

# Inference and Clustering Based Routing Techniques in WMN

Monika<sup>1</sup>, Dr. Yashpal Singh<sup>2</sup>

Student of M.Tech Ganga Institute of Technology & Management, Jhajjar<sup>1</sup>

Associate Professor, Computer Science and Engineering, Ganga Institute of Technology & Management, Jhajjar<sup>2</sup>

**Abstract:** The main goal of using the WMN (Wireless Mesh Network) is to find the correct and easy path from source to destination. The routing techniques have the potential to find the correct path. With the increase in demand of the service in WMN [1],[8],[17], the Routing topology comes out to be an interesting topic in Research Field. WMN provides the concept of new challenges in the next generation level networks for example Flexibility, adaptive nature and cost efficiency. WMN supports AODV (Ad Hoc on Demand Distance Vector) [5],[7], Hop Count, Fuzzy model and throughput that has the capability of self forming and self organizing. WMN consist of static WMR (wireless Mesh Router) called Ap's. As in the Other way, Clustering is the other Routing technology consist of Wireless sensor, Congestion Control and Distributed System which provides the adaptive methods of routing.

**Keywords:** Wireless Mesh Network, AODV, fuzzy Inference, Cluster Routing, LEACH.

## 1. INTRODUCTION

The Networking technology are developing and increasing continuously in the field of computer application, business, education and defence system. The inference model and clustering algorithms are becoming an important part of the computer application system [2].

These technology improves the network for message passing between the computers. In this paper we will study how the inference model will help to provide an efficient way of finding the best path for message passing using multiple constraints in wireless mesh network.

The Inference [13] [14] and Cluster based routing protocols [31],[32] includes Multiple Constraints in Routing such as energy consumption, energy efficiency, throughput, End to end Delay, Packet delivery and traffic Intensity.

## 2. INFERENCE ROUTING TOPOLOGY IN WMN

Routing protocols can be classified into proactive and reactive. Proactive protocols need to maintain routes between all node pairs all the time, while reactive routing protocols only build and maintain routes on demand.

Studies have shown that reactive routing protocols perform better in terms of packet delivery ratio and incur lower routing overhead especially in the presence of high mobility. In WMN, transfer of data takes place to and from the AP. Each node sends route requests to its neighboring node.

When the requests reach the different APs, they send back a feedback to the route. The sender node receives all these feedback and decides which route and AP to use based on different conditions.

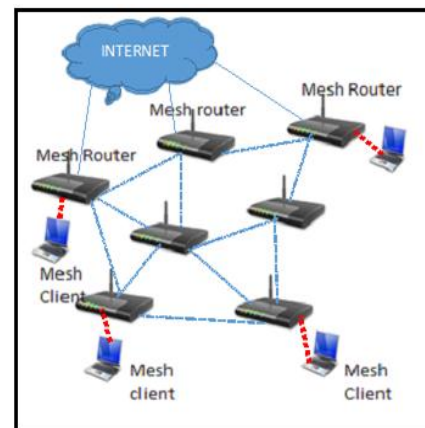


Figure 1. Wireless mesh networks.

### 2.1 Routing with AODV

AODV [5],[7] method used for message routing between mobile computers. Every mobile host operates as a specialized router and routes are obtained as required i.e. (on demand). AODV provides loop free routes even while repairing broken links. AODV works on establishment of dynamic route table at the intermediate nodes. AODV defines links between consecutive nodes. Figure 2.

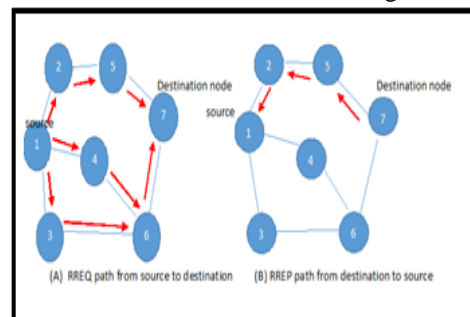


Figure 2. AODV (Ad Hoc on Demand Distance Vector)

2.2. Routing with Fuzzy Logic

In this paper a routing algorithm is based upon fuzzy logic [11],[12] which decrease the communication overhead and storage space. The inference algorithms include the fuzzy system which consist of :

1. Fuzzification
2. Inference engine
3. Defuzzification

The Fuzzifier includes the crisp set which assign the truth value and membership function for each fuzzy set. The Inference engine consist of rule base and inference rules .This includes linguistic variables, IF-THEN rules described by fuzzy set. The Defuzzification is composed by Defuzzifier for solution this will give a optimal solution for crisp set.

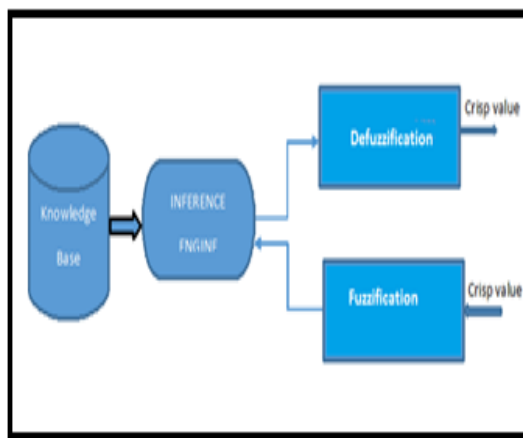


Figure 3. Fuzzy routing topology

The functions performed by various units in the fuzzy controller are explained as follows:

2.2.1. Membership Function with Fuzzification

The membership function of a fuzzy set represents the degree of truth. Fuzzy truth represents membership in vaguely defined sets, not likelihood of some event or condition. Membership functions on any fuzzy input X represent fuzzy subsets of X. In the membership function under consideration, the fuzzy inputs buffer occupancy and hop count have been divided into three fuzzy subsets - low, medium and high. Fuzzifier is the mechanism that is used to map the real-world fuzzy inputs to the range [0, 1].

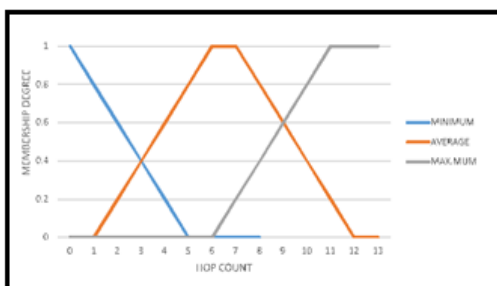


Figure 4. Triangular membership function for buffer occupancy, residual node energy and hop count over a normalized range.

2.2.2. Inference Engine and Fuzzy Rule Base

The fuzzy inference engine takes the value of fuzzy inputs at each node and scans through the fuzzy rule base to find the appropriate entry corresponding to the fuzzy inputs to calculate the fuzzy output cost for each node.

2.2.3. Defuzzifier

Defuzzifier is a process that convert fuzzy grade to crisp output .It is valid the Symmetrical outout of the membership function using in the fuzzy system. The Defuzzification defines:

1. Middle of Maxima
2. Center of gravity
3. Center of area

3. CLUSTERING IN WMN

Wireless networks are collection of wireless sensor nodes [27],[28],[29],[30] and cluster Head. The cluster Head are responsible for routing process and communicate through the Gateway node. The cluster Nodes are used to collect the information about the small task happening in the network. The Cluster Network includes

1. Cluster Head
2. Cluster Node
3. Sensor Data
4. Aggregated Data
5. LEACH(Low energy adaptive clustering hierarchy)

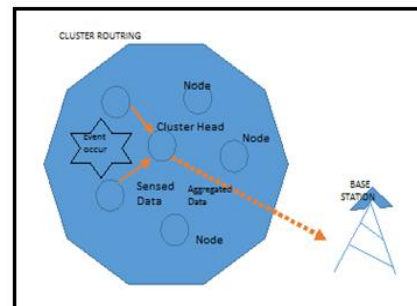


Figure 4. Working of Clustering in a network

3.1 Clustering method for Congestion Control in WMN

In Wireless Network to reduce the flow of traffic, to require the maintain the packet sending rate .In Ad-hoc Network ,Congestion will occur with limited amount of resources so the estimated intensity of the traffic propagated to the network. The intensity of each one is related to the nodes present in control packets. In clustering congestion control the same type of node are grouped into one that collaborate by exchanging information on estimated traffic intensity.

3.2 Clustering method for Wireless Sensor in WMN

Wireless Sensor Network(WSN) [29],[30]sometimes also called the actuator network and Sensor networks. The Sensor Networks used to send data or information to the main network. The WSN is widely used in different fields such as health and medical, security and surveillance for military, industries and consumer application.

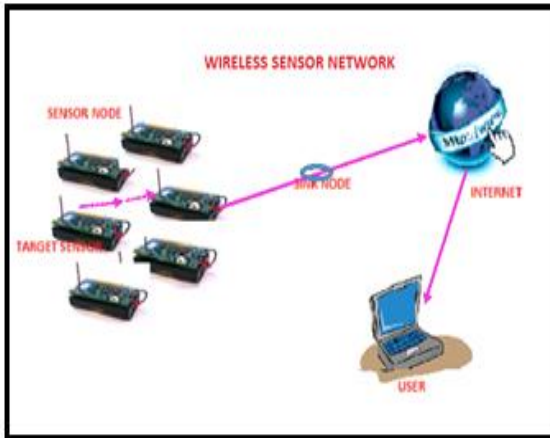


Figure 5. working of wireless sensor network

3.3 Clustering method for Energy Efficiency in WMN Clustering Routing Protocol play an important part for the network to increase the stability of the network for lifetime. In WSN, there are various protocols which are proposed to increase the network connectivity and decrease the energy consumption of the network. There are multiple sensor nodes working into the WSN cluster to increase the working efficiency of the network by using Sink node and Cluster Head.

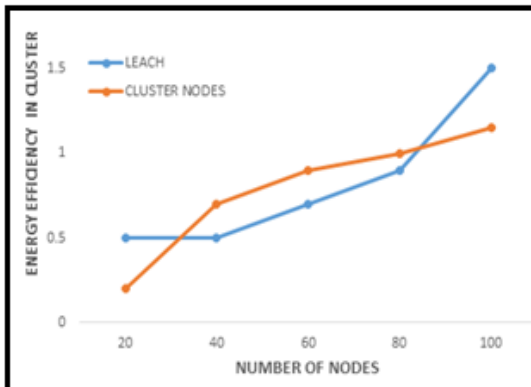


Figure 6. Description of energy- efficiency in cluster using MATLAB simulator.

3.4 LEACH for Cluster Network in WMN LEACH (Low energy adaptive clustering hierarchy) [19],[20] is designed for Sensor Network to monitor the environment where the each node sent to the base station, which is far located from the sensor network. Various protocols used in the network are:

1. It uses the multiple node to send the information to the base network (such as 100-1000).
2. It will increase the network lifetime.
3. Use the Distributed cluster and uniform better operated node.

The Distributed Cluster and Processing network are used to decrease in number of cluster heads which allow the LEACH to gain the desired energy efficiency. The energy efficiency in the LEACH can be calculated as  $E_c$  is the energy for current node and  $E_a$  is used for average energy.

$$f(E_c) = \frac{E_c}{E_a}$$

The function  $F$  is relevant to the Leach with the cluster head with increase in probability of getting near to base station node and  $E(n)$  is the impact on cluster head (ch). The average in efficiency will be

$$E(ch) = \frac{E_{max} - E(n)}{E_{max} - E_{min}}$$

#### 4. COMPARING THE INFERENCE AND CLUSTERING ROUTING PROTOCOLS

##### 4.1 Flow Diagram for inference and cluster based routing

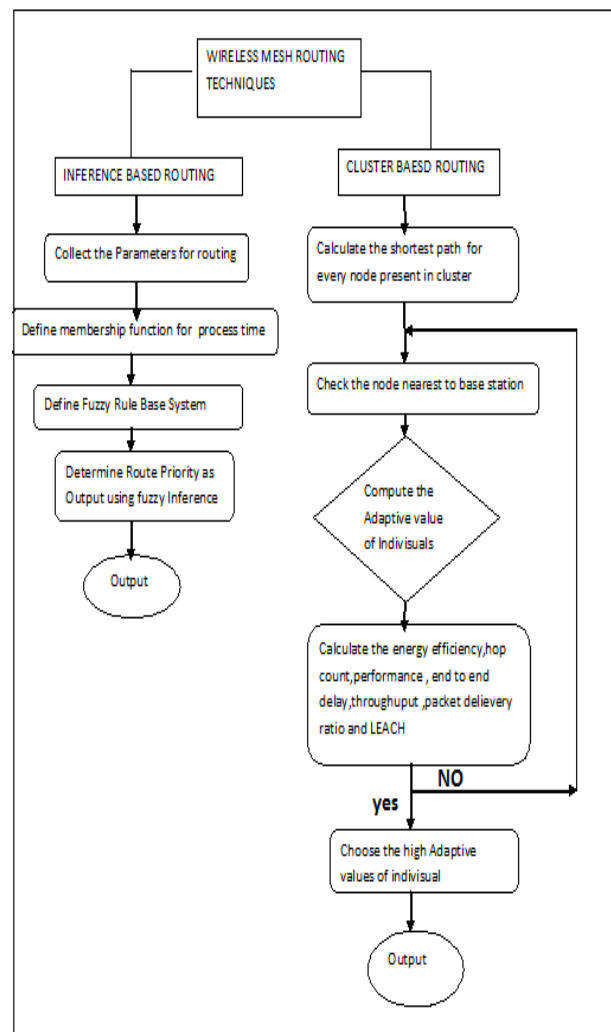


Figure 7 Flowchart for Inference and Cluster based Routing

Inference and Clustering Routing both are different in their routing scheme. According to the simulation results the routing protocols find the difference in their energy consumption, performance and reliability as we see in the Inference Routing methodology, fuzzy system. The following table shows how the multiple constraints in the inference and clustering routing protocols varies with each other.

S.NO	INFERENCE ROUTING PROTOCOLS	CLUSTERING ROUTING PROTOCOLS
Hop Count $\Theta \left[ \frac{1}{R(n)} \right]$	Unbounded	Based upon number of cluster head used in transmission
Throughput	High	High
Congestion Rate	Decrease with the traffic rate	Very low with
Performance and Cost	Maximum	High
Energy consumption Rate	High	Decrease with increase in performance
End to End Delay	Decrease with the mobility	Dependes upon the error checking and scheduling of queues
Packet Delievery Ratio	Average Overhead per flow of packets	Minimum
Traffic Intensity	Average	Increase/decrease in traffic
Routing Path	Choose Optimal Path	Based on cluster protocols
Reliability	Maximum	Maximaum

Table 4.1 Representation of different constraints in Inference and cluster routing

### 5. SIMULATOR RESULTS FOR INFERENCE AND CLUSTER ROUTING

In this paper we are using MATLAB as simulator .MATLAB is a fourth Generation programming language. It is developed by MATHWORKS. MATLAB is generally used for the manipulation ,plotting the graphs by using function & data and implementation of various algorithms. The result of Routing schemes using Multiple Contraints as follows:

Here we consider that  $E_c$  is the energy consumed for reciever.

Then the total amount of energy consumed to send packet at distance of single HOP is calculated by  $E_n = \text{Energy of node from node a to b}$

$$\{ E_n = E_{ab} + E_c \}$$

$E_{ab}$  is also known as the packet loss from one node to other. The cluster based routing schemes used te different contraints such as

1. LEACH(Low energy adaptive clustering hierarchy)
2. EEHC(Energy efficient hierarchical clustering)
3. HEED(High energy efficient distributed)

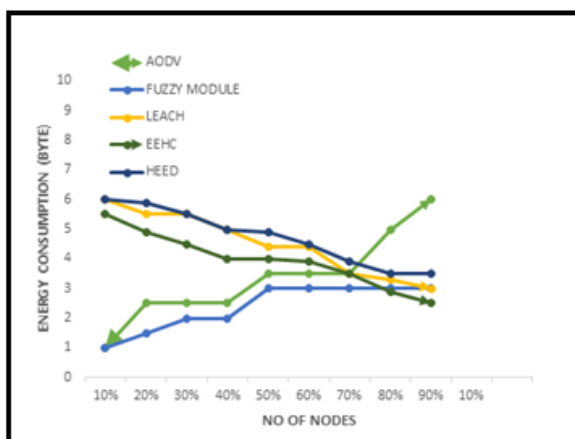


Figure 6.1 Energy consumption using Inference and cluster based Routing scheme

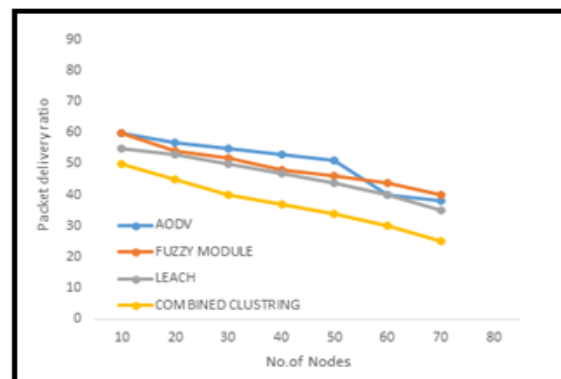


Figure 6.2 Packet delivery using Inference and cluster based Routing scheme

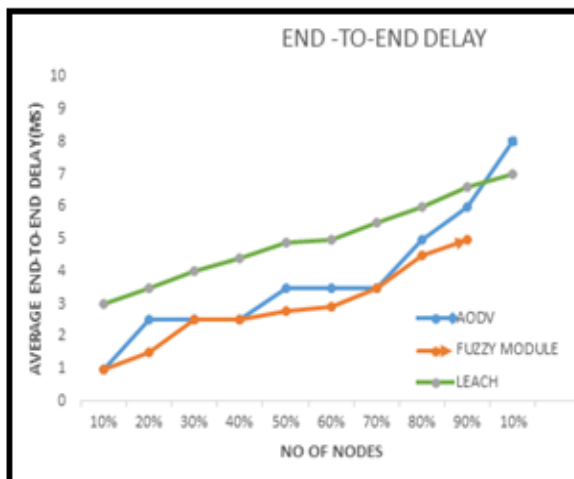


Figure 6.3 End to end delay using Inference and cluster based Routing scheme

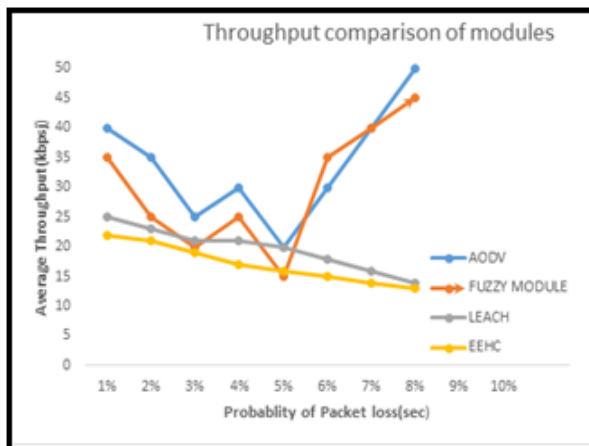


Figure 6.4 Average Throughput using Inference and cluster based Routing scheme

## 6. CONCLUSION AND FUTURE WORK

Now the Routing techniques of Wireless Mesh Network are improving day by day. WMN proposed the different Routing techniques. This paper has Proposed two techniques of WMN such as Inference routing scheme and Cluster based Routing scheme. Our proposed routing scheme is based upon finding the difference between both the techniques in their own quality of fields. Our simulation results will show the compatibility between the different modules of the routing techniques.

### FUTURE WORK

Inference model and cluster routing is suitable tool to be applied in the wireless mesh network routing decision purposes. The research work in the present paper is to show a difference between the two technologies using the energy efficiency, energy consumption, hop count, Throughput and delay of packets. We believe that the proposed routing scheme can be further investigated based on other routing metrics in order to design better adaptive technique for wireless mesh networks.

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