CH Selection Algorithm in Leach Protocol by Node Failure Probabilities

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Abstract— An emerging class of Wireless Sensor Network (WSN) applications involves the acquisition of large amounts of sensory data from battery powered, low computation and low memory wireless sensor nodes. This paper focuses on minimizing and optimizing energy consumption based on the routing method as a general model for WSN deployment and development. The model deals with all common aspects of energy consumption in all types of WSNs. The proposed work presents an improved version of LEACH protocol which aims to reduce energy consumption within the wireless sensor network and prolong the lifetime of the network. This paper improves LEACH protocol by improving the selection strategy of the cluster-head node based on remaining the previous performance with respect to failure of sensor nodes as being a cluster head.

Keywords: WSN, LEACH, Probability, Entropy

I. Introduction

One of the main applications of Wireless Sensor Networks is monitoring remote and isolated areas, and collecting information about unexpected phenomenon like a Fire in Forest, volcano eruptions or enemy movement in the battle field. In these applications the channel state is expected to be continuously varying because of the dynamic changes in environmental factors. Also vehicles and rocks movements can crash some nodes which may be the separate parts of the network. In this context it is hard for the network to deliver the collected information, even when transmitting at the maximum power, without strong error correction techniques. Energy conservation in wireless sensor networks (WSNs) is the primary performance parameter, because of their limited energy resources [1, 2, 7]. Thus, some energy saving technologies should be applied.

II. Wireless Sensor Network

Wireless Sensor Network (WSN) comprises of spatially circulated independent sensors to screen physical or ecological conditions, for example, temperature, sound, pressure and so on and to helpfully go their information through the system to a fundamental area.

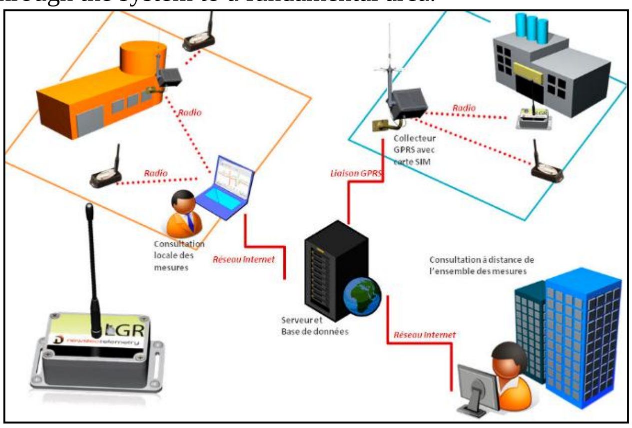

Fig. 1: Wireless Sensor Networks

The advancement of remote sensor systems was roused by military applications, for example, front line observation. Today such systems are utilized in numerous modern and shopper applications, for example, mechanical process checking and control, machine wellbeing observing, etc. The WSN is built of "nodes" – from a few to several hundreds or even thousands, where each node is connected to one or several sensors. Each such sensor network node has regularly a few sections: a radio handset with an inward reception apparatus or association with an outer receiving wire, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, a battery or an implanted form of energy harvesting. The propagation method between the hops of the network can be routing or flooding. Some more applications are air pollution monitoring, forest fire detection, landslide detection, water quality monitoring, natural disaster prevention, industrial monitoring, machine health monitoring etc.

III. Work Done So Far

Enrique J. Duarte-Melo and Mingyan Liu et al 2002 [1], examines the performance as well as energy consumption issues of a wireless sensor network providing periodic data from a sensing field to a remote receiver. The sensors are assumed to be randomly deployed. We distinguish between two types of sensor organizations, one with a single layer of identical sensors (homogeneous) and one with an additional overlay of fewer but more powerful sensors (heterogeneous). We formulate the energy consumption and study their estimated lifetime based on a clustering mechanism with varying parameters related to the sensing field, e.g., size, and distance. We quantify the optimal number of clusters based on our model and show how to allocate energy between different layers.

Sokwoo Rhee, Deva Seetharam and Sheng Liu et al 2004 [2], have displayed a few methods to limit control utilization at various dimensions of the framework progressive system of low information rate remote sensor systems. In certain cases, we have indicated how the individual hubs can be intended to be proficient. In different occurrences, we exhibited strategies for creating vitality productive system calculations and conventions.

Yunxia Chen and Qing Zhao et al 2005 [5] determine a general equation for the lifetime of remote sensor systems which holds autonomously of the hidden system demonstrate including system design and convention, information accumulation inception, lifetime definition, channel blurring qualities, and vitality utilization show. This equation distinguishes two key parameters at the physical layer that influence the system lifetime: the channel state and the remaining vitality of sensors. Subsequently, it gives not just a measure to execution assessment of sensor organizes yet additionally a rule for the plan of system conventions. In view of this recipe, we propose a medium access control convention that abuses both the channel state data and the lingering vitality data of individual sensors.

IV. PROBLEM STATEMENT

Motivation to work in this research area is the Energy efficiency techniques which play a significant role in saving the energy. In general algorithm a node becomes a cluster-head by a stochastic mechanism of tossing biased coins. Hence non group head nodes having a place with the nearest locales, which are relied upon to transmit every now and again, disperse more energy in transmitting information to a remote bunch head situated far. This prompts non uniform energy scattering over the system decreasing the system lifetime. Additionally it expects that each time a node turns into a bunch head, it disperses an equivalent measure of energy. This is mistaken; as group heads situated a long way from the base station spend more energy in transmitting information than those nodes situated close to the base station. Energy minimization challenge has been surveyed from different aspects but there are still unsolved problems that should be taken into account.

V. PROPOSED METHODOLOGY

In our simulation, 40 sensors are deployed in $100X100m^2$ area that generates data from environment events at random times and places within the area. Sensing applications could equally environment temperature, pollution, or others. We considered the prevalent parameters of energy consumption of process, memory and radio units as constant in the individual constituent of all sensors. Also the duration of the experiments was assumed as constant 60 seconds. Monitoring neighbors and providing a secure communication with neighbors at the local level. The global constituent is concerned with maintenance of the whole network, selection of a suitable topology and an energy efficient routing strategy based on the application's objective. This may include energy wastage from packet retransmissions due to congestion and packet errors. The global constituent is defined as a function of energy consumption (EC) for topology management, packet routing, packet loss, and protocol overheads. The sink constituent includes the roles of manager, controller or leaders in WSNs. The sink tasks include directing, balancing, and minimizing EC of the whole network and the collection of generated data by the network's nodes. Execution of these tasks requires sensor resources, CPU, memory, radio, and sensing units.

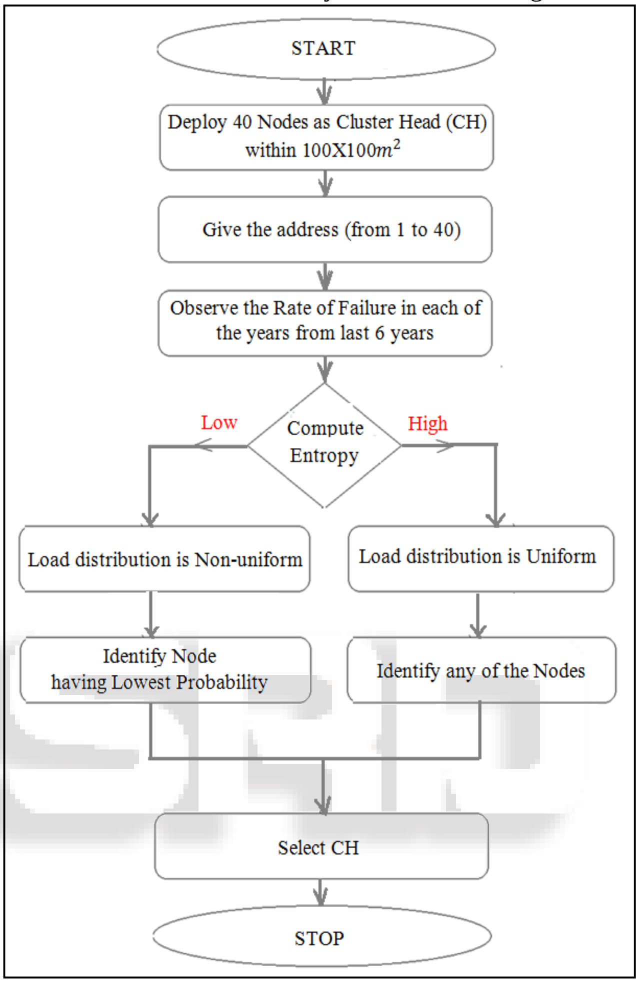

Fig. 2: Flow of the Proposed Methodology

As a CH	Address	Failure Rate in each of the year (from last 6 Years)	Probabilities (P)
Node 1	1	2, 5	2
Node 2	2	1, 4, 1	3
Node 3	3	5, 2, 4, 2, 3	5
Node 4	4	2, 2, 1, 3, 6	5
Node 5	5	1, 1, 2	3
Node 6	6	1	1
Node 7	7	2, 1	2
Node 8	8	1, 4, 3, 3, 2	5
Node 9	9	3, 2, 2, 3	4
Node 10	10	3, 1, 12	3
Node 11	11	4, 4, 5	3
Node 12	12	2, 2	2
Node 13	13	2	1
Node 14	14	1, 2, 2, 2, 3	5
Node 15	15	3, 2	2
Node 16	16	3, 1, 1	3
Node 17	17	2, 2, 1	3
Node 18	18	1, 1	2

Node 19	19	2	1
Node 20	20	1	1
Node 21	21	1, 3	2
Node 22	22	3, 5, 2, 2, 4, 5	6
Node 23	23	3, 4, 2, 1, 2	5
Node 24	24	2	1
Node 25	25	0	0
Node 26	26	3, 3, 5	3
Node 27	27	5, 2	2
Node 28	28	1, 1	2
Node 29	29	0	0
Node 30	30	0	0
Node 31	31	1, 1, 2, 3, 1	5
Node 32	32	0	0
Node 33	33	1, 2, 1	3
Node 34	34	1, 2	2
Node 35	35	0	0
Node 36	36	2	1
Node 37	37	1, 1, 3, 2	4
Node 38	38	4, 1, 2, 2, 4, 3, 1	6
Node 39	39	2, 3	2
Node 40	40	0	0

Table 1: 40 Nodes are selected by monitoring the Failure Probabilities

A. Entropy Calculation

A communication system not only dealing with a single node but with all possible nodes, hence a WSN may be described in average message per individual node, called Entropy.

Let M= Total number of nodes

Then entropy is maximum; if all the nodes have equal load.

$$H_{max} = -\sum_{k=1}^{M} \frac{1}{M}.\log_2 \frac{1}{M}$$ Selection of CH / Cluster

Node	Probability of Failure (PK)			$Log_{10}(1/Pk)$	PK * $Log_{10}(1/Pk)$
Node 1	P1	2	0.02	1.70	0.034
Node 2	P2	3	0.03	1.52	0.046
Node 3	P3	5	0.05	1.30	0.065
Node 4	P4	5	0.05	1.30	0.065
Node 5	P5	3	0.03	1.52	0.046
Node 6	P6	1	0.01	2.00	0.020
Node 7	P7	2	0.02	1.70	0.034
Node 8	P8	5	0.05	1.30	0.065
Node 9	P9	4	0.04	1.40	0.056
Node 10	P10	3	0.03	1.52	0.046
Node 11	P11	3	0.03	1.52	0.046
Node 12	P12	2	0.02	1.70	0.034
Node 13	P13	1	0.01	2.00	0.020
Node 14	P14	5	0.05	1.30	0.065
Node 15	P15	2	0.02	1.70	0.034
Node 16	P16	3	0.03	1.52	0.046
Node 17	P17	3	0.03	1.52	0.046
Node 18	P18	2	0.02	1.70	0.034
Node 19	P19	1	0.01	2.00	0.020
Node 20	P20	1	0.01	2.00	0.020
Node 21	P21	2	0.02	1.70	0.034
Node 22	P22	6	0.06	1.22	0.073
Node 23	P23	5	0.05	1.30	0.065
Node 24	P24	1	0.01	2.00	0.020
Node 25	P25	0	0	0.00	0.000
Node 26	P26	3	0.03	1.52	0.046
Node 27	P27	2	0.02	1.70	0.034
Node 28	P28	2	0.02	1.70	0.034
Node 29	P29	0	0	0.00	0.000

Node 30	P30	0	0	0.00	0.000
Node 31	P31	5	0.05	1.30	0.065
Node 32	P32	0	0	0.00	0.000
Node 33	P33	3	0.03	1.52	0.046
Node 34	P34	2	0.02	1.70	0.034
Node 35	P35	0	0	0.00	0.000
Node 36	P36	1	0.01	2.00	0.020
Node 37	P37	4	0.04	1.40	0.056
Node 38	P38	6	0.06	1.22	0.073
Node 39	P39	2	0.02	1.70	0.034
Node 40	P40	0	0	0.00	0.000
TOTAL	100		1	H (X) =	1.474

Table 2: Entropy Calculation for 40 Nodes Failure Probabilities

One of the approaches to save energy in the link layer is to switch the radio to sleep mode. To take advantage of this opportunity, the link layer requires a time-based medium sharing, e.g., TDMA. In heterogeneous networks the nodes have different capabilities [1]. Nodes with high capability may be assigned more responsibility and overall energy consumption can be reduced by optimizing arrangements, while in homogenous sensor networks, all nodes are the same and the routing tasks are assigned equally among the nodes [4, 6].

Node	Probability of Failure (PK)			Log_{10}(1/Pk)	PK * Log_{10}(1/Pk)
Node 1	P1	2.5	0.025	1.60	0.040
Node 2	P2	2.5	0.025	1.60	0.040
Node 3	P3	2.5	0.025	1.60	0.040
Node 4	P4	2.5	0.025	1.60	0.040
Node 5	P5	2.5	0.025	1.60	0.040
Node 6	P6	2.5	0.025	1.60	0.040
Node 7	P7	2.5	0.025	1.60	0.040
Node 8	P8	2.5	0.025	1.60	0.040
Node 9	P9	2.5	0.025	1.60	0.040
Node 10	P10	2.5	0.025	1.60	0.040
Node 11	P11	2.5	0.025	1.60	0.040
Node 12	P12	2.5	0.025	1.60	0.040
Node 13	P13	2.5	0.025	1.60	0.040
Node 14	P14	2.5	0.025	1.60	0.040
Node 15	P15	2.5	0.025	1.60	0.040
Node 16	P16	2.5	0.025	1.60	0.040
Node 17	P17	2.5	0.025	1.60	0.040
Node 18	P18	2.5	0.025	1.60	0.040
Node 19	P19	2.5	0.025	1.60	0.040
Node 20	P20	2.5	0.025	1.60	0.040
Node 21	P21	2.5	0.025	1.60	0.040
Node 22	P22	2.5	0.025	1.60	0.040
Node 23	P23	2.5	0.025	1.60	0.040
Node 24	P24	2.5	0.025	1.60	0.040
Node 25	P25	2.5	0.025	1.60	0.040
Node 26	P26	2.5	0.025	1.60	0.040
Node 27	P27	2.5	0.025	1.60	0.040
Node 28	P28	2.5	0.025	1.60	0.040
Node 29	P29	2.5	0.025	1.60	0.040
Node 30	P30	2.5	0.025	1.60	0.040
Node 31	P31	2.5	0.025	1.60	0.040
Node 32	P32	2.5	0.025	1.60	0.040
Node 33	P33	2.5	0.025	1.60	0.040
Node 34	P34	2.5	0.025	1.60	0.040
Node 35	P35	2.5	0.025	1.60	0.040
Node 36	P36	2.5	0.025	1.60	0.040
Node 37	P37	2.5	0.025	1.60	0.040
Node 38	P38	2.5	0.025	1.60	0.040
Node 39	P39	2.5	0.025	1.60	0.040

Node 40	P40	2.5	0.025	1.60	0.040
TOTAL		100	1	H (X) =	1.602

Table 3: Entropy Calculation for 40 Nodes with equal Failure Probabilities

This shows that Average or Entropy is maximum if all the probabilities are equal. It means to increase the security of propagation, routing should be such that all the nodes have handled equal traffic load. This is the condition of balancing the Load. If balancing is used then all the Nodes share equal amount of Load. Therefore, the Failure Probabilities of all the Nodes are almost equal. Now the LEACH Protocol will be very secure because it can select any of the Nodes as Cluster Head. By this there is no problem of die the Cluster Head before completing the communication.

VI. Conclusions

Design and development of Energy Efficient Routing Protocols for Wireless Sensor Network (WSN) is one of the active research fields. Cluster based routing protocols have proven to be energy efficient and LEACH is one of most popular cluster based routing protocol for WSN [8, 9]. However, LEACH suffers from several drawbacks such as possibility of choosing a low energy node as Cluster Head (CH) and non-uniform (unbalancing) distribution of CHs, etc. In the paper given by Md. Saiful Islam Rubel, Nahi Kandil and Nadir Hakem [9] proposed protocol EiP-LEACH (Energy influenced Probability based LEACH) is an enhanced version of LEACH protocol that is influenced by the energy parameter for CH selection. EiP-LEACH helps in deciding the better CH nodes. Furthermore, in both of the methods there is a risk of failure the CH during the propagation. The proposed method would be very useful for reducing the risk of Failure. In the future simulation may be implemented with the Leach Protocol and we will try to deploy the Nodes and implement the proposed methodology.

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