



## An Improvised Leach Protocol with Reduced Data Redundancy for Wireless Sensor Networks

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**Abstract**— WSN is a set of connected tiny devices (sensor nodes) with limited energy resource. WSNs have ability to extract the information from the harsh and hostile environment without human interaction. Once, WSN is deployed, it is impossible to recharge or replace the energy resource due to inaccessibility of nodes. So, network lifetime and fault tolerance are critical parameters. It's become very important to handle energy resource carefully as it plays vital role in prolonging the network lifetime. The nodes close to each other send most correlated data to the sink. Transmitting and processing of correlated data results in wasting the energy that shortens the lifetime of WSNs. Since WSN is energy constrained, energy must be utilized in an efficient way so that most of the energy is dissipated in doing useful work. In the literature of WSN, hierarchical routing techniques have great impact on energy efficiency in both collecting and transmitting data based on clustering approach.

**Keywords**— Tiny Devices, Harsh and hostile environment, Fault tolerance, Energy constrained, Clustering approach

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### I. INTRODUCTION

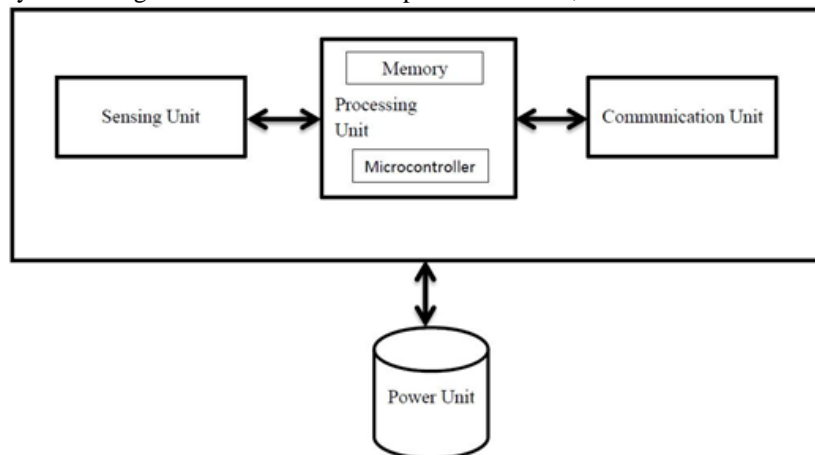
Wireless Sensor Networks (WSNs) have been recognized as one of the emerging technologies of the 21st century (Megerian et al., 2003). They are expected to bring the interaction between humans and physical phenomenon or environment to a new level by enabling remote monitoring of an ambient environment. The technology, however, is still in its infancy and is undergoing rapid evolution with a tremendous amount of research effort in the networking community. The purpose of a WSN is to monitor a physical phenomenon by gathering, processing the data and delivering information to the interested party. Sensor nodes perform specific task of sensing the environment in which they are deployed and send the information to a base station (Cordeiro et al., 2006). The advances in micro-electronic-mechanical systems (MEMS), processor, radio and memory technologies make these operations successful. These technologies made it possible to produce the powerful micro sensor nodes, capable of sensing and wireless communication. WSN can be deployed in any field where human interaction is very difficult but monitoring is necessary e.g. security surveillance (Ye et al., 2002), military applications (Jone et al., 2001), environmental applications, disaster and seismic (Bonnet et al., 2000), home applications, traffic monitoring. Due to these wide ranges of potential applications, WSNs have become an integral part of our lives. Despite of being a fascinating topic, wireless sensor networks still have some challenges to be resolved (Cordeiro et al., 2006). Wireless sensor nodes are severely constrained by energy, computation resources and memory. Once the sensor nodes are deployed in a field where human interaction is dangerous, it becomes impossible to change or recharge the sensor node battery. One of the challenging tasks is how to prolong the network lifetime in such a way to monitor the environment for long time. In order to prolong the lifetime of the WSN, designing efficient routing protocol is critical. Most of the energy consumption in WSNs came from the operation of data sending and receiving. Therefore, a good routing protocol can reduce the number and size of unnecessary transmissions that take place, thus helping to reduce the energy consumption crisis in WSNs. Hierarchical routing protocols are new technique with special advantage that of providing scalability and energy efficient communication. The main purpose of hierarchical routing protocols is to optimize energy consumption of sensor nodes by arranging the nodes into clusters and selecting one of the nodes as a cluster head for local operations. The role of a cluster head node is to gather the data from the member nodes, perform data aggregation and fusion in order to decrease the number of transmitted messages and send the information to the base station. Low Energy Adaptive Clustering Hierarchy (LEACH) (Heinzelman et al., 2000) is one of the first hierarchical routing approach for sensors networks. The idea proposed in LEACH has been an inspiration for many hierarchical routing protocols. However, LEACH does not guarantee even distribution of cluster head nodes across the sensor field and assumes that each cluster head transmits data to the base station over a single hop.

### II. SYSTEM MODEL

The basic block diagram of a wireless sensor node is presented in Figure 1.1. A sensor node consists four basic components: a sensing unit, a processing unit, a transceiver unit and a power unit. There can be application dependent additional components such as a location finding system, a power generator and a mobilizer. A MICA2 mote (xbow) is shown in fig.1.1

### 1.1 Sensing unit

Sensing unit is an interface to the physical world. It is usually composed of two subunits: sensors and analog to digital converters (ADCs). Sensor is a device which observes a physical phenomenon and generates equivalent electrical signals. There are many types of sensors based on the applications that measure environmental parameters such as light intensity, temperature, magnetic fields, sound, image, etc. Sensors are of two types, passive and active. Passive sensors work in well-defined direction for measurement. Examples of this type are cameras, thermometers, ultrasonic sensors etc. Active sensors are continuously measuring the environment. Examples are seismic, radar sensors etc.



**Fig. 1.1: Architecture of a Wireless Sensor Node**



**Fig. 1.2: MICAZ Mote (xbow)**

### 1.2 Processing unit

The processing unit in the sensor does all the computation on the data so it is known as intelligence center. The processing unit consists of two components: microprocessor and memory. Microprocessor is responsible for controlling the sensors, executing the communication protocols and signal processing algorithms on the digital data generated by the sensing unit. Commonly used microprocessors are Intel's Strong ARM microprocessor, Atmel's AVR microcontroller and Texas Instruments' MP430 microprocessor. For example, the processing unit of a smart dust mote prototype is a 4 MHz Atmel AVR8535 microcontroller with 8 KB instruction flash memory, 512 bytes RAM and 512 bytes EEPROM (Mohanty, 2010). This processor used TinyOS operating system, developed at University of California, Berkeley.

### 1.3 Transceiver unit

Sensor nodes use radio wireless communication that enables communication between neighboring nodes and the outside world. Transceiver unit uses a short range radio which usually has single channel at low data rate and operates at unlicensed near 2.4 GHz (global ISM band). For example, the TR1000 family from RF Monolithic works in the 800–900 MHz range can dynamically change its transmission power up to 1.4 mW and transmit up to 115.2Kbps. The Chipcon's CC2420 is included in the MICAZ mote that was built to comply with the IEEE 802.15.4 standard for low data rate and low cost wireless personal area networks (IEEE 802.15.4, 2006).

### 1.4 Battery

The battery is a precious resource that supplies power to all the sensor node components. It is the only challenge that gives rise a new direction to research in determining sensor node lifetime since battery replacement is not an option for networks. The amount of power drawn from a battery should be carefully monitored. Sensor nodes are generally too small to accommodate large battery. So, it limits the size of a battery. AA batteries normally store 2.2-2.5 Ah at 1.5 V (Karl and Willig, 2005).

**III. RESULTS & DISCUSSION**

Here, the given table shows the percentage of dead nodes by varying the initial energy of nodes in both the approaches. It is found that in LEACH, first node dies at 337<sup>th</sup> round while in proposed methodology (LEACH-RDR) first node dies at 406<sup>th</sup> round having 0.25 j energy per node. Thus LEACH-RDR extends the working period of network by 49 rounds in terms of FND. In next sections, we will discuss all results obtained during this work.

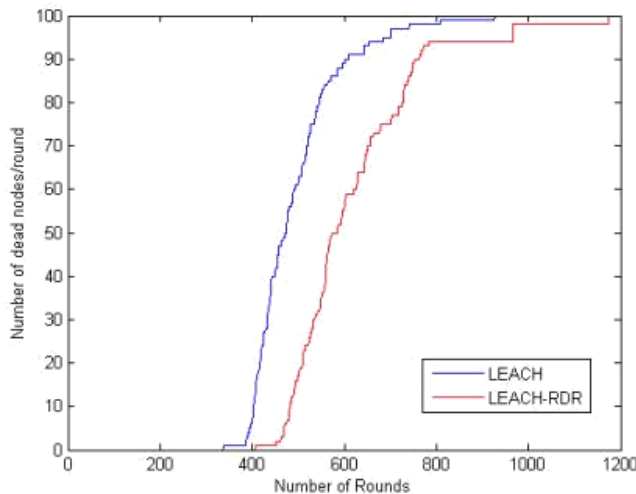
Table 4.2 Percentage of dead nodes per round.

Energy (j/node)	Method	FND	10%	20%	30%	40%	HNA	60%	70%	80%	90%	LND
0.25	LEACH	337	402	416	432	442	471	489	518	544	601	926
	LEACH-RDR	406	481	508	532	558	572	621	650	725	752	1174
0.5	LEACH	720	778	804	832	869	924	963	1040	1068	1177	2448
	LEACH-RDR	819	966	1019	1081	1158	1210	1264	1301	1414	1568	2608
1.0	LEACH	1481	1541	1595	1635	1701	1768	1845	2019	2179	2374	4104
	LEACH-RDR	1627	1794	1981	2012	2122	2219	2378	2424	2916	2992	3489

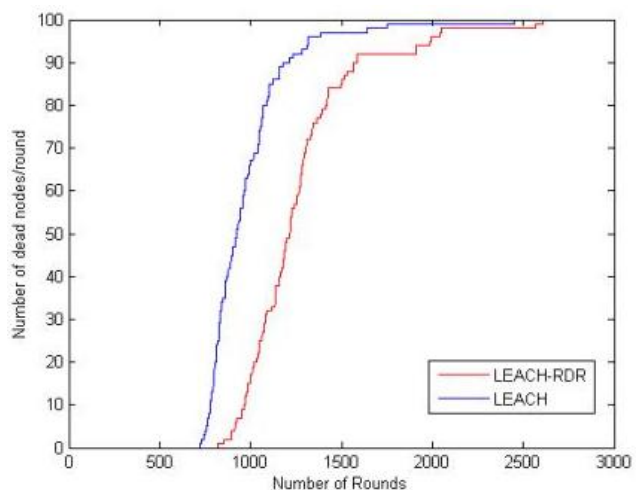
**4.3.1 Network lifetime**

In WSNs, it is important to get the data from environment as long as it is possible this in turn determines the lifetime of the networks. It is clear from the Fig. 4.2, 4.3 and 4.4 that nodes die early in LEACH protocol as compared to our approach. For 0.25 j energy, proposed approach extends the lifetime of network was improved. It can be measured by the total number of rounds a network completed successfully.

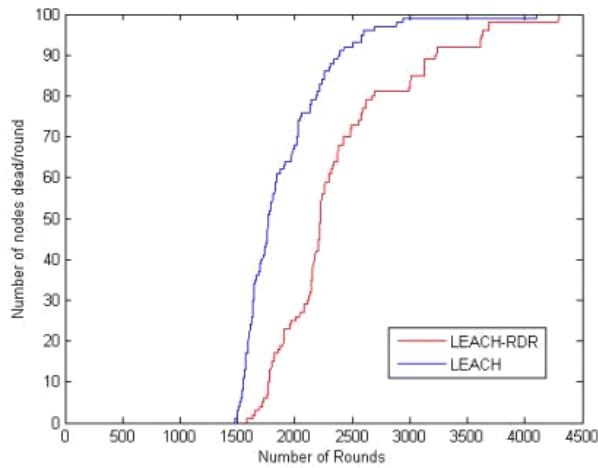
The proposed approach extends the lifetime by 20%, 19% , 22% , 23%, 26% , 21% , 26% , 25% , 33% , 25% and 26% in terms of FND, 10% nodes die, 20% nodes die, 30% nodes die, 40% nodes die, HNA, 60% nodes die, 70% nodes die, 80% nodes die, 90% nodes die, and LND respectively having 0.25 j of energy per node. In a nutshell, proposed approach extends the network lifetime by 24% at average. It is observed that proposed method gives better results on 0.5 j and 1.0 j energy also as shown in figure 4.3 and 4.4.



**Fig. 4.2: No. of dead nodes per round on 0.25 j/node energy.**



**Fig. 4.3: No. of dead nodes for 0.5 j/node energy.**



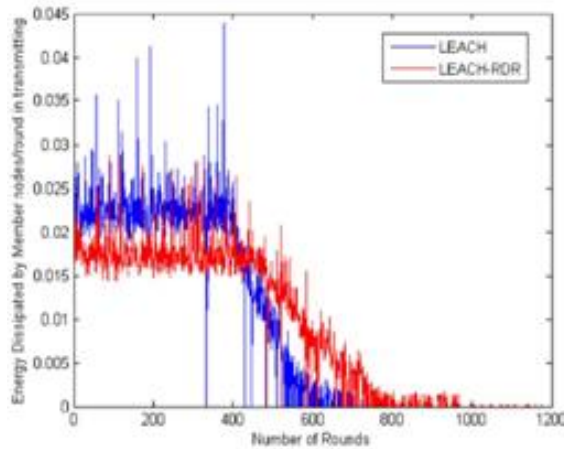
**Fig. 4.4: No. of dead nodes on 1.0 j/node energy.**

**4.3.2 Energy consumption**

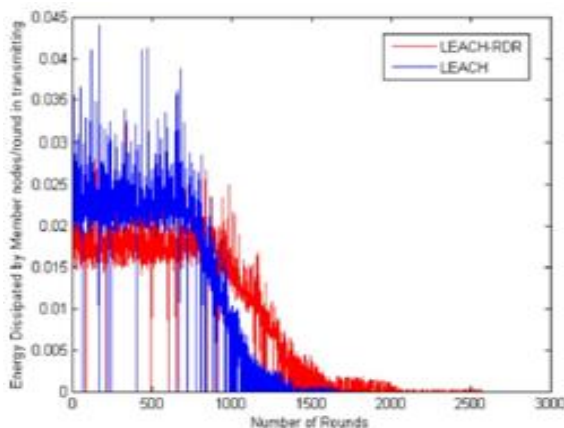
Since sensor nodes consume more energy in radio operations. We analyse the energy dissipation in both transmission and receiver operation by member nodes and CHs respectively. It is possible to send the redundant data to CH in a densely deployed sensor networks.

**4.3.2.1 Energy consumption in member nodes**

Member nodes in a cluster send their data according to the allotted TDMA slot periodically. As said above, due to the high density nodes that are close to each other send highly correlated data to CH. This redundant data wastes the energy of member nodes in transmitting. This can be suppressed and do not affect the quality of monitoring, and saves significant amount of energy that leads to monitor the environment for long time as compared to traditional LEACH. Simulation results in Fig. 4.5, 4.6 and 4.7 shows that energy dissipation by member nodes in LEACH-RDR is less than the traditional LEACH. It is also observed that in 400 to 800 rounds, energy dissipation in LEACH-RDR is more than LEACH. This is because nodes die early in LEACH than LEACH-RDR.



**Fig. 4.5: Energy dissipation by member nodes on 0.25 j/node energy.**



**Fig. 4.6: Energy dissipation by member nodes on 0.5 j/node energy.**

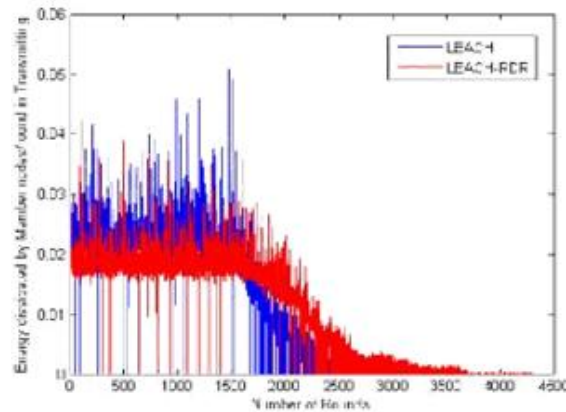


Fig. 4.7: Energy dissipation by member nodes on 1.0 j/node energy.

#### IV. CONCLUSIONS

In this study, we focus on extending the wireless sensor networks lifetime. To achieve our goal, we study various design issues in WSNs followed by the examination of routing protocols, specifically hierarchical routing protocols and analyze LEACH in particular. Routing protocols have great impact in Determining the network lifetime since most of the energy is consumed in sending and receiving of data.

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