



An Exploration of LEACH Protocol Family for Clustered Architecture

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Abstract -- One of the common communication architecture in sensor network is clustered network. In this architecture, complete network is divided in smaller segments and each segment is controlled by a Cluster head. The clustered network communication reduces the long distance communication and provides the effective improvement to network throughput and network life. LEACH is the standard clustering protocol used to generate the cluster. Lot of improvement is done in this protocol architecture to improve the QoS in clustered network. In this paper, a study to some of the common form of LEACH protocol is discussed.

Keywords – Clustered, LEACH, QoS, Network Architecture

I. INTRODUCTION

Clustering is a process in which the network is divided in smaller segments called clusters and each segment is controlled by a controller node called cluster head. The cluster head collects the data from all the cluster nodes and pass it to the base station. Clustered network is the most common network scenario defined in many sensor networks to perform the effective communication over the network. These kind of networks are controlled under different protocol specification. These protocols includes the clustering as well as aggregation based protocols. These protocols includes the Leach, Pegasis and ESPDA protocols. The clustering is explored by these protocols to improve the network by reducing the network communication and by reducing the energy consumption over the network. The localization of nodes in the network also reduce the communication as well as the energy consumption over the network[11][12].

These kind of networks are effective because of its aggregative communication nature. The network provides the efficiency as the short distance communication is restricted to the cluster head and the cluster head collect the data from different nodes and perform the data aggregation while performing the communication over the network. As the data is collected by the cluster head, the collected data is transferred to base station. The network model reduce the network communication and energy consumption over the network. These kind of network are divided in two main models given here under

A) Single Hop Model

This kind of model performs the direct communication with cluster head. LEACH is an example of homogenous Single Hop model. Both LEACH and LEACH – C use one level clustering (The Cluster heads of each cluster directly connected with the sink node or base station.)[9]

B) Multi-Hop Model

In multi hop network, the data is transferred from multiple nodes and transferred to cluster head. The extension of LEACH called M – LEACH or multi – hop LEACH is a good example of multi hop model. This model is shown in figure 1

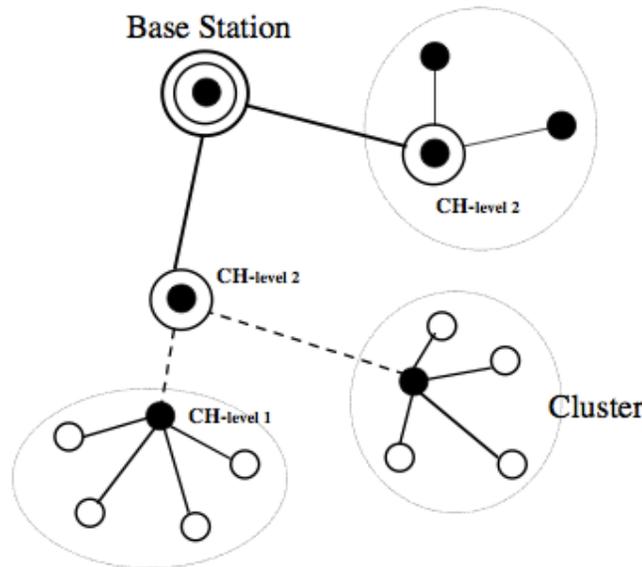


Figure 1 : Multi-Hop Model

C) LEACH PROTOCOL

LEACH protocol is defined as the basic clustered protocol that follow the cluster structure formation and the clustered communication over the network. This kind of network performs the hierarchical communication over the network. The clustered short distance communication is performed to the cluster heads and the information from the cluster head is transferred to base station by using the multi hop path. The clustered communication over the network is performed under the balanced and load distributed communication. The network is defined under the life time analysis and greatly defined as the effective communication node so that the network life will be improved. This kind of network are effective to provide the effective clustered communication over the network. The clustered communication will reduce the energy loss and provide the effective communication. The leach protocol defined the random selection of cluster over the network [17][18].

In this paper, the clustering architecture is defined along with the description of LEACH family. This section has defined a short introduction on clustered architecture. In section II, the work defined by earlier researchers is discussed. In section III, the LEACH functionality is defined. In section IV, the conclusion obtained from the work is presented.

II. LITERATURE SURVEY

Lot of work is already done, in the area of Clustering and leach protocol. Some of the work defined by earlier researchers is defined here under

Edward J. Coyle, et al.[1] is defined to improve the clustering scheme over the sensor network and to perform the long distance communication by using multihop aggregative communication. The network is divided in the form of communication groups and the cluster head specific communication is performed to improve the processing power and center specific communication over the network. The network estimation is also performed to improve the network communication and network life. Energy adaptive communication is performed in the defined network environment under long distance. H. Chen, et al. [2] defined a work on clustering so that the network architecture will be improved and the aggregative communication is performed over the network. Author defined the algorithm under the hierarchical network by splitting the network in sub group. Now each group is defined with controller cluster head, the aggregative communication is performed between these group leaders so that the reliable communication will be performed over the network. Yuan, et al.[3] defined an improvement over the data acquisition process for sensor network so that the energy reduction will be achieved. The work is also to improve the network communication and to reduce the communication delay. The agent based analysis is performed at the earlier stage so that the cluster head definition and the individual communication analysis will be performed. The next node analysis is defined to improve the communication with hop count analysis and path loss analysis. The intensity based analysis is performed to improve the communication reliability.

Deb, et al.[4] presented an improvement over the network reliability by combining the multi path communication on single path. The communication analysis is here defined under the dynamic packet tracing and context sensor network analysis so that the network reliability over the network will be achieved. The communication analysis is here defined under the error reduction and error rate analysis under the topology generation and formation. The data delivery analysis is also defined to improve network reliability. Ganesan, et al. [5] defined a work on disjoint path collection so that the network reliability in case of network failures will be improved. The network analysis under the braided path analysis is defined under alternate path specification and generation. Tao Shu, et al. [6] developed mechanism that generates randomized multipath routes. Under their designs, the paths taken by the shares of different packets changes over time. So even if the routing algorithm becomes known to the opponent, the opponent still cannot point out the routes cross over by each packet. Besides irregularities, the generated paths are also highly distributive and energy efficient, making them quite capable of mislead black holes. They tentatively check out the security and energy performance of the proposed schemes. They also formulate an optimization problem to decrease the end-to-end energy consumption under given security compulsions. Wide simulations are conducted to verify the validity of our mechanisms. They propose arbitrary multipath routing algorithm that can overcome the above problems. In their approach, multiple paths are computed in arbitrary way each time an information packet needs to be sent, such that the set of routes taken by various shares of different packets keep changing over time. As a result, a large number of routes can be conceivably generated for each source and destination. To interrupt different packets, the opponent has to accord or jam all possible paths from the source to the destination, which is practically not possible. Rezavi, et al. [7] on the subject of Dynamic Macro-programming of WSNs, whose goal was to enable diverse functionality of WSNs by using MA technology. The use of uQueries is the main advantage of macro-programming and by enabling the same in WSN.

III. LEACH PROTOCOL

The working of LEACH protocol is divided in two main stages called the setup phase and steady phase. In first phase, the election of cluster head is performed over the network. This decision is based on the energy analysis. In this phase, each node is represented as the cluster head itself so that the information broadcast over the network can be performed. As some nodes receive this information, the cluster join and signal strength analysis is performed to decide a node as cluster head. During the steady stage, the cluster nodes waits to accept the data from other nodes of clusters and to perform the aggregative communication over the network. This protocol is divided into rounds and each round consists of two phases. Figure 2 represent the LEACH protocol phase.

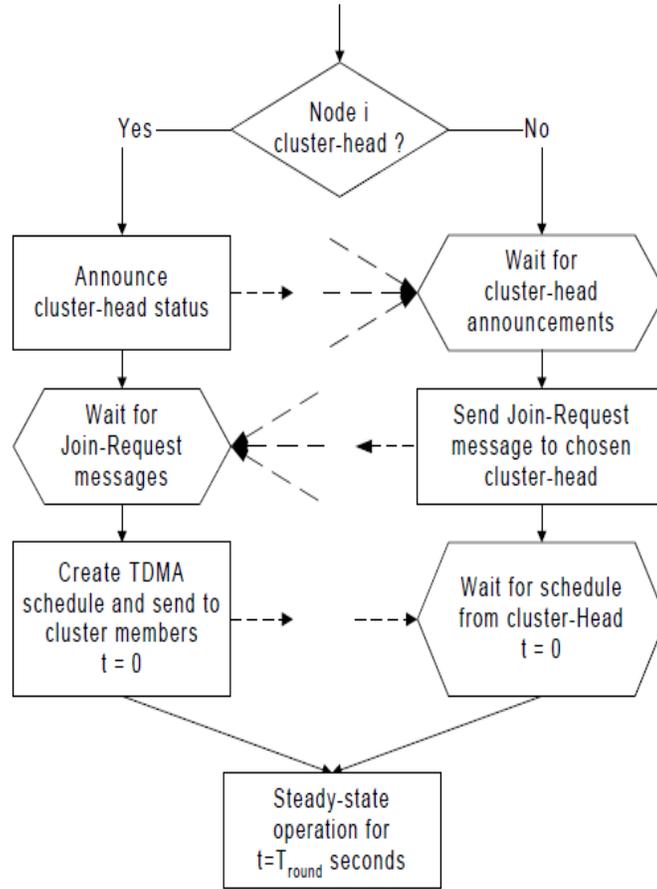


Figure 2 : Cluster Formation in LEACH

A) Setup Phase

In the advertisement phase, the Cluster-heads inform their neighborhood with an advertisement packet that they become Cluster-heads. Non-cluster-head nodes pick the advertisement packet with the strongest received signal strength. In the next cluster setup phase, the member nodes inform the Cluster Head that they become a member to that cluster with "join packet" contains their IDs using CSMA. After the cluster-setup sub phase, the Cluster-Head knows the number of member nodes and their IDs. Based on all messages received within the cluster, the Cluster-Head creates a TDMA schedule, pick a CSMA code randomly, and broadcast the TDMA table to cluster members. After that steady-state phase begins. [Kay Romer and Friedemann Mattern, Eth Zurich (2000)] [Hiren Kumar Deva Sarma and Avijit Kar (2002)][M. Ibrahim Channa and Irum Memon(2001)][Michael O'Rourke (2012)]

B) Steady Phase

In this phase data transmission begins. Nodes send their data during their allocated TDMA slot to the Cluster-Head. This transmission uses a minimal amount of energy (chosen based on the received strength of the Cluster-Head advertisement). The radio of each non-Cluster-Head node can be turned off until the nodes allocated TDMA slot thus minimizing energy dissipation in these nodes. When all the data has been received, the Cluster-Head aggregate these data and send it to the BS [Kay Romer and Friedemann Mattern, Eth Zurich (2000)]. Figure 1.7 shows a flow-graph of the steady-state operation. [Michael O'Rourke(2012)]

In this section, some other LEACH protocol under LEACH family are explained

C) LEACH-F

LEACH with Fixed clusters (LEACH-F) is based on clusters that are formed once and then fixed. In this protocol concept, the position of the next cluster head is changed only within that cluster, no global search or the request is reformed for the cluster head selection. It improves the clustering head by reducing the cost effective cluster head selection after each round. The centralized cluster head is responsible for the cluster head selection. It also gives the restriction to not to add new nodes in the system or in the clustering architecture.

D) E-LEACH

Energy-LEACH protocol improves the CH selection procedure. It makes residual energy of node as the main metric which decides whether the nodes turn into CH or not after the first round. Same as LEACH protocol, E-LEACH is divided into rounds, in the first round, every node has the same probability to turn into CH, that mean nodes are randomly selected as CHs, in the next rounds, the residual energy of each node is different after one round communication and taken into account for the selection of the CHs. That mean nodes have more energy will become a CHs rather than nodes with less energy.

E) TL-LEACH

In LEACH protocol, the CH collects and aggregates data from sensors in its own cluster and passes the information to the BS directly. CH might be located far away from the BS, so it uses most of its energy for transmitting and because it is always on it will die faster than other nodes. A new version of LEACH called Two-level LEACH was proposed. In this protocol; CH collects data from other cluster members as original LEACH, but rather than transfer data to the BS directly, it uses one of the CHs that lies between the CH and the BS as a relay station.

F) M-LEACH

In LEACH, Each CH directly communicates with BS no matter the distance between CH and BS. It will consume lot of its energy if the distance is far. On the other hand, Multihop-LEACH protocol selects optimal path between the CH and the BS through other CHs and use these CHs as a relay station to transmit data over through them. First, multi-hop communication is adopted among CHs. Then, according to the selected optimal path, these CHs transmit data to the corresponding CH which is nearest to BS. Finally, this CH sends data to BS. M-LEACH protocol is almost the same as LEACH protocol, only makes communication mode from single hop to multi-hop between CHs and BS.

G) N-LEACH

The WSN topological model of N-LEACH and LEACH was same basically, the difference between them was that N-LEACH algorithm took into account the difference of remaining energy after each round running, LEACH was assumed it was the same that energy consumption of nodes each round LEACH algorithm was operated by round, there were two phases in each round that cluster established and stable data transmission. Process of cluster established consists with two parts, Next Node formed and spanning tree built. The Next Node of the first round was generated by base station, the Next Node of remaining rounds generated from the node which had largest residual energy in last round, Next Node elected periodically and cluster produced dynamically

H) V-LEACH

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IV. CONCLUSION

In this paper, the exploration to clustering architecture is given along with the specification of LEACH protocol and its family. The paper has defined the functioning of LEACH protocol and explores different improvement done in this protocol time to time.

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