CHAPTER 4

IN-TIME ROUTE DISCOVERY MECHANISM USING
REACTIVE ROUTING MODE

4.1 INTRODUCTION

In recent years, the demand for internet has grown so large that the future scalability of the use of internet has become a major concern. The users prefer their own Internet Service Provider (ISPs) for internet connectivity. They choose their own ISPs, but once their packets have entered the network, the users have no control over the overall routes their packets acquire. To handle the situation, New Internet Routing Architecture (NIRA) is introduced. Wherein, the users’ might be able to pick their routes of their choice. However, the NIRA did not consider the provider compensation scalable route discovery and efficient route representation. The route discovery schemes need to be scalable, reliable, and secure.

IRDM detailed discussion is given in chapter 3 that counts the users’ demand for route passage and destination point at different instances. It describes the process which is based on the users’ timestamp and identifies the corresponding route for transmission of packets. With varied demands of users for routing path, route failures arise and in due course, network topology gets changed. In this chapter the reactive routing IRDM finds feasible route path if one such route exists in the network with regard to less network resources, namely bandwidth and delay.
4.1.1 Organization of Chapter

The chapter starts with the route discovery applied to In-Time Routing Discovery using Reactive Routing Mode. An elaborate illustration of pseudo code for route discovery with bandwidth and delay as metric is presented. Next, the pseudo code model for path discovery using reactive routing IRDM is provided with primary and secondary route path provided. Finally, experiments are conducted using NS2 and comparison analysis is made in detail.

4.1.2 Topology Based Reactive Routing Protocol

In topology based reactive routing protocols, the network forwards packet based on the information about offered links in the network. The topology based routing protocols are subdivided into proactive, reactive and hybrid protocols as shown in Figure 4.1.

![Figure 4.1 Topology Based Routing Protocols](image-url)
4.1.2.1 Proactive (table driven) routing protocol

Proactive Routing Protocol maintains information about global topology in the form of tables at each node (Javaid et al, 2013). These tables are updated and categorized frequently so as to maintain information about the state of the network. In proactive routing protocols, nodes search always for routes within a network which makes it possible for the users to find routes easily as and when needed.

DSDV Routing Protocol

DSDV routing protocol is based on the classical bellman ford routing algorithm. In this, every mobile node in the network maintains routing table that contain all possible destination within the network and records number of hops to each destination. Each entry is marked with the sequence number assigned by destination mode. DSDV is one of the early algorithms presented. It is relatively appropriate for creating ad hoc networks among small number of nodes but it requires a usual update of its routing tables and uses a small amount of bandwidth even when the network is inactive which its disadvantage is. In addition, once the network topology gets updated, the updated sequence number is required whenever the network re-converges. Thus, DSDV routing protocol is not appropriate for highly dynamic networks.

4.1.2.2 Reactive routing protocol

Reactive routing protocols are also known as on demand driven or source initiated routing protocol (Arpita Singh, et al, 2012). These protocols create a route only when a source node requires the route towards destination. This process gets completed only when one route is identified after examining all possible routes. One of the possibilities is to make the network silent whenever there is no packets to be routed which are purely based on
bandwidth and delay factors. Reactive routing protocols do not maintain routes but they build them on demand by flooding the network with packets that consist of route request made to the network. These protocols have the following advantages. They are

- Necessitates no limitations towards maintaining global routing table as in the case of proactive protocols
- Take immediate measures towards restructuring of network in the case of failure in nodes

**ADHOC On demand Distance Vector (AODV) Routing Protocol**

ADHOC On demand Distance Vector (AODV) is an improved version of DSDV Routing Protocol as it reduces the broadcasting time of the packet by determining the routes on the basis of demand than DSDV which maintains a complete list of route determination. It is an untainted on demand route acquisition system because nodes are not on a selected path. It neither maintains routing information nor participates in routing table exchange.

In AODV, whenever a source node has to send a packet to a destination, without having a stringent route path to the intended destination, the route identification is initialized in order to identify the other nodes. The node, then forwards a Route Request (RREQ) towards its neighbor nodes. The process continues until the destination is identified or the intermediate nodes are determined to forward the packets to the destination. Proactive Routing protocol provides the capability to determine the route and information about the network. Nodes use reactive topology for primary channel assignment.
4.1.2.3 Hybrid routing protocol

Hybrid routing protocol combines both proactive and reactive protocols to achieve a higher level of efficiency and scalability. Though, hybrid routing protocol combines the advantages related to proactive and reactive approach, the route that issued currently has to be considered for identifying the best path. Hybrid routing makes sure that the topological changes have to be maintained for a stipulated period of time. Nevertheless, the protocol differs from other networks due to its highly dynamic topology.

Hybrid routing protocol suffers from poor route determination with tendency towards minimized communication throughput. Due to the high dynamic nature of vehicles present in the network. Hence, the routing protocols based on position has been determined as to be the highly significant routing protocols because they result in good performance and produce scalability and robustness with frequent changes in topology.

In Reactive Routing based IRDM, secondary ad hoc routes are evaluated using reactive routing mode. Secondary route path is chosen according to the feasible route path measure. This secondary route is used if the first route is unavailable. In this way, data are transmitted through primary and secondary routes. For efficient data transmission, reactive outing based updates both primary and secondary path simultaneously. During transmission of data, whenever the primary route fails, secondary route path gets data and transmits them finally to the destination.

4.2 PROCESS OF ROUTE DISCOVERY

Feasible route discovery for IRDM using reactive routing involve the following requisites: the source node, destination node and network N with initialized bandwidth and delay. Feasible routes are discovered based on
locally available information. In addition, the method requires no knowledge of the network topology. It aims at distributing the total traffic flow from source to destination over F routes with transmission rates mi as shown in Figure 4.2. The flow is split up with the purpose of the major part is routed at a high bitrate RH over the primary path as the remaining parts are similarly distributed on secondary paths with lower bitrate RL.

![Diagram showing primary and secondary paths](image)

**Figure 4.2 Primary and Secondary Paths**

During feasible path selection, the source node finds the feasible path if one such exists. There might be more than one feasible path available in the network. In order to efficiently use the network resources it should select the feasible path, which consumes less network resources within the available multiple feasible paths. So, it needs some optimality criteria in choosing a feasible path from among the multiple feasible paths. The optimality criteria considered are minimum hop count, less delay, throughput, and bandwidth.
The routing algorithm operates in the following way. When a new
flow between source and destination arrives, the paths are established. Since
there does not exist any information about topology, the source must send
probing packets which are, then, forwarded to the destination. This happens
with RREQ and RREP packets as in the case of AODV and contributes to the
choice and storing of all the feasible paths. Once the first path is found, data
transmission takes place.

After determining the feasible path, new paths have to be inserted
and deleted. Nevertheless, the number of paths should be kept within certain
limits Fmin (not less than 3) and Fmax. Once the number of current paths F
reaches Fmin, the discovery of additional paths is again activated. The
Bandwidth Rates BR is automatically selected according to the measured
values of the path metric and of each path. In order to minimize the overhead
occurred during routing; a novel method based on inline measurement is
employed to obtain the values with the use of both primary and secondary
routes.

4.3 IN-TIME ROUTE DISCOVERY MECHANISM

In network routing architecture, the users need to choose their
routes of their own which is based on the performance and behavior of the
corresponding routes by sending and receiving packets. After choosing the
routes, the packets are sent and received. When a user sends a packet, it can
be observed that the route performs very low. This happens mainly when
many users choose the same path for broadcasting packets.
Figure 4.3 In-Time Route Discovery Mechanism

Figure 4.3 represents the process of In Time Routing Discovery Mechanism (IRDM) to conquer the issues occurred from network routing architecture. The implementable routing architecture, IRDM counts the user demand of route passage and destination point at different instances. IRDM describes the process that is based on users’ entering time into the network; the route is identified for transmission of packets.

4.3.1 In-Time Routing Discovery Mechanism Using Reactive Routing Mode

Reactive routing based IRDM is used to identify the best route path for the user based on the in-time of the user. After calculating the in-time, the IRDM uses reactive routing mode which is the best method to select the route path. This reactive routing mode seeks to establish routes on-demand. If a node desires to begin communication with another node to which it has no route, the routing protocol is employed to found such a route.
IRDM using reactive routing finds a feasible route path if one such exists in the network. Using the minimum network resources among the available numerous feasible route paths has to be selected. Thus, reactive routing based IRDM selects a feasible route path among multiple feasible route paths based on factors like bandwidth and delay. To do so, the IRDM identifies the priorities of user based on in-time.

**Figure 4.4  In-Time Routing Discovery Mechanism Using Reactive Routing Mode**
Figure 4.4 shows the process of identifying the route path from source to destination using reactive routing based IRDM. IRDM using reactive routing is constructed by reactive routing mode which updates primary path and secondary paths for efficient data transmission. During transmission, when the primary route path fails then the secondary route path acquire the data and transmits it to the destination.

4.3.2 Pseudo Code - Route Discovery with Bandwidth and Delay

The IRDM using Reactive Routing has used bandwidth and delay as prime constraints to select the feasible route paths. It initially, finds the feasible route path represented by the two constraints namely delay and bandwidth. A feasible route path is established and then the data are sent through the feasible route path. Pseudo code1 shows the feasible route discovery for IRDM using Reactive Routing with bandwidth and delay as two constraints.

1: Let N be network, S be source and D be Destination

02: For each source S do

03: Find feasible route path based on bandwidth and delay

04: Compute Bandwidth bw

05: \( bw = \text{Available bandwidth} - \text{Utilization} \)

06: Compute Delay d

07: \( d = \text{Number of bits transmitted} / \text{Rate of transmission} \)

08: return Route path

09: if (success =1) then, // Feasible path found

10: return F_path
11: \textbf{else}
12: set success=0 // No Feasible path found
13: \textbf{return} no F\_path
14: \textbf{End if}
15: \textbf{End for}

\textbf{Pseudocode1: Feasible route discovery}

Initially, the source node s, destination node d and network N are initialized. These initialized parameters are considered for discovering the feasible route path to satisfy user requirements. Much focus is given to recognize the feasible route path that satisfies both the metrics: delay and bandwidth.

The path with larger bandwidth and less delay is taken for routing the packets. The Success Rate (SR) of finding the feasible path is given by

\[
\text{Success Rate (SR)} = \frac{\text{Number of packets successfully received}}{\text{Total number of packets sent}}
\]  

This success rate in finding the feasible path in the proposed pseudocode1 shows excellent results. When there is an increase in packet size the success ratio also increases, than in the other algorithms.

To find the feasible path in a network, the bandwidth is calculated using the equation given below:

\[
\text{Available bandwidth} = \text{total bandwidth} \times \text{utilization} - \text{reserved bandwidth}
\]
The route path with enough bandwidth and less delay is considered as the feasible route path. If a feasible route path is discovered then the algorithm returns that route path and the success is 1. If the algorithm is not able to discover the feasible route path then the algorithm ends giving success as zero and no route path is discovered in the network.

4.4 PSEUDO CODE – IRDM USING REACTIVE ROUTING IRDM

The pseudo code for routing discovery mechanism using Reactive Routing IRDM with primary and secondary route path is given below:

**Pseudo code: Path discovery using Reactive routing IRDM**

**Input:** Number of users’ n, Source address, Destination Address

**Output:** Best Route

01: Let Bandwidth rate be BR, Feasible Route be FR, Network be N

02: For Each user u_i do {where i= 1, 2 ….n}

03: Calculate IT (In Time)

04: End For

05: Let R_m be the predefined routing information

06: If user u_i enters into N

07: Compute r_1, r_2…r_n

08: Select the route path r_i

09: If r_i presents in R_m

10: Choose recently used r_i in R_m

11: return r_i as Primary route R_p
12: If $R_p$ meets Route failure
13: Select the route $r_i$ based on BR and FR
14: Return $r_i$ as Secondary route $R_s$
15: Return the best route path for user
16: End if
17: End if
18: End if

To provide an efficient routing path without any interruption, the IRDM using Reactive Routing provides a routing path method using reactive routing strategies. IRDM using Reactive Routing discovers primary route and secondary route eventually for efficient data transmission.

4.5 EXPERIMENTAL EVALUATION

Experimental evaluation of reactive routing based IRDM is carried out with NS2 simulator. For this simulation model, a network topology is constructed with sufficient source and destination nodes. The constraints such as bandwidth and delay are generated.

The NS2 simulation is modeled on a network in a 1000m * 1000 m area with 60 mobile nodes. The radio broadcast range for every node is assumed to be 100 m. The velocity of each mobile node that varies from 3-15 m/s is considered. These simulations use the similar communication pattern for all mobility simulations. The traffic pattern of Constant Bit Rate (CBR) traffic is used. The communication traffic and scenario simulations are arbitrarily produced by NS2. The mobility of the mobile nodes is considered to be arbitrary. Every simulation is run for 650 seconds.
Table 4.1 Parameters Used During Simulation

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>1000*1000 m</td>
</tr>
<tr>
<td>No. of nodes</td>
<td>60</td>
</tr>
<tr>
<td>Simulation duration</td>
<td>650 sec</td>
</tr>
<tr>
<td>No. of repetition</td>
<td>6 times</td>
</tr>
<tr>
<td>Radio transmission range</td>
<td>100 m</td>
</tr>
<tr>
<td>Physical/Mac layer</td>
<td>IEEE 802</td>
</tr>
<tr>
<td>Pause time</td>
<td>100 sec</td>
</tr>
<tr>
<td>Mobility model</td>
<td>Random waypoint model</td>
</tr>
<tr>
<td>Node movement</td>
<td>3 – 15 m/s</td>
</tr>
<tr>
<td>Data sending rate</td>
<td>2 kbps</td>
</tr>
<tr>
<td>Each packet</td>
<td>2 mega byte</td>
</tr>
</tbody>
</table>

Table 4.1 shows some assumptions on the parameters of the system architecture in the NS2 simulations.

Four performance metrics are used to evaluate the performance of reactive routing based IRDM. The performance metrics are given below:

- Delivery ratio
- Bandwidth Rate of ISP
- Success Rate
- Feasible Route Path Measure

**Delivery ratio**: It is the ratio of the number of data received by a destination over the number of data delivered by the corresponding source in the network.
**Bandwidth Rate of ISP:** The number of packets has been sent by ISP along the route path between the source and the destination nodes.

**Success Rate (SR):** SR defines the identification and determination of several paths and its success rate. The success rate is a measure which determines the ratio between the packets received and packets sent during in-time.

**Feasible Route Path Measure:** A route path is said to be feasible if it satisfies the given constraint between the source and destination nodes and the values are generated in percentage.

### 4.5.1 Results and Discussion of Reactive Routing IRDM

The proposed Reactive Routing IRDM performs better in terms of bandwidth rate and feasible route path measure than the existing NIRA. Reactive Routing IRDM allows the users’ choice for selecting the number of service providers on their own. It chooses the ISPs efficiently based on users’ in-time. The existing NIRA is compared with the proposed reactive routing IRDM which shows that the reactive routing IRDM is the best routing mechanism.

### 4.5.2 Measure of Delivery Ratio

The table and graph given below describe the performance of the proposed reactive routing IRDM.
Table 4.2 Number of User Vs. Delivery Ratio

<table>
<thead>
<tr>
<th>No. of Users</th>
<th>Delivery Ratio (%)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NIRA</td>
<td>NIRA Using IRDM</td>
<td>Reactive Routing IRDM</td>
</tr>
<tr>
<td>100</td>
<td>71.23</td>
<td>92.48</td>
<td>88.25</td>
</tr>
<tr>
<td>150</td>
<td>69.62</td>
<td>80.82</td>
<td>87.55</td>
</tr>
<tr>
<td>200</td>
<td>66.15</td>
<td>78.32</td>
<td>97.98</td>
</tr>
<tr>
<td>250</td>
<td>64.32</td>
<td>80.75</td>
<td>85.15</td>
</tr>
<tr>
<td>300</td>
<td>65.86</td>
<td>74.84</td>
<td>86.25</td>
</tr>
<tr>
<td>350</td>
<td>64.56</td>
<td>71.85</td>
<td>85.1</td>
</tr>
<tr>
<td>400</td>
<td>62.95</td>
<td>72.63</td>
<td>84.25</td>
</tr>
</tbody>
</table>

Figure 4.5 Number of User Vs. Delivery Ratio

Figure 4.5 shows the packet delivery ratio of three mechanisms Reactive Routing IRDM, NIRA using IRDM and NIRA with different number of users. It is observed that the reactive routing IRDM transmits and receives more data packet than NIRA using IRDM and NIRA because NIRA
using IRDM uses proactive routing mode. It exploits the route path which may break whereas Reactive Routing IRDM always choose the most feasible route path using less network resources, bandwidth and processing capability and finally the chance of route failure is lower than NIRA using IRDM and NIRA. The variance is 15-20% high in reactive routing based IRDM than the existing methods which did not take into account the feasibility of the selected path.

4.5.3 Measure of Bandwidth Rate of ISP

The table and graph describes the performance of the proposed reactive routing IRDM.

Table 4.3 Number of Users Vs. Bandwidth Rate of ISP

<table>
<thead>
<tr>
<th>No. of Users</th>
<th>Bandwidth Rate of ISP (Bit per seconds)</th>
<th>NIRA</th>
<th>NIRA Using IRDM</th>
<th>Reactive Routing IRDM</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>24.326</td>
<td>23.375</td>
<td>20.238</td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>27.27</td>
<td>25.294</td>
<td>21.792</td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>28.374</td>
<td>27.281</td>
<td>26.935</td>
<td></td>
</tr>
<tr>
<td>250</td>
<td>33.113</td>
<td>27.904</td>
<td>27.719</td>
<td></td>
</tr>
<tr>
<td>300</td>
<td>38.836</td>
<td>35.835</td>
<td>30.286</td>
<td></td>
</tr>
<tr>
<td>350</td>
<td>49.274</td>
<td>42.268</td>
<td>30.674</td>
<td></td>
</tr>
<tr>
<td>400</td>
<td>50.532</td>
<td>47.178</td>
<td>31.347</td>
<td></td>
</tr>
</tbody>
</table>
Figure 4.6 Number of Users Vs. Bandwidth Rate of ISP

Figure 4.6 shows the bandwidth rate of ISP for reactive routing IRDM, NIRA using IRDM and NIRA with different number of users in network. Reactive Routing IRDM has the normal flow meaning i.e., it has fewer drops in the number of packets being sent and hence the bandwidth usage is nearly 30MB. NIRA using IRDM and NIRA shows slight variation in the bandwidth as the simulation time periodically increases because they have aggressive flow of data. So, more packets are to be queued and less priority packets are dropped. It is clear that both NIRA using IRDM and NIRA use high bandwidth, while reactive routing IRDM achieves less bandwidth rate due to the fact that IRDM using reactive routing selects a feasible route path among multiple feasible route paths based on one of the factors bandwidth. The variance is 25-30% low of ISP because it consumes only 10-20 MB.

4.5.4 Measure of Success Rate

The table and graph describe the performance of the proposed reactive routing IRDM.
Table 4.4 Number of Packets Vs. Success Rate

<table>
<thead>
<tr>
<th>Number of Packets</th>
<th>Success Rate (Score)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NIRA</td>
<td>NIRA Using IRDM</td>
<td>Reactive Routing IRDM</td>
</tr>
<tr>
<td>5</td>
<td>91.57</td>
<td>94.41</td>
<td>84.01</td>
</tr>
<tr>
<td>10</td>
<td>92.39</td>
<td>94.74</td>
<td>84.57</td>
</tr>
<tr>
<td>15</td>
<td>93.07</td>
<td>95.15</td>
<td>86.12</td>
</tr>
<tr>
<td>20</td>
<td>93.66</td>
<td>95.82</td>
<td>87</td>
</tr>
<tr>
<td>25</td>
<td>94.17</td>
<td>96.51</td>
<td>89.1</td>
</tr>
<tr>
<td>30</td>
<td>94.62</td>
<td>96.53</td>
<td>91.2</td>
</tr>
<tr>
<td>35</td>
<td>95.96</td>
<td>96.86</td>
<td>92.5</td>
</tr>
</tbody>
</table>

Figure 4.7 Number of Packets Vs. Success Rate

Figure 4.7 shows the success rate for varied number of packets sent by source to destination using reactive routing IRDM. When varied number of packets are sent from a source to destination and with the increase in number of packets, the success rate of feasible path from ‘s’ to ‘d’ in Reactive Routing IRDM crosses above 95%, with an increased rate of 10-15% for
number of packets and yields better performance than the NIRA and NIRA using IRDM. This is due to the fact that Reactive Routing IRDM adopts the feasible path using reactive routing mode. When the number of packets increases, it is observed that the success rate for the proposed algorithm is improved. When the routing information is more accurate, the success rate in finding the feasible path also increases.

4.5.5 Measure of Feasible Route Path Measure

The table and graph below describes the performance of the reactive routing IRDM in term of feasible route path measure.

Table 4.5 Number of Users vs. Feasible Route Path Measure

<table>
<thead>
<tr>
<th>Number of Users</th>
<th>Feasible Route Path Measure (%)</th>
<th>NIRA</th>
<th>NIRA Using IRDM</th>
<th>Reactive Routing IRDM</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>74.56</td>
<td>70.17</td>
<td>88.26</td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>73.17</td>
<td>72.18</td>
<td>87.12</td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>79.66</td>
<td>67.98</td>
<td>87.87</td>
<td></td>
</tr>
<tr>
<td>250</td>
<td>71.17</td>
<td>68.13</td>
<td>85.23</td>
<td></td>
</tr>
<tr>
<td>300</td>
<td>70.42</td>
<td>67.12</td>
<td>82.17</td>
<td></td>
</tr>
<tr>
<td>350</td>
<td>71.63</td>
<td>66.1</td>
<td>83.48</td>
<td></td>
</tr>
<tr>
<td>400</td>
<td>73.45</td>
<td>68.2</td>
<td>84.58</td>
<td></td>
</tr>
</tbody>
</table>
Figure 4.8 Number of Users vs. Feasible Route Path Measure

Figure 4.8 shows the feasible route path measure of reactive routing IRDM, NIRA using IRDM and NIRA with different number of users. As shown in the Figure feasible route path measure gets decreased with the increase in the number of users. It is clear that feasible route path measure for reactive routing IRDM is higher than NIRA using IRDM and NIRA, which consume high bandwidth and meet route failure. Reactive routing IRDM uses secondary route for data delivery in case of route failures in primary route. Reactive routing IRDM achieves high feasible route path measure which is about 15 to 20%. Finally, the observations show that the reactive routing IRDM performs better in routing discovery process due to the introduction of primary and secondary route paths.

4.6 SUMMARY

In IRDM using Reactive Routing, a new routing architecture, Reactive routing In-Time Route Discovery Mechanism (Reactive routing IRDM) overcomes the route failures. In this, secondary ad hoc routes are evaluated using reactive routing mode. This reactive routing IRDM is
implemented as an inter-domain routing system based on the users’ entering
time for routing the packets and practically supports user choice. In case of
any route failure in primary route, the proposed reactive routing IRDM uses
secondary route for data transmission. It discovers the feasible route path
based on the bandwidth rate and delay.

Experimental evaluation analyzes the performance of the reactive
routing IRDM through simulations by calculating delivery ratio. It proves that
it yields a success with an increased rate of 10-15% for number of packets
and better performance, routing overhead, bandwidth rate of ISP is 25-30%
low and feasible route path measure is 15-20% low. It is clear that the reactive
routing IRDM has high success rate than other methods with the same number
of packets and even with the increased number of packets. Thus the proposed
method has obtained better performance in finding the feasible route path for
routing of packets than the NIRA using IRDM and NIRA.