Jitter in a network increases for an indefinite period .

Energy Consumption–Energy consumption in the WSN is the amount of energy required by the packets to reach from source node to destination node. The energy consumption should be as low as possible for an efficient network. If the energy utilization is more in the network, excess of energy utilization leads to the following consequences- Reduction in the amount of data transmission across the network, duty cycle range lower the transceiver, redundant transmission reduces, frequency of data transmission slows down, reduction in overhead frame.

Design of Basic Wireless Sensor Network

Cluster Formation – Clustering is used for reducing the energy utilization of the wireless sensor network as well as prolong the life span of the networks and preserve a reasonable energy outflow by the nodes of the network. The no. of nodes are divided into several clusters (group of nodes).By analyzing the energy of all the nodes in a cluster, the node having highest energy is appointed as cluster head. The sensor nodes can use the light network resources power more competently [1]. Within a cluster, data aggregation and synthesis are performed at cluster- head to reduce the amount of data transmission to the base station. Non cluster-head nodes select their cluster-head immediately after deployment and sends data to the cluster-head [3].

- The communication in nodes will be done by using cluster head on the basis of energy distribution of the nodes, selection of the cluster head for respective cluster is done and then the node from one cluster can communicate with other nodes with the help of cluster head.
- Node can send the data to the cluster head of the first cluster and then this data can send to another cluster node head and then cluster head will send the data to the destination node. Power consumption can be increased by using this procedure of data communication [5].

Low Energy Adaptive Clustering Hierarchy (LEACH)

The networks have a definite lifetime throughout which nodes have restricted energy .The energy of nodes are used by them to gather procedure and send information. It reflect that the all the nodes, from the sensor unit to the hardware and protocols, must be intended to be particularly energy efficient. Declining energy usages by a factor of two can double system life span which results in the utility of the system. To reduce energy dissipation, protocols should be robust to node failures, fault tolerance and scalable in order to minimize system life span [2].

The network protocol that uses hierarchical routing to increase the life time of network for wireless sensor networks is LEACH. All the nodes in a network categorize themselves into local clusters, while the cluster head node receive data from all the other node members of cluster, perform signal processing function on the data, and transmit data to remote base station [4]. Therefore cluster head node is having more energy i.e. more rigorous than a non-cluster head node [16]. Thus, when a cluster-head node dies, all the nodes that belong to the cluster be unable to find communication capability.

Formation of Clusters Using NS-2

Wireless Sensor network containing 30 nodes is designed using NS-2, Figure 2 shows the Wireless Sensor network containing 30 nodes.

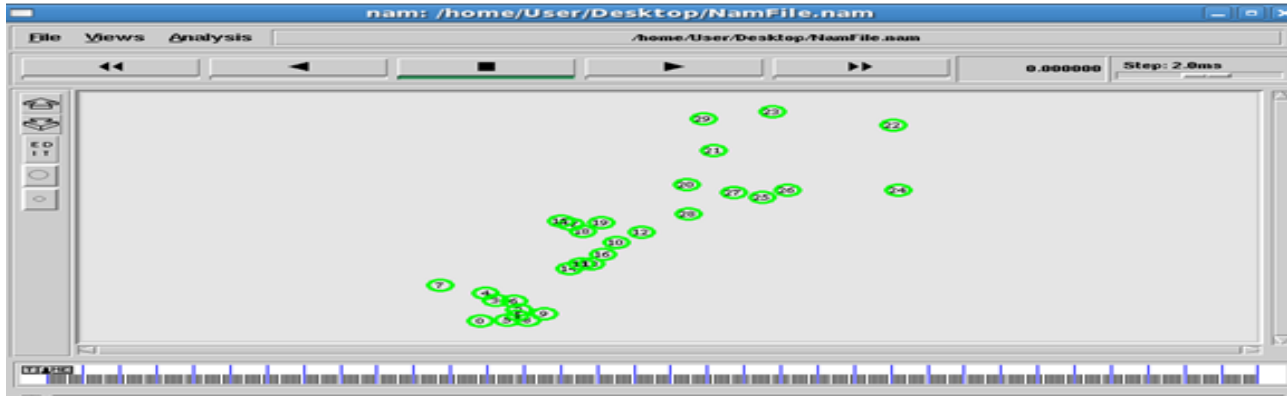


Figure 2: Design of Wireless Sensor Network Consists of 30 Nodes.

After applying the clustering these 30 nodes are divided into three clusters as shown in figure 3 given below. Each cluster consists of 10 nodes. Cluster1 consist of node 0 to node 9, cluster2 consist of node 10 to node 19 and cluster 3 consist of node 20 to node 29.

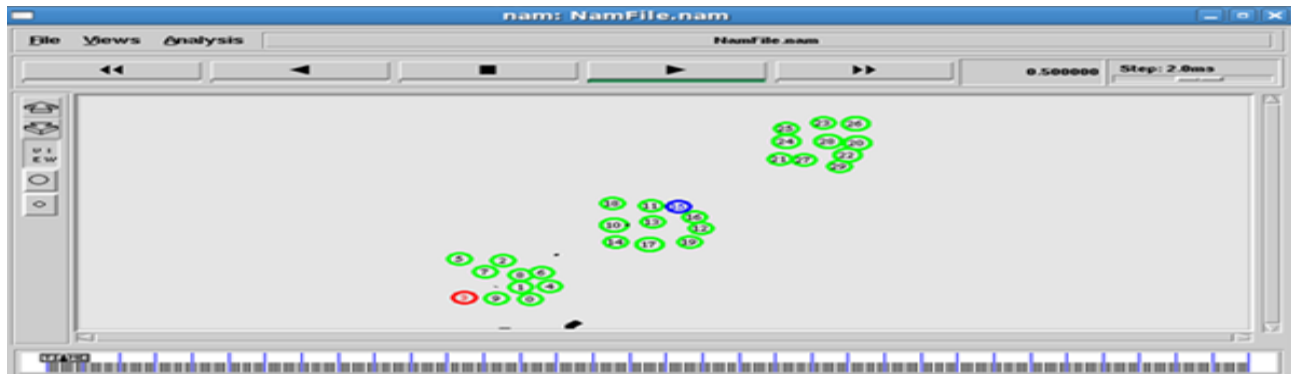


Figure 3: Formation of Clusters After Applying Clustering

Figure 3 shows cluster head formation on the basis of maximum energy acquired by the node. The node number 3, 19 and 29 are having the maximum energy hence they are considered as the cluster heads of the cluster 1, 2 and 3 respectively. If we want to apply the clustering & encryption to the Wireless Sensor Network consist of 30 nodes, then we have to give the input as '1' that means yes we want to apply. After applying the clustering, and encryption we have to give the number of communication we want. For example we want only one communication then we have to give input as '1'. The number of communication we want, the same number of source and destination nodes we have to enter. Let the number of communication we want is 1. For example, if node number 5 is the source from cluster1 and node number 14 is the destination, then for sending the packets from node 5 to node 14 the communication will be held through cluster heads. Node 5 will send the packet to cluster head (node 3) of cluster 1. Cluster head 1 will send the data to cluster head (node 15) of cluster 2. The cluster head 2 will send the data to node 14. In this way the communication takes place from the source to destination. The energy and time required to send the packets directly from source to destination is more as compared to the energy and time required to send the data through the cluster head.

Results and Discussion

Comparison of the protocols is done by analyzing the combined graph of four protocols for Quality of Service Parameters. The comparative graphs of protocols on the basis of QoS parameters are shown and analyzed. It is analyzed that AODV is having the best overall performance among the four protocols. For optimization of QoS clustering is applied to the AODV and it is found that QoS parameters are improved after application.

Comparison of the Routing Protocols on the Basis Quality of Service Parameters:

The protocols are analyzed and the comparison is done on the basis of simulation results obtained for different QoS parameters. The red color shows the graph for AODV, the green color shows the graph for AOMDV, the yellow color shows the graph for DSR, the blue color shows the graph for DSDV.

Simulation Result of Delay Parameter for Four protocols

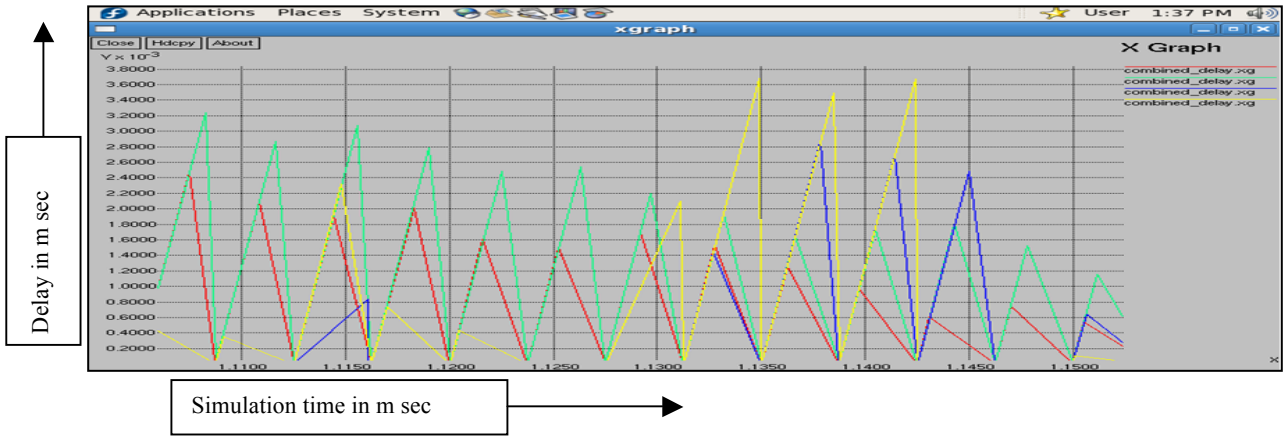


Figure 4: Simulation Result of Delay for AODV, AOMDV, DSDV & DSR Protocols

Figure 4. shows the simulation result of delay parameter for the four protocols. For an efficient Wireless Sensor Network, the delay should be as low as possible. After analyzing simulation result given below, it is found that AODV is having the minimum delay and AOMDV is having the maximum delay. Hence AODV is better as compare to other protocols when delay is considered.

Simulation Time in m sec	Delay in m sec			
	AODV	AOMDV	DSR	DSDV
1.11	2.4	3.2	0.3	0
1.12	2	2.8	0.4	1.1
1.13	1.7	2.2	1.6	1.8
1.14	1	1.8	1.7	1.8
1.15	0.6	1.2	0.1	0.8
1.11	2.4	3.2	0.3	0

Table 1: Delay Parameter of Four Protocols

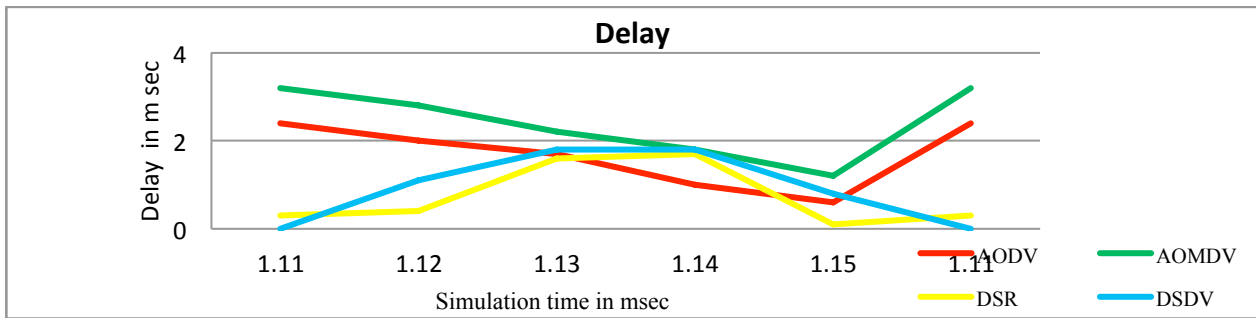


Figure 5: Combined Delay Graph of AODV, AOMDV, DSDV & DSR Protocols

Simulation Result of Energy Consumption Parameter of Four Protocols –

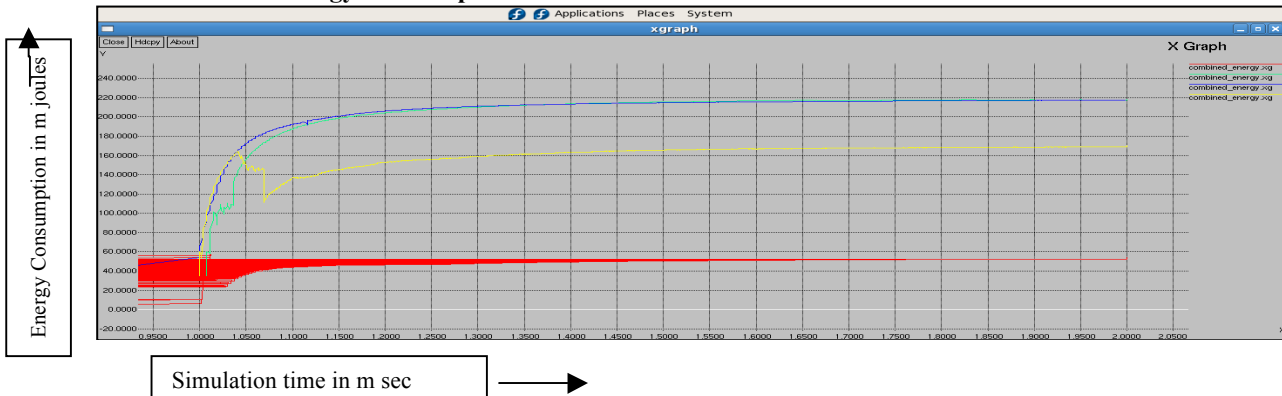


Figure 6: Simulation Result of Energy Consumption for AODV, AOMDV,DSDV & DSR Protocols

Figure 6 shows the simulation result of energy consumption parameter for the four protocols .For an efficient Wireless Sensor Network, the energy consumption should be as low as possible. After analyzing simulation result given below, it is found that AODV having the minimum Energy consumption and DSDV is having the maximum energy consumption. Hence AODV is better as compare to other protocols when energy consumption is considered.

Simulation Time in m sec	Energy consumption in m joules			
	AODV	AOMDV	DSR	DSDV
1	40	100	60	50
1.2	50	183	150	200
1.4	57	186	162	211
1.6	58	195	165	213
1.8	59	198	167	216
2	59	200	170	220

Table 2: Energy Consumption of Four Protocols

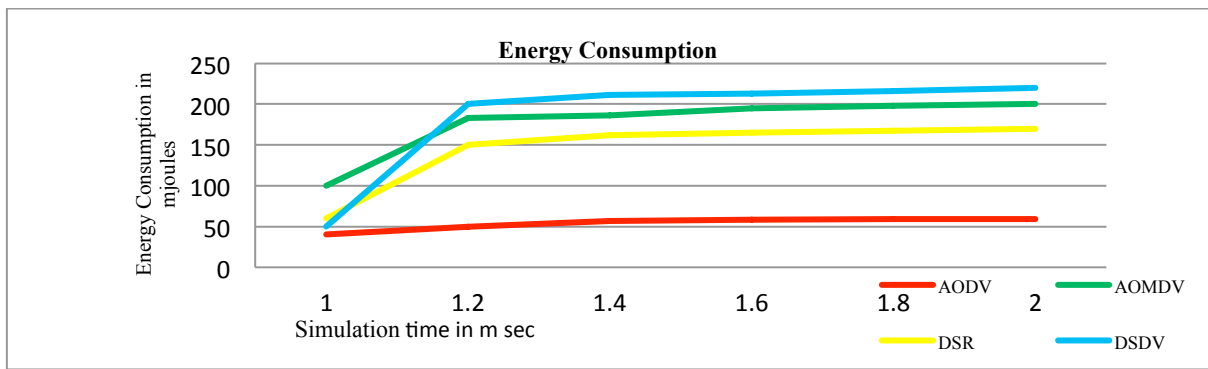


Figure 7: Combined Energy Consumption Graph of AODV, AOMDV, DSDV & DSR Protocols

Simulation Result of Jitter Parameter of Four Protocols –

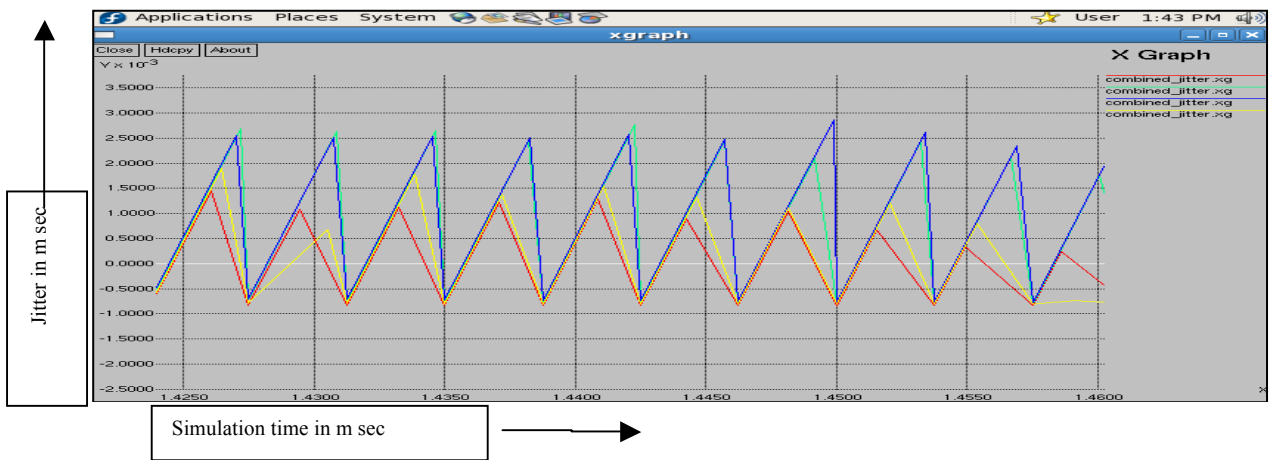


Figure 8: Simulation Result of Jitter for AODV, AOMDV, DSDV & DSR Protocols

Figure 8 shows the simulation result of jitter parameter for the four protocols .For an efficient Wireless Sensor Network, the jitter should be as low as possible .After analyzing simulation result given below, it is found that AODV is having the minimum jitter and DSDV is having the maximum jitter. Hence AODV is better as compare to other protocols when jitter is considered.

Simulation Time in m sec	Jitter in m sec			
	AODV	AOMDV	DSR	DSDV
1.42	0.5	0.7	0.8	0.7
1.43	0.5	2	0.7	2
1.44	-0.5	0.5	1.3	0.3
1.45	-0.7	0.3	0.2	3
1.46	-0.3	1.5	-0.5	1.9

Table 3: Jitter of Four Protocols

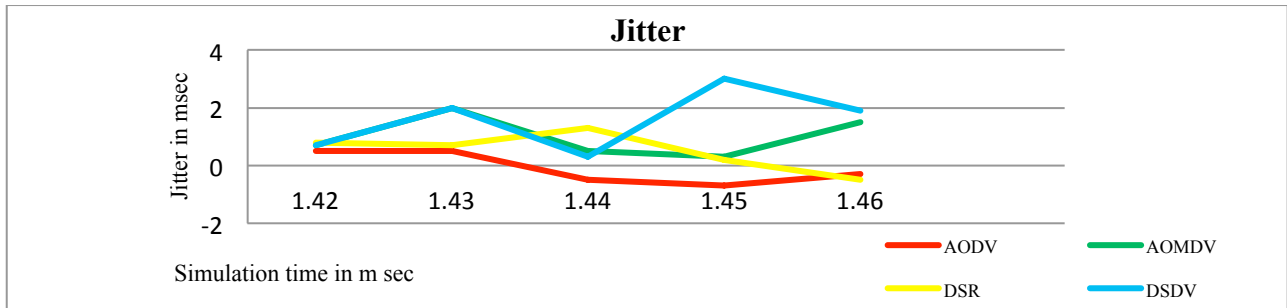


Figure 9: Combined Jitter Graph of AODV, AOMDV, DSDV & DSR Protocols

After the comparison of four protocols on the basis of QOS, it is found that out of four protocols AODV is the best overall performance. Because AODV is having minimum delay, jitter & energy consumption and maximum throughput as compare to other protocols. The table below shows the comparative performance of routing protocols.

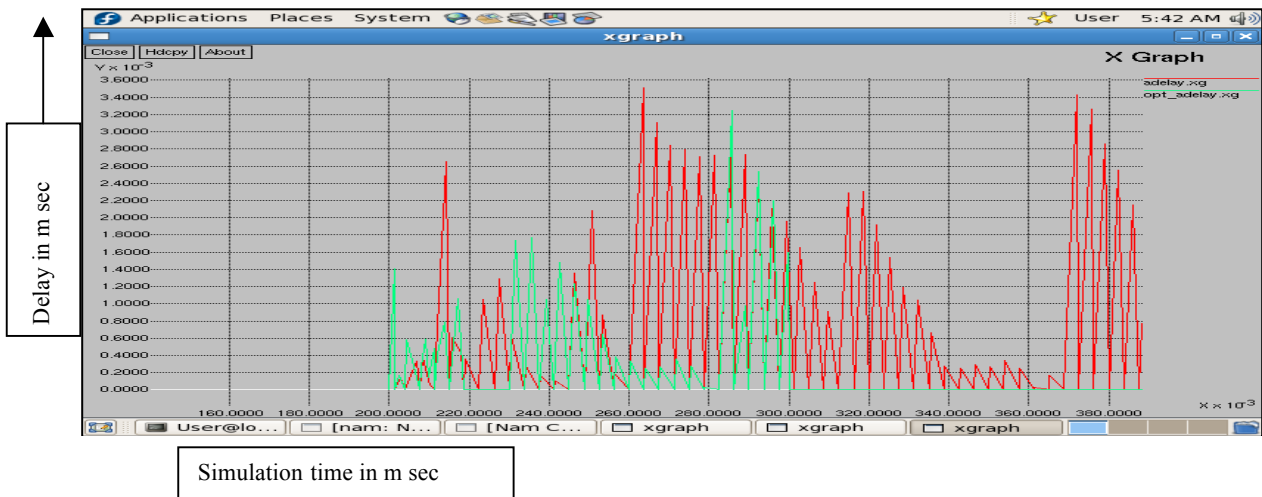
SR.NO.	QOS PARAMETERS	AODV	DSR	DSDV	AOMDV
1	Jitter in m sec	Low	Medium	Highest	Medium
2	Energy Consumption in m joules	Low	Medium	Highest	High
3	Delay in m sec	Low	Medium	High	Highest

Table 4: Comparison of Four Protocols on the Basis of QOS

Simulation Results showing Performance of AODV Protocol After Applying Clustering

After the comparison of four protocols on the basis of QOS parameters, it is found that AODV is having best overall performance as compared to other protocols. The performance of AODV is further improved by applying clustering. The graphs below show the comparison of the QOS parameters before and after application of clustering. The red color shows the performance of protocol before application of clustering, green color shows the after application results.

Simulation Result of Delay Parameter After Clustering –



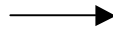


Figure 10: Simulation Result of Delay

It is observed that after applying clustering there is minimization of delay as shown in the figure 10 in the simulation result the red color is more and at higher level as compare to green color which shows that, before application of clustering the delay is more as shown by red color and after applying clustering the delay is minimized as shown by green color.

Simulation Time in m sec	Delay in m joules	
	Before clustering	After Clustering
210	2.6	0.6
230	0.65	0.6
250	0.8	0.62
260	0.45	0.35
270	2.8	0.25
280	2.65	0.2

Table 5: Reduction in Delay After Application of Clustering

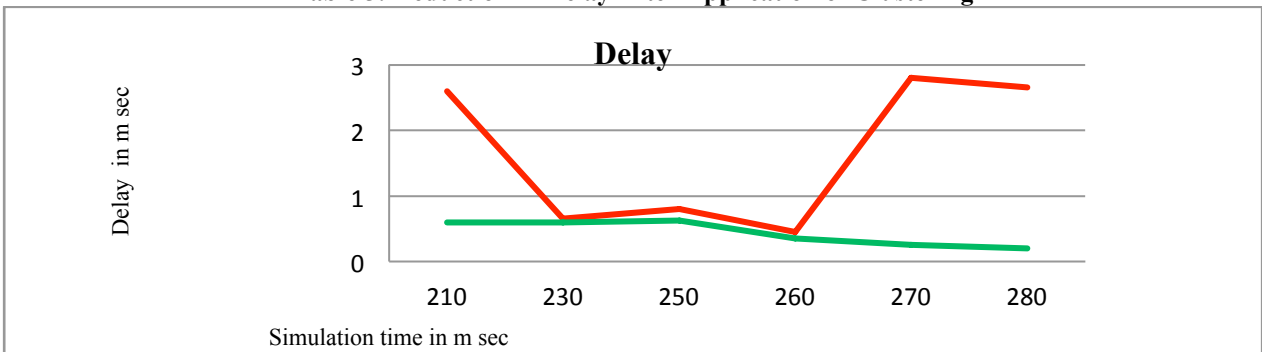


Figure 11: Graph of Delay After Application of Clustering

5.2.2. Simulation Result of Jitter Parameter After Clustering -

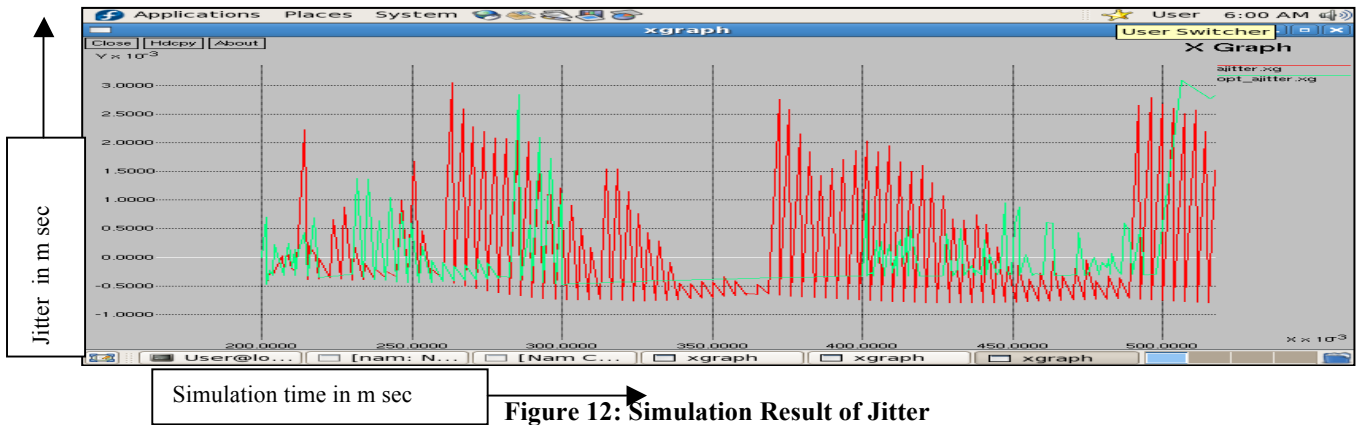


Figure 12: Simulation Result of Jitter

It is observed that after applying clustering, there is minimization of jitter as shown in the figure 12. In the simulation result the red color is more and at higher level as compare to green color which shows that, before application of clustering, the jitter is more as shown by red color and after applying the jitter is minimized as shown by green color.

Simulation Time in m sec	Jitter in m sec	
	Before clustering	After Clustering
240	1	0.6
250	1.6	0.5
270	2.3	2.3
300	1.2	0.9
330	1.5	-0.6

350	-0.6	-0.7
-----	------	------

Table 6: Reduction in Jitter After Application of Clustering

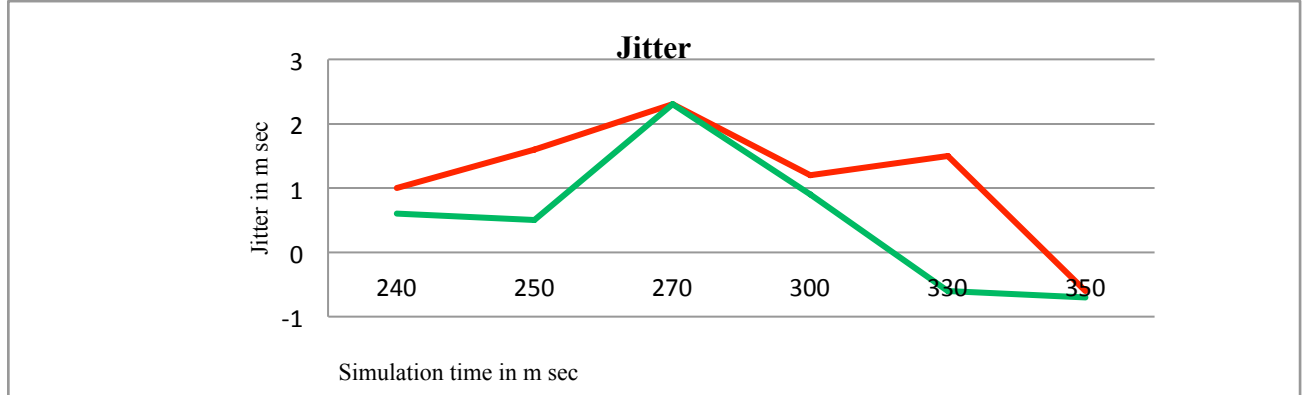


Figure 13: Graph of jitter after application of Clustering

Simulation Result of Energy Consumption After Clustering -

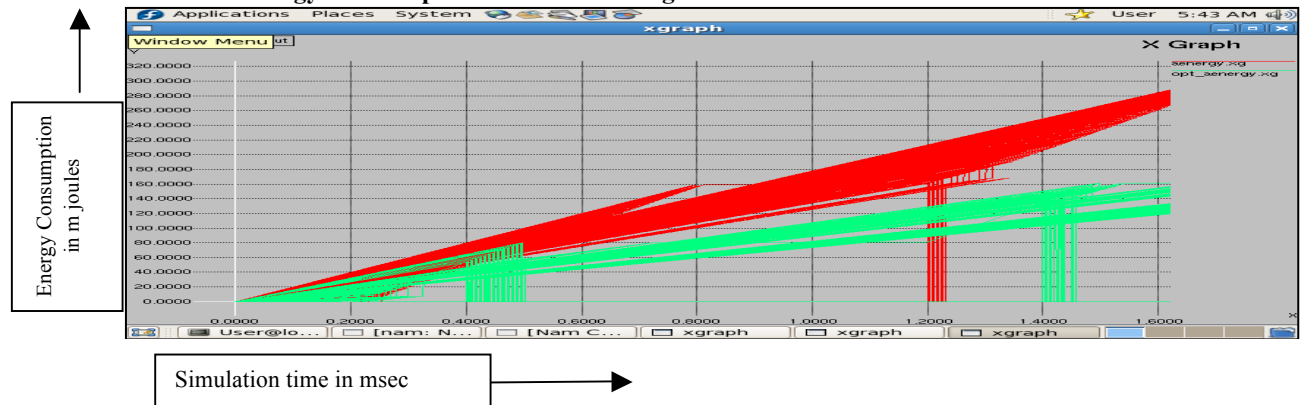


Figure 14: Simulation Result of Energy Consumption

It is observed that after applying clustering there is minimization of energy consumption as shown in the figure 14. In the simulation result the red color is more and at higher level as compare to green color, which shows that before application of clustering the energy consumption is more as shown by red color and after applying clustering the energy consumption is minimized as shown by green color.

Simulation Time in m sec	Energy Consumption in m joules	
	Before clustering	After Clustering
0.1	21	19
0.2	40	38
0.4	80	62
0.5	115	60
0.6	120	62
0.8	160	85

Table 7: Reduction in Energy Consumption After Application of Clustering

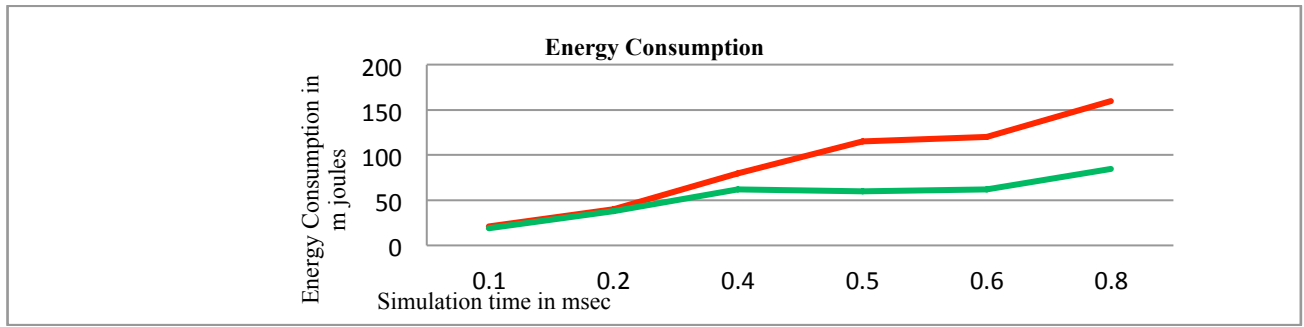


Figure 15: Graph of Energy Consumption After Application of Clustering

After analyzing the simulation results, It is found that delay, jitter & energy consumption is reduced after application of clustering

Clustering & Encryption	QOS PARAMETERS		
	Delay in m sec	Energy Consumption in m joules	Jitter in m sec
Before Applying	High	High	High
After Applying	Low	Low	Low

Table 8: Improvement in QOS after Clustering

The simulation results shows that the proposed clustering method on AODV protocol, is efficient than the existing method in terms of QOS parameters. The reduction in delay, jitter and energy consumption results in increase in the efficiency of routing protocol

Conclusion & Future Scope

Conclusion - After analyzing the simulation results and the comparative tables , the aim and objective of this research work, is achieved. The four protocols AODV, AOMDV, DSDV and DSR are taken into consideration and their individual performance analysis is done on the basis of Quality of Service parameters .The Quality of Service Parameters considered are Delay, Jitter and Energy Consumption. After the performance analysis the comparison between four protocols is done on the basis Quality of Service Parameters. By analyzing the comparative simulation results it is concluded that

- AODV has the best all round performance among the four protocols.
- DSDV & DSR is suitable for networks with Moderate mobility rate. It has low overhead that makes it suitable for low bandwidth and low power network.
- AOMDV is suitable for operation in large mobile networks having dense population of nodes. The major benefit is its excellent support for multiple routes and multicasting

The Optimization of the Wireless Communication Sensor Network for Power efficient application. Clustering is done by using LEACH. The energy consumption is less by using clustering because the total numbers of nodes in WSN are divided into several clusters and in these clusters the node having highest energy is considered as Cluster Head. In this way network energy optimization is done and it leads to increase in lifetime.

Future Scope

Based on the theoretical and experimental work carried out during this research, it is recommended that further research can be done to improve the efficiency of WSN to address the following points:

- In future, researchers may concentrate on data transmission schemes to facilitate high throughput, high packet delivery ratio and minimum end to end delay in complex scenarios.
- Further probable future research meant for routing protocols include the grouping of sensor networks with wired networks (i.e. Internet). Applications like security and monitoring requires the data collected from the sensor nodes that can be transmitted to a server so that further study can be done. On the other hand, the requests from the user side should be made to the Base Station through Internet. Since the routing necessities of each environment are dissimilar, further research is needed for managing these kinds of situations.

References

- [1] Lalita Yadav and Ch. Sunitha, "Low Energy Adaptive Clustering Hierarchy in Wireless Sensor Network (LEACH)", vol. 5, (IJCSIT) International Journal of Computer Science and Information, 2014, pp. 4661-4664.

- [2] Sanjeev Kumar Gupta and Neeraj Jain, “Energy Efficient Clustering Protocol for Minimizing Cluster Size and Inter Cluster Communication in Heterogeneous Wireless Sensor Network”, Vol. 2, Issue 8, International Journal of Advanced Research in Computer and Communication Engineering, August 2013, pp. 3295-3304.
- [3] Dervis Karaboga , Selcuk Okdem and Celal Ozturk, "Cluster based wireless sensor network routing using artificial bee colony algorithm", in Springer Wireless Network 2012 pp. 847-860.
- [4] Dali Wei,Yichao Jin, Klaus Moessner and Rahim Tafazolli, “An Energy-Efficient Clustering Solution for Wireless Sensor Networks” ,Vol 10, no 2 in IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS, Nov 2011 pp. 3793-3983.
- [5] K.Ramesh, Dr.K.Somasundaram, “A COMPARATIVE STUDY OF CLUSTER HEAD SELECTION ALGORITHMS IN WIRELESS SENSOR NETWORKS”, Volume 2 , International Journal of Computer Science & Engineering Survey ,Nov 2011 pp. 153-164.
- [6] Ning Sun, Young-bok Cho, Sang-ho Lee, “A Distributed Energy Efficient and Reliable Routing Protocol for Wireless Sensor Networks”, in IEEE 14TH International Conference on Computational Science and Engineering CSE/I-SPAN, 2011, pp.273-278.
- [7] M. Ismail and M.Y. Sanavullah, “Security Topology In Wireless Sensor Networks With Routing Optimization,” IEEE, 2008.
- [8] Amrinder Kaur and Sunil Saini,“Simulation of Low Energy Adaptive Clustering Hierarchy Protocol for Wireless Sensor Network”, International Journal of Advanced Research in Computer Science and Software Engineering, Volume 3, Issue 7, July 2013,ISSN: 2277 128X
- [9] K.Gupta and V.Sikka, “Design Issues and Challenges in Wireless Sensor Networks”, International Journal of Computer Applications (0975 – 8887) Volume 112 – No 4, February 2015
- [10] E. Vishnupriya and T. Jayasankar, “Performance Analysis Of Optimum Routing Protocols In Wireless Sensor Networks”,IJSET International Journal of Innovative Science, Engineering & Technology, Vol. 2 Issue 2, February 2015.
- [11] Kanchan Dhote, GM Asutkar, “Enhancement in the Performance of Routing Protocols for Wireless Communication Using Clustering, Encryption, and Cryptography” ,Artificial Intelligence and Evolutionary Computations in Engineering System,2016,547-558
- [12] Kanchan Dhote, GM Asutkar, “Optimization of routing techniques in wireless sensor network using queue management” Devices for Integrated Circuit (DevIC), 2017”,500-504,IEEE