

# Comprehensive Analysis of Clustering Techniques in WSN

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**Abstract:** Wireless Sensor Networks (WSN) are growing in the current years and providing solutions to the real world applications. Due to the diverse applications provided by the WSNs in the field of disaster and military management, health care monitoring, smart phones and other surveillance systems, it proved to be the significant technology. Sensor nodes deployed generally are large in number and work unattended and independently in typical environment. Due to limited energy resources the sensor nodes are grouped into various clusters to have efficient communications among nodes. This paper presents systematically few prominent fine grained and comprehensive analyses of various clustering algorithms with numerous significant metrics. Finally, some future directions are made based on the analysis and summary of clustering routing techniques.

**Index Terms-** Cluster based routing, WSN, energy efficient

## 1. INTRODUCTION

Wireless sensor networking is an up -coming technology that deploy wireless sensor networks (WSNs) for a broad variety of applications such as tracking of objects and data collection environment monitoring, biosensors for health applications and smart sensor environments for home electronics. Sensor nodes are powered by battery and estimated to function for longer period of time. So after deployment of nodes it is not possible to recharge the sensor node battery. Hence, power is the important resource in little powered WSNs, so energy management and consumption is very crucial in order to enhance the lifetime of network. Manufacturing, designing and networking wireless sensor devices is challenging and complex task in order to support such a broad variety of applications[11]. As a consequence, WSN has been the area of extensive research in the previous years.

A sensor node normally comprises of basic four components: a communication unit, a sensing unit, a power unit and a processing unit [2]. The sensing unit typically contains one or more sensors and converters ADCs (analog-to-digital). The sensors use to record and monitor the environment physical conditions such as pressure, temperature etc. and based on the observed data it produce analog signals. The analog signals are converted into digital form using ADC, the these signals are sent to the processing unit. The processing unit generally comprise of a microprocessor or microcontroller with memory,

which makes the sensor node intelligent. The communication unit performs data reception and transmission over a short range radio channel. The power unit is to drive all other components in the system by supplying battery power. All these units should be manufactured into a small module with low production cost and low power consumption.

## 2. ROUTING IN WIRELESS SENSOR NETWORK

Routing is the main task of wireless network communications. It ensures the correct delivery of messages from one node to another node. It includes the following steps: (1) Route discovery and (2) transmission of messages through the established routes. In WSNs, routing protocols are categorized in various types based on the network structure as cluster based, flat-based, and location-based routing as shown in Figure 1. In flat-based routing, equal functionality and roles are given to all the nodes. In cluster-based routing, nodes will play different roles in the network. Sensor positions are used in location-based routing, to route data in the network. In adaptive routing some of the system parameters and factors can be controlled in order to adapt to the current available energy levels and network conditions.

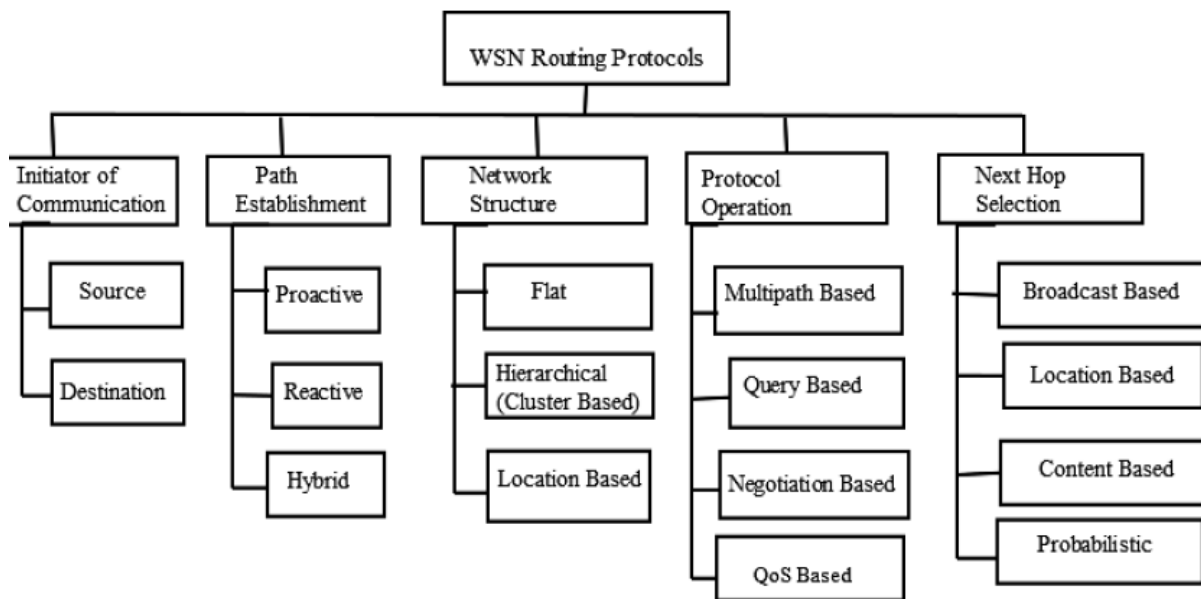


Fig. 1: classification of WSN Routing algorithms.

### 3. CLUSTERING TECHNIQUES IN WSN

The nodes in WSN are divided into clusters. The communications among nodes can communicate in intercluster, cluster heads CHs communicate and intracluster, nodes and CHs can communicate. To establish a cluster following process is used: (a) cluster head election, (b) cluster formation (set-up phase), (c) data transmission phase (steady-state phase). Different techniques are used to implement different stages.

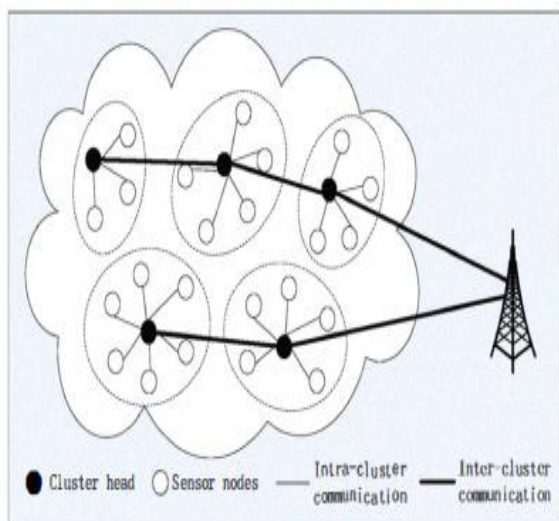


Fig.2: Architecture of cluster-based routing protocols

The cluster based algorithms are divided into three types: chain cluster, block cluster, grid cluster. The

classifications of clustering routing algorithms are shown in the figure 3.

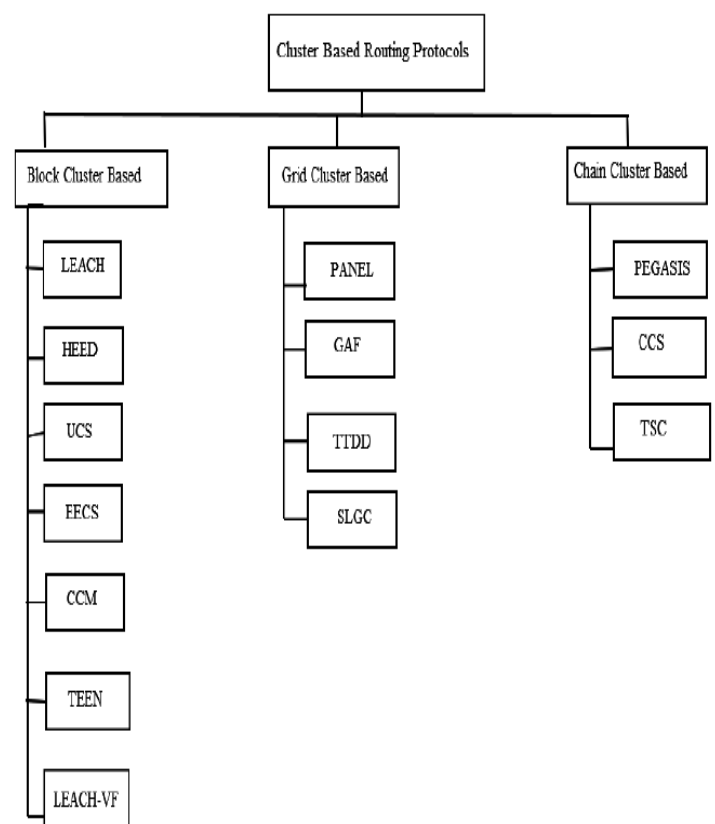


Fig. 3: classification of clustering algorithms.

**A. Clustering Parameters**

*i. Cluster count*

Cluster count is a crucial factor to measure efficiency of routing technique. In some clustering techniques cluster count is fixed.

*ii. Intra-cluster communication*

In various clustering techniques the communication between a CH and a sensor is direct (one-hop communication). However, when large numbers of sensors are there, multi-hop Intra-cluster communication is required.

*iii. Nodes and CH mobility*

The clusters need to be maintained regularly as nodes and CH are continuously mobile. Static sensor nodes and static CHs lead to stable clusters with facilitated intra-cluster and inter-cluster network management.

*iv. Cluster-head selection*

The cluster head can be elected based on certain factors such as remaining power and connectivity etc.

*v. Algorithm complexity*

The primary design goal of the recent algorithms is fast termination of the executed protocol. therefore, the convergence rate and time complexity of most of the cluster formation procedures proposed nowadays is constant or just dependent on the the number of hops or number of CHs. In some previous studies it has been observed that the complexity is dependent on the total number of sensors in the network, focusing in other criteria.

**4. COMPARATIVE ANALYSIS OF VARIOUS CLUSTERING TECHNIQUES**

Table 1: Comparison of various Clustering Techniques

Technique	Load Balancing	Energy efficient	Cluster stability	Delay	Scalability	Algorithm complexity
TTDD	Good	Very poor	Very high	Very large	Poor	Poor
DEEAC	Good	Good	High	small	low	Moderate
FEMCHRP	Poor	Good	Moderate	Moderate	Low	Moderate
LEACH	Moderate	Very low	Moderate	Very small	Very low	Low
GAF	Moderate	Moderate	Moderate	Very small	High	Moderate
CCS	Very poor	Low	low	Large	Low	Moderate
UCS	Very poor	Very low	High	Small	Low	Moderate
PANEL	Good	Moderate	Low	Moderate	Low	high
TEEN	Good	Very high	High	Small	Low	High
PEGASIS	Moderate	Low	Low	Very large	Very low	High
CCS	Very bad	Low	Low	Large	Low	Moderate
BCDCP	Good	Very low	High	Small	Very low	Very high

**5. CONCLUSION**

In WSNs, the routing is the main and crucial task because of rapid change in size of WSN and its applications. The main requirements of cluster baser algorithms are energy efficiency, scalability, load balancing and link stability. The centralized routing protocols are not enough to cater all these requirements. In this paper, a rigorous comparative analysis is performed of several important distributed cluster based routing algorithm. Every technique has its own pros and cons. Based upon the analysis a new scheme can be proposed which take into account the above mentioned factors and enhance the performance of cluster schemes.

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