CHAPTER 3

MOBILE AGENT BASED RELIABLE AND ENERGY EFFICIENT ROUTING PROTOCOL FOR MANET

3.1 INTRODUCTION

Right from the modernization of communication media, communication among people and devices has evolved in a marvelous way. The communication is carried out by using various communication models. Wireless communication itself is carried out in two different ways such as the infrastructure-based method of communication in which mobile nodes are communicating through a stationary backbone network and the other is infrastructure less model which the communicating among the mobile devices. A MANET is one of the instances of infrastructure-less system model in which nodes have prearranged themselves and they act as a router as well as host. Nodes in a MANET does not use centralized management. Hence the communication between the nodes is performed either in single hop if the receiver is within transmission range of sender or by relaying through some intermediate nodes.

This chapter discusses the overview of Mobile Agent based Reliable and Energy Efficient Routing Protocol (MAREERP) in mobile ad hoc networks. It also describes the methodology to obtain the link cost metrics such as network load, bandwidth, energy consumption and link availability.
Then the mobile agents are deployed randomly over the source node and it migrates hop by hop until reaches the destination. Mobile agents collect the metrics mentioned above form each node that they traverse and combined them to estimate the cost metric. Multiple paths are established based on the collected information and then the sender selects the optimal path using the path cost metric which is the summation of link cost metric along the path. Further, this chapter evaluates the performance of the detection system.

3.2 ROLE OF MOBILE AGENTS IN MOBILE AD HOC NETWORKS

The Mobility characteristics and intelligence make Mobile Agent-based System (MAS) preferred choice for employment of highly dynamic MANET atmosphere. Reliability of MAS can be termed as the degree to which provides accurate output. Mobile Agent is an autonomous and distinguishable program that can move within the network and integrates application logic to perform the desired task today, mobile agent model becomes the desired choice for communication in MANET because it allows the programming load to be balanced evenly across information, middleware, and client. In case of MANET, the mobile agent performs better in its dynamic environment due to it fundamentally distributed characteristics.

In General, a Mobile Agent executes on a machine that hopefully provides the resources or services that it needed to do its work. If a machine does not contain the needed resources or services, the mobile agents migrate itself to a new machine. The benefits of using a mobile agent in MANET routing are:

- Mobile agents are capable of upgrade protocols in use by moving to a destination and setting up communications operating under revised policies.
Mobile agents become independent of the process that created them after being dispatched and operates asynchronously and reacts dynamically and autonomously to environmental changes.

Mobile agents can reduce network life load and latency by running remotely.

3.2.1 Routing Using Mobile Agents

Mobile agents are used for routing in dynamic networks concentrates on route discovery process by using the agents continuously track the changes in the topology and update their routing tables at all the mobile nodes it has visited. When a route is requested, an agent is sent to discover routes to the destination. These agents analyze the routing table on the host that they arrive at and either return a discovered route to the sender and migrate to another machine if the route is not found. Each agent consists of three components such as agent identifier, anagent program, and the agent briefcase. Here the agent briefcase consists of a set of network state variable such as survival time, counter, available bandwidth, and energy consumption etc. A mobile agent is capable of sharing its briefcase with other agents and nodes available in the network. The state variable has to be updated when an agent leaves a node. The structure of a node is shown in Figure 3.1

<table>
<thead>
<tr>
<th>Node</th>
<th>1</th>
<th>2</th>
<th>…</th>
<th>n</th>
<th>Counter</th>
<th>Bandwidth</th>
<th>Energy</th>
<th>History</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>…</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Link Expiration time of link between nodes 1 & 2
Counter value of node 1
Remaining Energy of node 1
Available Bandwidth of node 1
History information of recent 3 visits
To grasp node i, an agent code P perform the following steps:

**Step 1:** update the information cache of a node i with any new information available in its own briefcase. The counter information stored in node i is compared with the corresponding counter carried in the briefcase of this agent. If the counter of some node is less than the counter in the agent’s briefcase that node information is overwritten by the information available in the agent’s briefcase.

**Step 2:** Determine which neighboring node has the least counter. Hence it considers as the least visited neighbor.

**Step 3:** if this neighbor of node i have not visited in past three times, then the agent select this neighbor as its next visited node. History information about the last three visit can be found in the node’s information cache. In the instance node nominated has been visited in the latest past, the agent selects the second minimum visited neighbor and so on.

**Step 4:** After selecting the nest destination, the agent updates its next destination’s ID with the selected node ID, and changes the history in the host node’s information cache with the next destination node.

**Step 5:** Increment 1 to the node’s counter and stores this value against node’s ID in the agent briefcase.

**Step 6:** When the agent ready to migrate, it copies the entire content of the host node’s cache information to its briefcase.
Step 7: The agent starts again traversing.

3.3 RELIABLE AND ENERGY EFFICIENT ROUTING IN MANET

MANET routing protocols are classified under two major categories such as proactive or table driven and reactive or on-demand routing protocols. Siddhantet al. (2016) specifies the role of efficient node-energy utilization in mobile ad-hoc networks. Node failure due to the energy drain in ad hoc networks leads to the division of networks and causes communication failure in the network. Since the energy is restricted in wireless Ad-hoc networks, designing energy-aware routing protocols has become a major issue. The objective of these protocols is to reduce the energy consumption of mobile nodes in the network in order to enhance the network lifetime. The Minimum Energy routing protocols can be further divided into three classes based on the types of link cost. These are

- Minimum Total Transmission Power (MTTP)
- Minimum Total Transceiving Power (MTTCP)
- Minimum Total Reliable Transmission Power (MTRTP)

The following issues have to consider in designing a routing protocol in MANET:

- Unpredictability of Environment
- Unreliability of wireless medium
- Resource-constrained nodes.
The bandwidth of a network is usually considered to be a critical resource, even though power efficiency is also a prime concern. The variety of methods used different parameters like link available time, link expiration time, node residual energy, node stability, successful data transmission and received signal strength to achieve a reliable route. Designing also consider the issues like link quality and load balancing.

In existing energy efficient routing protocols minimum drain rate, energy consumption and network load balancing were not considered. In the case of existing reliable routing protocol, link availability and queuing delay was not considered and also routing overhead was not reduced. Even though there are lots of work done on energy efficiency and reliability, none of the work concentrated on both. Hence MAREEP is to design to solve the above issues. A link cost metric is designed based on the following metrics in this protocol

- Network load in terms of node burden degree and bandwidth usable degree.
- Minimum drain rate(MDR) for energy consumption
- Link availability

Vishnu et al. (2012) Specifies that once the link cost metric is designed then the mobile agents are deployed randomly over the source nodes and the mobile agents are migrate hop by hop until it reached the destination. They collected the information related to the above-said metrics from the node which they visited and estimated the combined cost metric based on the collected metrics. Once the information is collected from the agents, multiple paths are established and then the source selected the optimal path based on
the estimated path cost metric which is the summation of link cost metric along the path.

![Diagram of MAREEP](image)

**Figure 3.2** Block Diagram of MAREEP
3.3.1 Link Cost Metrics

The link cost metrics is estimated using the following metrics such as network load, minimum drain rate, and link availability.

3.3.1.1 Network load

The network load works on the basis of node burden degree and bandwidth usable degree. Hence look into how the node burden degree and bandwidth usable degree of network load is calculated as shown in expression 3.1 and 3.2

- **Node Burthen Degree:**

  \[ NBD = \frac{u_x + \sum_{y \in N_x} y}{C_x + \sum_{y \in N_x} C^y_x} \]  
  \[ (3.1) \]

  where,

  - \( u_x \) - Queue length of the node x
  - \( u^y_x \) - Queue length of the node which is neighbor to the node x
  - \( C_x \) - Cache length of the node x
  - \( C^y_x \) - Cache length of the node which is neighbor to the node x

- **Bandwidth Usable Degree**

  \[ BUD = \frac{A_b}{N_b} \]  
  \[ (3.2) \]

  where,
BUD - bandwidth usable degree

\( A_b \) - Available bandwidth of the node

\( N_b \) - Total bandwidth of the node

### 3.3.1.2 Minimum drain rate

In Minimum drain rate, the node will accept all the route request only if it has enough residual battery capacity. Due to this logic, the drain rate of energy consumption will rise to high and resultant in of battery. Hence to overcome the problem of traffic load characteristics has to be evaluated. At first, the node \( x \) will observe the energy consumption caused by the transmission, response and overhearing behavior and then evaluate the drain rate denoted as \( RD_x \) for every seconds and it is denoted as \( T \). The \( RD_x \) represented as follows

\[
RD_{cr,x} = RD_x(t)
\]  

\[
RD_x(t) = \beta RD_x(t-1) + (1-\beta)RD_{cr,x}
\]

where,

\( RD_{cr,x} \) - Previous and new calculated rates

### 3.3.1.3 Link availability

The Link availability between two nodes for a particular duration, the node velocity and the distance between the nodes less than a minimum transmission range of the node is evaluated as follows,

\[
LA(D_j) = LA_1(D_{j1}) + (LA_2(D_{j2})
\]  

\[(3.5)\]
where,

\[ \text{LA} - \text{Link Availability} \]

\[ D_t - \text{Duration of link availability between two nodes} \]

The direction of node movement, the direction of the node that moves towards or away from each other can be found at using Received Signal Strength Indication (RSSI). If both nodes are moving away from each other means then the link quality can be evaluated as

\[
LA(w) = \frac{w + (D_t - w)}{D_t}
\]  \hspace{1cm} (3.6)

### 3.4 MOBILE AGENTS

In Mobile Agent (MA), every node has their own routing table in which it stores the N new routing information records from all node i.e. each and every node such as,

\[ \text{Rs: } [\text{Rs}, \{(Tx, Nh, Ax, and Nx)\ldots \text{(Tm, Nh, Am, Nm)}\}] \]

where,

\begin{align*}
\text{Tx} & - \text{Time of visiting the adjacent node Ax} \\
\text{Nh} & - \text{Number of hops} \\
\text{Nx} & - \text{Number of MAs on Ax} \\
\text{MA} & - \text{Mobile Agent}
\end{align*}

Hence then MA visits a node N, then the routing information of the node N is updated.
3.5 OPTIMAL PATH SELECTION

After collection the information’s from agents, multiple paths are established first and then the source node selects the optimal path using the path cost metric which is the summation of link cost metric along the path. The optimal path selection using link cost metric function is as follows:

\[ OL_c = \sum (NL + RD_x + LA(D_x)) \]  \hspace{1cm} (3.7)

\[ NL = (NBD + BUD) \]

By applying Network Load (NL) such as NBD (Equation 3.1) and BUD (Equation 3.2), drain rate (RD) (Equation 3.4) and Link availability (LA) (Equation 3.5) in Equation (3.7), we get

\[ OL_c = \sum \left( \frac{u_r + \sum u_r^i}{C_r + \sum C_i^r} + \left( \frac{A_r}{N_r} \right) + (\beta RD_x(t-1) + (1-\beta)RD_{x_n}) + (LA(D_x) + (LA(D_x)) \right) \]  \hspace{1cm} (3.8)

where,

- **NL** - Network Load
- **NBD** - Node Burthen degree
- **BUD** - Bandwidth usable degree
- **RD_x** - Drain Rate
- **LA(D_x)** - Link Availability

3.6 RELIABLE AND ENERGY EFFICIENT ROUTING ALGORITHM
The overall algorithm for developing Mobile Agent Based Energy Efficient Reliable routing protocol for MANET is given below,

**Step 1:** Start

**Step 2:** Read the network parameters such as Network Load in terms of the node burthen degree and bandwidth usable degree, Minimum Drainrate(MDR) for energy consumption, and Link availability.

**Step 3:** Calculate the Link cost metrics based on the received Network load, Minimum drain rate, and Link availability.

**Step 4:** Mobile Agents are employed on every node in the network after designing the Link cost metrics.

**Step 5:** Mobile agents are migrated from hop to hop and collect the Information’s related to the link cost metrics and estimation for the same is carried out.

**Step 6:** After gathering the information from the agents, numerous paths are constructed.

**Step 7:** Then the source select the optimal path using the path cost metric.

**Step 8:** stop.

### 3.7 PERFORMANCE ANALYSIS

### 3.7.1 Simulation Model and Parameters
To validate the efficiency of the proposed model, Mobile Agent Based Reliable and Energy Efficient Routing Protocol (MAREER) simulated with varying network conditions under Linux environment using Network Simulator (ns-2).

Figure 3.3 Simulation Overview

The IEEE 802.11 for MANETs as the MAC layer protocol. The performances of the suggested approaches are analyzed with a variety of simulation parameters. Figure 3.3 explains the process of simulation. The first
step in the simulation is to create a scenario. The scenario is created with scenario file and communication file. Then the simulation is started based on the scenario as shown in table 3.1. Then the output trace file is processed with network animator.

### Table 3.1 Network Simulation Parameters

<table>
<thead>
<tr>
<th>S.No</th>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Topology size</td>
<td>1000 X 1000 m²</td>
</tr>
<tr>
<td>2</td>
<td>Number of Nodes</td>
<td>50, 100, 150, 200, 250</td>
</tr>
<tr>
<td>3</td>
<td>MAC</td>
<td>802.11</td>
</tr>
<tr>
<td>4</td>
<td>Simulation Time</td>
<td>50 sec</td>
</tr>
<tr>
<td>5</td>
<td>Traffic Source</td>
<td>CBR</td>
</tr>
<tr>
<td>6</td>
<td>Rate</td>
<td>100 Kb</td>
</tr>
<tr>
<td>7</td>
<td>Propagation</td>
<td>Two Ray Ground</td>
</tr>
<tr>
<td>8</td>
<td>Antenna</td>
<td>Omni Antenna</td>
</tr>
<tr>
<td>9</td>
<td>Pause Time</td>
<td>5, 10, 15, 20, and 25</td>
</tr>
<tr>
<td>10</td>
<td>Flows</td>
<td>2, 4, 6, and 8</td>
</tr>
</tbody>
</table>

### 3.7.2 Performance Metrics

The performance of the Mobile Agent Based Reliable and Energy Efficient Routing Protocol (MAREERP) model is evaluated based on various performance metrics namely, Packet delivery ratio, Throughput, Packet drop, and Average End-to-end delay. Packet delivery ratio is the ratio of a number of packets received successfully and the total number of packets transmitted. Throughput is defined as the number of packets/bytes received by destination per unit time. The average end-to-end delay is defined as the average delay a data packet experiences to cross from source to destination and includes all possible delays. Packet drop is the number of packets fallen for the
duration of the data transmission. The performance of the MAREERP is evaluated according to the parameters such as packet delivery ratio, end-to-end delay, throughput and packet drop.

This MAREERP protocol is compared with the Adaptive MANET Multipath Routing Algorithm (AMRA) in terms of average packet delivery ratio, average end-to-end delay, throughput and packet drop.

The network parameters network density and speed of nodes is varied to evaluate the performance of the system. The network is tested with different scenarios such as flows and pause time. Two different scenarios are obtained with varying number of nodes and four scenarios with varying the speed of nodes. Network density represents the number of nodes in the network.

3.7.3 Analysis Based on Nodes

In this first experiment, the number of nodes is varied as 2, 4, 6, and 8 for CBR traffic.

Figure 3.4 shows the effect of network nodes and network delay while using MAREERP and AMRA protocol. When comparing the performance of the two protocols, result concludes that MAREERP protocol has decreased in delay when compared to AMRA protocols in terms 42 %. Hence the performance of MAREERP protocol increases when compared to the AMRA protocol.
The packet delivery ratio (PDR) is used to evaluate the quality of the network. In this scenario, the number of nodes varied from 50 to 250. Figure 3.5 shows the effect of network nodes and packet delivery ratio. The figure 3.5 shows that Packet delivery ratio between the MAREERP and AMRA protocol.
When comparing the performance of the two protocols, result infers that MAREERP outperforms AMRA protocols 55% in terms of delivery ratio. However, the proposed protocol increases the delivery ratio when compared to the existing protocol.

Figure 3.6 shows the effect of network density and packet drop. If the nodes are less the packet drop in the network are also decreases.
Whenever the number of nodes is increased the packets drop are also increased.

![Node Vs. Packet Drop](image)

**Figure 3.6 Node Vs. Packet drop**

**Table 3.4 Node Vs. Packet drop**

<table>
<thead>
<tr>
<th>Number of Nodes</th>
<th>Packet drop in Pkts.</th>
<th>AMRA</th>
<th>MAREERP</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>9700</td>
<td>6402</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>12612</td>
<td>8318</td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>25200</td>
<td>16632</td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>30124</td>
<td>19881</td>
<td></td>
</tr>
<tr>
<td>250</td>
<td>39884</td>
<td>26324</td>
<td></td>
</tr>
</tbody>
</table>

MAREERP model reduces the packet drop by monitoring traffic pattern of a network. Figure 3.6 shows the effect of network nodes and packet drop. The proposed protocol outperforms 66% of decreased packet drop when
compared to the existing AMRA protocol. The decreased drop in the packet delivery increased the reliability of a network.

The energy available in each node of a network increased the lifetime of a network. If a node has a maximum residual energy that node has the capability to act as a sender, receiver and the intermediate node to transmit the packet to the subsequent node to reach the destination. Figure 3.7 shows the residual energy available in a network while using the MAREEP and AMRA routing protocol. Here the proposed MAREERP protocol has the increased residual energy in terms of 12% when compared to the existing protocol.

![Figure 3.7 Node Vs. Residual Energy](image)

**Table 3.5 Node Vs. Residual Energy**

<table>
<thead>
<tr>
<th>Number of Nodes</th>
<th>Residual Energy in Joules</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AMRA</td>
</tr>
<tr>
<td>50</td>
<td>1.06</td>
</tr>
</tbody>
</table>
Figure 3.8 shows the effect of network nodes and control overhead analysis. When comparing the performance of the two protocols, Result infer that MAREERP outperforms AMRA protocols by 53% in terms of overhead.

Figure 3.8 Node Vs. overhead

Table 3.6 Node Vs. overhead

<table>
<thead>
<tr>
<th>Number of Nodes</th>
<th>Overhead in Bits.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AMRA</td>
</tr>
<tr>
<td>50</td>
<td>7580</td>
</tr>
<tr>
<td>100</td>
<td>6540</td>
</tr>
</tbody>
</table>
Figure 3.4 to 3.8 shows the results of delay, delivery ratio, residual energy, and overhead by varying the nodes rates from 50, 100, 150, 200 and 250 for the CBR traffic in MAREERP and AMRA protocols. When comparing the performance of the two protocols, Result infer that MAREERP outperforms AMRA protocols by 42% in terms of delay, 55% in terms of delivery ratio, 66% in terms of packet drop, 12% in terms of residual energy and 53% in terms of overhead.

3.7.4 Analysis Based on Pause Time

In thesecond experiment, the pause time is varied as 5, 10, 15, 20 and 25 seconds for CBR traffic and the simulation result is given below.

Figure 3.9 Pause Time Vs. Delay
Table 3.7 Pause Time Vs. Delay

<table>
<thead>
<tr>
<th>Pause Time in Seconds</th>
<th>Delay in ms.</th>
<th>AMRA</th>
<th>MAREERP</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>18.55</td>
<td>16.58</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>20.55</td>
<td>12.34</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>19.27</td>
<td>17.87</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>18.52</td>
<td>17.07</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>23.16</td>
<td>19.32</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3.9 shows the effect of pause time and network delay while using MAREERP and AMRA protocol. When comparing the performance of the two protocols, result concludes that MAREERP protocol has decreased in delay when compare to AMRA protocols in terms 18 %. Figure 3.10 shows the effect of pause time and delivery ratio, MAREERP has 61% of delivery ratio compared to AMRA protocol.

Figure 3.10 Pause Time Vs. Delivery ratio
Table 3.8 Pause Time Vs. Delivery ratio

<table>
<thead>
<tr>
<th>Pause Time in Seconds</th>
<th>Delivery ratio in %</th>
<th>AMRA</th>
<th>MAREERP</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>0.10</td>
<td>0.21</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>0.13</td>
<td>0.22</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>0.16</td>
<td>0.29</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>0.10</td>
<td>0.14</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>0.05</td>
<td>0.17</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3.11 Pause Time Vs. Packet Drop

Table 3.9 Pause Time Vs. Packet Drop

<table>
<thead>
<tr>
<th>Pause Time in Seconds</th>
<th>Packet Drop in packets</th>
<th>AMRA</th>
<th>MAREERP</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>13358</td>
<td>5117</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>13076</td>
<td>5338</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>12900</td>
<td>4457</td>
<td></td>
</tr>
</tbody>
</table>
Figure 3.11 shows the effect of pause time and packet drop. When comparing the performance of the two protocols, result concludes that MAREERP protocol has 61% less packet drop compared to AMRA protocol and Figure 3.12 Shows 8% of increased residual energy when compared with existing AMRA protocol.

<table>
<thead>
<tr>
<th>Pause Time in Seconds</th>
<th>Residual Energy in Joules</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AMRA</td>
</tr>
<tr>
<td>5</td>
<td>6.90</td>
</tr>
<tr>
<td>10</td>
<td>6.85</td>
</tr>
</tbody>
</table>

Figure 3.12 Pause Time Vs. Residual Energy

Table 3.10 Pause Time Vs. Residual Energy
In figure 3.13 shows the comparison pause time with the control overhead. The results infer that the MAREERP protocol outperforms 53% less control overhead.

Table 3.11 Pause Time Vs. Overhead

<table>
<thead>
<tr>
<th>Pause Time in Seconds</th>
<th>Overhead in Bits.</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMRA</td>
<td>MAREERP</td>
</tr>
<tr>
<td>5</td>
<td>14518</td>
</tr>
<tr>
<td>10</td>
<td>15260</td>
</tr>
<tr>
<td>15</td>
<td>15266</td>
</tr>
<tr>
<td>20</td>
<td>14459</td>
</tr>
<tr>
<td>25</td>
<td>15274</td>
</tr>
</tbody>
</table>

Figure 3.13 Pause Time Vs. Overhead
In Figure 3.9 to 3.13 show the simulation result of the delay, delivery ratio, packet drop, residual energy, and overhead by varying the pause time from 5 to 25 seconds for the CBR traffic in MAREERP and AMRA protocols. When comparing the performance of the two protocols, the simulation results show that MAREERP protocol outperforms AMRA protocol by 18% in terms of delay, 47% in terms of delivery ratio, 61% in terms of packet drop, 8% in terms of residual energy and 53% in terms of overhead.

3.8 SUMMARY

This chapter discusses the mobile agent based reliable and energy efficient routing protocol model presented to find the optimal path for routing. Numerous algorithms have been given for energy efficient and reliable routing in MANET. The efficiency of the model is analyzed with different performance metrics and compared with another model.