

# Clustering in Wireless Sensor Networks: Survey

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## ABSTRACT

*Wireless sensor networks (WSNs) are evolving as indispensable and popular ways of given that persistent computing surroundings for various applications. In these entire surroundings energy limit is the most critical problem that must be well thought-out. Clustering is introduced to WSNs because of its network scalability, energy-saving attributes and network topology stabilities. There also exist some disadvantages linked with individual clustering scheme, such as additional outlays during cluster-head (CH) selection, assignment and cluster construction process.*

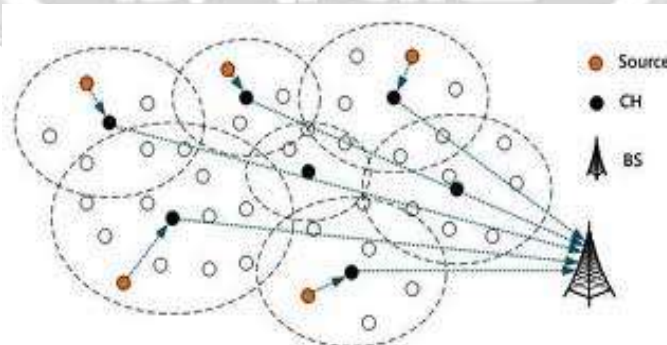
**Keyword:** - WSN, MEMS, PN, SNs.

## 1. Introduction

Introduction WSNs consist of a large number of limited capabilities (power and processing) Micro Electro Mechanical Systems (MEMS) capable of measuring and reporting physical variables related to their environment. A WSN consists of spatially distributed autonomous sensors to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants. Sensor networks are being deployed for a wide variety of applications [1], including by military applications such as battlefield surveillance and is now used in many industrial and civilian application areas, environment and habitat monitoring, healthcare applications, home automation, and traffic control. In surveillance applications, sensors are deployed in a certain field to detect and report events like presence, movement, or intrusion in the monitored area. Data collected by sensors are transmitted to a special node equipped with higher energy and processing capabilities called "Processing Node" (PN) or "sink". The PN collects, filters, and compiles data sent by sensors in order to extract useful information.

### 1.1 Sensor Network Architecture

We consider the sensor network architecture depicted in Figure 1. In the architecture SNs are grouped into clusters controlled by a single command node. Sensors are only capable of radio-based short-haul communication and are responsible for probing the environment to detect a target/event. Every cluster has a gateway node that manages sensors in the cluster. Clusters can be formed based on many criteria such as communication range, number and type of sensors and geographical location. Sensors receive commands from and send readings to its gateway node, which processes these readings.



**Fig-1** Sensor Network Architecture

Gateways can track events or targets using readings from sensors in any clusters as deemed by the command node. However, sensors that belong to a particular cluster are only accessible via the gateway of that cluster. Therefore, a gateway should be able to route sensor data to other gateways. Gateway nodes interface the command node with the sensor network via long haul communication links.

The gateway node sends to the command node reports generated through fusion of sensor readings, e.g. tracks of detected targets. The command node presents these reports to the user and performs system-level fusion of the collected reports for overall situation awareness.

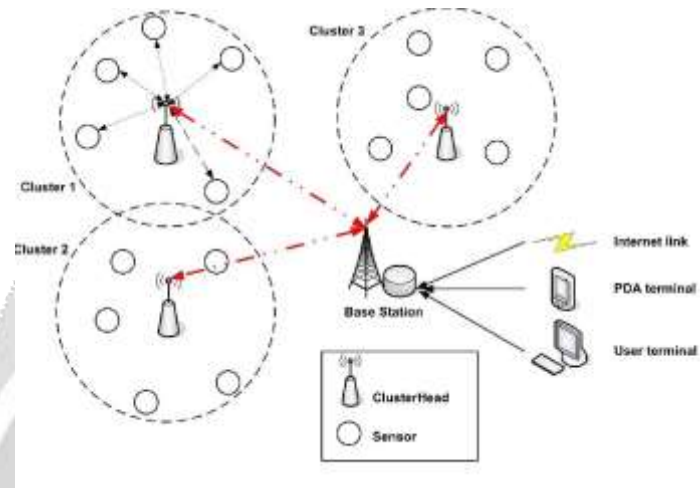
## 2. CLUSTERING IN WSNs

The major advantage of WSN is the ability to deploy it in an ad-hoc manner [2], as organizing these nodes into groups pre-deployment is not feasible. For this reason, a lot of research has been conducted into ways of creating these organizational structures (or clusters) [3]. A clustering scheme divides the sensor nodes in a WSN into different virtual groups, according to some set of rules. In a cluster structure, sensor nodes may be assigned a different status or function, such as cluster head or cluster member [4]. We can see in the Figure 2, the architecture of a generic WSN, and examine how clustering is an essential part of the organizational structure [3].

**Sensor Nodes:** Sensor nodes are the building blocks of a WSN. They can play multiple roles in a WSN, such as simple sensing, data processing, data storage and routing.

**Clusters:** Clusters are the organizational unit of WSNs. The dense nature of WSNs requires them to be broken down into clusters to simplify tasks such as routing.

**Cluster heads:** Cluster head is the organizational leader of a cluster. It organizes the activities in a cluster.



**Fig-2** Clusters in WSNs

The activities include data-aggregation, diffusion, organizing the communication schedule of the cluster, etc.

**Base Station:** The base station is often located far from the network. It provides the communication link between the WSN and the end-user.

**End User:** The data obtained from sensor network can be used for a wide-range of applications. A particular application can make use of the network data over the internet, using a PDA, or even a personal computer. In a queried sensor network, queries are generated by the end user.

## 3. CLUSTERING ALGORITHMS

Many algorithms have been proposed for routing in WSN. Clustering algorithms have gained popularity in this field. Clustering algorithms can be classified as:

- Distributed algorithm,
- Centralized algorithm,
- Hybrid algorithm

In distributed clustering techniques, any node can choose itself as a CH or join an already formed cluster on its own initiative, independent of other nodes. Distributed clustering techniques are further classified into four sub types based on the cluster formation criteria and parameters used for CH election as identity based, neighborhood information based, probabilistic and iterative. In centralized methods [5], the BS requires global information of the network to control the network. CHs are elected by the base station. Hybrid schemes are composed of centralized and distributed approaches. In a hybrid environment, distributed approaches are used for coordination between CHs, and centralized schemes are followed for CHs to build individual clusters. In design of routing protocols for WSN, clustering algorithms have following advantages:

- Clustering reduces number of nodes taking part in long distance transmission.
- Clustering algorithms are scalable for large number of nodes.
- They reduce communication overhead.
- Energy is utilized properly by the use of clustering algorithms.

## 4. LITERATURE SURVEY

The table shows a brief survey of clustering in WSNs.

TABLE I  
Literature Survey of various Clustering protocols.

Year Authors	Literature	Main contributions
2006 Arboleda. et al.	Comparison of clustering algorithms and protocols for wireless sensor networks [7]	① Discussion of basic concepts related to the clustering process
		② Analysis of LEACH-based protocols
		③ Survey of proactive and reactive algorithms in WSNs
2007 Abbasi et al.	A survey on clustering algorithms for wireless sensor networks [6]	① Presentation of a taxonomy of typical clustering schemes
		② Survey of variable convergence time clustering protocols and constant convergence time clustering algorithms in WSNs
		③ Comparison of popular clustering methods
2008 Kumarawadu et al.	Algorithms for node clustering in wireless sensor networks: a survey [8]	① Presentation of a classification based on cluster-formation parameters and CH election criteria
		② Discussion of the key design challenges of WSN clustering
		③ Analysis of the performance issues related WSN clustering
2008 Deosarkar et al.	Cluster head selection in clustering algorithms for wireless sensor networks: a survey [9]	① Discussion of CH selection strategies based on the classification of deterministic scheme, adaptive scheme and combined metric scheme
		② Comparison of the costs of CH selection with respect to cluster formation, distribution of CHs and creation of clusters
2009 Jiang et al.	Towards clustering algorithms in wireless sensor networks-a survey [10]	① Presentation of a classification of WSN clustering schemes based on 8 clustering attributes
		② Analysis of popular WSN clustering algorithms
		③ Comparison of popular WSN clustering algorithms
2010 Maimour et al.	Cluster-based routing protocols for energy-efficiency in wireless sensor networks [11]	① Presentation of a classification of WSN clustering algorithms
		② Discussion of typical WSN clustering protocols based on pre-established and on-demand manners
		③ Summary of some future research directions
2010 Lotf et al.	Hierarchical routing in wireless sensor networks: a survey [12]	① Discussion of typical clustering routing protocols for WSNs
		② Comparison of clustering routing algorithms based on energy consumption and network lifetime
2010 Boyinbode et al.	A survey on clustering algorithms for wireless sensor networks [13]	① Discussion of the main challenges for WSN clustering
		② Analysis of popular clustering algorithms for WSNs
		③ Comparison of popular WSN clustering algorithms based on many attributes
2011 Wei et al.	Cluster-based routing protocols in wireless sensor networks: a survey	① Presentation of a classification based on three attributes
		② Discussion of the challenges in WSN clustering

	[14]	③ Analysis of popular clustering routing techniques
2011 Xu et al.	Comparison study to hierarchical routing protocols in wireless sensor networks [15]	① Analysis of popular clustering routing protocols in WSNs
		② Comparison of popular WSN clustering routing algorithms
2011 Joshi et al.	A survey of hierarchical routing protocols in wireless sensor network [16]	① Discussion of familiar clustering routing algorithms in WSNs
		② Comparison of familiar WSN clustering routing protocols based on energy conservation and network lifetime
2012 Haneef et al.	Design challenges and comparative analysis of cluster based routing protocols used in wireless sensor networks for improving network life time [17]	① Discussion of the challenging factors in WSN clustering
		② Presentation of a classification of routing protocols in WSNs
		③ Analysis of classical WSN clustering routing protocols
		④ Comparison of classical clustering routing algorithms for WSNs

## 5. CONCLUSIONS

The main objective of clustering routing techniques is to deploy sensors in such a way that network lifetime increases. The WSN is a wide area the paper has covered only few clustered based routing protocols and the main characteristics of discussed protocol with their major advantages and disadvantages have been discussed here.

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