CHAPTER 5

IMPLEMENTATION OF NEURO FUZZY SCHEDULING BASED CONNECTED DOMINATING SET IN WIRELESS MESH NETWORK

5.1 Introduction

Neuro fuzzy logic method is taken in wireless mesh network to increase a network performance. Comparison must be made between the fuzzy logic routing and neuro fuzzy logic scheduling based CDS method on the process. A Connected Dominating Set (CDS) based virtual backbone plays an important role in wireless mesh network for efficient routing and broadcasting. A CDS is a promising approach for broadcasting. A node in the CDS consumes more energy and the energy depletes quickly than non dominating nodes. Although previous conditional shortest path routing algorithms achieve good results in terms of the network, one has to increase a network performance and to reduce the energy level in the network.

A minimum size CDS does not necessarily guarantee an optimal network performance from an energy efficient point of view (Santhi G and Nachiappan 2013). The data transfer takes place from source to destination in the network. The Neighbour discovery distance (NDD) method is used to identify the nearby nodes on network using CDS. The CDS provides high priority node on neighbour model. This type of CDS is used for priority based data transmission in the networks. This method is used to avoid traffic and improve the network performances on the system (Sakthidharan G R and Chitra S 2013).
The most efficient routing method for wireless mesh network is Neuro fuzzy scheduling based conditional shortest path routing method on the process. Here Connected dominating set construction algorithm uses the NDD method in the network. The Simulation results in NS-2 verify that they perform better than multiple restriction routing. The AP need not to be in the reach of all the nodes in the network. Nodes around the AP forward the packets from the neighbour nodes to the AP. The SNF routing protocol improves the network performance and reduces the energy level on network.

**Priority based data transmission**

The priority based data transmission on the high priority node with NDD and their delay constraints drive the selection of optimal transmission strategies at the different layers hop-by-hop. In order to realize the mentioned priority in (Pushpalakshmi R and Vincent A K 2011) queuing framework for data transmission process in the network, defining information feed back to a node for a connected dominating set priority model on this algorithm is required.

**Mobility Management Model**

A WMN must manage the mobility of user nodes throughout the network. As they move, user devices change their point of attachment to the network, connecting to the access point with the strongest signal. Mobility raises several issues, similar to those known in both wired and cellular networks. Mobility management has been integrated into the routing process in order to cope with highly mobile nodes (Parimal K G 2012). In wired and cellular networks, routing and mobility management have been defined separately although they are complementary mechanisms.
Neuro Fuzzy Logic Method

In a network like WMN, the various constraints like collisions, traffic level, buffer occupancy, energy level need to be considered. It is not enough if only one constraint is considered. This is because of the complex relationship existing between the different constraints. Multi-constrained routing is to resolve their complete problem and does not have solution. It is required to use various heuristics and soft computing techniques to solve them. Using the routing algorithm for neighbour discovery distance method to set a priority based data transmission in the network is recommended besides using an AODV routing protocol with connected dominating set constraints on the data pre processing model. The neuro fuzzy scheduling based CDS is chosen for the best result on network, so all data transmissions are secured and they reduce the data loss in the network.

Implementation of Routing Model

In the SNF model, one has to implement an AODV routing protocol used in ad-hoc networks. In AODV, each node maintains a routing table which is used to store destination and next hop IP addresses as well as destination sequence numbers. Each entry in the routing table has a destination address, next hop, precursor nodes list, lifetime and distance to destination. It is simple with each node behaving as a router, maintaining a simple routing table, and the source node initiating route discover request, making self-starting the network.
5.2 Scheduling Neuro Fuzzy

The AODV with Scheduling based Neuro Fuzzy Logic with Neighbour discovery distance method is used for checking a priority and nearby nodes in the network. CDS is applied to dominate the set of nodes and collect the neighbour nodes information and send the data to destination on shortest path and reduce the energy level on their whole network performance. Recent research does focus on multi-path routing protocols for load balancing. Multipath on-demand routing protocols tend to compute multiple paths, at the traffic sources as well as at the intermediary nodes, in a single route discovery attempt (Radunovic B 2010). This reduces both the routes discover latency and the control overhead as a route discover is needed only when all the discovered paths fail. Spreading the traffic along several routes could alleviate congestion. Multi-path routing also provides a higher aggregate bandwidth and effective energy level based on scheduling as the data forwarding load can send the data to all paths on network.

Neighbour Distance Discovery technique

The Neighbour Distance Discovery (NDD) method is used to send the information quickly and to rectify low latency of the network transmission on the process. This method is for broadcasting in the network. The new scheme minimizes the traffic by location information and limits broadcast retransmission only to host near the node coverage in the network (Ortiz A M and Olivares T 2012).
Each broadcasting node attaches the list of selected forwarding nodes to the message before broadcasting it. So that the NDD method improves the performance of the resources and energy level of the network latency.

**Connected Dominating Sets**

Using a Connected Dominating Sets (CDS) is considered to be very efficient for broadcasting a message from one node to all the nodes in the network. One has to implement the NDD method. A CDS is a sub graph of a given undirected connected graph such that all nodes in the graph are included in the CDS or directly attached to a node in the CDS. A Minimum connected dominating set is the smallest CDS for the entire network. For a virtual backbone-based route discover, smaller the size of CDS used, the smaller is the number of unnecessary retransmissions. RREQ packets of a broadcast route discover process get forwarded only by the nodes in the CDS for minimum number of retransmissions.

**Connected dominating set forwarding rule**

A node retransmits if it has not already received the packet in the connected dominating set. On the other hand, the multipoint relay technique has been proposed to optimize flooding at the time of last hop information. The idea behind this technique is to compute some kind of local dominating sets. Each node computes a multipoint relay set with the following properties:

- The multipoint relay set is included in the neighbourhood of the node. The elements of the multipoint relay set are called multipoint relays (or MPR for short) of the node.

- Each two-hop neighbour of the node has a neighbour in the multipoint relay set. Some multipoint relay covers the two hop neighbour.
5.3 Dominating Set based Routing

Assume that a CDS has been determined for a given ad-hoc network. Dominating-set based routing usually consists of three steps:

1. If the source is not a gateway host, it forwards the packets to a source gateway, which is one of the adjacent gateway hosts in its absorbent set.

2. This source gateway acts as a new source to route the packets in the induced graph generated from the connected dominating set.

3. Eventually, the packets reach a destination gateway, which is either the destination host itself or a gateway in the dominating neighbour set of the destination host.

Priority based Data transmission

To take advantage of transmissions that reach nodes other than the next-hop, a novel mechanism called priority-based forwarding is introduced. Priority based forwarding maximizes the progress. Each packet makes by choosing the node closest to the destination to forward the packet. Different priorities are realized by using priority-based timers: the node with highest priority performs forwarding first, and other nodes hearing the transmission automatically cancel their transmissions, thereby minimizing the number of duplicate transmissions in a cheap and distributed way.
5.4 SNF-Connected Dominating Set Algorithm

S-Source, D-Destination, T-Traffic, P-Packets, M-message,
CD-Connected Dominating, R-Route, F-priority

Step 1: Initialize network nodes
    Initialize the packet counter function
    Send S message to D

Step 2: If (M=true)
    S sends Packets to D

Step 3: if Else (M=false)
    Get T on Network Path

Step 4: Message dropped on network
    Using NDD method

Step 5: Broadcast scheduling NEURO FUSSY-SET logic
    Enter total neighbour Route discovery

Step 6: Check if (F=0)
    Check the Neighbour list and connected set node
    Goto First Priority Node on CDS Path

Step 7: if Else (F≠0)
    Preprocess of Priority model
    Else
    Waiting on network model
    End

Step 8: Check Available Route & Energy to Save on CDS Path

Step 9: R=0&&T=0;

Step 10: P send to S to D normally
    Packets sending to Destination
    Else
    End
**Step 11:** Drop the Packets $P$

Exit

**Step 12:** Every Time update Route information

**Implementation of the SNF-Connected Dominating Sets routing algorithm working steps**

1. The data are sent by wireless mesh network from source (S) to destination (D) on network topology.

2. Access point collects the neighbour node list and connected dominating nodes to transmit the data to destination intermediately from source to destination on network.

3. AP has to gather the data sending and receiving process in the network. The traffic conditions need to be checked on access point. If there is any traffic in the network, it is intimated to the AP.

4. The scheduling based neuro fuzzy logic is used to set the minimum number of connected set to the destination in the network. It saves more energy and finds shortest path route in the network.

5. It reduces the packet’s delay and reduces the energy level on their wireless mesh network. The connected set is more efficient and scalable network on that time of network process.

6. The scheduling based neuro fuzzy-set logic applies some conditions when there is the data loss and it can be retrieved from the source to destination process.
7. Using a new route processing model in the network and then connected dominating set routing algorithm for processing method in the network.

8. When data are being sent from source to destination, the network saves the energy, reduces the traffic and quickly sends the data from source to destination in the network.

5.5 Results and Discussions

The platform used was the NS-2 (Network Simulator version 2). NS-2 is a discrete event simulator targeted at networking research. NS-2 provides substantial support for simulation of TCP, routing, and multicast protocols over wired and wireless networks. The simulation environment is created in NS-2, a network simulator that provides support for simulating mesh wireless networks. NS-2 was written using C++ language and it uses the Object Oriented Tool Command Language (OTCL). It came as an extension of Tool Command Language (TCL). Fuzzy Routing Decision was implemented using the Fuzzy Logic.

The simulator executed with various input configuration settings and the statistics collected were analyzed in comparison with other well-known on demand routing protocol AODV. This simulation modeled a network of nodes placed randomly within 1200 × 1200 meter area. Each node had a radio propagation range of 250 meters and channel capacity. Two-way propagation model was used. The IEEE 802.11 distributed coordination function was used as the medium access control protocol.
A random waypoint mobility model was used in SNF model. Each node randomly selected a position and moves toward that location with a speed ranging from just above 0 m/s to 20 m/s. When the node reached that position, it became stationary for a programmable pause time; then it has selected another position and repeat the process. The simulation was repeated with different start values. Neuro Fuzzy logic Based Connected Dominating Set Routing Algorithm with a Multiclass Scheme for generator was developed to simulate CBR (Constant Bit Rate) sources. The radio and IEEE 802.11 MAC layer models were used. The size of the data payload was 512 bytes. Data sessions with randomly selected sources and destinations were simulated. Each source transmitted data packets at a minimum rate of packets to send the source to destination in the network. Traffic classes were randomly assigned and simulation was carried out with different bandwidth requirements. There were no network partitions throughout the simulation. Each simulation was executed for 600 seconds of simulation time. The parameter values for simulation are shown in table 5.1.

Table 5.1: Parameters for SNF-AODV Simulation

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version</td>
<td>Ns-all in one 2.28</td>
</tr>
<tr>
<td>Protocols</td>
<td>SNF-AODV</td>
</tr>
<tr>
<td>Propagation model</td>
<td>Free Space</td>
</tr>
<tr>
<td>Area</td>
<td>1500m x 1500m</td>
</tr>
<tr>
<td>Transmission Range</td>
<td>250 m</td>
</tr>
<tr>
<td>Traffic model</td>
<td>UDP,CBR</td>
</tr>
<tr>
<td>Packet size</td>
<td>1024 KB</td>
</tr>
<tr>
<td>Mobility Model</td>
<td>Random Way Point</td>
</tr>
<tr>
<td>Node’s Mobility</td>
<td>0-100m/sec</td>
</tr>
</tbody>
</table>
Throughput Performance

Each protocol has different average throughput levels. The average throughput of scheduling Neuro fuzzy routing outperforms AODV and traffic balancing as it is always choosing the optimal path.

Figure 5.1 Throughput Performance of SNF-AODV

Throughput is the ratio of successful packet delivery and minimum packet delay over a network. The throughput performance of Neuro Fuzzy and the Scheduling Neuro fuzzy logic routing is depicted in figure 5.1.
The performance of Scheduling Neuro fuzzy logic based Connected Dominating sets routing throughput level was higher than neuro fuzzy logic routing in the network. The performance of throughput level and high accuracy of the data transfer from source to destination in the network was calculated.

**Packet Delivery Fraction**

Packet delivery fraction is the ratio of data packets delivered to the destination and those generated by the source. It is calculated by dividing the number of packet received in the destination by number packet originated from the source.

\[
\text{PDF} = \frac{\text{Pr}}{\text{Ps}} \times 100
\]

Where, Pr is total Packet received & Ps is the total Packet sent.

![Figure 5.2 Packet Delivery Performance of SNF-AODV](image-url)
Packet delivery fraction calculates the data transmission between the one to another node in the network. The performance of packet delivery fraction for the SNF routing is depicted in figure 5.2. The scheduling Neuro fuzzy logic used the optimal routing. Fuzzy Logic has been used for routing and management of an ad-hoc wireless network. The fuzzy logic routing algorithm takes into account of input variables, such as delay, throughput and energy consumption. The Neuro fuzzy routing might have more routing overhead because of measuring lots of constraints at each node on the path. It has the least overhead due to routing. It is true that a lot of time is spent initially for setting up of the route. But fuzzy routing always leads to stable routes and the routes are used for a longer period.

**End-to-End Delay**

Average end-to-end delay included all possible delay caused by buffer during route discovery latency, queuing at the interface queue, retransmission delay at the MAC, propagation and transfer time. It is defined as time taken for a data packet to be transmitted across a MESH network from source to destination. Average end-to-end delay is written as

\[
D = (Tr - Ts)
\]

Where, Tr is receive Time and Ts is sent Time.
The performance of delay for the SNF routing protocol and also a comparison of delay for different routing algorithms is depicted in figure 5.3. Delay is used to calculate the packet dropping level of the network and if the data are dropped, the time taken by scheduling neuro fuzzy logic routing is very low in the network.
5.6 Conclusion

Fuzzy logic routing in wireless mesh network improved the handling of accuracy and removed the traffic. A Neuro Fuzzy scheduling based CDS and NDD method are presented on the wireless mesh network. The performance of this scheduler was studied using NS-2 and evaluated in terms of quantitative measures such as path success ratio, average end-to-end delay, and throughput. The Scheduling data transmissions are priority based data sending and receiving process. It is an important process on this AODV protocol model. The simulation shows that the approach is efficient, promising and applicable in ad-hoc wireless mesh network.