A Review on Cluster Based Routing Protocols for Wireless Sensor Network

ShilpaMohindra[1], Kanika Sharma [2]
[1]ME student, [2]Assistant professor
Electronics and Communication Department
National Institute of Technical Teacher's Training & Research, Chandigarh

Abstract- Recent advancement in the field of wireless sensor network leads to design the new protocols for energy conservation. The most important is to develop the routing protocols which work on the application and network layer. This paper presented a review on the different routing approaches that are used in the WSN in recent years. These algorithms are mainly based on three approaches that are location-based, hierarchical and data-centric.

Keywords- wireless sensor network (WSN), clustering protocols, cluster head.

I. INTRODUCTION

Wireless Sensor Network(WSN) consist of huge number of tiny, self-directed, low power and circulating devices known as Sensor nodes that have capability to transmit data with each other. These Sensor nodes are deployed in real world environment with one or more than one Base Station (BS) to detect environmental effects. Sensor nodes sense and collect data from environment and transmit data to destination (Base Station). BS is a node that receives data from nodes. Nodes communicate with each other via transceivers. Ad Hoc Network consist of less nodes when compared with Sensor Network [1]. Wireless Sensor Network is one of advance technology in 21st century that has made human life much easy. In 1970, during first generation of Sensor Networks, simple peer to peer communication was possible between nodes. During second generation, low power nodes start working independently and transmit data to each other. During third generation, method of bus connection and Sensor controller were introduced. During fourth generation and at present time, multi hop and self-organizing nodes are working.

Clustering is an energy efficient routing protocol that reduces consumption of energy and improves lifetime of networks. WSN includes huge number of sensor nodes. Sensor nodes are divided into small groups and these groups are known as clusters. Cluster head is best suited sensor node and it is selected by using different methods. Nodes will sense data and will send data to cluster heads and CH gathers and suppress data and send sensed data to BS. Different cluster perform different tasks. Hierarchal clustering is the efficient way to utilize energy in an efficient manner. Low Energy Adaptive Clustering Hierarchy (LEACH) is one of the most efficient routing protocols. Main aim of clustering is to improve energy efficiency, distribution of load over network equally, scalability and reduction of network delays.

II. RELATED REVIEW

AmrAmwary et al. in [1] have proposed a protocol called modified LEACH having two phases' set-up and steady-state phase. Modification at setup phase is done by selecting Cluster Head only from advanced sensor nodes which improves overall lifetime of network. Result represents number of nodes that are dead vs. rounds. Energy harvesting generator can provide power requirement level by sensor nodes in WSNs. Modified LEACH is compared with other protocols and it provide improvement in performance of network significantly. Tarunpreet Bhatia et al. in [2] have proposed a Genetic Algorithm Distance Aware –LEACH (GADA- LEACH) for improvement of election of Cluster Head. Network lifetime is main concern of wireless sensor networks as nodes are battery operated. Introduction of relay nodes act as an intermediate between base station and Cluster Head. Fitness function includes node's left energy, distance among Cluster Heads, sensor node and base station. Energy consumption is reduced and network lifetime is enhanced.

Jin-Shyan Lee and Tsung- YiKao in [3] have proposed an energy efficient algorithm based on energy awareness called EDAC. Author has proposed hybrid approach based on centralized and distributed clustering. In proposed algorithm energy left in the sensors and distance are considered along with probability of selection of Cluster Head. Result show reduction in communication cost in terms of energy. EDAC shows better results than LEACH and DEEC in networks having multi levels. Ramnik Singh et al. in [4] have proposed a routing protocol called ATEER which is a Threshold sensitive and cross layers routing method and is energy efficient. This protocol shows better results for heterogeneous Network. Energy efficiency is improved when compared with DEEC, EECH and EDDEEC. Weighed probability of node helps in selection of Cluster Head. Threshold function can be improved by considering modified TDMA scheduling along

with CDMA to reduce inferences between nodes, Cluster Head and base station. Time span of Network is improved.

Samayveer Singh et al. in [5] have proposed a model for wireless sensor Networks based on three levels of heterogeneous Networks. Model parameter will describe level of heterogeneity and will help in selection of CH. Cluster Heads are elected by using Threshold function. Probability of weighted election is also useful in CH selection. When compared with DEEC, Lifetime of Network is increased by 154% and 182% in DEEC 3 and HetDEEC 3 and total energy is improved by 100%. WenliangWuet al. in [6] have presented an improved Clustering algorithm which depends on LEACH protocol. It depends on distance ratio and weighted energy that helps in saving nodes with more distance and little energy. Residual energy of nodes helps in readjustment of Threshold along with long distance node's factors. Data fusion is performed before transmitting data to base station and data fusion rate is calculated to solve transmission issue. To reduce energy consumption multi path fading and free space models are used. Result shows death rate and energy consumption is improved. Energy utilization rate is increased by 15.9%. It has drawbacks like mobility of node leads to alter network size, which is not consider in routing algorithm and selection of ratio coefficient has certain randomness which may affect algorithm.

HemavathiNatarajan et al. in [7] have discussed about reselection of Cluster Head frequently leads to increase in overhead and increase in energy consumption. Author attempted to reduce the reselection frequency of Cluster Heads by considering recurrent communication rate of sensor node (RCSN), distance between nodes and BS and node's remaining energy. Results are verified using software and hardware experiments. Low RCSN leads towards low Cluster Head reselection. Lifetime of nodes is increased by 2169s in compare to 309.79s in TLEACH. PeymanNeamatollahi et al. in [8] have proposed a Clustering scheme which is node driven called as Hierarchical Clustering based task schedule scheme. GRBP which is time driven scheme results in overhead of energy due to global Clustering and this problem is reduced by HCSP. It proposes a new protocol called DMCC which is a Distributed Dynamic Clustering. Distributed clustering requires local information only. Network lifetime is enhanced by increasing length of LSRs and GHRs. It is compatible with existing protocols.

Khalid A. Darabkh et al. in [9] have proposed two protocols C-DTB-CHR and C-DTB-CHR-ADD to overcome drawbacks of LEACH, TLEACH and MTCHR. C-DTB-CHR-ADD is a protocol where data is distributed adaptively, which provides multi hop and direct communications. Free-space-propagation method is being adopted by Cluster Heads in this approach. Numbers of re-clustering operations are reduced and thus energy optimization is performed. Nodes belonging to dense areas are kept in sleep mode and thus long distance communications are reduced which increase Network Lifetime. Cluster Heads among nodes are selected randomly. Cluster heads can be selected again and again as sensor nodes have sufficient energy. Number of nodes that are alive per round and Network utilization is improved. Lifetime of Network is up to 1134 rounds when compared with MTCHR protocol. Early death rounds starts at 423 rounds rather than 327 rounds in MTCHR. P. Sivakumar et al. in [10] have analyzed different hierarchical protocols used for routing to improve Lifetime and energy consumption of Network. LEACH using Genetic algorithm (LEACH GA), LEACH C and LEACH are analyzed in terms of Lifetime of Network by changing Cluster probability and energy of nodes initially. Lifetime of Network is improved by 53.35% and 44.8% in LEACH GA when compared with LEACH and LEACH C. Thus selection of Cluster Head using LEACH GA can reduce energy consumption.

AbdulhamidZahedi et al. in [11] have proposed a mechanism based on reservation to decrease the number of transmitting messages for Clustering phase execution and to decrease number of Cluster Head selection. It reduces energy dissipation significantly. At the starting of Network configuration, reservation phase is added which consume more energy initially but saves overall energy of Network. It improves Network Lifetime and reduces control messages and it requires little memory.

Muhammad Kamran Khan et al. in [12] have proposed an energy efficient multistage routing protocol (EEMRP) consisting of routing algorithms for election of Cluster Heads, method of Cluster Head formation and transmission of data. By analyzing different routing protocol multi stage transmission routing algorithm is proposed. Network is divided into multi stages and Cluster Heads are distributed evenly to enhance throughput and Lifetime of Network. Efficient method for selection of Cluster Head is used and unnecessary Re-clustering is removed. Unnecessary rotation of Cluster Head is removed by using election of Cluster using Threshold. For intra-communication in Network multiple power amplifiers are used.

Khalid A. Darabkh et al. in [13] have proposed a protocol called as Modified Threshold Cluster Head Replacement (MTCHR) to overcome TLEACH protocol's drawbacks. In this protocol each sensor node has probability to become a CH. It proposes a new method for Threshold energy that results in no data loss and death of first node gets delayed. The parameters used for calculation of MTCHR are lifetime of network, utilization of network and number of alive nodes. Results are improved when compared with LEACH and TLEACH. For long lasting networks MTCHR is effective protocol. It is suitable for Homogeneous Network having same initial energy. It helps in controlling overhead and increasing Lifetime. In MTCHR, at 330 rounds early deaths

will start when compared with LEACH and TLEACH early death of nodes begin at 220 and 160 rounds. Network functioning in TLEACH and LEACH for about 790 and 700 rounds while in MTCHR is 900 rounds.

Chaoming Wang et al. in [14] have proposed a routing protocol based on hybrid multi hop Clustering called HMPBC involve portioning management. It balances energy overload and enhance network lifespan. Cluster Heads are operated by considering remaining energy. Nodes can organize themselves as they are self-configurable and deployed without any preplanning. It reduces number of forwarding as by selecting cluster heads during process of data transmission. Single chain structure within a cluster reduces energy consumption. Network lifetime is improved by 39.70% and energy consumption fluctuations are also reduced.

PratimaSarkar et al. in [15] have proposed an Energy Efficient Protocol called Threshold value and Heterogeneous nodes LEACH (TH-LEACH). Heterogeneous networks do not have same initial energy. Selection of Cluster Head in each round is not cost effective and it consumes more energy. Energy consumption can be reduced by using Threshold value based Cluster formation. This method helps in reducing overhead caused during Cluster formation and enhance Lifetime of Network. Network lifespan is increased by 40%. Improvement is first node dies with respect to LEACH is 50% and in last node dies is 43%.

Inference from Literature Review.

Author's Name	Year	Technology/ Algorithm used	Outcomes
Amr et al.	2016	LEACH Algorithm	Energy harvesting generator can provide power requirement level by sensor nodes in WSNs. Modified LEACH is compared with other protocols and it provide improvement in performance of network significantly.
Bhatia et al.	2016	Genetic Algorithm	Introduction of relay nodes act as an intermediate between base station and Cluster Head. Fitness function includes node's left energy, distance among Cluster Heads, sensor node and base station. Energy consumption is reduced and network lifetime is enhanced.
Jin Shyan et al.	2016	Low-Energy Adaptive Clustering	In proposed algorithm energy left in the sensors and distance are considered along with probability of selection of Cluster Head. Result show reduction in communication cost in terms of energy.
Ramnik et al.	2017	Adaptive Threshold Routing Protocol	Weighed probability of node helps in selection of Cluster Head. Threshold function can be improved by considering modified TDMA scheduling along with CDMA to reduce inferences between nodes, Cluster Head and base station. Time span of Network is improved.
Samayveersingh et. al.	2017	DEEC Protocol	Model parameter will describe level of heterogeneity and will help in selection of CH. Cluster Heads are elected by using Threshold function. Probability of weighted election is also useful in CH selection.
Wengliang et al.	2017	Clustering Algorithm	To reduce energy consumption multi path fading and free space models are

			used. Result shows death rate and energy consumption is improved. Energy utilization rate is increased by 15.9%.
Hemavathi et al.	2017	Reselection of Cluster Head	Author attempted to reduce the reselection frequency of Cluster Heads by considering recurrent communication rate of sensor node (RCSN), distance between nodes and BS and node's remaining energy.
Payment et al.	2017	Task Scheduling	It proposes a new protocol called DMCC which is a Distributed Dynamic Clustering. Distributed clustering requires local information only. Network lifetime is enhanced by increasing length of LSRs and GHRs.
Khalid et al.	2017	Cluster Head Replacement Approach	Free-space-propagation method is being adopted by Cluster Heads in this approach. Numbers of re-clustering operations are reduced and thus energy optimization is performed. Nodes belonging to dense areas are kept in sleep mode and thus long distance communications are reduced which increase Network Lifetime.
P.Shivakumar et al.	2017	Genetic Algorithm with LEACH	LEACH using Genetic algorithm (LEACH GA), LEACH C and LEACH are analyzed in terms of Lifetime of Network by changing Cluster probability and energy of nodes initially. Lifetime of Network is improved
Abdulhamit et al.	2018	Clustering Approach	At the starting of Network configuration, reservation phase is added which consume more energy initially but saves overall energy of Network. It improves Network Lifetime and reduces control messages and it requires little memory.
Muhammad et al.	2018	Energy Efficient Multistage Routing Protocol	Efficient method for selection of Cluster Head is used and unnecessary Re-clustering is removed. Unnecessary rotation of Cluster Head is removed by using election of Cluster using Threshold. For intra-communication in Network multiple power amplifiers are used.
Khalid et al.	2018	Cluster Head Replacement by LEACH and TLEACH	It proposes a new method for Threshold energy that results in no data loss and death of first node gets delayed. The parameters used for calculation of MTCHR are lifetime of network, utilization of network and

			number of alive nodes.
Chaoming et al.	2018	Partitioning Based Clustering Protocol.	It reduces number of forwarding as by selecting cluster heads during process of data transmission. Single chain structure within a cluster reduces energy consumption.
Pratima et al.	2018	Threshold-Based LEACH Protocol	Energy consumption can be reduced by using Threshold value based Cluster formation. This method helps in reducing overhead caused during Cluster formation and enhance Lifetime of Network. Network lifespan is increased.

III. CONCLUSION

Wireless sensor network supports the different types of the applications that are used for surveillance system, monitoring system and military target tracking. Each application in WSN is different and based on different features like protocols, algorithms and services. This review presents the related study to network services, communication protocols and network services and their issues in deployment. There are still many issues in the WSN applications and their security mechanism. The gap shows the issues between technology and applications.

IV. REFERENCES

[1]. AmrAmwary, DusanMaga, TarekNahdi, "Modified LEACH Protocol for Heterogeneous Wireless Networks", IEEE New Trends in Signal Processing, pp. 1-4, October 2016.

[2]. Tarunpreet Bhatia, SimmiKansal, ShivaniGoel, A. K. Verma, "A Genetic Algorithm based Distance-Aware Routing Protocol for Wireless Sensor Networks", Computers & Electrical Engineering, Elsevier, Vol. 56, pp. 441-455, November 2016.

[3]. Jin-Shyan Lee, Tsung-Yi Kao, "An Improved Three-Layer Low-Energy Adaptive Clustering Hierarchy for Wireless Sensor Networks", IEEE Internet of Things Journal, Vol. 3, No. 6, pp. 951 – 958, December 2016.

[4]. Ramnik Singh, Anil Kumar Verma, "Energy Efficient Cross Layer based Adaptive Threshold Routing Protocol for WSN", AEU- International Journal of Electronics and Communications, Elsevier, Vol. 72, pp.166-173, February 2017.

[5]. Samayveer Singh, Aruna Malik, Rajeev Kumar, "Energy Efficient Heterogeneous DEEC Protocol for Enhancing Lifetime in WSNs", Engineering Science and Technology, an International Journal, Elsevier, Vol. 20, No. 1, pp. 345-353, February 2017.

[6]. Wenliang Wu, NaixueXiong, Chunxue Wu, "Improved Clustering Algorithm based on Energy Consumption in Wireless Sensor Networks", IET Networks, Vol. 6, No. 3, pp. 47-53, May 2017.

[7]. HemavathiNatarajan, Shobhit Kumar Nagpal , SudhaSelvaraj, "Impact of Rate of Recurrent Communication of Sensor Node on Network Lifetime in a Wireless Sensor Network", IET Science, Measurement & Technology, Vol. 11, No. 4, pp. 473-479, June 2017.

[8]. PeymanNeamatollahi, SaeidAbrishami, Mahmoud Naghibzade, Mohammad HosseinYaghmaee, OssamaYounis, "Hierarchical Clustering-task Scheduling Policy in Cluster-based Wireless Sensor Networks", IEEE Transactions on Industrial Informatics, Vol. 14, No. 4, pp. 1-11, September 2017.

[9]. Khalid A. Darabkh,Wala'a S. Al-Rawashdeh,Raed T. Al-Zubi,Sharhabeel H. Alnabelsi, "C-DTB-CHR: Centralized Density and Threshold-based Cluster Head Replacement Protocols for Wireless Sensor Networks", The Journal of Supercomputing, Springer, Vol. 73, No. 12, pp. 5332-5353, December 2017.

[10]. P. Sivakumar, M. Radhika, "Performance Analysis of LEACH-GA over LEACH and LEACH-C in WSN", Procedia Computer Science, Elsevier, Vol. 125, pp. 248-256, December 2017.

[11]. Abdulhamid Zahedi, Mahdi Arghavani, FariborzParandin, Abbas Arghavani, "Energy Efficient Reservation-Based Cluster Head Selection in WSNs", Wireless Personal Communications, Springer, Vol. 100, No. 3, pp. 1-13, January 2018.

[12]. Muhammad Kamran Khan, Muhammad Shiraz, KayhanZrarGhafoor, Suleman Khan, Ali SafaaSadiq, Ghufran Ahmed, "EE-MRP: Energy-Efficient Multistage Routing Protocol for Wireless Sensor Networks", Wireless Communications and Mobile Computing, pp. 1-13, January 2018.

[13]. Khalid A. Darabkh, Wala'a S. Al-Rawashdeh, Mohammed Hawa, RamziSaifan, "MT-CHR: A Modified Threshold-based Cluster Head Replacement Protocol for Wireless Sensor Networks", Computers & Electrical Engineering, Elsevier, Vol. 67, pp. 1-13, February 2018.

[14]. Chaoming Wang, Yuan Zhang, Xuewen Wang, Zhiyong Zhang, "Hybrid Multihop Partition-Based Clustering Routing Protocol for WSNs", IEEE Sensors Letters, Vol. 2, No. 1, pp.1-4, March 2018.

[15]. PratimaSarkar, ChinmoyKar, "TH-LEACH: Threshold Value and Heterogeneous Nodes-Based Energy-Efficient LEACH Protocol", Algorithms and Applications, Springer, Vol. 88, pp. 41-49, April 2018.