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An Advanced Clumping Leach Protocol for Energy Efficient Routing in Wireless Sensor Networks

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Abstract:- One of the very important issues in wireless sensor network is that inherent limited battery power within network sensor nodes. Minimizing energy dissipation and maximizing network lifetime are two important issues in the design of the sensor networks. There are various routing protocols in network like flat routing protocols, location-based, QoS based, heterogeneity based, hierarchical routing protocol etc. in which optimal routing can be achieved. LEACH (low-energy adaptive clumping hierarchy) is well-known protocol because it is very simple and efficient. LEACH protocol divides the whole network into several clumps, and the run time of the whole network is broken into many rounds. In every round, the nodes in a clump contend to be clump head according to a predefined criterion area. The main purpose of this paper is to develop a mechanism that increase the lifetime of homogeneous sensor nodes controlling very long-distance communication, node balancing and efficient delivery of information Minimizing energy dissipation and maximizing the network lifetime are two important issues in the design of applications and protocols for sensor networks. Energy-efficient sensor state planning consists in finding an optimal assignment of states to sensors in order to maximize network lifetime. In this paper, we define the optimal planning of sensors' states in clump-based sensor networks. Typically, any sensor in network can be turned on, turned off, or promoted clump head, and a different power consumption level is met with each of these states. We seek an energy-optimal enhancement to the network in such a way that maximizes network lifetime while ensuring simultaneously full area coverage.

Keywords:- QoS, LEACH protocol, WSN.

I. INTRODUCTION

Due to the energy constraints, wireless sensors mostly have a limited transmission range, making multi hop information routing towards the PN(processing node) more energy efficient than direct transmission (one hop) [1]. A primary design goal for wireless sensor networks is to use the energy very efficiently. Clump-based routing algorithm has a better energy utilization rate as compared with non-clump routing algorithm.

Why Wireless: –

With wireless a user can find shared information without looking for a place to plug in, and network managers can set up without installing or moving wires [2]. Wireless offer the following productivity, convenience, and cost advantages over traditional wired networks:

- **Mobility: -**Wireless system can access to real time information anywhere in their organizations.
- **Installation Speed and Simplicity: -**To Install wireless systems can be quick and easy
- **Installation Flexibility: -** Wireless technologies allow the networks to go where wire can't go.
- **Reduced Cost-of-Ownership: -** Overall installation expense and total life cost can be notably lower.
- **Scalability: -**We can configure a Wireless System in different topologies to meet the need of a specific application and installation.

Mobile Ad Hoc Networks (MANET): -

A mobile ad-hoc network is a combination of digital information terminals equipped with wireless transceivers that also can communicate with one another without using any fixed networking infrastructure [4]. Communication is setup by the transmission of information packets over a common wireless channel. The invisibility of any fixed infrastructure, such as an array of base stations, makes ad-hoc networks radically different from other wireless LANs. Whereas communication from terminal in an infrastructure network, such as the cellular network, is always setup with a fixed base-station, mobile terminals (node) in an ad-hoc network can communication range [5]. When transmit to a node that is placed outside its radio range, information

packets are relayed over a sequence of intermediate nodes using a store-and-forward multi hop transmission principle. All nodes in ad hoc networks are requires to relay packets on behalf of a multi hop wireless network.

Types of **MANET**: -

1. Homogenous Mobile Ad Hoc Network.
2. Heterogeneous Mobile Ad Hoc Network.

Characteristics of **MANET: -**

1. Dynamic Topologies.
2. Ad Hoc Topologies.
3. Variable capacity links, Bandwidth constrained.
4. Energy constrained operation.
5. Mobility.
6. Wireless Network.

MANET Applications: -

1. Formations of soldiers, tanks, planes….
2. Conferences, exhibitions, meetings, lecturers.
3. Telemetric applications in traffic.
4. Extension of cell-based systems (WLANS, UMTS).
5. Entertainment on travels (file sharing, gaming, in trains, cars or planes).
6. Sport events.
7. Networks for cabs, police…
8. Sensor networks.

Wireless Local Area Network (WLAN): -

A wireless local area network (LAN) is a flexible information communications system used as an extension to or as an alternative for, a wired LAN [6]. Using radio frequency (RF) technology, wireless LANs send and receive information over the air, minimizing the need for wired connections. Thus, wireless LANs connects information connectivity with user mobility. Wireless LAN is famous in a number of ethical markets, including the health-care, retail, manufacturing, warehousing. These industries have profited from the productivity gains of using hand-held terminals and notebook computers to send real-time information to centralized hosts for processing [7]. Today wireless LANs are becoming more widely recognized as a general-purpose connectivity alternative for a long range of business customers.

Wireless LAN Technologies: -

Manufacturers of wireless LANs have a range of technologies to choose from when designing a wireless LAN solution [8]. Each technology comes with its own set of advantages and limitations.

1. Narrowband Technology.
2. Spread Spectrum Technology.
3. Frequency-Hopping Spread Spectrum Technology.
4. Direct-Sequence Spread Spectrum Technology
5. Infrared Technology.

Wireless Sensor Network (WSN): -

A wireless sensor network is made by hundreds or thousands of small compact devices, called sensor nodes, equipped with sensors (e.g. acoustic, seismic or image), that are densely deployed in a great geographical area. These sensors measure ambient conditions in the environment surrounding them and then transform this information into electric signals which can be propagate to reveal some characteristics about phenomena placed

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in the area around these sensors [9]. Therefore the information can be achieved about the area which is far away. The applications are environment control such as office building, robotics control and guidance in automatic manufacturing environments, interactive toys, highly security smart homes, and identification and personalization. Wireless sensor networks (WSNs) are the products which integrate sensor technologies, embedded technologies, and distributed information processing and communication techniques [10]. The appearance of the wireless sensor network is a change in information sensing and detection. There have been significant improvements in processor design and computing, advances in battery technology still lag behind, preparing energy resource considerations the fundamental challenge in the wireless sensor networks [11].

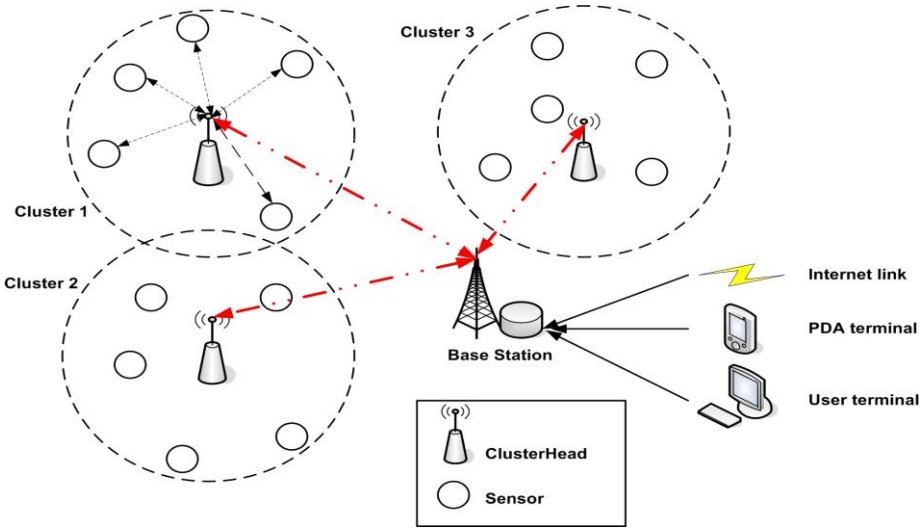

Figure 1: Wireless Sensor Network Architecture

Types of nodes used in the WSN: -

1. Micro-sensor nodes.
2. Aggregation and forwarding nodes.
3. Base-station.

Features and Requirement of WSN: -

Application specific wireless sensor networks contains of thousands of low-power multi-functioning sensor nodes, operating in an unattended environment, with less computational and sensing capabilities, they demand many following requirements.

- A sensor junction must be inexpensive.
- Information gathering protocol should be efficient enough to give longer life to the network.
- Nodes ought to be able to create a network by itself without any external methodology.
- Sensor junctions should be abled to work together and aggregate their information in a formatted way.

WSN Components: -

The idea of the wireless sensor networkingcomponents is based on a very simple formula.

Sensing + CPU + Radio = Thousands of potential applications

Conceptually, according to figure 2, a sensor node contain a power unit, sensing unit, processing unit and radio unit that is capable to both send and receive information. Sometimes the sensor node also has a mobility unit and a localization unit e.g. a global positioning system (GPS).

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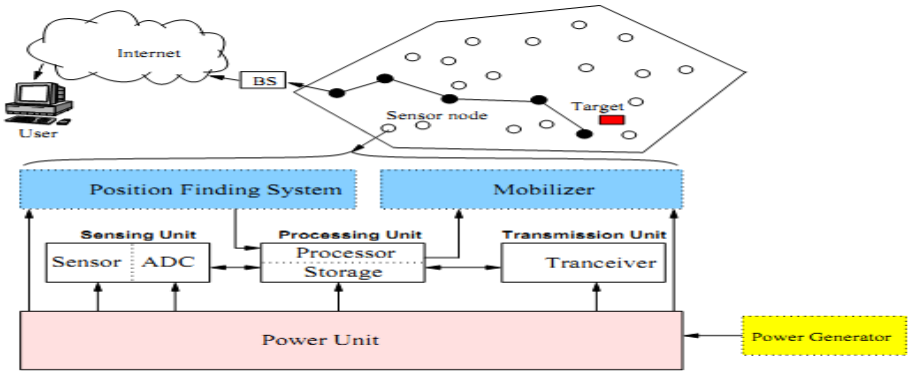

Figure 2: Component of wireless sensor node

WSN Protocols: -

I am introducing the most well-known routing protocols for wireless sensor networks.

Category	Routing Protocols
Location Based Protocols	MECN, SMECN, GAF, GEAR
Information Centric Protocols	SPIN, Directed Diffusion, EAD
Hierarchical Protocols	LEACH, PEGASIS, HEED,TEEN
Mobility Based Protocols	SEAD, TTDD
Multipath Based Protocols	SDM, BM
Heterogeneity Based Protocols	IDSQ, CADR,CHR

Table: Routing Protocols for WSN

II. WORK METHODOLOGY

1. Clumping algorithm taxonomy: -

In the literature, there have been several different ways to classify Clumping algorithms for WSNs: The parameters used for electing CHs can be – remaining energy, degree, mobility, and average distance to nearby routers & the execution nature of a clumping algorithm can be probabilistic and iterative.

In Iterative clumping techniques, a node waits for a specific event to find or certain nodes to decide their role (e.g. become clump heads) before planning. Probabilistic Clumping Techniques enables each node to independently decide on its role in the clumped network while keeping the message overhead low.

- Considering how the clump formation is carried out, a clumping algorithm is either executed at a mid point (Base station) or in a distributed fashion at local nodes.
- Authors of (Abbasi & Younis, 2007) classify clumping algorithms according to their convergence rate into two classes: variable and constant convergence time algorithms.
- Clumping algorithms can also be classified into homogeneous or heterogeneous depending on the nature of the deployed sensor network.

2. The Leach Protocol: -

Low Energy Adaptive Clumping Hierarchy ("LEACH") is a TDMA-based MAC layer set of rules which is integrated with clumping and a very simple routing protocol in wireless sensor networks (WSNs).

LEACH is a distributed clumping protocol which utilizes randomized rotation of local CHs to evenly distribute energy utilization between the nodes of WSNs. The goal of LEACH is to provide information aggregation for sensor networks while serving energy efficient communication that does not recognisably deplete some nodes more than others. LEACH is a hierarchical protocol in which most nodes transmits to clump heads, and the clump heads aggregate and compress the information and forward it to the base station. Each node uses a

stochastic algorithm at each round to determine whether it will become a clump head in this round. LEACH assumes that every node has a radio powerful enough to directly reach the base station or the nearest clump head, but that using this radio at full power all the time would consumption of energy. Nodes that have been clump heads cannot become clump heads again for P rounds, where P is the assumed percentage of clump heads. There after each node has a 1/P probability of becoming a clump head in every round. At the end of every round, each node that is not a clump head selects the nearest clump head and connects that clump. The clump head then creates a schedule for each node in its clump to send its information. All nodes that are not clump heads only communicate with the clump head in a TDMA fashion, according to the schedule created by the clump head. They do so using the minimum energy needed to achieve the clump head, and only need to keep their radios on during their time slot. LEACH uses CDMA so that every clump uses a different set of CDMA codes, to minimize interference between clumps.

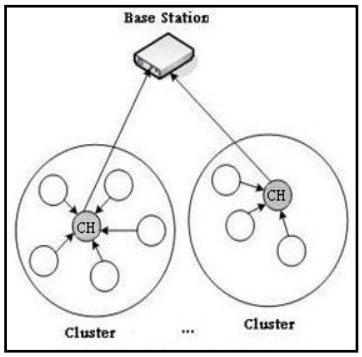

Figure 3: LEACH Protocols

The complete operation on the LEACH rule is divided into rounds.

Each round consists of:

a) Set-up phase (clumps are organized)

Clump Head Selection.

Clump Formation.

b) Steady state Phase (information transmission)

A sensor node chooses a random number, r b/w 0 and 1. If this random number is less than a threshold value, T(n), the node becomes a clump head for the current round. This threshold value is calculated using:

$$T(n) = \begin{cases} \dfrac{p}{1 - p\,(r \bmod (1/p))} & \text{, if } n \in G \\ 0 & \text{, otherwise} \end{cases} \quad \text{..... (1)}$$

Where,

p = predetermined fraction of nodes that elect themselves as CHs.

G = the set of nodes that have not been selected as a clump-head in the last (1/P) rounds.

r = number of current round.

Phases of Leach Protocol: -

1. Set-up Phase.
2. Steady-State Phase.

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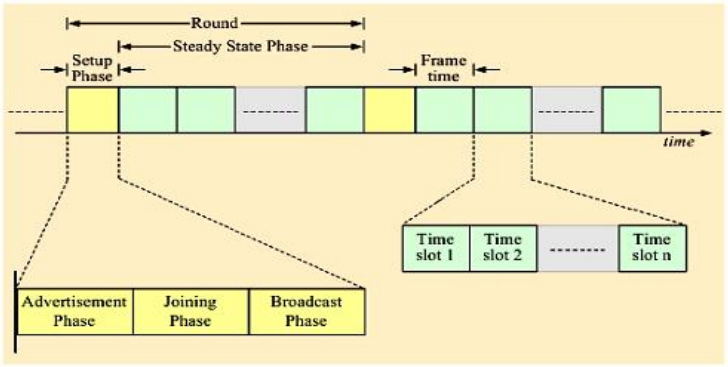

Figure 3.2 Timeline diagram of leach protocol

Other types of LEACH Protocols: -

- E-LEACH protocol
- TL-LEACH
- M-LEACH protocol
- LEACH-C protocol
- V-LEACH

Properties of LEACH Protocols: -

- Clump based
- Random clump head selection each round with rotation
- Communication done with clump head via TDMA
- Clump membership adaptive
- Information aggregation at clump head
- Clump head communicate directly with sink or user

Problems with leach: -

1. The main problem with LEACH protocol lies in the random selection of clump heads. There exists a probability that the clump heads formed are unbalanced and may remain in one part of the network making some part of the network unreachable.
2. Also, the protocol assumes a homogeneous network i.e., all nodes begin with the same amount of energy capacity in each election round, assuming that being a CH consumes approximately the same amount of energy for each node. The protocol should be extended to account for non-uniform energy nodes, i.e., use energy-based threshold.

It forms one-hop intra and inter clump topology, which is not applicable to large region networks. Clump heads are assumed to have a long communication range so they can reach the sink directly. This is not always a realistic assumption since the clump heads are regular sensors and the sink is often located far away.

PROPOSED WORK: -

Two main ideas of LEACH protocol improvement are given. Which are as follows:

1. The criterion of choosing clump head node LEACH protocol randomly chooses clump head at every round. Therefore, some nodes may exhaust energy too fast due to being chosen as clump head many times. Multi-hop communication among clump heads. Clump heads directly communicate with sink in LEACH protocol. The energy consumption between clump head and sink are greater than energy consumption among clump heads, so the clump head will exhaust energy soon.
2. Multi-hop communication can save the whole network from dying too quickly and enlarge the network lifetime by balancing the energy consumption among the network.

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III. Results And Discussions

The proposed work is the enhancement of some existing protocol in wireless sensor network in respect to the increased time. We are using the leach protocol as the base protocol. The first work is to implement the leach protocol. Till now we have worked on the same. We have made the leach methods in Matlab.

Scenario: -

Area	:	100x100
No of Nodes	:	100/200/300/400/500
Rounds	:	1000/2000/3000/4000/5000
Multi-hoping	:	Yes
Dynamic	:	Yes
Clumped	:	Yes

Parameters -

Time estimation of Network life time in terms of

1. Time till the nodes are alive
2. Time analysis when the nodes are dead
3. Track the working of Clump head
4. Network lifetime

Till now we have implemented the leach protocol respective to the above said parameters and to fulfill the defined objectives.

Tool Used: -

MATLAB: -

It is a computer program to do the numerical computation, especially linear algebra (matrices).The MATLAB began as Matrix Laboratory. It is a very strong tool for programming, visualization, engineering, research, and communications. MATLAB strengths are cutting-edge algorithm, enormous information base management systems capability, and powerful programming tool. MATLAB is not created for Symbolic Programming, but it this also has this weakness i.e. it directly links the users. The GUI is usually text-based, which may be disconcerting for some of the users. MATLAB is the Software tool used here for above algorithm. MATLAB is a powerful computing system for handling the calculations find in scientific and engineering problems. Instead of having to go through a tedious process of plotting something by hand you can just have MATLAB generate any nice and clear plot you desire. The version used here is that MATLAB Version 9.4.0.813654 (R2018a), 32-bit (win-32).

IV. Conclusion, Recommendations and Future Scope

Conclusion and Recommendations

The clump head generation algorithm with the original LEACH clumping protocol can see dun stable dissemination of clump heads that often lead to unnecessary clump heads in a small region and thus cause the significant loss of energy. To solve this problem, we proposed a progressive algorithm for the clump head selection. Simulation results show that our algorithm is much more efficient and indicate that this algorithm can balance nodes' energy consumption and prolong the network's life span. It also has good stability and extensibility. Such results are obtained under additional conditions, i.e., known location information and ability to adjust information transmission power based on distance. The algorithm can be easily implemented.

Future Scope

1. In order to evaluate the network performance more precisely, we should consider more extreme cases.
2. This approach is different than the approaches exist, like LEACH-C/E/F and DCHS, in them they all consider energy consumption as a factor in method enhancement. We will explore the possibility of combining the strengths of these different approaches.

3. There is an assumption on the selection of new clump head and key management scheme, which is the locations of nodes in a network are known. In reality this assumption may not be true. We will improve our protocol to deal with such situations.

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