Energy Analysis of LEACH & Directed Diffusion Protocols using NS2.34

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Abstract—This paper presents Energy analysis of Wireless Sensor Network. Energy is the main concern of any node including cluster heads. We have measured mainly LEACH & DIRECTED DIFFUSION protocols with their associated energy models on different values. We observed the lifetime of wireless sensor nodes and cluster heads in the maximum capacity of their performances in the form of their lifetime (Number of Rounds). We found that LEACH protocol is better than DIRECTED DIFFUSION.

Keywords- Wireless Sensor Network, LEACH, DIRECTED DIFFUSION, NS2.34

1. INTRODUCTION

Recent advances in wireless communications led to the emergence of Wireless Sensor Networks (WSNs), which consist of a large number of sensing devices each capable of sensing, processing and transmitting environmental information. A single sensor node may only be equipped with limited computation and communication capabilities; However, nodes in a WSN, when properly programmed and networked, can collaboratively perform signal processing task to obtain information of a remote areas in robust way[1].

Due to stringent constraints and very nature of radio communication it is impossible to think of, in a typical WSN, every sensor node to be able to reach Gateway node directly. Inevitably, hop-by-hop basis data transfer will be chosen to meet constraints.

But, hop-by-hop mode of communication increases overhead on routing table management in all sensor nodes and quickly brings down lifetime of those nodes which are very near to Gateway since they will be extensively used as relay nodes. This makes network to be virtually non-existent. Many routing protocols have been proposed to solve such routing issues. Out of these, clustering algorithms have been of much interest as they well balance several key factors of WSN operation simultaneously. Choosing one arbitrary node to act as servicing node for several sensor nodes than each trying to reach Gateway node can extend network lifetime and bring down energy utilization considerably. This process of choosing one node to act as servicing node for several neighbor nodes is known as 'clustering'. The concept of hierarchical clustering comes when levels of hierarchy are increased. The level of hierarchy can be increased to some extent to attain the maximum lifetime of the network based on the requirement of application of WSN. For example, if the application consists of thousands of nodes, then...
it may be desirable to prefer two level hierarchies or three level hierarchies [2].

In this research study, we have simulated Wireless Sensor Network Node with fixed number of nodes under the routing protocols LEACH and DIRECTED DIFFUSION. The performance of such network tested on the basis of with various simulation parameters using NS2.34[9]. Following are the various section of this research study:

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2. PREVIOUS WORK

Various research studies have shown their valuable significant outcome of WSN protocols with different performance matrices. Some of them which influences and motivated us towards this research study are as follows:

(I) Jun Yuea, Weiming Zhang, Weidong Xiao, Daquan Tang, Jiuyang Tang

The cluster-based WSNs have an inherent problem of unbalanced energy dissipation. Some nodes drain their energy faster than others and result in earlier failure of network. Some researchers have studied this problem and proposed their algorithms which have both advantages and disadvantages. Our motivation is to propose a novel solution to this problem in the cluster-based and homogeneous WSNs, in which the CHs transmit data to BS by one-hop communication, with an objective of balancing energy consumption by an energy efficient way and prolonging network lifetime[3].

Enan A. Khalil, Bara’a A. Attea

The formation of dynamic cluster-based routing in WSN has turned out to be an NP-hard problem, making it highly unlikely to develop a polynomial-time algorithm to compute an optimal clustered route. This paper has presented a new evolutionary-based dynamic cluster formation in WSN. The proposed EAERP with the formulation of the fitness function ($\phi_{EAERP}$), when compared with other protocols (LEACH, SEP, and HCR), has been proven to be a meaningful way in deriving clustered routes with better tradeoff between network stability and network lifetime, while guaranteeing a well-distributed energy consumption[4].

(II) Ahmed Ibrahim Hassan, Maha Elsabrouty, Salwa El-Ramly

The variable-power data-centric routing technique was proposed. In this kind of routing, each sensor node (source) adjusts its transmission power based on the distance between itself and the receiver (data recipient/sink). Simulation results showed significant improvement in terms of less energy consumption in the variable-power scenario when compared to the fixed-power scenario. It was also shown that no benefit is seen from increasing the communication radius in the variable-power scenario as no significant change is recorded in the energy savings. Although variable-power scenario results in less energy costs, there comes at the price of delay. In general, a single multicast tree cannot have minimum cost and minimum delay[5].

(IV) Chiming Huang*, Jhih-Sian Huang

Here quantized routing models are proposed to simulate the operations of clustering routing protocols. Under the processes of data compression in forwarding, the load distribution of sensors in the WSN and the total energy required for the whole network are derived thoroughly. Because of that the load distributions of networks are relatively balanced,
the analyses show that clustering routing protocol performs better when the data received by the head can be compressed very much. By using the quantized models, we estimate the energy consumed by sensors in different positions more precisely than previous related works do. Some proposed methods such as enlarging the battery capacity, increasing the density or increasing the sensing range of sensors around the BS can thus be more effectively [6].

(V) Enan A. Khalil, Bara’a A. Attea
Here we have presented a new contention-free TDMA-based integrated MAC and routing protocol named DGRAM, which can provide deterministic delay guarantee. Nodes in DGRAM go through a short beacon exchange phase to learn the location of other nodes. DGRAM is fully self-configuring and slot assignment is done without exchange of any control messages. We presented the detailed design of time slot assignment, transmission and reception cycles of nodes. We also provided the worst-case delay analysis of DGRAM. We compared our protocol with another TDMA protocol called FlexiTP and a basic TDMA MAC using simulation, which showed that our protocol is a much better choice in terms of delay, packets meeting their deadlines, and energy consumption. Our simulation results also validated that the actual delay is always less than the analytical worst-case delay bound for which DGRAM is designed. Thus, DGRAM can be used for hard real-time applications such as biohazard detection, radioactive emission control, etc. DGRAM is designed to handle interevent time greater than or equal to the superframe size. That is, DGRAM can guarantee delay bound and zero packet loss as long as interevent time is greater than or equal to the superframe size. This characteristic of DGRAM can be exploited while choosing various operating parameters of the protocol [7].

3. WSN Routing Protocols
Routing in sensor networks is very challenging due to several characteristics that distinguish them from contemporary communication and wireless ad hoc networks. First of all, it is not possible to build a global addressing scheme for the deployment of sheer number of sensor nodes. Second, in contrary to typical communication networks almost all applications of sensor networks require the flow of sensed data from multiple regions (sources) to a particular sink (command center). Third, generated data traffic has significant redundancy in it since multiple sensors may generate same data within the vicinity of a phenomenon. Fourth, sensor nodes are tightly constrained in terms of transmission power, on-board energy, processing capacity and storage and thus require careful resource management. Due to such differences, many new algorithms have been proposed for the problem of routing data in sensor networks [8].

3.1 LEACH (Low-energy adaptive clustering hierarchy)
This is one of the most popular hierarchical routing algorithms for sensor networks. The idea is to form clusters of the sensor nodes based on the received signal strength and use local cluster heads as routers to the sink. Cluster heads change randomly over time in order to balance the energy dissipation of nodes.

\[ T(n) = \begin{cases} p & \text{if } n \in G, \\ 0 & \text{otherwise,} \end{cases} \]

LEACH uses single-hop routing where each node can transmit directly to the cluster-head and the sink [8].

3.2 DD (Directed Diffusion)
Direct Diffusion suggests the use of attribute-value pairs for the data and queries the sensors in an on demand basis by using those pairs. In order to create a query, an interest is defined using a list of attribute-value pairs such as name
of objects, interval, duration, geographical area, etc. The interest is broadcast by a sink through its neighbors. Each node receiving the interest can do caching for later use. The interests in the caches are then used to compare the received data with the values in the interests [8].

\[
\text{Cost}(N_j) = \sum_{i \in F_{T_j}} P_{N_j,N_i} C_{N_j,N_i}.
\]

2. Data communication phase:
Each node forwards the packet by randomly choosing a node from its forwarding table using the probabilities.

3. Route maintenance phase:
Localized flooding is performed infrequently to keep all the paths alive.

4. SIMULATION TOOLS AND ENVIRONMENT SETUP
We have used following three tools to setup and simulate our network:
(a.) MANNASIM SGT[09]: Mannasim is a Wireless Sensor Networks simulation environment comprised of two solutions: the Mannasim Framework; the Script Generator Tool. The Mannasim Framework is a module for WSN simulation based on the Network Simulator (NS-2). Mannasim extends NS-2 introducing new modules for design, development and analysis of different WSN applications. The Script Generator Tool (SGT) is a front-end for TCL simulation scripts easy creation. SGT comes blunded with Mannasim Framework and it's written in pure Java making it platform independent.

(b.) NS2.34[10]: This is a discrete event simulator targeted at networking research. Ns2 provides substantial support for simulation of TCP, routing, and multicast protocols over wired and
wireless (local and satellite) networks [9].

c.) jTrana[11]: This tool is used to read ns2 trace files by a software. This software known as jTrana can be used for generating packet delivery ratio, average end to end delay, tcp traffic and packet dropped information.

Firstly we have used MANNASIM SGT tool [9] for generating our desired tcl code [9] using following simulation parameters:

<table>
<thead>
<tr>
<th>Protocols</th>
<th>LEACH, DIRECTED DIFFUSION</th>
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<tbody>
<tr>
<td>No of Nodes</td>
<td>1000</td>
</tr>
<tr>
<td>No of Cluster</td>
<td>400</td>
</tr>
<tr>
<td>Area</td>
<td>500 X 500 m</td>
</tr>
<tr>
<td>Simulation time</td>
<td>550 seconds</td>
</tr>
<tr>
<td>Initial Energy</td>
<td>10 J</td>
</tr>
<tr>
<td>Propagation Model</td>
<td>Two ray ground</td>
</tr>
<tr>
<td>Transmission Range</td>
<td>50 m</td>
</tr>
<tr>
<td>Transport Protocol</td>
<td>UDP</td>
</tr>
<tr>
<td>Channel Type</td>
<td>Wireless</td>
</tr>
<tr>
<td>Sensing Interval</td>
<td>05 seconds</td>
</tr>
<tr>
<td>Data generator type</td>
<td>Temperature</td>
</tr>
</tbody>
</table>

Finally our Simulation Result is the outcome of the Table01 and better described in Figure 03.

6. CONCLUSION

We can conclude on the basis of simulation result described in Table 01 and Figure 03 that LEACH protocol has utilized his energy with more number of rounds than DIRECTED DIFFUSION protocol. In future we can carry forward this research outcome with more energy, increasing number of nodes and cluster heads.

REFERENCES


