Routing (DSR) protocol is used in Opportunistic Networks along with Membrane Computing. The use of Membrane Computing is also one of an important concept which depends on the behaviour of natural computing [7].

After giving the introduction to Opportunistic Networks, the rest of the paper is arranged in an organizational manner. Section-2 presents the related work that is important for understanding the concept of Opportunistic Network. Section-3 focuses on the concept of Membrane Computing


In the Year 2006, the authors explained that Opportunistic Networks show a significant role in the evolution of MANETs. The mobile nodes are facilitated to provide the communication among the nodes even if there no any type of permanent route exists. Moreover, most of the nodes are presumed to be getting aware or consists of any knowledge regarding the topology of the network. In this paper, the authors studied many of the motivating study of cases which is related to opportunistic networks [10].

## 3. Membrane Computing

Membrane computing is a branch of natural computing which is inspired biologically from it. Membrane Computing is mainly used in abstracting computing models from the configuration and execution of living cells from the organization of cells in tissues. The essential elements of a membrane system are also known as a P-System after the name Gheorghe Păun. These are the membrane arrangement and the sets of development rules which process multi-sets

[14].

## 4. Proposed Methodology

In this work, the methodology for the work proposed is discussed to enhance the routing efficiency of Opportunistic Networks by the use of Dynamic Source Routing (DSR) protocol along with Membrane Computing Scheme. The

whole of the simulations is done on NS-2 which shows the effective simulations of the proposed work.

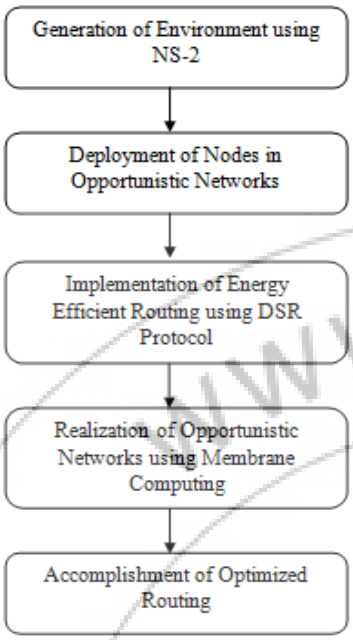


**Figure 3:** Flow of Work

Figure 3 shows the flow of work of the work proposed. The first step elaborates the generation of environment using NS-2 simulator. The deployment of nodes takes place in the step 2 and energy effective routing using DSR protocol is implemented in the step 3. The concept of opportunistic networks using membrane computing is realized in the step 4. The step 5 is the final step where the accomplishment of optimized routing is taken out.

## 5. Simulation Results and Discussion

### 5.1 Simulation Setup

In this work, we have done the simulation and compare the performance evaluation of two different protocols AODV and DSR along with membrane computing algorithm using NS2 simulator. In order to evaluate the performance of the protocols as the networks size scales up, each experiment was carried out on the 1000m × 1000m square simulation fields of four different scales of mobile nodes. 50, 100, 150 and 200 nodes were chosen to represent ad hoc network. Nodes were generated randomly at random position. Nodes were generated at random time as if few nodes were entering into the topology. Nodes were moving at constant random speed. Radio propagation model used was two-Ray Ground. Antenna model used was Omni Antenna. Movement was linear and node speed was constant for a simulation.

The configuration of the network used in our scenario is given in the Table 1.

Network Characteristics are shown in the table below:

**Table 1:** Network Characteristics

| | |
|---|---|
| *Channel* | Wireless |
| *Antenna* | Omni Antenna |
| *Nodes* | 20 |
| *Protocols* | DSR |
| *Layer* | Mac 802.11 |
| *X co-ordinate* | 1000 |
| *Y co-ordinate* | 1000 |
| *Simulation Time* | 10.0 |
| *Queue Type* | Drop Tail PriQueue |
| *Queue length* | 50 |
| *Propagation* | Two-way Ground |

We use the following parameters in our comparison:

#### 5.1.1 Packet delivery Ratio (PDR)

It is the ratio of all the received data packets at the destination to the number of data packets sent by all the sources. It is calculated by dividing the number of packet received by destination through the no. of packet originated from the source.

$$PDR = \left( \Pr / Ps \right) \times 100 \quad (1)$$

Where, $P_r$ is total packet received and $P_s$ is total packet sent.

#### 5.1.2 End to End Delay

This includes all possible delays caused by buffering during route discovery, latency, and retransmission by intermediate nodes, processing delay and propagation delay. It is calculated as:

$$D = \left( Tr - Ts \right) \quad (2)$$

Where, $T_r$ is receive time and $T_s$ is sent time of the packet.

#### 5.1.3 Average Number of Hops

It is defined as the number of hops that a packets need to go through routers before they reach their final destination.

### 5.2 Performance Evaluation

The simulation results have been taken out by using effective and optimized routing scheme consisting of DSR protocol along with Membrane Computing. The whole of the work is carried out on a system having core i3 processor having 2GB of RAM. The simulator used is NS2-2.35.

Figure 4 demostrates the Delivery of Packets. The performance of entire system is primarly depends on the concept of Packet Delivery. More the number of Packet delivery more improved will be the performance of the system. The two arcs are shown in this figure where the red arc is used to show the Membrane Computing results and Green arc shows the AODV protocol results. A comparative analysis has been carried out showing that the arc which is red in color outperforms the Green arc.

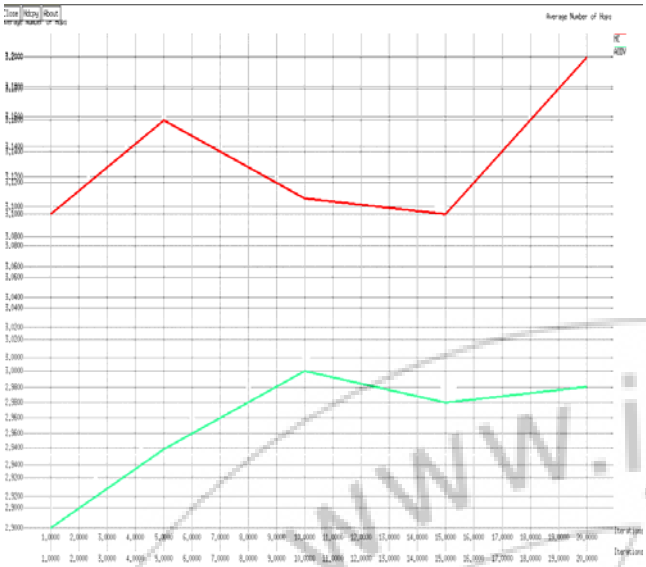

**Figure 4:** Comparison of MC and AODV on the basis of Packet Delivery

Figure 5 shows the graphical representation of the Packet Delay. The performance of whole of the system can be carried out by the use of packet delay as whole of the system depends on the delay in packet. As the packet delay decreases, the system becomes improved in nature and hence can become more efficient as compare to conventional ones.

The comparative analysis of two arcs is being taken out in the figure 5 where the red arc is showing the membrane computing results whereas the green arc shows the AODV protocol results which put into practice to reveal the AODV protocol characterstics. The figures shows that the arc which is red in color shows the highest improved and efficient outcomes as compare to Green arc.

**Figure 5:** Comparison of MC and AODV on the basis of Packet Delay

**Figure 6:** Comparison of MC and AODV on the basic of PDR

In Figure 6, the comparative analysis of MC and AODV is being taken out which is shown in green and red colour arc respectively. The simulated results reveal that the arc which is red in colour shows efficient outcomes as compared to green arc.

## 6. Conclusion and Future Scope

In this section, the concept of Dynamic Source Routing (DSR) protocol is being used along with membrane computing in order to enhance the routing efficiency in opportunistic networks. From the simulation results and discussion, we have concluded that the proposed protocol Dynamic Source Routing is one of an efficient protocol which shows effective outcomes when get modeled with membrane computing scheme. The comparative analysis of AODV and DSR protocols has been carried out in which DSR protocol outperforms the performance of AODV protocol. In our future work we will plan to develop new efficient routing protocol in Opportunistic Networks and compare their performance against the existing protocols.

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## Author Profile

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