Energy Conservation Routing in WSN using LDAE-SEP Protocol

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Abstract - Wireless sensor networks (WSNs) composed from a large number of sensor node with the ability to sense and process data in the physical world in a timely manner. The sensor nodes contain a battery constraint which limit the network lifetime. Due to energy constraints, the deployment of WSNs will required advance techniques to maintain the network lifetime. Energy is the most prominent factor in wireless sensor networks because all the sensors are battery operated and the consumption of energy is inversely proportional to the lifetime of the sensor node. The less energy consumed by the node to transmit information larger the lifetime of the node. The energy conservation of the sensor node is directly affected the way information transmitted to the base station or server. The transmission of information is considered as routing methods. In this paper a more efficient energy efficient routing technique is proposed for the wireless sensor network. The energy of data aggregation in Stable Election Protocol (SEP) is kept lower to enhance the lifetime of the wireless sensor network(WSN). The proposed approach having better lifetime as well as throughput. The lifetime is increased upto 3440 transmission rounds and throughput is about 7.8x10⁴.

Keywords - Energy Efficient Routing, Lifetime, Throughput, WSN, SEP.

I. INTRODUCTION

Recent advancement in micro-electronics technology facilitated sensor designers to develop low cost, low power and small sized sensors. Numbers of sensors are deployed in order to achieve high quality network. In the recent few years WSNs has emerged as an important technology for monitoring physical environment. WSNs consist of large number of sensor nodes which are small in size, low-cost and battery power-driven. These WSNs can be used in various applications such as Military surveillance, environment monitoring, border protection, health care monitoring, climate monitoring. These applications require data without delay and energy consumed by them should be small. WSNs are deployed in harsh environment. Since it is not possible to replace or charge battery of sensor nodes, So it is desirable to design communication protocols such that energy source is used effectively and the delay in the network in minimum.

Sensor nodes senses the environment, gathers the data from its surrounding(computation) and communicates it to the base station(BS).Out of the three tasks communication takes large amount of battery power of a sensor node, so the major concern is the communication task. We have to minimize the communication cost in order to save battery power. Wireless sensor networks[4] consists of a thousands of sensor nodes which are deployed randomly environment or space. In sensor network there is a BS (base station) which is located far away from the sensor field. A sensor node sends the sensed data to the Base Station. In order to send the sensed data to BS directly a lot of energy is consumed. So it is desirable to develop some protocols to minimize this communication expenditure. Power conservation and maximization of network lifetime are the key challenges in the design and implementation of WSNs.

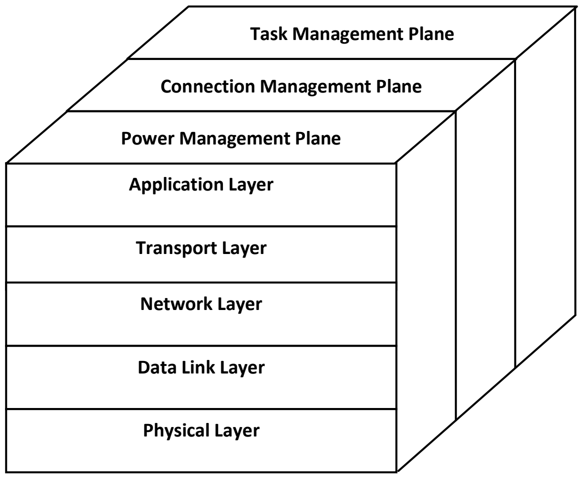

Fig. 1.1: Protocol stack for WSN

Architecture of Sensor Node:

Every sensor node mainly consists of four components. They are sensing unit, transceiver, processing unit and power source. some sensor nodes also consist of optional components like location finding system, power generator and mobilizer. The sensing unit generally consist of sensor and ADC(Analogue and digital converter).The ADC converts the analogue data to digital data so that node can process it before transmitting the data. Transceiver connects the node to the network. The processing unit consists of processor and memory. This unit is responsible for managing the task of sensor unit. Mobilizer is used to enable node movement.

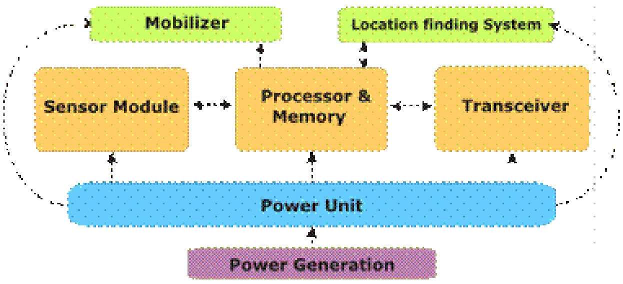

Figure 1.2: Sensor Node's Architecture

II. DIFFERENT ROUTING TECHNIQUE

Challenges encountered as a result of constrained energy supply and bandwidth in WSN when managing the network necessitates the need for development of energy awareness protocol at all levels of networking protocol stack. To present efficient power management in WSN, researches have been focus on areas such as system-level power awareness like radio communication hardware, low duty cycle work and energy-aware MAC protocol [7]. Also, it was observed that the network layer offers a better means through which reliable relaying of data and energy-efficient route setup within a network can help to maximize the network lifetime.

It should be noted that routing in WSN has much distinguishable features compare to contemporary communication and ad hoc networks [7]. These features are as follows:

- WSN cannot be built with global addressing (internet protocol address) scheme due to the enormous number of sensor nodes;
- There is significant redundancy in generated data because several sensors may gather the same data within a specified field. These redundancy bits need to be removed to increase the bandwidth utilization and also reduce energy consumption in the network;
- Transmission power of the system, processing capacity and storage are constraint factors to be considered when managing a WSN.

Clustered Architecture:

Hierarchical or cluster based routing methods are well known routing methods with a special advantage related to scalability and efficient communications. Hence, they are used for energy efficient routing in wireless sensor networks. In hierarchical routing, higher-energy nodes can be used to process and send the information, whereas low-energy nodes can be used to perform the sensing in the vicinity of the target. The creation of clusters and the assignment of special tasks to cluster heads contribute to the overall systems scalability. Nodes within a cluster lower the energy consumption by performing data aggregation and fusion, lowering the number of transmitted messages to the base station, thus prolonging network lifetime. Hierarchical routing is mainly comprised of two levels: one for the selection of cluster heads and the other for routing.

A clustered architecture consists of a cluster head, or Personal Area Network coordinator, which organizes sensor nodes, communicates for them to the BS and typically interfaces with another network. This structural design is well suited when data fusion is necessary. The cluster head fuses data gathered by member nodes and transmits the resulting information to the base station. A design of a clustered architecture is shown in Figure 2.1 In order for clustered networks for achieving the self-organization, the cluster formation and election process must be an autonomous, distributed procedure. This is achieved during network layer protocols, such as Low-Energy Adaptive Clustering Hierarchy (LEACH). [8,9]

A set of protocols for complete implementation of a layered architecture is described as a Unified Network Protocol Framework (UNPF). Three operations are integrated into the protocol structure of UNPF: network initialization and maintenance, Medium Access Control (MAC) and routing protocols. The BS broadcasts an identifying beacon on a common control channel. All nodes which receive the beacon broadcast their signal at their low power setting along with their own identification. Those nodes that the BS can directly communicate with form layer one.

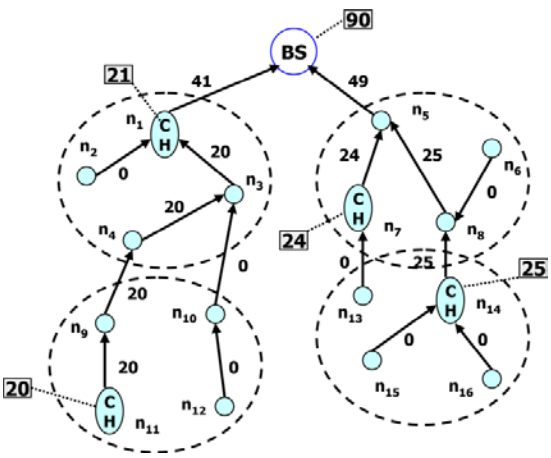

Fig. 2.1. Clustered Architecture Illustrating data aggregation.

All nodes then transmit a beacon signal again. Nodes that receive this beacon again broadcast their signal at their low power setting along with their own identification. Therefore, the nodes of layer one establish layer- two nodes by recording the identification of the nodes with which they can communicate. The iterations continue until all nodes are identified with a layer. Thereafter, a periodic beacon refreshes the architecture. [8]

LEACH:

LEACH operates in two phases, setup and steady state. During the setup phase, LEACH minimizes energy dissipation by randomly selecting and periodically reselecting nodes as cluster heads. In this way, the high energy consumption experienced by cluster heads is distributed all through the network, so assuring that all cluster heads eventually expend equal energy. Later than selection, the cluster heads advertise their selection to all network nodes. The nodes are in turn associate themselves with the nearest cluster head based on the received signal strength of the selection advertisement. A TDMA schedule is then assigned for node communication. The steady-state phase is extensive long in comparison to the setup phase in order to minimize the overhead of cluster formation. Data transmission takes place during the steady-state phase based on the TDMA schedule established during setup. Energy is conserved by local processing and data aggregation at the cluster head. [9]

Ad hoc On-demand Distance Vector:

Ad hoc On-demand Distance Vector (AODV), as the name suggests is an on-demand protocol designed for mobile ad hoc networks [6]. This protocol responds quickly to changing link conditions and link breakages. The nodes mark the routes as invalid whenever there is a link breakage. AODV does not necessitate a node to maintain routes to destinations that are not in active communication. Loop freedom in AODV is ensured by using destination sequence numbers. These also allow nodes to use the most recent route to a target. The routing table information consist the destination address and the next hop address with the number of hops required to reach the destination. Also, the most recent destination sequence number associated with destination and lifetime of the route is stored in the table. If throughout the lifetime, the route is not used, the routing table entry is discarded.

SEP (Stable Election Protocol):

In SEP [3] protocol all nodes use the initial and residual energy level to define the cluster heads. SEP estimate the ideal value of network lifetime to compute the reference energy that each node should expend during each round. In a two-level heterogeneous network, where we have two categories of nodes, m.N advanced nodes

with initial energy equal to $Eo.(1+a)$ and $(1-m)$.N normal nodes, where the initial energy is equal to Eo. Where a and m are two variable which control the nodes percentage types (advanced or normal) and the total initial energy in the network E_{total} .

The value of Total Energy is given as

$$E_{total} \ = N.(1-m).E_o + N.m.E_o.(1+a) \qquad (1)$$

•The average energy of r^{th} round is set as follows

$$E(r) \ = \frac{1}{N}\ E_{total}\,(1\ -R) \qquad (2)$$

R represent the total rounds of the network lifetime and is defined as

$$R = \frac{E_{total}}{E_{Round}} \qquad (3)$$

• E_{Round} is the total energy dissipated in the network during a round, is equal to: E_{Round} = L(2NEelec +NEDA + $kEmpd^4$toBS+NEfsd2toCH) (4)

k: number of clusters

EDA: data aggregation cost expended in the cluster heads

dtoBS : average distance between the cluster head and the base station

dtoCH: average distance between the cluster members and the cluster head.

• Because it has been assumed that the nodes are uniformly distributed then get:

$$dtoCH \ = \frac{M}{\sqrt{2k\pi}}$$

$$dtoBS \ = \frac{0.765\ M}{2}$$

III. PROPOSED METHODOLOGY

The wireless sensor network a subset of mobile ad-hoc network has lot of challenges to reduce the energy consumption of sensor nodes or wireless nodes to live longer in network and keep communicating with the network. Here we have to work out main areas by which a node can live longer and i.e. either make batteries (source of energy) equipped with nodes having larger in size or the material having larger charges saving capability but this approach having limited capabilities because the larger battery size make sensor node more bulk which is not feasible in any case, and to finding out the material has larger charge storing capability is also tough task to do.

Instead doing above things another method is to make transfer of information on network more efficient. For this many routing protocols has been given as we discussed in the previous sections.

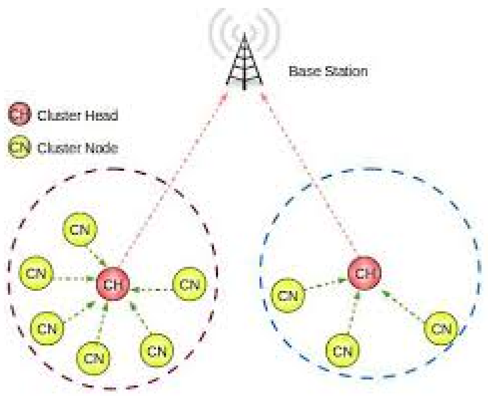

Fig. 3.1 Network Diagram of Proposed Methodology with LDAE-SEP

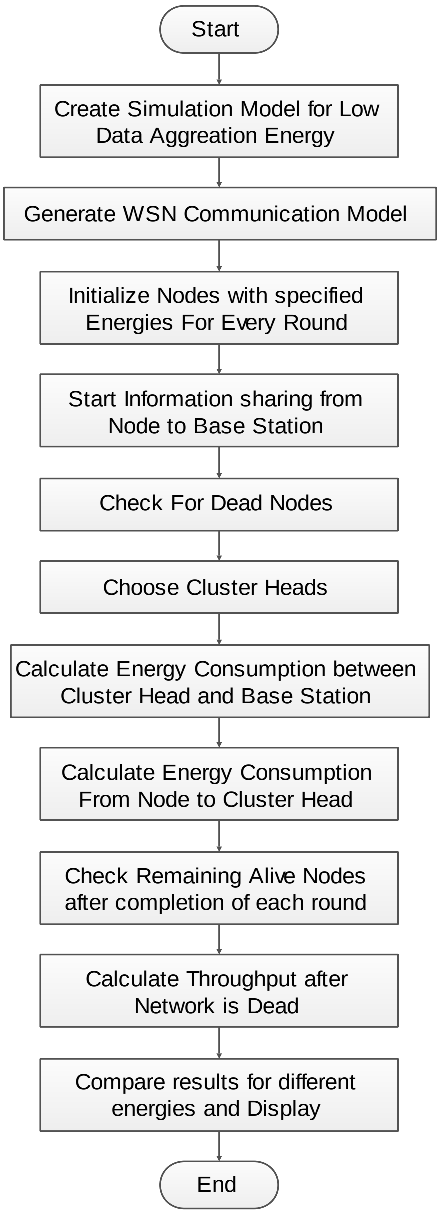

Fig. 3.2 Flow Chart of the Proposed Methodology

Here we are making changes in one of the routing protocol i.e. Stable Election Protocol (SEP), where changes are being made in the information aggregation energy. The proposed approach is to have the lower data aggregation energy and the energy can be conserve for such frequent changes in the network. The proposed diagram of network is presented in Fig. 3.1.

The above mentioned proposed routing strategy is implemented and its step by step execution is shown in below steps which are as follows:

a) *Start the program.*

b) *Initialization environmental variables (with low data aggregation energy)*
c) *Generation of wireless sensor network model*
d) *Set loop for the number of rounds*
e) *Set number of alive nodes at the beginning of network*
f) *Check number of dead nodes*
g) *Select the cluster heads.*
h) *Calculate energy consumptions to transfer data between cluster head (CH) to Base station(BS) and nodes(N) to cluster head(CH)*
i) *Check alive nodes after data transfer*
j) *If alive nodes are > 0 then Go back to Next Round (step c)*
k) *If alive nodes are = 0 then calculate Throughput of the network*
l) *Compare and display results*
m) *End of program*

Table I: Network Simulation Parameters

Operation	Energy Dissipated
Transmitter / Receiver Electronics	Eelec = Etx = Erx = 50nJ/bit
Data aggregation energy	EDA = 1/5/10-nJ/bit/signal
Transmit amplifier (if d to BS < do)	E_{fs} = 10pJ/bit/4m^2
Transmit amplifier (if d to BS > do)	E_{mp} = 0.0013pJ/bit/m^4

IV. SIMULATION RESULTS

Wireless Sensor Network(WSN) is having lots of research areas to work on and here we have chosen routing protocol to make network lifetime more than the previous work. The simulation performed on Stable Election Protocol (SEP) which is based on reducing the data aggregation energy.

The simulated outcomes are in terms of number of alive nodes and number of dead nodes versus number of transmission rounds and throughput curve.

In the previous work lifetime of the network with low energy adaptive clustering hierarchy(LEACH) is calculated up to 2490 transmission rounds.

If the network sustain for more number of rounds means lifetime of the network is going better. In proposed approach the lifetime of the network increased up to 3099 rounds in 100x100 network, 2826 rounds in 134x134 network, 2521 rounds in 150x150 network and 2867 rounds in 200x200 network which is greater than the previous work. Table II shows comparison of the network lifetime with existing work.

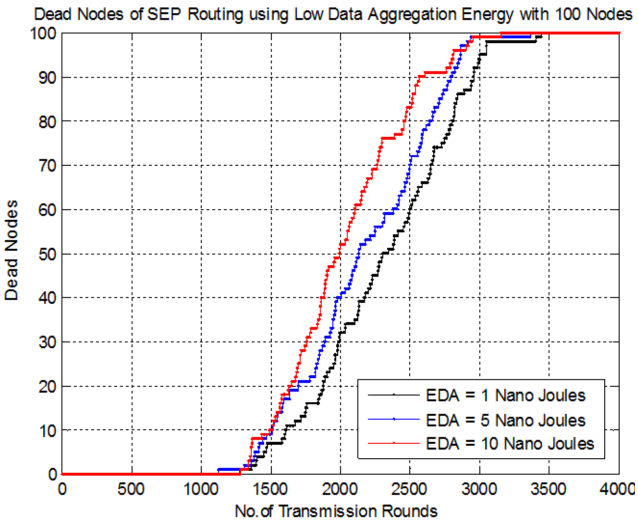

Fig. 4.1 Network lifetime in terms of dead nodes versus no. of rounds

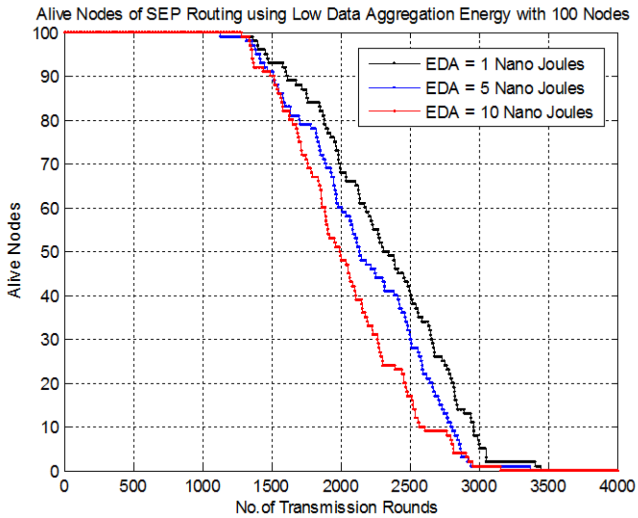

Fig. 4.2 Network lifetime in terms of alive nodes versus no. of rounds

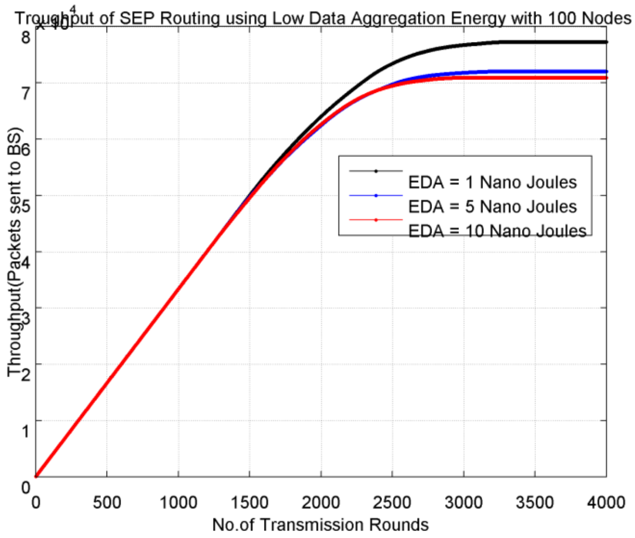

Fig. 4.3 Throughput versus no. of rounds

The alive nodes versus no. of transmission rounds graph is shown in the Fig. 4.1 and dead node versus no. of transmission rounds graph is shown in Fig. 4.2 the Throughput is also shown in the Fig. 4.3. The results are given for 100x100 network size and the network lifetime is also shown for other network sizes in Table-II.

Table II: Comparison of Proposed and Existing Work

Routing Technique	Network Size	Number of Nodes	First Node Death Round	Last Node Death Round
Proposed Approach (LDAE-SEP)	100mX100m	100	1276	3440
	134mX134m	134	1234	3104
	150mX150m	150	1233	3237
	200mX200m	200	855	3066
Previous Work [1]	100mX100m	100	1496	2490
	134mX134m	134	1460	2459
	150mX150m	150	1424	2388
	200mX200m	200	1204	2270

V. CONCLUSION AND FUTURE SCOPE

The wireless sensor network(WSN) is need to be sustain longer to stay with the network, and from the proposed methodology and its simulation results analyzed that with the lower data aggregation energy of information in the Stable Election Protocol (SEP) routing will have longer network lifetime which is higher than the existing methodologies. During simulation of proposed methodology number of dead nodes vs transmission rounds are calculated and the same for alive nodes and throughput i.e. packets send to base station also calculated for different data aggregation energy and found longer network lifetime(the sensor nodes survived to more number of transmission rounds) with better throughput. With the analysis of other network like network area, initial energy etc. researcher will make out something more robust routing protocols which has lower energy consumption and higher network lifetime.

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