INTERNATIONAL JOURNAL FOR ADVANCE RESEARCH IN ENGINEERING AND TECHNOLOGY
WINGS TO YOUR THOUGHTS…..

A Survey on various Hierarchical Routing Protocols in Wireless Sensor Network

Neelam Shekhawat[1], Moumita Ghosh[2]

[1]Mody University of Science and Technology,
Laxmangarh, Sikar(Rajasthan)
er.neelamshekhawat@gmail.com

[2]Mody University of Science and Technology,
Laxmangarh, Sikar(Rajasthan)
mompal2001@email.com

Abstract: *Advances in wireless sensor network (WSN) technology has given the availability of low-cost and small sensor nodes with efficiency of sensing various types of physical and environmental conditions, wireless communication and data processing. Variety of sensing abilities results in profusion of application areas. However, the characteristics of wireless sensor networks need more effective methods for data processing and forwarding. In WSN, the sensor nodes have a bounded transmission range, and their storage and processing capabilities as well as their energy resources are also bounded. Routing protocols for wireless sensor networks are responsible for managing the routes in the network and have to assure reliable multi-hop communication under these conditions. In this paper, we give a survey of Hierarchical routing protocols for Wireless Sensor Network. The routing protocol is a major issue in the research area of wireless sensor networks. In this paper we intend to discuss some of the major hierarchical routing protocols for wireless sensor networks.*

Keywords: *Wireless Sensor Networks, Hierarchical Routing Protocol.*

1. INTRODUCTION

With the continued advances in Micro-Electro-Mechanical Systems (MEMS), Wireless Sensor Networks (WSNs) have and will perform a vital role in our daily lives. Humans have based on wired sensors for years, for simple tasks such as temperature monitoring, to complex tasks such as monitoring life-signs in hospital patients. Wireless Sensor Networks given foreseen applications in this new field of design [1]. From military applications such as battlefield mapping and target surveillance, to creating context aware homes where sensors can monitor safety and serve automated services tailored to the individual user; the number of applications are boundless. Smart Dust is an example of one such application. However this new technology acts many design goals, [1] that up until recently, have not been determined feasible for these applications.

One such problem is how to create an organizational structure amongst these nodes. Since the fundamental advantage of WSNs is the ability to deploy them in an ad hoc manner, as it is not appropriate to organize these nodes into groups pre deployment. For this reason, there has been an large amount of research into ways of creating these organizational structures (or clusters). The architecture of a generic Wireless Sensor Network is shown in fig.1. [1]. By the figure we examine how the clustering phenomenon is an essential part of the organizational structure.

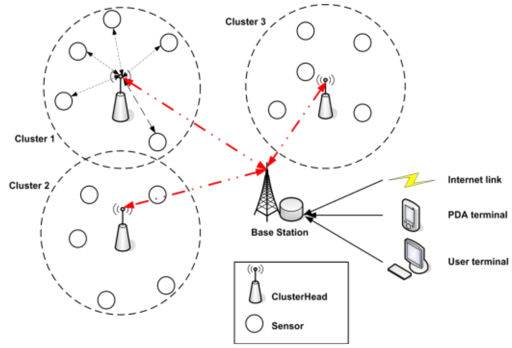

Figure 1: General Sensor Network Architecture

• Sensor Node: A sensor node is the core parameter of a WSN. Sensor nodes can provide on multiple roles in a network, such as data storage; simple sensing; routing; and data processing.

• Clusters: Clusters are the organizational entity for WSNs. The dense nature of these networks desires the need for them to be broken down into clusters to simplify tasks such a communication.

• Cluster-heads: Cluster-heads are the organization manager of a cluster. They often are desired to organize activities in the cluster. These tasks enclose but are not limited to data-aggregation and organizing the communication schedule of a cluster.

• Base Station: The base station is at the upper level of the hierarchical WSN. It gives the communication link between the sensor network and the end-user.

• End User: The data can be used for a wide-range of applications in a sensor network. [1] Therefore, a particular application may create use of the network data over the internet, even a desktop computer, or using a PDA. Ina queried sensor network (where the required data is gathered from a query sent through the network). This query is created by the end user.

2. HIERARCHICAL ROUTING PROTOCOLS

Many research projects in the last few years have explored hierarchical clustering in WSN from different perspectives [2]. Clustering is an energy-efficient communication protocol that can be used by the sensors to report their sensed data to the sink. In this section, we describe a sample of layered protocols in which a network is composed of several clumps (or clusters) of sensors. Each clump is managed by a special node, called cluster head, which is responsible for coordinating the data transmission activities of all sensors in its clump. The procedure of hierarchical routing protocol is shown in figure 2.

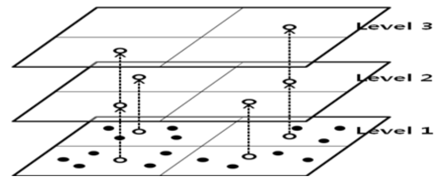

Figure 2: Hierarchical scheme procedure

2.1 LEACH

Heinzelman et. al. [3], proposed Low Adaptive Clustering Hierarchy-Energy (LEACH) which is one of the initiative clustering routing approaches for WSNs. The basic thought of LEACH has been an inspiration for many consequent clustering routing protocols. To select sensor nodes as CHs by rotation, is the main object of LEACH so the high energy dissipation in communicating with the BS is to all sensors Disperse widely nodes in the network. The operation of LEACH is collapsed into lots of rounds and each round is subdivided into two phases, the steady-state phase and set-up phase. The clusters are arranged in the set-up phase, while in the steady-state phase data is send to the BS. In the time interval of the set-up phase, each node decides that for the current round whether they want to become CH or not. This decision is depend on the suggested percentage of CHs for the network and the number of times the node has been a CH so far. This decision is taken by the nodes which choose a random number between 0 and 1. If the number is less than the following threshold then the node becomes a CH for the current round.

$$T(n) = (P/1-P(r \bmod 1/P) \text{ if n belongs to G}$$
$$0 \text{ otherwise}$$

Where n is the given node, P is the a priori probability of a node being elected as a cluster head, r is the current round number and G is the set of nodes that have not been elected as cluster heads in the last 1 P rounds. Each node during cluster head selection will generate a random number between 0 and 1. If the number is less than the threshold (T(n)), the node will become a cluster head. Figure 3 showed the basic topology of LEACH.

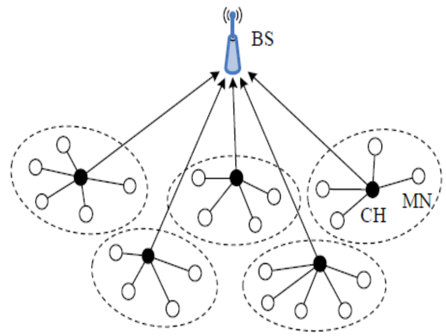

Figure 3: The Basic Topology of LEACH

The advantages of LEACH are[4]: (1) Any node that delivered as a CH in certain round cannot be elected as the CH again, so every node can equally share the load established upon CHs to some extent; (2) Utilizing a TDMA schedule stops CHs from unnecessary collisions; (3) Cluster members can on or off communication interfaces in compliance with their appropriate time slots to avoid excessive energy dissipation.
The disadvantages in LEACH as follows[4]: (1) It provides the single-hop inter-cluster, from CHs directly to the BS, routing method, which is not able to large-region networks.; (2) Despite the fact that CHs rotation is achieved at every round to get load balancing, LEACH cannot assure real load balancing in the case of sensor nodes with different amounts of initial energy, because CHs are selected in terms of probabilities without energy considerations.; (3) Since CH selection is determined in terms of probabilities, it is hard for the pre found CHs to be uniformly distributed throughout the network. Thereby there exist the selected CHs that are concentrated in one part of the network and some nodes that have not any CHs in their vicinity; (4) The idea of dynamic clustering imports extra overhead.

2.2 TL-LEACH

Loscrì et al [5] introduced Two-Level Hierarchy LEACH (TL-LEACH) which is an expansion to the algorithm of LEACH. TL-LEACH apply the following two methods to obtain energy and latency efficiency: adaptive, randomized, self-configuring cluster formation and localized control for data transfers. In TL-LEACH, a CH gathers data from MNs as original LEACH, but rather than of transmitting data to the BS directly, it consumes a part of CHs that lies between the CH and the BS as a relay station. TL-LEACH is introduced two-level hierarchy: top CHs is known as primary cluster heads (CHi), second level represented from secondary cluster heads (CHij) and ONs. Four basic phases are used to compose the algorithm: advertisement, cluster setup, schedule creation and data transmission. In the first phase, each node take decision whether it become a primary CH, secondary CH and ON in each round which is the same as that of LEACH. If a node is selected a primary CH, it must promote other nodes. Carrier sense multiple access (CSMA) mechanism is used in this phase. After that, secondary CH nodes transmit the advertisement to the ONs. In this phase, each secondary CH establishes to which primary CH it resides and sends an advertisement message to its primary CH. In the same way, each ON must determine which secondary CH it resides to and informs it through an opposite message. In the third phase, each primary CH generates a TDMA schedule assigning each node in its group a slot to transfer. Each primary CH selects a CDMA code and informs all the nodes at second level in its group to use this code. In the same way, each secondary CH can transmit this information to ONs in its group using both the code and the schedule from the primary CH. In the last phase, clusters are created and each node can transmit in respect to the TDMA schedule decided by its primary CH. Fig.4 shows the two level hierarchy in TL-LEACH.

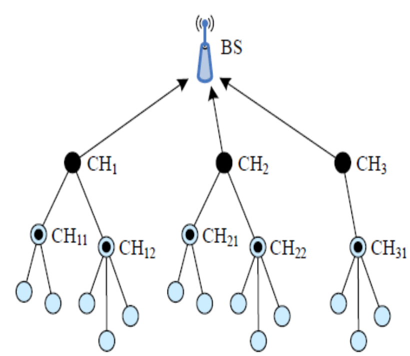

Figure 4: The Two-level Hierarchy in TL-LEACH

The advantages of TL-LEACH are: (1).TL-LEACH is used random rotation of local cluster

Base Stations, i.e., primary CHs and secondary CHs, which can get about better energy load distribution across the network; (2).TL-LEACH is used localized coordination, which is conductive to scalability and robustness in the network; (3).Compared with LEACH, the scheme of two-levels clustering leads to less average transmission distance, and less nodes are needed to transmit far distances to the Base Station via TL-LEACH. This effectively minimizes the total energy consumption.

However, a few disadvantages of TL-LEACH as follows: (1).Despite that the average transmission distance is minimized in comparison with LEACH, the two-hop inter-cluster routing of TL-LEACH is still not appropriate to large-range networks, because it uses only two hops for data transmission from sources to the Base Station, and long-distance communications can take much energy consumption; (2).CH election without energy considerations takes an ideal homogeneous network and cannot assure real load-balancing in case of nodes with different amount of initial energy.

2.3 HEED

Hybrid Energy-Efficient Distributed Clustering (or HEED) is a multi-hop clustering algorithm for wireless sensor networks, with main focus on efficient clustering by proper election of cluster heads based on the physical distance between nodes. The main objectives of HEED are to [6]: Energy consumption is distributed to prolong network lifetime; Decrease energy during the cluster head election phase; Decrease the control overhead of the network. The most important form of HEED is the method of cluster head election.

Cluster heads are established based on two important parameters [6]: 1) The residual energy of every node is used to probabilistically take the initial set of cluster heads. This framework is commonly used in many other clustering schemes. 2) Intra-Cluster Communication Cost is used to determine the cluster to join by nodes. This is especially useful if a provided node falls within the range of more than one cluster head. In HEED it is important to find what the range of a node is in terms of its power levels as a provided node will have multiple discrete transmission power levels. The power level used for intra-cluster announcements by a node and during clustering is referred to as cluster power level [7]. Low cluster power levels improve an increase in spatial reuse [6] while high cluster power levels are desired for inter-cluster communication as they span two or more cluster areas. Therefore, when electing a cluster, a node will communicate with the cluster head that yields the lowest intra-cluster communication cost. The Average Minimum Reachability Power (AMRP) measurement is used to determine the intra-cluster communication cost [6]. The AMRP is the average of all minimum power levels desired for each node within a cluster range R to communicate effectively with the cluster head i.

The AMRP of a node i then become a measure of the supposed intra-cluster communication energy if this node is elevated to cluster head. Utilizing Average Minimum Reachability Power (AMRP) as a second parameter in cluster head election is more useful than a node selecting the nearest cluster head [7].

There are following advantages of HEED protocols: (1).It is a fully distributed clustering method which takes benefits by the use of the two important parameters for CH election. (2).Low power levels of clusters encourage increase in spatial reuse while high power levels of clusters are used for inter-cluster communication. By this method we have uniform CH distribution across the load balancing and network. (3).More energy conservation and scalability would obtain from Communications in a multi-hop fashion between CHs and the BS, as compare with the single-hop fashion. i.e., long-range communications directly from CHs to the sink, in the LEACH protocol [8].

However there are also some limitations of HEED protocol, these are following: (1).The use of doubtful CHs that do not go in final stage, leave some uncovered nodes. As per HEED[9] execution, these nodes are forced to become a CH and these forced CHs may be in range of other CHs or may not have any member associated with them. Due to this more CHs are generated than the expected number and which leads to unbalanced energy consumption in the network. (2). Similar to the LEACH, significant overhead is imposed by the performing of clustering in each round. This overhead causes significant amount of energy dissipation which decrease the lifetime of network. (3).As HEEDS needs several iterations to form clusters so it suffers from a consequent overhead. A lot of packets are broadcast at each iteration. (4). Due to more workload some CHs specially near to sink may die earlier, and the hot spot will come into being in the network [10,11].

2.4 TEEN

Threshold Sensitive Energy Efficient Sensor Network Protocol (TEEN) is a hierarchical clustering protocol, which is grouped sensors into clusters with every led by a CH. The sensors within a cluster inform their sensed data to their CH. The CH transmits aggregated data to higher level CH until the data to be reached at the sink. Thus, the sensor network structure in TEEN is based on a hierarchical grouping where nearer nodes form clusters and this process goes on the second level until the BS (sink) is reached. TEEN is appropriate for applications where the users can control a trade-off between data accuracy, energy efficiency and response time dynamically. TEEN is used a data-centric method with hierarchical approach. Most features of TEEN are, its suitability for time critical sensing applications. Also, since message transmission expands more energy than data sensing, so in this scheme the energy consumption is less than the proactive networks. However, TEEN is not useful for sensing applications where periodic reports are needed since the user may not get any data at all if the thresholds are not reached.

In TEEN, a 2-tier clustering topology is built as illustrated in Figure 5 and two thresholds, hard threshold and soft threshold, are defined. The former threshold is a threshold value for the sensed attribute. It is the absolute value of the attribute beyond which, the node sensing this value must switch on its transmitter and report to its CH. The latter threshold is a small change in the value of the sensed attribute which triggers the node to switch on its transmitter and transmit.

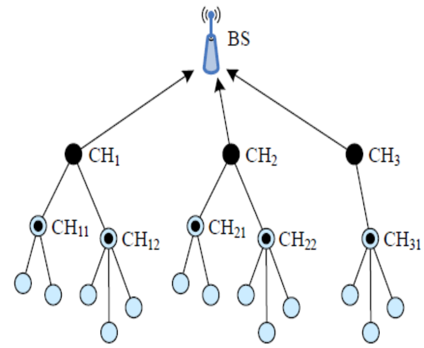

Figure 5: Illumination of the 2-tier Clustering Topology in TEEN

The advantages of TEEN are: (1).Based on the two thresholds, by using commands data transmission can be controlled, we can transmit only sensitive data if we demand, so the energy transmission consumption reduces and the effectiveness and usefulness of the receiving data would improve. (2).TEEN is suitable for reactive scenes and time critical applications as it is complement for reacting to large changes in the sensed attributes.

The disadvantages of TEEN are: (1).As the user may not collect any data at all if the values of the attributes may not reach the threshold [12]; so it is not suitable for periodic reports applications. (2).In TEEN we have wasted time-slots and it is possible that the BS may not be able to differentiate dead nodes from alive ones, because only when the data reaches at the hard threshold and has a variant higher than the soft threshold did the sensors report the data to the BS. (3).The data may be lost If CHs are not in the communication range of each other , because information propagation is completed only by CHs [13].

2.5 APTEEN

Adaptive Periodic Threshold Sensitive Energy Efficient Sensor Network Protocol is an advancement to TEEN to conquered its shortcomings and aims at both taking periodic data collections (LEACH) and reacting to time-critical events (TEEN). Thus, APTEEN is a hybrid clustering-based routing protocol that allows the sensor to send their sensed data periodically and react to any sudden change in the value of the sensed attribute by reporting the corresponding values to their CHs. The structure

INTERNATIONAL JOURNAL FOR ADVANCE RESEARCH IN ENGINEERING AND TECHNOLOGY

WINGS TO YOUR THOUGHTS…..

of APTEEN is same as in TEEN, which is used the concept hierarchical clustering for energy efficient communication between source sensors and the sink. APTEEN is supported three different query types namely (i) historical query, to evaluate past data values, (ii) one-time query, to return a snapshot view of the network; and (iii) persistent queries, to auditor an event for a period of time. APTEEN guarantees lower energy dissipation and a larger number of sensors alive.

The advantages of APTEEN include following points: (1).APTEEN uses combination of both proactive policies (which is alike that of LEACH) and reactive policies (which is alike that of TEEN). Accordingly it is suited to both proactive and reactive applications. (2).By setting the count-time interval It personifies a lot of flexibility, and also by changing the count time the threshold values for the energy consumption can be adjusted as well as the threshold values.

The main disadvantages of APTEEN includes:(1).APTEEN subsist additional complexity required to carry out the threshold functions and the count time. (2). Actually, both TEEN and APTEEN have the same drawbacks of additional overhead and complexity of cluster construction in multiple levels, implementing threshold-based functions, and dealing with attribute-based naming of queries-APTEEN more than TEEN [14].

2.6 EECS

An Energy Efficient Clustering Scheme (EECS)[15] is a clustering algorithm in which cluster head candidates compete for the ability to elevate to cluster head for a given round. This competition associates candidates broadcasting their residual energy to neighboring candidates. If a provided node does not find a node with more residual energy, it becomes a cluster head. Cluster formation is different than that of LEACH. LEACH forms clusters based on the minimum distance of nodes to their corresponding cluster head. EECS extends this algorithm by dynamic sizing of clusters based on cluster distance from the base station. The result is an algorithm that addresses the problem that clusters at a greater range from the base station require more energy for transmission than those that are closer. Ultimately, this improves the distribution of energy throughout the network, resulting in better resource usage and extended network lifetime.

Advantages of EECS are: (1) EECS constructs balancing point between intra-cluster energy consumption and inter-cluster communication load which is based on energy consumption and distance. (2) Clustering is performed by dynamic sizing Based on cluster distance from the BS Clustering is performed by dynamic sizing. This indicate the problem that clusters having a larger distance from the BS need more energy for transmission than those having a shorter distance, and give low message overheads and uniform distribution of CHs compared to LEACH.

Disadvantages of EECS are: (1).Record of single-hop communications in EECS, long-range transmissions directly from CHs to the BS can consume more energy. Hence it is not desirable for large-range networks; (2).Data collection gives overheads to all sensor nodes. (3).EECS introduce much more control overhead complexity because all nodes must compete to become CHs.

2.7 CCS

CCS[16] is a protocol which is used to reduce energy consumption in PEGASIS protocol. In CCS, the whole network is distributed into co-centric circular tracks and each one of these tracks performs a cluster. Every one of these tracks is located with a level. For example, the nearest track to the BS is located as level-1, and as it moves further from the BS the level number maximizes like level-2, level-3 and so on. In every one of these tracks, nodes form a chain just like PEGASIS. One of the nodes in the chain is selected as the head node and these head nodes are assigned with node numbers. For example, a head node in level L is assigned with a node number obtained by calculating i mode ML, where ML considers the number of nodes that have the same level in i round. Each non head node in a chain, gets data from its one-hop neighbor, fuses it with its own data and then transmits it to its one-hop neighbor. So it is clear that the head node in each track gets atmost two data messages. After transmitting data in a track and obtaining it at the head node it's time for the head nodes in adjacent tracks to cooperate and

deliver data to the BS.
CCS includes following advantages: (1) The distance between BS and CH in which the data can be transmitted is reduced in CCS. Hence, the energy consumption is reduced in considerable amount as the transmission distance is reduced in CCS [17]; (2) It divides network into a series of concentric clusters, and the reverse data flow from the BS is also decrease. Thus, energy consumption is reduced in a considerable amount during data transmission.
However, there are some disadvantages to be considered as follows: (1).The distribution of nodes in each level is unbalanced, thus the levels having low number of nodes will consume their energy first, in that the probability of election to be a CH is high; (2). In CCS the Residual energy is not accounted for CH election, which may lead to unbalanced energy consumption among all nodes; (3). Chain-based protocols, such as PEGASIS and CCS, use low radio power which enable nodes to communicate with their closest neighbor, but we have large delay due to the long chain. [18]; (4). The CH selection for next hop is entirely based on the position rather than the residual energy of nodes, thus energy of CH may reduce quickly on the path among CHs, and even energy hole will come out in the network.

2.8 PEGASIS

PEGASIS stands for Power-Efficient Gathering in Sensor Information Systems [19] is a near-optimal chain-based and data-gathering algorithm that determines the concept that energy conservation can result from nodes not directly forming clusters. This algorithm minimizes the energy consumption by production of continually data aggregation and a chain structure comprised of all nodes across the chain. The algorithm provides the idea that if a chain from source to sink is form by nodes than only a node in any given transmission time-frame will be transmitting to the BS. Data-fusion appears at each node in the sensor network granting for all relevant data to infuse across the network. PEGASIS escapes cluster formation and uses only a node in a chain to transmit to the BS in place of using multiple nodes. In order to maximize the network life time, nodes need to communicate with their nearest neighbors and they take turns in conversations with the BS. When the round of all nodes conversations with the base-station ends, a new round will start and so on. This decreases the power required to transmit information per round as the power draining is extract uniformly over all nodes. Hence, PEGASIS accomplishes energy conservation in two ways: 1. The number of data messages received by the head node is at most two. 2.The distance over which the data are transmitted to one-hop neighbor is much less So, PEGASIS conserves energy by reducing the number of data messages gathering at head node [19][20].

The advantages of PEGASIS contains following points: (1).This protocol is better in performance in compare to LEACH for different network sizes and topologies, because it decrease the overhead of dynamic cluster formation in LEACH, and reduced the number of data transmission volume through the chain of data collection. (2).The energy load is shared uniformly in the network. All sensor nodes act as the leader to make sure that the fixed sensor node is not select as the leader and thus to forbid the subsequent early death of this sensor node [21].
However, there are some disadvantages in PEGASIS: (1).To construct chain it is the necessity of having a complete view of the network topology at each node and that all nodes must be able to transmit data directly to the sink. Thus, this scheme is not suitable for those networks which have a time varying topology [22]; (2).It is assumed that each sensor node can be able to communicate with the sink directly, but in actual cases nodes usually use multi-hop communications with the sink. Furthermore, long-range communications directly from the node to the sink can breed too much energy consumption; (3).The communication manner has to suffer from excessive delays caused by the single chain for distant nodes and there is a high probability that any node may become a bottleneck. (4).It is a not a easy task for all nodes to keep a complete database about the position of all other nodes in the network, furthermore the network is not very scalable because all nodes must have global knowledge of the network and employ the avaricious algorithm.

2.9 BCDCP

Base-Station Controlled Dynamic Clustering

Protocol (BCDCP) is an integrated clustering routing protocol with the BS being enable of complex computation, introduced by Muruganathan et al. [23]. Cluster formation, is the main idea of BCDCP, where each CH provides an almost equivalent number of MNs to balance uniform CH placement and CH overload throughout the network. A multi-hop routing scheme is adopted in BCDCP, which is used to transfer the considered data to the BS. When the clusters and the CHs have been determined, the BS elects the lowest-energy routing path and transfer data to the nodes along with the details on cluster groupings and selected CHs. Minimum Spanning Tree (MST) approach by first connecting all the CHs, is used to select the routing paths[24], which reduces the energy consumption for every CH, and then randomly electing a CH to forward the data to the BS. The transmission load is divided almost evenly among all CHs in BCDCP, by randomizing the CH transmissions to the BS.

The advantages of BCDCP contain the following points [4]: (1) Clusters and transmission paths are designed by the BS, thus BCDCP resolves the problem of CH distribution and make sure that power dissipation of CHs is similar. (2) The time slots of cluster members are scheduled by TDMA; this allows sensor nodes to open communication interfaces only if data transmissions are necessary, which means energy consumption would be less so energy can be saved.

However, there are a few disadvantages of BCDCP: (1) BCDCP is a centralized algorithm which gives worse scalability and robust to large networks than distributed algorithms; (2) During the process of cluster formation each node needs to transmit information regarding its position and level of energy to the BS. Accordingly it raises the design complexity and the energy consumption of the nodes to some extent; (3) It is not appropriate for long-distance communications due to the single-hop routing scheme, which would increase energy consumption. Therefore, BCDCP is not suitable for applications having large-range networks; (4) BCDCP is not adoptive to reactive networks where the users are not interested in periodic data recovery, while the nodes only need to give response to events of certain significance in reactive networks.

2.10 EEUC

Energy-Efficient Uneven Clustering (EEUC) algorithm is a distributed and clustering competitive algorithm which is proposed by Li et al. [25], where CHs are chosen by localized competition, which is unlike LEACH. Each node has a pre-assigned competitive range, which is smaller as it gets near to the BS. This makes EEUC an unequal clustering approach for the purpose of solving the hot spots problem and balancing energy consumption among CHs. In EEUC, during the process of election of CH, every node creates a random number, and only the node whose number is larger than a threshold will be activated for election of CH by broadcasting attempt message within a competition radius which is resolved by its distance to the BS.

The node(si)'s competition radius is given by:

$$s_i.R_{comp} = \left[1 - c\frac{d_{max} - d(s_i, BS)}{d_{max} - d_{min}}\right] R^0_{comp}$$

Where R0 comp which is predefined is the maximum competition radius, dmax and dmin define the maximum and minimum distance between sensor nodes and the BS, d(si, BS) is the distance between node si and the BS, c is a constant coefficient between 0 and 1.

The advantages of EEUC are as follows:(1).To mention the hot spots problem, EEUC came with an inadequate clustering mechanism which balance the energy consumption among CHs. Accordingly, the inadequate clustering mechanism in EEUC increase the network lifetime as compare to LEACH and HEED; (2).Based on communication cost, in steady state phase EEUC can save more energy by using inter-cluster multi-hop routing mechanism, because a CH used to choose a relay node from two nodes whose communication cost are the least among all of its neighbor CHs.

There are several limitation of EEUC which are following as: (1).Executing of clustering in each round obtrude significant overhead, because each node must broadcast and obtain a high amount of competition message for CH election, even though most of them may not win and most of the elected nodes are not in a good condition to be as CHs; (2).The extra global data collection can produce much overhead for all nodes and make the network performance worse; (3).The routing scheme may introduce new hot spots, in that only one of the two nodes can be relay nodes whose communication costs are the least among the neighbor CHs , even though both nodes have little amount of residual energy.

3. CONCLUSION

In this paper we have examined the current state of proposed hierarchical routing protocols. In wireless sensor networks, the energy limitations of nodes play a crucial role in designing any protocol for implementation. In addition, Quality of Service metrics such as delay, data loss tolerance, and network lifetime expose reliability issues when designing recovery mechanisms for clustering schemes. However there is still much work to be done. Many energy improvements thus far have focused with minimization of energy associated in the cluster head selection process or with generating a desirable distribution of cluster heads. Optimal clustering in terms of energy efficiency should eliminate all overhead associated not only with the cluster head selection process, but also with node association to their respective cluster heads. Sensor network reliability is currently addressed in various algorithms by utilizing re-clustering that occurs at various time intervals; however the result is often energy inefficient and limits the time available within a network for data transmission and sensing tasks. Further improvements in reliability should examine possible modifications to the reclustering mechanisms following the initial cluster head selection. These modifications should be able to adapt the network clusters to maintain network connectivity while reducing the wasteful resources associated with periodic re-clustering. In addition, other mechanisms such as the ability of nodes to maintain membership in auxiliary clusters can reinforce the current state of sensor network reliability.

REFERENCES

[1] I. F. Akyildiz,W. Su, Y. Sankarasubramaniam, and E. Cayirci, "A Surveyon Sensor Netowrks," IEEE Communications Magazine, vol. 40, no. 8,pp. 102–114, Aug 2002.

[2] W. Heinzelman, A. Chandrakasan, and H. Bal Krishnan, Energy Efficient Communication Protocols for Wireless Sensor Networks In Proceedings of the 33rd Annual Hawaii International Conference on System Sciences (HICSS), 3005±3014, Big Island, Hawaii, USA, January 2000.

[3] Heinzelman, W.R.; Chandrakasan, A.; Balakrishnan, H. Energy-Efficient Communication Protocol for Wireless Microsensor Networks. In Proceedings of the 33rd Annual Hawaii International Conference on System Sciences, Maui, HI, USA, 4–7 January 2000; pp. 10–19.

[4] Lai, W.K.; Fan, C.S.; Lin, L.Y. Arranging cluster sizes and transmission ranges for wireless sensor networks. Inf. Sci. 2012, 183, 117–131.

[5] Loscri, V.; Morabito, G.; Marano, S. A Two-Level Hierarchy for Low-Energy Adaptive Clustering Hierarchy. In Proceedings of the 2nd IEEE Semiannual Vehicular Technology Conference, Dallas, TX, USA, 25–28 September 2005; pp. 1809–1813.

[6] 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, Oct-Dec 2004.

[7] 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, Oct-Dec 2004.

[8] Taheri, H.; Neamatollahi, P.; Younis, O.M.; Naghibzadeh, S.; Yaghmaee, M.H. An energy-aware distributed clustering protocol in wireless sensor networks using fuzzy logic. Ad Hoc Netw. 2012, 10, 1469–1481.

[9] Aslam, N.; Phillips, W.; Robertson, W.; Sivakumar, S. A multi-criterion optimization technique for energy efficient cluster formation in wireless sensor networks. Inf. Fusion 2011, 12, 202–212.

[10] Poonguzhali, P.K. Energy Efficient Realization of Clustering Patch Routing Protocol in Wireless Sensors Network. In Proceedings of the 2nd International Conference on Computer

Communication and Informatics, Coimbatore, Tamilnadu, India, 10–12 January 2012; pp. 10–12.

[11] Wei, D.; Jin, Y.; Vural, S.; Moessner, K.; Tafazolli, R. An energy-efficient clustering solution for wireless sensor networks.IEEE Trans. Wirel. Commun. 2011, 10, 3973–3983.

[12] Kandris, D.; Tsagkaropoulos, M.; Politis, I.; Tzes, A.; Kotsopoulos, S. A Hybrid Scheme for Video Transmission over Wireless Multimedia Sensor Networks. In Proceedings of the 17th Mediterranean Conference on Control & Automation, Makedonia Palace, Thessaloniki, Greece, 24–26 June 2009; pp. 964–969.

[13] Kandris, D.; Tsagkaropoulos, M.; Politis, I.; Tzes, A.; Kotsopoulos, S. Energy efficient and perceived QoS aware video routing over wireless multimedia sensor networks. Ad Hoc Netw. 2011, 9, 591–607.

[14] Vidhyapriya, R.; Vanathi, P.T. Conserving energy in wireless sensor networks. IEEE Potentials 2007, 26, 37–42.

[15] V. Loscri, G. Morabito, and S. Marano, A Two-Level Hierarchy for Low Energy Adaptive Clustering Hierarchy, DEIS Department, University of Calabria.

[16] W.R.Heinzelman, A.Chandrakasan, and H.Balakrishnan "Energy Efficient Communication Protocol for Wireless Sensor Networks" Proceedings of the 33 Hawaii International Conferences on System Sciences, 2000.

[17] [17] Gautam, N.; Lee, W.I.; Pyun, J.Y. Track-Sector Clustering for Energy Efficient Routing in Wireless Sensor Networks. In Proceedings of the 9th IEEE International Conference on Computer and Information Technology (CIT), Xiamen, China, 11–14 October 2009; pp. 116–121.

[18] Liang, J.; Wang, J.; Chen, J. A Delay-Constrained and Maximum Lifetime Data Gathering Algorithm for Wireless Sensor Networks. In Proceedings of the Fifth International Conference on Mobile Ad-hoc and Sensor Networks, Wu Yi Mountain, China, 14–16 December 2009; pp. 148–155.

[19] S. Bandyopadhyay and E. J. Coyle, "An Energy Efficient Hierarchical Clustering Algorithm for Wireless Sensor Networks," IEEE INFOCOM,April 2003

[20] S.M.Jung, Y.J.Han, and T.M.Chung "The Concentric Clustering Scheme for Efficient Energy consumption in the PEGASUS 9th International Conf. on Advanced Communication Technology, vol.1, pp.260-265, Feb. 2007.

[21] Chen, Y.-L.; Lin, J.-S. Energy efficiency analysis of a chain-based scheme via intra-grid for wireless sensor networks.Comput.Commun. 2012, 35, 507–516.

[22] Fasolo, E.; Rossi, M.; Widmer, J.; Zorzi, M. In-network aggregation techniques for wireless sensor networks: A survey. IEEE Wirel. Commun. 2007, 14, 70–87.

[23] Murugunathan, S.D.; Ma, D.C.F.; Bhasin, R.I.; Fapajuwo, A.O. A Centralized Energy-Efficient Routing Protocol for Wireless Sensor Networks.IEEE Radio Commun.2005, 43, S8–S13.

[24] Shen, H. Finding the k Most Vital Edges with Respect to Minimum Spanning Tree. In Proceedings of the IEEE National Conference on Aerospace and Electronics, Dayton, OH, USA, 14–17 July 1997; pp. 255–262.

[25] Li, C.F.; Ye, M.; Chen, G.H.; Wu, J. An Energy-Efficient Unequal Clustering Mechanism for Wireless Sensor Networks. In Proceedings of the 2nd IEEE International Conference on Mobile Ad-hoc and Sensor Systems Conference (MASS), Washington, DC, 7–10 November 2005; pp. 596–604.