An Extensive Review on Design and Simulation of Enhanced MODLEACH for Wireless Sensor Network

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Abstract - Abstract - Wireless sensor networks (WSNs) composed from a large number of sensor node with the ability to sense and process data in the physical world in a timely manner. The sensor nodes contain a battery constraint which limit the network lifetime. Due to energy constraints, the deployment of WSNs will required advance techniques to maintain the network lifetime. The energy efficient routing is the need of the modern wireless sensor networks to increase the lifetime of the network. The wireless sensor network is mostly battery operated which needs to be conserve as possible as to make network sustain longer and longer. WSN has emerged as an important computing platform in the recent few years. Wireless Sensor Networks consists of a large number of sensor nodes, which are operated by a small battery. The energy of the battery operated nodes is the most vulnerable resource of the WSN, which is depleted at a high rate when information is transmitted, because transmission energy is dependent on the distance of transmission. Sensor nodes can be deployed in the harsh environment. Once they are deployed, it becomes impossible to replace or recharge its battery. So the battery power of sensor node should be used efficiently. Many routing protocols have been proposed so far to maximize the network lifetime and decrease the consumption energy. This work presents an extensive review on various issues in wireless sensor network and protocols used to enhance the performance and network lifetime of wireless sensor network.

Keywords - MANET, WSN, Energy Consumption, Network Lifetime, Clustering.

I. INTRODUCTION

The emerging field of wireless sensor networks combines sensing, computation, and communication into a single tiny device. Through advanced mesh networking protocols, these devices form a sea of connectivity that extends the reach of cyberspace out into the physical world. As water flows to fill every room of a submerged ship, the mesh networking connectivity will seek out and exploit any possible communication path by hopping data from node to node in search of its destination. While the capabilities of any single device are minimal, the composition of hundreds of devices offers radical new technological possibilities.

The power of wireless sensor networks lies in the ability to deploy large numbers of tiny nodes that assemble and configure themselves. Usage scenarios for these devices range from real-time tracking, to monitoring of environmental conditions, to ubiquitous computing environments, to in situ monitoring of the health of structures or equipment. While often referred to as wireless sensor networks, they can also control actuators that extend control from cyberspace into the physical world.

The most straightforward application of wireless sensor network technology is to monitor remote environments for low frequency data trends. For example, a chemical plant could be easily monitored for leaks by hundreds of sensors that automatically form a wireless interconnection network and immediately report the detection of any chemical leaks. Unlike traditional wired systems, deployment costs would be minimal. Instead of having to deploy thousands of feet of wire routed through protective conduit, installers simply have to place quarter-sized device, such as the one pictured in Figure 1-1, at each sensing point. The network could be incrementally extended by simply adding more devices – no rework or complex configuration. With the devices presented in this work, the system would be capable of monitoring for anomalies for several years on a single set of batteries. Figure 1.1 demonstrates basic representation of wireless sensor network.

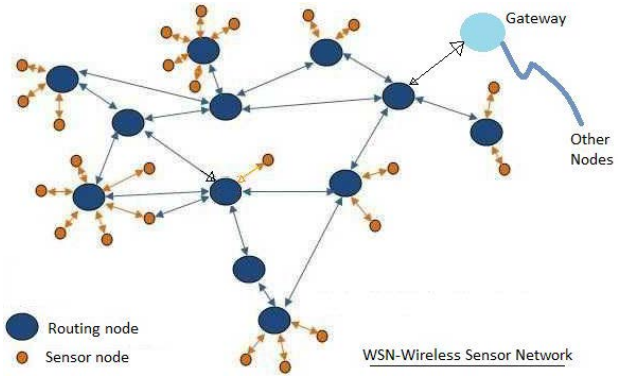

Figure 1.1 wireless Sensors Network

In addition to drastically reducing the installation costs, wireless sensor networks have the ability to dynamically adapt to changing environments. Adaptation mechanisms can respond to changes in network topologies or can cause the network to shift between drastically different modes of operation. For example, the same embedded network performing leak monitoring in a chemical factory might be reconfigured into a network designed to localize the source of a leak and track the diffusion of poisonous gases. The network could then direct workers to the safest path for emergency evacuation.

Current wireless systems only scratch the surface of possibilities emerging from the integration of low-power communication, sensing, energy storage, and computation. Generally, when people consider wireless devices they think of items such as cell phones, personal digital assistants, or laptops with 802.11. These items costs hundreds of dollars, target specialized applications, and rely on the pre-deployment of extensive infrastructure support. In contrast, wireless sensor networks use small, low-cost embedded devices for a wide range of applications and do not rely on any pre-existing infrastructure.

Unlike traditional wireless devices, wireless sensor nodes do not need to communicate directly with the nearest high-power control tower or base station, but only with their local peers. Instead, of relying on a pre-deployed infrastructure, each individual sensor or actuator becomes part of the overall infrastructure. Peer-to-peer networking protocols provide a mesh-like interconnect to shuttle data between the thousands of tiny embedded devices in a multi-hop fashion. The flexible mesh architectures envisioned dynamically adapt to support introduction of new nodes or expand to cover a larger geographic region. Additionally, the system can automatically adapt to compensate for node failures.

The vision of mesh networking is based on strength in numbers. Unlike cell phone systems that deny service when too many phones are active in a small area, the interconnection of a wireless sensor network only grows stronger as nodes are added. As long as there is sufficient density, a single network of nodes can grow to cover limitless area.

II. CLUSTERING IN WIRELESS SENSOR NETWORK

In clustering, the sensor nodes are partitioned into different clusters. Each cluster is managed by a node referred as cluster head (CH) and other nodes are referred as cluster nodes. Cluster nodes do not communicate directly with the sink node. They have to pass the collected data to the cluster head. Cluster head will aggregate the data, received from cluster nodes and transmits it to the base station. Thus minimizes the energy consumption and number of messages communicated to base station. Also number of active nodes in communication is reduced. Ultimate result of clustering the sensor nodes is prolonged network lifetime. Sensor Node: It is the core component of wireless sensor network. It has the capability of sensing, processing, routing, etc.

- Cluster Head: The Cluster head (CH) is considered as a leader for that specific cluster. And it is responsible for different activities carried out in the cluster, such as data aggregation, data transmission to base station, scheduling in the cluster, etc.

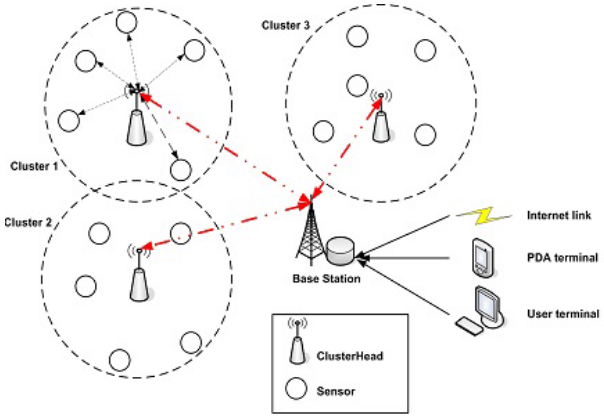

Figure 2.1 Clustered Sensor Network.

- Base Station: Base station is considered as a main data collection node for the entire sensor network. It is the bridge (via communication link) between the sensor network and the end user. Normally this node is considered as a node with no power constraints.
- Cluster: It is the organizational unit of the network, created to simplify the communication in the sensor network.

A. Low Energy Adaptive Clustering Hierarchy

LEACH is acronym regards “Low Energy Adaptive Clustering Hierarchy”. The hierarchal clustering was introduced by Heinzelman. It clusters all nodes of the network into clusters (cells) where each cell has center called “head of cluster”. In such protocol, each node transmit its information to the head of cluster, and it collects the data from all cluster’s nodes, then, it compress and format the data before sending it to the base mobile station. The cluster’s head consumes more power than other sensors, because of the load on it. The load is subjected to collecting data from all nodes, formatting data, sending and receiving data from base station. This needs to make the CH to have max power or energy than

other sensor nodes. The LEACH, uses random selection of the head of cluster, so, it may not be the maximum energy node. The LEACH protocol rotates the node that is selected as head of cluster when its energy becomes low after a threshold value.

The LEACH protocol attack is very difficult in comparison with the conventional protocols of multi-hope networks. The conventional protocols of multi-hop imply all nodes to be surrounding to the base station, so, this is attractive to compromise. But, in the LEACH protocol, the heads of clusters are communicates directly with the base station while the other nodes are not.

The head of cluster can be located anywhere in network irrespective of the mobile base station. Also, the heads of clusters (CH) can be changed randomly. This makes head cluster to be difficult to be spotted. Hence, the wireless sensor networks based on a negligible memory sensors and low computational power, thus, the security of the network is a key management of improving the networks.

III. PRIOR WORK

Pandya, N.K.; Kathiriya, H.J.; Kathiriya, N.H.; Pandya, A.D., [1] Energy efficiency is resent issue in wireless sensor network (WSN). Hierarchical routing or Clustering is best solution for reducing energy consumption in WSN. LEACH (Low energy adaptive clustering hierarchy) is good hierarchical protocol. There are many protocols introduced based on LEACH but still have issue of energy efficiency. Lots of research is going on CH (cluster head) election algorithm, data aggregation, reducing number of transmission and different power levels. MODLEACH (Modified LEACH) uses three transmission power levels which reduces energy consumption in network; also it uses different cluster head election algorithm in which node have remaining energy greater than threshold it remain as cluster head for next round. Equation used in MODLEACH for electing cluster head was same as used in LEACH. We enhance MODLEACH by using different equation for cluster head election as used in HEED (Hybrid Energy-Efficient Distributed clustering) such that it elect node as cluster head based on remaining energy of node. Also we enhanced MODLEACH by putting energy hole removing mechanism such that if node has energy less than threshold, it puts a node into sleep mode. If number of sleep nodes greater than 10 then putting sleep nodes one by one into active mode. So our approach increased lifetime in terms of first dead node, stability period and packets to base station (BS) or sink.

Pandya, N.K.; Kathiriya, H.J.; Kathiriya, N.H.; Pandya, A.D., [2] Wireless Sensor Networks have been organized for various aspects like, data collection, security, tracking, military applications etc. But one of the major challenges in Wireless Sensor Network (WSN) that is yet to be sorted out is the lack of energy efficiency which retards the lifetime of the network. Clustering or Hierarchical routing is good solution for reducing much of energy consumption in WSN. LEACH (Low energy adaptive clustering hierarchy) is best energy efficient hierarchical protocol for WSN and there are many protocols introduced based on LEACH but still have issue of energy efficiency. Lots of research is going on CH (cluster head) election algorithm, data aggregation, reducing number of transmissions and different power levels. MODLEACH (Modified LEACH) uses dual transmission power levels which reduces energy consumption of nodes; also it uses different cluster head election algorithm in which node have residual energy greater than threshold it remain as CH for next round. E (Enhanced)-MODLEACH also appoint the CH same as hybrid energy efficient distributed (HEED) Protocol but in which last node become dead earlier. In this exploration, We advances MODLEACH by different mathematical equation such that it elects node as cluster head based on residual energy of nodes and it puts limit on number of CH. Also we A (advances) - MODLEACH by including energy hole removing mechanism such that if node has remaining energy less than Eth, it puts a node into sleep mode. If number of sleep nodes more than 11 then we are invoking the sleep nodes one by one into active mode. So our approach increases stability period and packets to base station (BS) or sink. We uses MATLAB as simulation software.

Gambhir, S.; Fatima, N., [3] A Wireless Sensor Network (WSN) is a collection of small, self-contained electro-mechanical devices that monitor the environment conditions. There are many design issues for WSNs such as deployment, mobility, infrastructure, network topology, network size and density, connectivity, lifetime, node addressability, data aggregation etc. The hierarchical routing protocols are LEACH (Low-Energy Adaptive Clustering Hierarchy) is one of the routing protocols designed for communication in WSNs. LEACH is clustering based protocol that utilizes randomized rotation of local cluster-heads to evenly distribute the energy load among the sensors in the network. LEACH uses localized coordination to enable scalability and robustness for dynamic networks, and incorporates data fusion into the routing protocol to reduce the amount of information that must be transferred to the base station. But LEACH is based on the assumption that each sensor nodes contain equal amount of energy which is not valid in real scenarios. LEACH uses a TDMA based MAC protocol, in order to maintain balanced energy consumption. A number of these TDMA slots are wasted when the nodes have random data distribution. A modification to existing LEACH protocol is needed in order to use the slots corresponding to nodes that do not have data to send at its

scheduled slot. This exploration presents a new version of LEACH protocol called OP-LEACH which aims to reduce energy consumption within the wireless sensor network. Both existing LEACH and proposed OP-LEACH are evaluated through extensive simulations using OMNET++ simulator which shows that Op-LEACH performs better than LEACH protocol.

Rahayu, T.M.; Sang-Gon Lee; Hoon-Jae Lee, [4] Energy efficiency is one of the major concerns in designing protocols for WSNs. One of the energy-efficient communication protocols for this network is LEACH that works on cluster-based homogeneous WSNs. Though LEACH is energy-efficient but it does not take security into account. Because WSNs are usually deployed in remote and hostile areas, security becomes a concern in designing a protocol. In this exploration we present our security analysis of five security protocols that have been proposed to strengthen LEACH protocols. Those protocols are SLEACH, SecLEACH, SC-LEACH, Armor LEACH and MS-LEACH.

Kodali, R.K.; Aravapalli, N.K., [5] A Wireless Sensor Network (WSN) consists of a large number of tiny devices called sensor nodes, which are usually deployed randomly over a wide area in order to sense and monitor various physical phenomena related parameters including environmental conditions at various locations. The WSN nodes communicate with each other. WSN devices have various resource constraints such as less memory, low clock speed, finite battery energy, and limited computational power. It may not be feasible to replace the batteries in the WSN nodes. As all the nodes are battery operated it is necessary to conserve the limited battery energy so that the lifetime of the network can be extended. Network lifetime, energy efficiency, load balancing and more over scalability are some key requirements of WSN applications. This work presents a multi level hierarchical routing protocol, which is based on the LEACH protocol. This protocol improves both the energy efficiency and the lifetime of the network. Two-level LEACH (TL-LEACH), Three-level LEACH (3L-LEACH) and Four-level LEACH (4L-LEACH) have been presented. NS-3 simulation platform has been used to carry out performance analysis of these hierarchical routing protocols. The performance analysis shows that the hierarchical routing protocols, TL-LEACH, 3L-LEACH and 4L-LEACH fare better than the LEACH protocol.

Salim, M.M.; Elsayed, H.A.; El Ramly, S.H., [6] Wireless sensor networks are composed of hundreds or even thousands of sensor nodes which have limited energy. Energy consideration is a very critical issue for designing routing protocols. This exploration discusses a common clustering protocol, called LEACH, and improves cluster-head selection criteria. LEACH selects cluster-heads based on random probability, while the proposed algorithm considers the sensor nodes residual energy in order to balance energy dissipation among all of the nodes to extend network lifetime as one unit to minimize dead-spots. MATLAB simulation shows that the proposed energy consideration protocol which is called Percentage LEACH (PR-LEACH), provides better performance compared to LEACH protocol.

Yong-Zhen Li; Ai-Li Zhang; Yu-Zhu Liang, [7] LEACH is a hierarchical routing protocol special for WSN. Many researchers have proposed many improved algorithms based on LEACH, such as LEACH-C, LEACH-M and so on, and these algorithms have much improvements on efficiency of energy in certain extent. Within the lifetime of networks, based on the shortcomings of LEACH that each node is frequently repeated several times elected cluster-head and consumed some energy, this exploration proposes a hierarchical routing improved algorithm based on the LEACH algorithm(i.e., LEACH-R). The simulation results show that the improved algorithm makes the energy distribution more balanced, and LEACH-R outperforms LEACH-M nearly 20%.

Table 1 Summary of Literature Review

SR. NO.	TITLE	AUTHORS	YEAR	METHODOLOGY
1	Design and simulation of enhanced MODLEACH for wireless sensor network	Pandya, N.K.; Kathiriya, H.J.; Kathiriya, N.H.; Pandya, A.D	2015	Enhance MODLEACH by using different equation for cluster head election as used in HEED.
2	Design and simulation of advance MODLEACH for wireless sensor network,	Pandya, N.K.; Kathiriya, H.J.; Kathiriya, N.H.; Pandya, A.D	2015	Advances MODLEACH by different mathematical equation such that it elects node as cluster head based on residual energy of nodes and it puts limit on number of CH
3	Op-LEACH: An Optimized LEACH Method for Busty Traffic in WSNs,	Gambhir, S.; Fatima, N	2014	Presents a new version of LEACH protocol called OP-LEACH which aims to reduce energy consumption within the wireless sensor network

4	Survey on LEACH-based security protocols,	Rahayu, T.M.; Sang-Gon Lee; Hoon-Jae Lee,	2014	present our security analysis of five security protocols that have been proposed to strengthen LEACH protocols
5	Multi-level LEACH protocol model using NS-3	Kodali, R.K.; Aravapalli, N.K.,	2014	Two-level LEACH (TL-LEACH), Three-level LEACH (3L-LEACH) and Four-level LEACH (4L-LEACH) have been presented
6	PR-LEACH: Approach for balancing energy dissipation of LEACH protocol for wireless sensor networks	Salim, M.M.; Elsayed, H.A.; El Ramly, S.H	2014	Discusses a common clustering protocol, called LEACH, and improves cluster-head selection criteria
7	Improvement of Leach Protocol for Wireless Sensor Networks,	Yong-Zhen Li; Ai-Li Zhang; Yu-Zhu Liang,	2013	Proposes a hierarchical routing improved algorithm based on the LEACH algorithm (i.e., LEACH-R).

IV. PROBLEM STATEMENT

Introduces that clustering reduces energy consumption in Wireless Sensor Network. LEACH was first clustering protocol. There are few protocols based on LEACH introduces with their advantages and disadvantages in this report. Given protocol for homogeneous and also for proactive network as well as reactive are explained. Protocol used different cluster head election equation and algorithm in which limits number of cluster heads and increases lifetime of network as well as sleep and awake schedule introduce for removing energy hole and better stability period as well as different power levels introduced for reduces energy consumption and decrease the retransmission of packet, collisions and interference for other signals. So energy consumption is reduced and lifetime increases. In reactive protocol soft threshold and hard threshold reduces number of transmissions. According to simulation results and analysis of proposed schemes, we say that our proposed protocol performs better than LEACH and MODLEACH. Lifetime of reactive protocol is much higher than proactive protocol.

V. CONCLUSION

Energy efficiency is resent issue in wireless sensor network (WSN). Hierarchical routing or Clustering is best solution for reducing energy consumption in WSN. LEACH (Low energy adaptive clustering hierarchy) is good hierarchical protocol. There are many protocols introduced based on LEACH but still have issue of energy efficiency. Lots of research is going on CH (cluster head) election algorithm, data aggregation, reducing number of transmission and different power levels. MODLEACH (Modified LEACH) uses three transmission power levels which reduces energy consumption in network; also it uses different cluster head election algorithm in which node have remaining energy greater than threshold it remain as cluster head for next round. Equation used in MODLEACH for electing cluster head was same as used in LEACH. We enhance MODLEACH by using different equation for cluster head election as used in HEED (Hybrid Energy-Efficient Distributed clustering) such that it elect node as cluster head based on remaining energy of node. Also we enhanced MODLEACH by putting energy hole removing mechanism such that if node has energy less than threshold, it puts a node into sleep mode.

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