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Energy Efficient Probabilistic Routing over Sensor Network: Survey

Akant Kumar Raghuwanshi, Dr. Virendra Singh Chaudhary
Department of Electronics & Communication Engineering,
RKDF University, Bhopal, India

Abstract: Sensor Network comprises of an expansive number of distributed Sensor Node, which are associated and composed through multi-hop steering. Because of the presence of related data and excess in measuring data, data messages can be joined and converged by performing data aggregation work in the steering procedure. To diminish energy utilization is a noteworthy enhancement target of data aggregation approaches, which can be accomplished by diminishing the mandatory correspondence load of steering. The objective of this paper is to demonstrate a forefront survey on clustering calculations announced in the writing of sensor. This paper presents different energy effective clustering calculations in sensor. From the hypothetical level, an energy show is proposed to approve the advantages of data aggregation on energy utilization. The key parameters which may affect the aggregation execution are additionally examined.

Keywords: Clustering, Load Balancing, Fault Tolerance, Latency, Data Aggregation, LEACH.

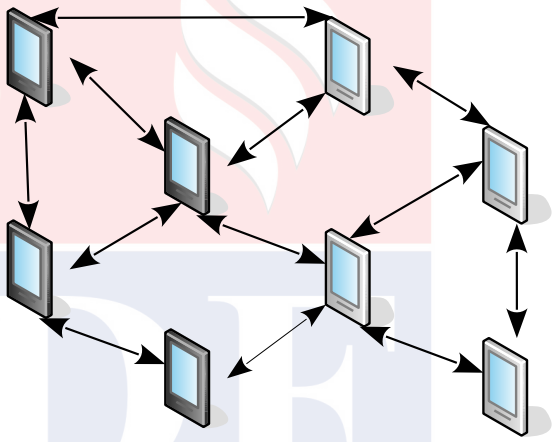

Figure 1: Scenario of Ad-Hoc Network

I Introduction

Sensor Networks consist of specific number of nodes which are capable of computation and communication among each other deployed in remote areas to perform the specific task for sensing and collecting the information with the limited power supply from the batteries embedded in the nodes as shown in Figure 1. Node having finite amount of memory and energy. Each node has the capability to transfer and receive the packets from other nodes that are present in its range of access. The energy of the Sensor nodes is consumed due to its abundant use in various applications and it is a difficult task to recharge them frequently. Thus, the sensor is need to be configured in such a way that the lifetime of the network increases by effective utilization of nodes energy.

Sensor Node basically consists of batteries which has limited lifespan and irreplaceable [1]. Hence, the requirement of low energy consumption by the Sensor nodes is one of the most important issues to be taken into account to make network lifetime longer which is only possible when we are able to utilize the sensor nodes energy efficiently and saving it as much as possible. In sensor since embedded batteries act as the deciding factor for network lifespan which ultimately leads most researchers to currently target in designing protocols and algorithms to make use of power in an efficient manner as shown in Figure 2.

As the Sensor nodes are driven by low powered batteries, reducing the energy consumption for data transmission thereby improving the network lifetime has become an active research area. To transmit the sensed data, different approaches such as direct transmission, multi-hop routing [2] and clustering are used. Among them, clustering enables the utilization of energy to be spread as evenly as possible. In clustering, the Sensor nodes are grouped into clusters. For each cluster, a representative node referred to as cluster head (CH) is elected for collecting data from all nodes in the respective cluster. The collected information is then aggregated and transmitted to the base station. In order to efficiently manage clusters and the cluster heads and to reduce energy dissipation, several methods of clustering have been proposed. Most of the proposed protocols like LEACH [3] could achieve a significant overall energy dissipation savings when compared to direct transmission and multi-hop routing. But LEACH does not consider residual energy of the node and inter-relationship among the nodes. Because of its random nature, the topology constantly changes which can induce more dissipation of energy.

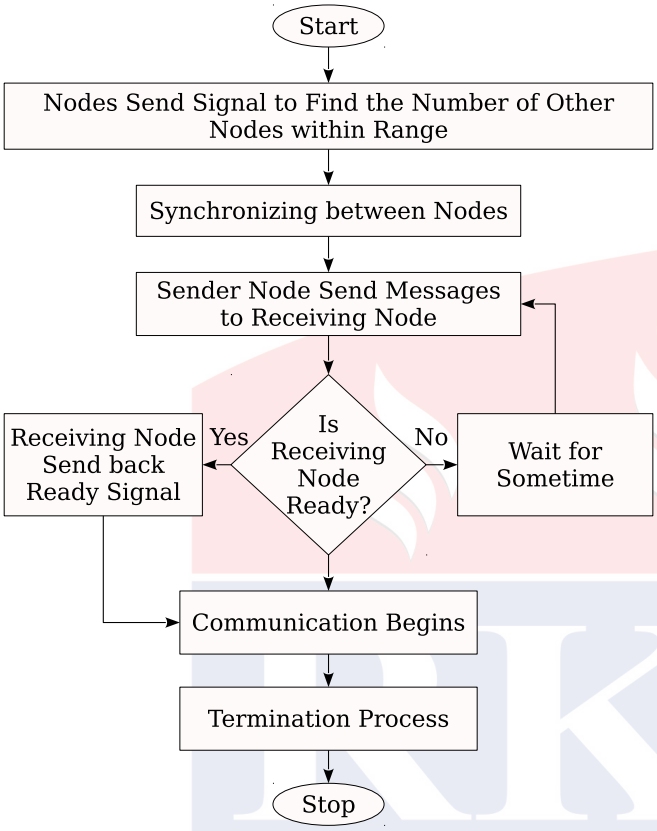

Figure 2: Working of a General Ad-Hoc Network

II Background

In Sensors, routing techniques are categorized into different types based on the underlying network structure. Some of them are flat-based and cluster-based [4]. In flat based routing, all nodes are assigned equal role of functionality. However, flat based routings do not work well in large scale Sensors. On the other hand, cluster based routing works well in a large scale network as shown in Figure 3. Due to the various advantages of cluster based routing like scalability and efficient communication, it is one of the most used routing technique in sensors. It could reduce energy consumption for communication by localizing the data traffic in the cluster. Therefore, several clustering algorithms were introduced for efficient communication. Initially, a cluster head is elected randomly. After the election of cluster head, all the members present in the cluster send packets to it. Cluster head aggregates the received data and forwards the aggregated data to the base station. In case, the energy of cluster head reaches a threshold (thr), it is replaced by a new cluster head. The new cluster head is elected dynamically based on residual energy of all the members in the cluster and distance from the base station [5].

Most of the clustering based protocol comprises of two phases namely set up phase and steady phase. These two phases make one round and new clusters are organized in each round. LEACH (Low Energy Adaptive Clustering Hierarchy) routing protocol is the most significant clustering based routing protocol in the present scenario [6]. In set up phase nodes elect themselves to be the cluster head (CH) for the current round after random deployment in the desired region. All nodes will generate a random number between 0 and 1 at the beginning of each round and if this random number is lesser than the threshold value it becomes CH for the particular round. Even though LEACH protocol provides lesser energy consumption for data transmission comparing with other protocols like MTE, Direct communication and static clustering it has some restraint which pave the way for further improvement. LEACH considered homogeneous energy nodes for all the rounds and also assumed that all CHs have uniform energy dissipation and have the same residual energy levels. Another disadvantage factor is that LEACH set up phase makes selection of CH based on the recent rounds CH nodes and the probability of being CH which eventually leads to dead of network nodes faster and unequal distribution of energy in the network due to repeated selection of CH in consecutive round.

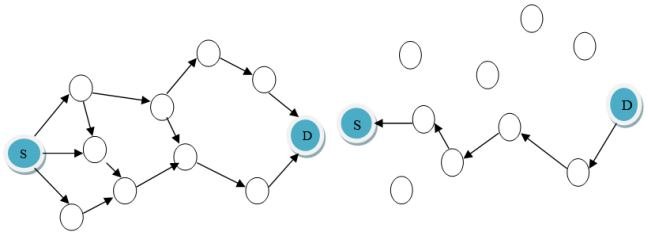

Figure 3: (a) Source node S initiates the path (b) A RREP sent back to the source

III Related Work

In this section we briefly report the existing clustering protocols which are related to our layout. LEACH [3] is the most prevalent clustering based hierarchical protocol and here the CH use data aggregation techniques to reduce rate of energy exhaustion while transmitting data to the BS. LEACH uses random selection of CH based on the threshold condition with distributed cluster organization and nodes get rotated among each other to perform the responsibility of CH after every round so that energy will be equally distributed in the network. Even though LEACH serve as the widely known clustering protocol because of all these attractive features there is no assurance that CH are distributed uniformly in the network and whether nodes are getting equal chance of becoming CH. To solve this unevenness in the network LEACH-C was proposed in which the cluster formation is controlled by a central node BS [7].

In [8] the authors proposed PEGASIS (Power Efficient Gathering in sensor information systems) where a node is allowed to link and communicate only with the nearby nodes

and a single node will take in charge for aggregating the sensed data and for final transmission of the data to the BS in turn wise manner. PEGASIS assumes that every node has overall knowledge of the network. All nodes are connected in chain fashion by using problem solving heuristic to link with the optimal neighbors. In HEED [9] the authors consider residual energy of each node and also make use of communication power levels of nodes, which basically relates to the distance that a node can cover, as the primary concern for intra cluster formation. In intra-cluster formation the connections of cluster head to other nodes also plays a main factor. In TEEN [10] unlike the LEACH protocol the nodes have to transmit the sensed data only when the data collected reaches some pre-defined threshold value. It can be counted as the first reactive protocol. Energy consumption is substantially low as comparing to proactive network protocol like LEACH since it does not require to transmit the message every time it sensed.

Many channel accessing protocols [11–14] are proposed to ensure collision reduction, energy conservation or both. In [15], the authors proposed ECA-MAC algorithm which improves the quality of service of WSN in terms of energy consumption, latency and collision avoidance. The algorithm differentiates the nodes into different levels based on their energy level. The nodes of lower energy level are prioritized to occupy the shared media. The probability of collision increases when more number of nodes in lower level are trying to access the shared media. To reduce the collision, the authors have proposed random back off algorithm, in which the node chooses a random interval from the contention window to access the shared media. The drawback is that if most of the contending nodes fall in the lower level then handling collision is a difficult task even with random back off algorithm, which ultimately increases energy consumption and effects the performance of WSN. In [6], PSAWSN algorithm presented a mechanism of allocating different slots to contending nodes based on their requests for the channel access. Thus, PSAWSN avoids the chances of collision between the nodes by giving priority to the contending nodes. But the effect of energy consumption in the network is less emphasized in this algorithm. The basic idea of CSMA/CD is adopted in many protocols.

In [16], the authors introduced IPSM protocol which dynamically allots the time slots to the nodes using FIFO technique. In this protocol, node occupies the empty slot after confirming if at least two of the neighbor nodes in its proximity are not occupying that slot. In [17], a CSMA/CD based protocol is proposed where a node keeps the information of its neighboring nodes. If the neighboring nodes are not using the shared media, then that node occupies it to send the packets. In [18], variation of CSMA protocol has been proposed. It uses the basic idea of CSMA along with probabilistic polling basic communication (UCSMA). In this protocol random numbers are generated for contending nodes. The nodes which have random value less than or equal to probabilistic polling value are allowed to access the shared media. To avoid further collision, carrier sensing mechanism is used by the nodes. The UCSMA protocol performs better for less number of nodes in a network. The works presented above improved the performance of the WSN in terms of energy consumption. But the effect of increase in average waiting time of the node is less emphasized in literature. Since, this leads to the starvation of nodes and increases energy consumption in the network thus, it has to be addressed. Furthermore, the performance of the above protocols degrade in terms of energy consumption in a dense network. The objective of this paper is to solve the problem of starvation of nodes with optimal energy consumption.

IV Conclusion

Specialists have been lured towards Sensor Network in later past both in scholarly and mechanical areas. The plan of compelling, strong, and versatile steering conventions for sensor is a testing undertaking. Then again, clustering directing calculations, for the most part, can well match the imperatives and the difficulties of sensor. Accordingly; it is plainly observed so far that, critical endeavors have been made in tending to the systems to outline compelling and effective clustering directing conventions for sensor in the previous couple of years. This paper have reviewed the condition of-specialty of various clustering calculations in sensor network a long side leach and other critical conventions detailed in the writing of sensor till today. Each exertion has been made to give finish and exact cutting edge review on energy productive clustering calculations as relevant to sensor.

REFERENCES

[1] A. K. Talele, S. G. Patil, and N. B. Chopade, "A survey on data routing and aggregation techniques for wireless sensor networks," in *2015 International Conference on Pervasive Computing (ICPC)*, Jan 2015, pp. 1–5. [Online]. Available: https://doi.org/10.1109/PERVASIVE.2015.7087155

[2] M. J. Handy, M. Haase, and D. Timmermann, "Low energy adaptive clustering hierarchy with deterministic cluster-head selection," in *4th International Workshop on Mobile and Wireless Communications Network*, Sept 2002, pp. 368–372. [Online]. Available: https://doi.org/10.1109/MWCN.2002.1045790te

[3] W. R. Heinzelman, A. Chandrakasan, and H. Balakrishnan, "Energy-efficient communication protocol for wireless microsensor networks," in *Proceedings of the 33rd Annual Hawaii International Conference on System Sciences*, Jan 2000, pp. 10 pp. vol.2–. [Online]. Available: https://doi.org/10.1109/HICSS.2000.926982

[4] T. Zhong, S. Wang, S. Xu, H. Yu, and D. Xu, "Time delay based clustering in wireless sensor networks," in *2007 IEEE Wireless Communications and Networking*

Conference, March 2007, pp. 3956–3960. [Online]. Available: https://doi.org/10.1109/WCNC.2007.723

[5] M. B. A, K. R. Dayananda, and S. D. H, "Energy efficient clustering scheme with secure data aggregation for mobile wireless sensor networks (eecssda)," in *2016 Online International Conference on Green Engineering and Technologies (IC-GET)*, Nov 2016, pp. 1–5. [Online]. Available: https://doi.org/10.1109/GET.2016.7916636

[6] M. Sutaone, P. Mukherj, and S. Paranjape, "Trust-based cluster head validation and outlier detection technique for mobile wireless sensor networks," in *2016 International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET)*, March 2016, pp. 2066–2070. [Online]. Available: https://doi.org/10.1109/WiSPNET.2016.7566505

[7] S. Shi, X. Liu, and X. Gu, "An energy-efficiency optimized leach-c for wireless sensor networks," in *7th International Conference on Communications and Networking in China*, Aug 2012, pp. 487–492. [Online]. Available: https://doi.org/10.1109/ChinaCom.2012.6417532

[8] S. Lindsey and C. S. Raghavendra, "Pegasis: Power-efficient gathering in sensor information systems," in *Proceedings, IEEE Aerospace Conference*, vol. 3, March 2002, pp. 3–3. [Online]. Available: https://doi.org/10.1109/AERO.2002.1035242

[9] O. Younis and S. Fahmy, "Heed: a hybrid, energy-efficient, distributed clustering approach for ad hoc sensor networks," *IEEE Transactions on Mobile Computing*, vol. 3, no. 4, pp. 366–379, Oct 2004.

[10] A. Manjeshwar and D. P. Agrawal, "Teen: a routing protocol for enhanced efficiency in wireless sensor networks," in *Proceedings 15th International Parallel and Distributed Processing Symposium. IPDPS 2001*, April 2001, pp. 2009–2015. [Online]. Available: https://doi.org/10.1109/IPDPS.2001.925197

[11] K. Kwong, T. Wu, C. Michie, and I. Andonovic, "A self-organizing multi-channel medium access control (smmac) protocol for wireless sensor networks," in *2007 Second International Conference on Communications and Networking in China*, Aug 2007, pp. 845–849. [Online]. Available: https://doi.org/10.1109/CHINACOM.2007.4469516

[12] J. H. Kim and J. K. Lee, "Capture effects of wireless csma/ca protocols in rayleigh and shadow fading channels," *IEEE Transactions on Vehicular Technology*, vol. 48, no. 4, pp. 1277–1286, July 1999. [Online]. Available: https://doi.org/10.1109/25.775376

[13] V. K. N. Lau and Y.-K. Kwok, "Charisma: a novel channel-adaptive tdma-based multiple access control protocol for integrated wireless voice and data services," in *2000 IEEE Wireless Communications and Networking Conference. Conference Record (Cat. No.00TH8540)*, vol. 2, Sept 2000, pp. 507–511 vol.2. [Online]. Available: https://doi.org/10.1109/WCNC.2000.903904

[14] Z. Zhao and S. Zheng, "Dual channel based ad hoc network channel access protocol," in *2003 5th European Personal Mobile Communications Conference (Conf. Publ. No. 492)*, April 2003, pp. 32–36. [Online]. Available: https://doi.org/10.1049/cp:20030214

[15] I. Iala, M. Ouadou, D. Aboutajdine, and O. Zytoune, "Energy based collision avoidance at the mac layer for wireless sensor network," in *2017 International Conference on Advanced Technologies for Signal and Image Processing (ATSIP)*, May 2017, pp. 1–5. [Online]. Available: https://doi.org/10.1109/ATSIP.2017.8075611

[16] N. Unk, A. Trivedi, and A. Razaque, "Dynamic allocation of slot using mac protocol," in *2016 IEEE Long Island Systems, Applications and Technology Conference (LISAT)*, April 2016, pp. 1–5. [Online]. Available: https://doi.org/10.1109/LISAT.2016.7494147

[17] P. K. Shukla, S. Silakari, and S. S. Bhadoriya, "Network security scheme for wireless sensor networks using efficient csma mac layer protocol," in *2009 Sixth International Conference on Information Technology: New Generations*, April 2009, pp. 1579–1580. [Online]. Available: https://doi.org/10.1109/ITNG.2009.231

[18] M. U. Rehman, M. Drieberg, and N. Badruddin, "Probabilistic polling mac protocol with unslotted csma for wireless sensor networks (wsns)," in *2014 5th International Conference on Intelligent and Advanced Systems (ICIAS)*, June 2014, pp. 1–5.