



**RESEARCH ARTICLE**

# A Study on Clustering Architecture and Protocols in Wireless Sensor Network

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## Abstract

To improve the effectiveness and QoS of service in a sensor network there are number of communication and localization architectures followed by sensor network. One of such architecture is clustering architecture. This architecture restrict the communication to short distances so that the energy consumption of a node is reduces. In this paper, the clustering architecture and functionality of Clustering process is explored. This paper also explored the concept of hierarchical routing as well as the LEACH protocol.

**Keywords – Clustering, LEACH, Hierarchical, Multi-hop**

## 1. INTRODUCTION

A sensor network is a self organized wireless adhoc network defined with large number of sensing nodes along with energy constraint. These sensing nodes are defined with limited power and resources. There are number of real time applications where sensor network is implemented such as scientific research applications, statistical applications, disaster area application, war zones etc. According to the architectural organization and application, there are number of associated challenges with sensor network some of these challenges includes the node localization, communication hurdles, route optimization, security effectiveness, dynamic operations etc. The most standard form of sensor network architecture is composed with multiple sensor nodes and a base station. The server is also attached as the main component of outer

environment to communicate the network information, outside the network. The standard form of network architecture is shown in figure 1.

This structured network form is defined under some network architecture. One of such architecture is clustered architecture. In this architectural form, complete sensor network is divided in small area segments called clusters. Each cluster is having number of sensor nodes and a cluster head. The sensor node perform communication

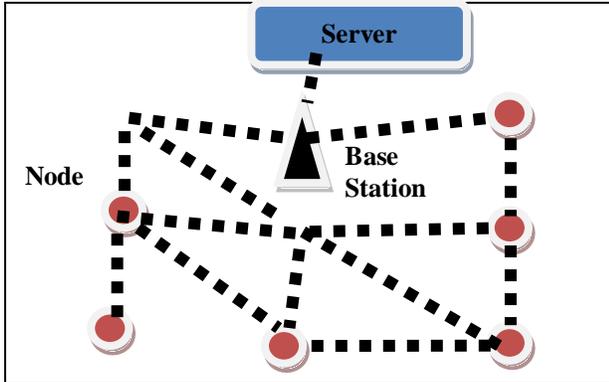


Figure 1 : Sensor Network Architecture

with cluster head and cluster head perform the communication with base station. There are number of associated protocols that improve the effectiveness of clustered architecture. These protocols include LEACH, PEGASIS, ESPDA etc. All these protocols support the concept of clustering and aggregation.

These cluster based protocol are liable to perform reliable and efficient network communication. The clustered network is further divided in two main network models called Single hop model and multi hop model. These models are described here under

#### A) Single-Hop Model

In this network model, the cluster members performs direct communication with cluster head. LEACH is such kind of protocol that support single hop communication. This protocol is further extended to LEACH C, LEACH E protocols. But these all protocol set support single level of clustering. According to this protocol architecture, the nodes communication directly with cluster head and cluster head is capable to communicate directly with base station. The single hop cluster level communication is shown in figure 2.

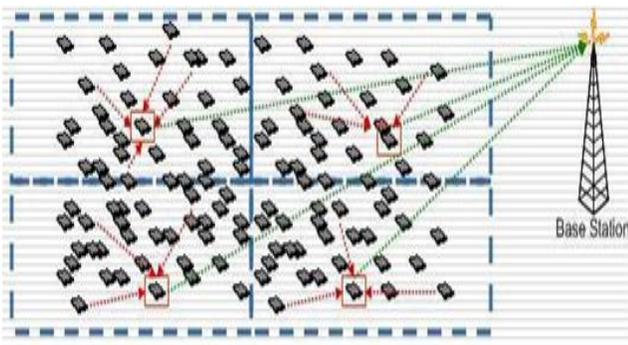


Figure 2 : Single Hop Clustering Architecture

#### B) Multi-Hop Model

As the name suggest, in this network architecture, the size of cluster head is large. In such case, the cluster head communication is based on the sensing range capability of network nodes. The closer nodes to cluster head can perform

direct communication with base station whereas the distance node can perform communication using intermediate node. The extension of LEACH protocol called LEACH M. This network architecture is shown in figure 3.

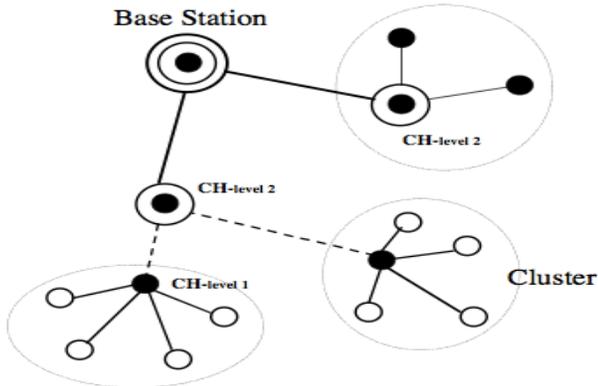


Figure 3 : Multi-Hop Clustered Model

In this paper, an exploration to the clustering protocols is defined. The clustered architecture and the standard clustering model is discussed. In this section, a description to the network clustered architecture and its types are described and explored. In section II, the work defined by earlier researchers is discussed. In section III, the study of clustering protocol or architectures is presented in detail. In section IV, the conclusion obtained from the paper is discussed.

## II. EXISTING WORK

Lot of work is already defined by different researchers on clustering architecture and communication in sensor network. In this section, some of the work defined by earlier researchers is discussed. Guofeng Hou[1] presented a traffic model for LEACH protocol for sensor network. Author defined the work on performance improvement on LEACH protocol. Author analyze the LEACH protocol for realistic traffic model so that effective transmission will be performed over the network. The analysis is here defined under different probabilities and different range network. Chalermek[2] explored a work on directed diffusion so that the network will be analyzed effectively. Author defined an energy effective approach to provide the effective communication under different scenarios. Richard William Skowrya[3] has presented a collision effective scheduling approach so that the time based network sharing will be performed. Author defined the genetic approach to perform the clustering and to perform cluster head selection. Author performed the performance analysis with LEACH protocol under normal and failure cases. Author defined a recovery mechanism so that effective network communication will be drawn.

Arati Manjeshwar[4] proposed a work on hybrid routing protocol so that the effective information retrieval will be performed. This work is defined under time criticality and the periodic interval so that the energy distribution will be effective. Author defined a request analysis based approach so that historical query based analysis will be performed. Author performed the evaluation so that the performance analysis so that energy reduction and observation of protocol will be done. Wendi Beth Heinzelman[5] presented an approach so that the micro sensor network analysis under the video communication will be performed. Author defined the hierarchical architecture so that the effective clustered routing and the application specific communication will be drawn. Author performed the latency and quality analysis based work to improve the communication performance.

Ameer Ahmed Abbasi[6] has presented a classification based clustering approach so that the network performance will be improve and the energy consumption will be reduced. Author defined a clustering approach so that the network improvement will be done under different parameters such as convergence rate, stability vector, location awareness etc. Mohamed Watfa[7] has presented a query processing based optimization approach so that the aggregative communication will be performed. Author presented the optimization approach under different vectors and under data management techniques so that the simulation efficiency will be achieved. Muruganathan[8] has defined a new protocol called APTEEN to improve the TEEN protocol. The main objective of work was to improve the query processing and reduce the response time so that multiple queries will be handled at same time. Sokwoo Rhee[9] has defined a power reduction approach so that efficient sensor network will be generated in a new i-Bean Network. Author defined the effectiveness of this new network form. Bhaskar Krishnamachari[10] has defined data centric model so that the network performance and the routing over the network will be improved. Author defined the cost and delay analysis approach so that the data aggregation will be

attained. Author provided the optimal data aggregation under the polynomial time. Jamal N. Al-Karaki Raza[11] presented a data gathering and routing scheme in aggregative network so that the network life time utilization will be attained. Author defined the grid based routing and the aggregator selection scheme so that the controlled energy dissipation and latency will be achieved. Yingpeng Sang[12] has defined a hop by hop communication in secure network. Author proposed a framework so that the communication time will be reduced and the encrypted communication will be obtained.

### III. CLUSTERING MODEL

Clustering architecture is one of the most adaptive communication architecture so that effective network communication will be obtained. Different work defined by different researchers on the study and improvement over the existing protocols and architectures. The main concept of clustering includes the effective cluster formation and the hierarical routing.

**Edward J. Coyle[13]** defined a work on energy effective hierarchical clustering approach so that the distance communication will be performed efficiently. Author defined the network organization and cluster formation with the cluster head specification and communication of the cluster head with cluster nodes. The cluster head actually perform the estimation under different parameters and perform the information transmission over the smaller distances. The energy effectiveness will be achieved so that the direct communication. H. Chen[14] also presented a work on the study of basic clustering process. Author, defined the work on clustering approach so that effective network communication will be performed. Author collect the data information and performed the aggregation over the network groups so that the data will be transferred to sink node effectively. The work improved the energy effectiveness and reduces the network complexity. Author defined an integrated clustered network so that the effective network communication will be performed. Yuan defined a work on data acquisition in clustered network. Author defined a agent based approach so that the monitoring of the network energy and network delay will be performed.

The role of mobile agents is to gather sensor data from all nodes within a cluster and return it to a cluster head node, thereby reducing power consumption of individual nodes communicating to the head cluster node. The key idea was that when a mobile agent calculates the next hop node, it has taken into calculation the power consumption of the hop, path loss, and the stimulated intensity (residual energy) of other nodes. The solution was cleared with experimental results from tests showing that the power consumption and network delay have decreased, opposed to the conventional data gathering. LEACH is one of the most effective protocol used to perform cluster formation. The description of this protocol is defined here under

#### A) LEACH

LEACH is one of the basic protocol supported by sensor network to control the cluster formation and to provide the hierarchical communication over the network. LEACH protocol is responsible to provide the energy effective communication over the network. Leach protocol actually limits most of the communication within cluster so that small distance and low energy communication is performed. The data values from the nodes are received by the cluster controller called cluster head and cluster head transfer this information to base station. Only the cluster heads can perform communicate with base station directly. The nearer cluster to base station can perform direct communication and distance cluster heads can perform multihop communication to base station. The clustered approach provided by LEACH protocol is effective enough to provide the class based network structure so that the balanced network is generated. As the data is divided in smaller segments, it is quite easy to monitor these small segments instead of whole network. It is easy to track the network nodes and to identify the problems in the area segment such as identification of redundancy, faulty nodes or communication fault etc. LEACH protocol is able to save the network energy and to provide the reliable and effective network communication.

But, even then LEACH is not perfect protocol in itself and having some limitations. Each node requires a power control mechanism while performing the communication. When the node selection is performed, the past communication analysis and the energy difference analysis is required. Another protocol associated with LEACH protocol is the random selection and distribution of nodes so that it is not necessary that the network will always provide the optimized results. Each node in LEACH has the equal chances to be the cluster head so that a low energy node if selected as the cluster head, the cluster head switching will be more frequently. Another associated problem with LEACH is the randomized distribution of energy so that particular network cluster or the part can die early. The uneven distribution of energy or power reduces the effectiveness of network as well as can be the reason of early network failure.

The basic features of LEACH protocols for a clustered sensor network are listed here under

- Self Configured network that gives the effective cluster formation.
- Low Energy Communication
- Adaptive Localized Control
- Application Specific Communication.

In this section, the basic working of LEACH protocol is also defined.

**B) FUNCTIONALITY**

The working of LEACH protocol is defined in terms of stages. These stages include the Setup Stage and Steady Stage. During the Setup stage, the decision is taken regarding the formation of a cluster head. It means it will check whether a node can be cluster head or not. This decision is based on the residual energy of the node. The

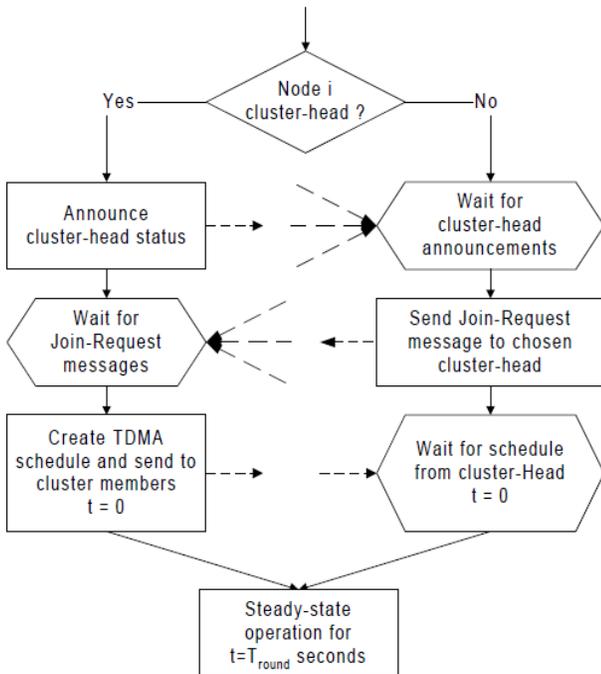


Figure 4 : Clustering Processing

decision is also based on the basic of threshold specification. To elect a node as the cluster head, each node broadcast an advertisement to show its intention. Once the requests are collected, the cluster head selection is performed based on the signal strength and the position of node. During the Steady Stage, each cluster head wait for receiving the data from all cluster nodes. As it gets the data, perform the aggregation and sent it to the base station. The functionality of clustering architecture is shown in figure 3.

**IV. CONCLUSION**

In this paper, a study of routing approaches is defined for sensor network. The paper has explored the concept of routing along with routing dependent elements. The challenges faced while performing the route selection is also discussed. The paper has also discussed different routing approaches under different network architectures.

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