DYNAMIC DATA GATHERING THROUGH MOBILE SINK FOR LIFE TIME IMPROVEMENT IN WSNs

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ABSTRACT

The most challenging aspect of Wireless Sensor Network (WSN) is that they are energy resource-constrained and that energy cannot be replenished. Clustering methods in WSN lead the sensor nodes to be organized into small disjoint groups, where each cluster has a coordinator referred as Cluster Head (CH). Maintaining the created clusters is the main challenging task in the methods. To choose a node as a CH, it is necessary to define its eligibility. That is calculated based on local information of the nodes' current situations such as its residual energy. The eligibility of the selected CHs however, reduces as the sensor nodes are consuming energy for transferring data. However, there is possibility that the CHs may fail and function incorrectly due to a number of reasons such as power instability. During the failure, the CHs are unable to collect and transfer data correctly. This affects the performance of the WSN. Early detection of failure of CHs will reduce the data loss and provide possible minimal recovery efforts. It is a self-configurable clustering mechanism to detect the disordered CHs and replace them with other nodes.

Keyword: - *Wireless Sensor Network (WSN), Cluster Head(CH), mobile sink, energy aware routing, mobile sink relocation, network simulator NS2.*

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1. WIRELESS SENSOR NETWORK (WSN)

A Wireless Sensor Network consists of sensor nodes capable of collecting information from the environment and communicating with each other via wireless transceivers. The collected data will be delivered to one or more sinks, generally via multi-hop communication. The sensor nodes are typically expected to operate with batteries and are often deployed to not-easily accessible or hostile environment, sometimes in large quantities. It can be difficult or impossible to replace the batteries of the sensor nodes. On the other hand, the sink is typically rich in energy. Since the sensor energy is the most precious resource in the WSN, efficient utilization of the energy to prolong the network lifetime has been the focus of much of the research on the WSN. The communications in the WSN has the many-to-one property in that data from a large number of sensor nodes tend to be concentrated into a few sinks. Since multi-hop routing is generally needed for distant sensor nodes from the sinks to save energy, the nodes near a sink can be burdened with relaying a large amount of traffic from other nodes.

Sensor nodes are resource constrained in term of energy, processor and memory and low range communication and bandwidth. Limited battery power is used to operate the sensor nodes and is very difficult to replace or recharge it, when the nodes die. This will affect the network performance. Optimize the communication range and minimize the energy usage, we need to conserve the energy of sensor nodes. Sensor nodes are deployed to gather information and desired that all the nodes works continuously and transmit information as long as possible.

Sensor nodes spend their energy during transmitting the data, receiving and relaying packets. Hence, designing routing algorithms that maximize the life time until the first battery expires is an important consideration.

In some applications the network size is larger required scalable architectures. Energy conservation in Wireless Sensor Networks has been the primary objective, but however, this constrain is not the only consideration for efficient working of Wireless Sensor Networks. There are other objectives like scalable architecture, routing and latency. In most of the applications of Wireless Sensor Networks are envisioned to handled critical scenarios where data retrieval time is critical, i.e., delivering information of each individual node as fast as possible to the base station becomes an important issue. It is important to guarantee that information can be successfully received to the base station the first time instead of being retransmitted.

1.1 Applications

The Wireless Sensor Network has wide range of applications they are as follows.

- Area Monitoring
- Environmental or Earth Monitoring
- Air Quality Monitoring
- Forest Fire Detection

1.2 Characteristics of WSN

The main characteristics of a WSN include

- Power consumption constrains for nodes using energy harvesting
- Ability to cope with node failures
- Mobility of nodes
- Communication failures
- Heterogeneity of nodes

2. EXISTING SYSTEM

APTEEN is a hybrid network which combines the best features of proactive and reactive networks, while minimizing their drawbacks. Nodes in such a network transmit data periodically at relatively longer interval while at the same time transmitting data when the sensed value goes beyond its threshold. Thus, the sensor energy is used very effectively by reducing the number of transmission of non-critical data.

The user can change the periodicity, threshold values, and the parameter to be sensed in different region. This network emulates either the proactive or reactive network by suitably changing the periodicity or threshold values. Thus, this network can be used in any type of application by suitably setting various parameters. However, this flexibility and versatility does increase the complexity at the sensor. There are applications in which the user wants time critical data and also wants to query the network for analysis of conditions other than collecting time critical data.

In APTEEN, once the CHs are decided, the following events take place in each cluster period. The CH first broadcasts the following parameter.

- Attributes: This is a set of physical parameters which the user is interested.
- Thresholds: This parameter consists of a Hard Threshold (HT) and a Soft Threshold (ST). HT is a value of an attribute beyond which a node can be triggered to transmit data. ST is a small change in the value of an attribute that can trigger a node to transmit.
- Schedule: This is a TDMA schedule, assigning a slot to each node.
- Count time: This is the maximum time period between two successive reports sent by a node. It can be a multiple of the TDMA schedule length, and it introduces the proactive component in the protocol.

In a sensor network, close-by nodes fall in the same cluster, sense similar data and try to send their data simultaneously, causing possible collisions. A TDMA schedule is introduced such that each node in the cluster is assigned a transmission slot, as shown in Figure 1.

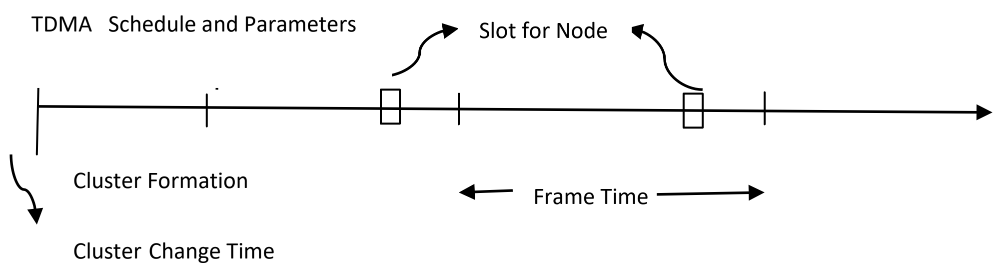


Fig -1: Time Line of APTEEN

2.1 TDMA Schedule

A best possible pairing of sleeping and idle nodes can be found by the BS using simulated annealing. The nodes which listen for the queries have to be always awake (i.e., in idle state ready to receive any query). Also, these idle nodes will have more data to send if they receive queries, since they might have to send data as well as the queries. Hence, the slots for these idle nodes have to be larger than the slots for the sleeping nodes. The TDMA schedule, we can have the sleeping nodes send their data first and then the idle nodes.

For example, if adjacent node a and node b constitute sleep/idle pair, they will have their slots at an average distance of half the frame time. So, even though the interval between two successive slots of node a is larger because of larger slots for idle nodes, the critical data can still be sensed and transmitted by node b without having to wait for node a's next slot. The nodes can change their roles midway between cluster change times, so that sleeping nodes now go into idle mode to handle queries and the idle nodes now go into sleep mode. The CH aggregates all the data and sends it to its higher level CH (or the BS). Once the BS receives the data from all the CHs, it extracts the queries and the answers from the data and transmits them in down-link mode, directly to the sensor nodes or the user rather than going through the CHs. Different CDMA code is used in each cluster to avoid inter-cluster collision. So, the BS has to calculate the length of the longest TDMA schedule among the clusters and make allowance for the transmitted data from the CHs to reach it, after which it can transmit its own data.

2.2 Limitations of Existing System

The additional complexity required to implement is the system

- Threshold functions
- The count time.

3. PROPOSED SYSTEM

In this system the life of the network is been enhanced by using EDCMS (Energetic Data Collection using Mobile Sink), LEACH (Low Energy Adaptive Clustering Hierarchy Protocol) and MCP (Maximum Capacity Path).

3.1 ENERGETIC DATA COLLECTION USING MOBILE SINK

In Energetic Data Collection Using Mobile Sink (EDCMS) method, we had incorporated the technique of energy-aware transmission range adjusting to tune the transmission range of each sensor node according to its residual battery energy. In the case of the residual battery energy getting low after performing rounds of message relaying and environment sensing tasks, then its transmission range will be adjusted to be small for energy saving.

In order to increase the network life time Maximum Capacity Path (MCP) routing protocol is used by the sink to relocate itself towards the moving destination. Note that the underlying message routing method may affect the performance of the entire operating scheme (the sink relocating and the message routing) significantly as the parameters of the routing algorithm vary. To limit the influence of the parameter of routing method on the proposed method MCP is used as the underlying routing method since residual battery energy of the sensor nodes is the only parameter of MCP which is also the decision parameter of EDCMS method.

The data flow is as shown in Figure 2. It shows that for each of the relocating steps, the determination criteria for selecting an intermediate moving destination are as follows. At first, the sink collects the residual battery energy from each sensor node within the communication range of the sink. Then, the sensor node in the direction heading to the moving destination which is in the transmission range of the sink is chosen such that it has the maximum residual battery energy value among the sensor nodes. Next node chosen will be the intermediate moving destination node & the sink will be relocated to this position. Along this path, the mobile sink will relocate itself from one intermediate moving destination to the other and finally it will reach the moving destination.

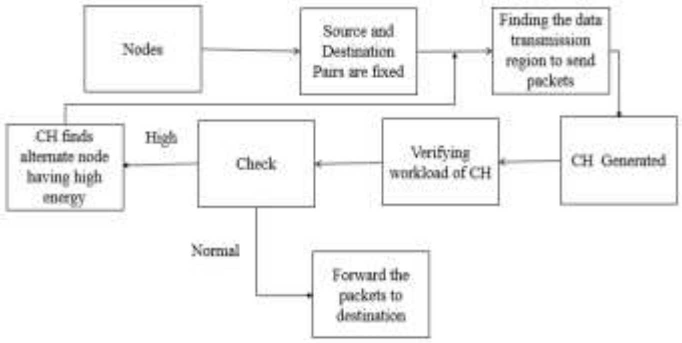


Fig -2: Flow Diagram of Energetic Data Collection Using Mobile Sink

3.2 Low Energy Adaptive Clustering Hierarchy Protocol (Leach)

Energy saving is one of the important and major consideration for the usage of this protocol. LEACH is one of the mostly used and famous algorithms for this type of applications which stand as Low Energy Adaptive Clustering Hierarchy which is a proactive network protocol. To reduce the energy used for working of a sensor network, the time interval in the middle of the transmissions is increased which affects in delay in the receiving of data by the user at the destination. If the time interval of the transmission is reduced, the data that has to be reached to the user will receive with late or delay in the data which results in not fitting for the time related applications. But, this increases the number of data transmissions and the energy consumption, hence reducing the network life.

LEACH is a good approximation of a proactive network protocol, with some minor differences. Once the clusters are formed, the CHs broadcast a TDMA schedule giving the order in which the cluster members can transmit the data. Every node in the cluster is assigned a slot in the frame, during which it transmit data to the cluster head. When the last node in the schedule has transmitted its data, the schedule is repeated. The report time is equivalent to the frame time in LEACH. The frame time is not broadcast by the CH but is derived from the TDMA schedule. However, it is not under user control. Also the attributes are predetermined and are not changed after initial installation. This network can be used to monitor machinery for fault detection and diagnosis. It can also be used to collect data about temperature or pressure or moisture change patterns over a particular area. But data collection is done periodically and centralized. Therefore it is most appropriate only for constant monitoring of networks. In most cases, the uses does not always need all that data, therefore periodic data transmission are unnecessary. It consumes more energy at each sensor.

3.3 Maximum Capacity Path

Note that a sensor node in the layered network may have multiple shortest paths to reply the sensing data to sink. For example, consider a layered network N of G as shown in Figure 3. The number beside each node represents its available energy. When sensor node e at level 3 has a data packet to send, it has three routing paths: $e \rightarrow c \rightarrow a \rightarrow s$, $e \rightarrow c \rightarrow d \rightarrow s$ and $e \rightarrow d \rightarrow b \rightarrow s$. Suppose that node e selects a neighbor node e with maximum available energy as its forwarder, say node d. That is, node e selects path $e \rightarrow d \rightarrow b \rightarrow s$ to forward the data. However, the available energy of node b is very low and then node b will run out of its energy rapidly.

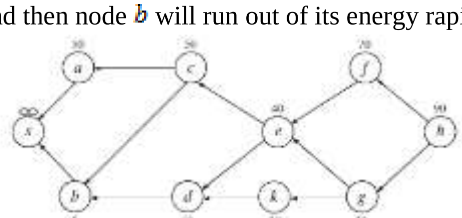


Fig -2: Example of path selection in the layered network

In order to avoid this fault, we proposed a path selection scheme, called as maximum capacity path scheme, for each sensor node to select a routing path with maximum capacity to sink. Let $c(v) \geq 0$ denote the available energy of node v in N and assume that $c(s) = \infty$. Define the capacity of a routing path $P = v_0, v_1, v_2, \ldots\ldots, v_k, s$ as minimum node energy in P. The maximum capacity path scheme is to determine a maximum capacity path from a specified sensor node to sink in the layered network. For example, as shown in Figure 3, the capacities of paths $e \rightarrow c \rightarrow a \rightarrow s$, $e \rightarrow c \rightarrow d \rightarrow s$ and $e \rightarrow d \rightarrow b \rightarrow s$ are 50, 5, and 5, respectively. Thus, the maximum capacity path scheme will select path $e \rightarrow c \rightarrow a \rightarrow s$ as forwarding path for node e. That is, node e sends data packets along path $e \rightarrow c \rightarrow a \rightarrow s$. In general, suppose that sensor node v has k in-bound links$(v, u_1), (v, u_2), \ldots\ldots, (v, u_k)$. Let $p(w)$ denote the maximum capacity value of maximum capacity path P from node w to sink s.Thus, sensor node v selects node u^* as forwarder to forward its data such that equation 1

$$p(u^*) = \max\{p(u_1), \ldots, p(u_k)\} \quad 1$$

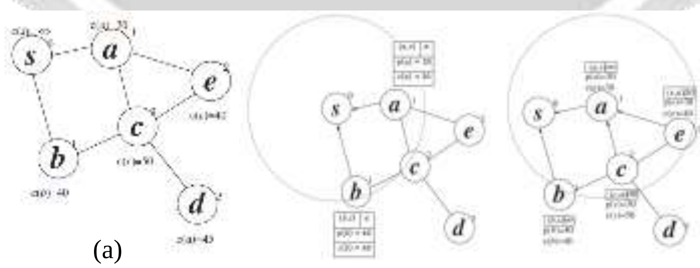
Then, node v updates its $p(v)$ by the equation 2

$$p(u) = \min\{c(v), p(u^*)\} \quad 2$$

3.3.1 Maximum Capacity Path Creation

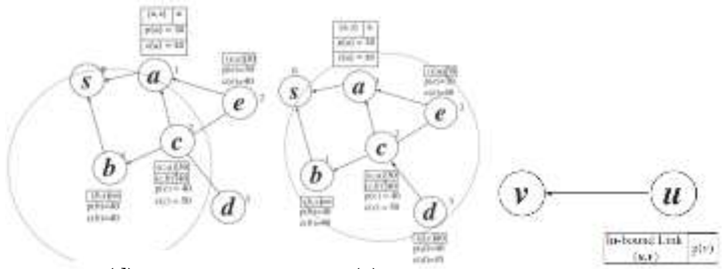
In order to achieve maximum capacity path scheme, each sensor node v maintains a local table to record its in-bound links $(v, u_1), (v, u_2), \ldots\ldots, (v, u_k)$ and the corresponding maximum capacity value $p(u_1), \ldots, p(u_k)$. In addition, node v sets $p(u) = \min\{c(v), p(u^*)\}$ where $p(u^*) = \max\{p(u_1), \ldots, p(u_k)\}$. The maximum capacity value is propagated along with the poll messages while layered network is building. Initially, sink s sends poll message with $p(s) = \infty$. When node v creates an inbound link (v, u) to, node u checks to see whether $p(u)$ is greater than $p(u^*)$ or not where node u^* is the current forwarder of node v. If $p(u) > p(u^*)$, then node v changes its forwarder to node u, sets $p(u)$ to $p(u^*)$ and updates $p(v) = \min\{c(v), p(u)\}$. Otherwise, node u does nothing.

Figure 3 shows an example for maximum capacity path scheme. Figure 3(a) shows a sensor network G. The available energy $c(v)$ is beside each node v.In Figure 3(b), sink s broadcasts a poll message with $h = 0$ and $c(s) = \infty$. Sensor nodes a and b receive the poll message from the sink and create in-bounds (a, s) and (b, s), respectively. Node a (Node b) sets $p(s) = \infty$ and $p(a) = \min\{p(s), c(a)\} = 30$ $(p(b) = \min\{p(s), c(b)\} = 40)$. In Figure 3(c), nodes c and e receive poll message with $h = 1$ and $c(a) = 30$ from node a. Since $1 < \infty$, nodes c and e set $h_c = h_e = 2$ and build in-bound links (c, a) and (e, a), respectively. Node c (Node e) sets $p(a) = 30$ and $p(c) = \min\{p(a), c(c)\} = 30$ $(p(e) = \min\{p(a), c(e)\} = 30)$. In Figure 3(d), nodes a and c receive poll message from node b. Node a discards this poll message since $h > h_a - 1$. Node c builds in-bound link (c, b) since $h = h_a - 1$ as shown in Figure 3(e). Node c sets $p(b) = 40$. Since $p(b) > p(a)$, node c selects node b as forwarder and sets $p(c) = \min\{p(b), c(c)\} = 40$. Finally, node d creates an in-bound link (d, c) and sets $p(d) = 40$ as shown in Figure 3(f).



(a) (b) (c)

(a) Sensor network (b) Sink broadcasting the signal (c) Nodes c and e receiving the signal



(d) (e) (f)

(d) Node a and c receiving the signal from node b (e) Node d is receiving the signal from node c (f) Link creation.
Fig -3: Example of maximum capacity path creation in layered network

4. CONCLUSIONS

The network lifetime is another form of deadline, where there is a need to investigate new solutions in the context and property of the network lifetime. With a mandatory network lifetime constraint, a WSN is characterized as a hard lifetime WSN in which every node must continue to function until the obligatory deadline. One of the research topics that had gathered significant interest is the issue of prolonging network lifetime under energy constraints. Several solutions to maximize network lifetime are available, and each approach provides different magnitudes of energy savings and levels of efficiency. A typical WSN is comprised of a base station, several cluster head nodes, and regular sensor nodes. For administrative purposes, the operation of a WSN is divided into rounds in which sensor nodes are grouped into clusters. In this Wireless Sensor Network the comparison is been made between APTEEN and EDCMS. When the number of nodes is increased in the network then the network lifetime is increased in the EDCMS comparatively in the APTEEN. The data gathering is done effectively in the EDCMS than the APTEEN when the number of nodes is increased. The end to end delay is being reduced in the EDCMS rather than the APTEEN when the nodes are increased.

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