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Route Optimization using Membrane Computing in Opportunistic Network

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Abstract: ***The most prominent evolution of Mobile Ad hoc Networks (MANETs) is opportunistic networks. The nodes try to make contact with each other within a network even under the conditions when there exist no any real route for the transference of information. Unlike conventional nodes in MANETs, the nodes in opportunistic networks may or may not be aware to the desired route. The disconnection or reconnection of the connections between the nodes in opportunistic networks is very common, hence for this reason the routes are built dynamically. The contacts between the nodes are discontinuous in nature. Therefore, the nodes which are intermediate in nature can take out the responsibility of transference of data or information during any blackout and again transmits the data after the re-connectivity of connections. Thus, the major concern in opportunistic networks is optimization of route. In this paper, the concept of Membrane Computing is being modeled with opportunistic networks in order to optimize the route between the nodes for the flow of data or information. The simulator used for the process of simulation is Network Simulation NS-2.35. Also, the integration of membrane computing algorithm within DSR protocol provides the better and efficient performance for packet delivery ratio and reduces end to end delay. The simulation results show that the proposed protocol DSR outperforms the performance of AODV protocol when get used in opportunistic networks along with Membrane Computing.***

Keywords: Mobile Ad hoc Networks (MANETs), Opportunistic Networks, Dynamic Source Routing (DSR) Protocol, Ad hoc On Demand Distance Vector (AODV) Protocol, Membrane Computing.

1. Introduction

Opportunistic Networks are entirely based on the concept where the nodes make contact with each other in an intermittent behaviour. For this reason, the existence of end to end delay in between the source and destination nodes may exist or may not be shown [1]. The concept of Opportunistic Networks are mainly depends on the multihop nature of ad hoc networks which is very much similar to mesh networks. In the idea of Opportunistic Networks, the real existence of main path or real path between the source node to another or in between the two nodes does not exist in a pure manner. This means that the source node and destination nodes may or may not get connected to the identical network at the same instant of time [2]. The network is mainly spilt up into numerous divisions which are called as regions. The conventional behaviour of some of the applications can never be implemented to Opportunistic Networks because of the absence of end to end delay information [3]. The protocol stack of Opportunistic Networks is primarily comprised of Application Layer, Bundle Layer, Transport Layer, Network Layer, Link Layer and Physical Layer. The nodes in Opportunistic Networks which shows the behaviour of intermediate nodes do the role to store and carry the information and then forward the messages. This process in done mainly by the layer named as Bundle Layer which shows the properties of host as well as router [4][5]. The Bundle Layer is used to store the information, carry the information and to forward the whole data between the two nodes, at that moment the bundle layer acts as a router. But, the bundle layer acts as host then it stores the data or information within it and support the responsibility of the transference of messages from one node to another [6].

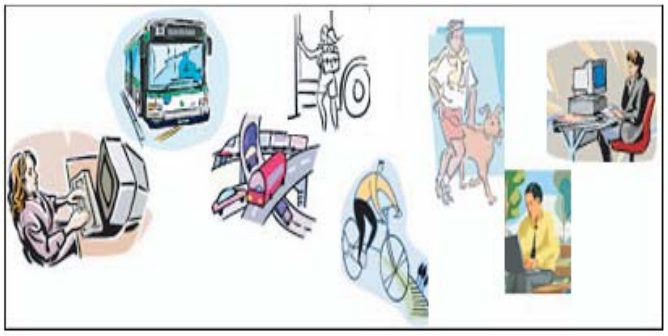

Figure 1: Architecture of Opportunistic Networks

Figure 1 demonstrates the architecture of Opportunistic Networks where the devices or materials are shows having the implementation of Opportunistic Networks in an efficient manner. Opportunistic Networks are implemented to provide the intermittent connectivity of internet to the areas which are developing or rural in nature. The major applications of these networks include the regions which show the high error rate.

Among all the benefits of Opportunistic Networks the routing is one of the major challenges which have to be reduced in order to get better efficiency of these networks. The proposal to design an efficient Opportunistic Networks using efficient routing is one of the difficult tasks. The efficient routing mainly depends on the implementation of efficient routing protocols which get integrated with the routing scheme. Many energy efficient routing protocols have been used during the last decade in which Ad hoc On Demand Distance Vector (AODV) protocol comes out to be more effective but having some of the constraints. In this paper, a new protocol is being proposed Dynamic Source

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 Scheme which is used to optimize the routing in Opportunistic Networks along with DSR protocol. Section-4 discussed the proposed methodology of the proposed work. Section-5 gives a detailed exploration on the simulated results and discussion. Section-6 describes the conclusion and future scope of the work proposed.

2. Related Work

Carlos et. Al, 2012 [9] proposed the mechanism of predictive routing to opportunistic networks. The authors provide a hypothesis in which each node has some extent of contextual knowledge regarding the predictive values for the achievement of better decisions. The authors presented a predictive routing agent which implements prediction of collaboration and context with the help of other agents. This is used for the process of effective predictive routing.

R. Rama et. Al, 1999 "A variant of P systems with active membranes: solving NP-complete problems," Opportunistic Networks is an algorithm which is associated with unique perspectives [8]. This category of network seeks to make simpler the complication at the network layer by the removal of supposition of substantial end-to-end connectivity while giving connectivity chances for invasive devices in the absence of direct access to the Internet. The foremost issue in this paper is how to send the messages between the nodes without proceeding knowledge concerning network topology.

Ahmad, I. and Rehman, M. , 2012 [17] "Efficient AODV routing based on traffic load and mobility of load in MANET" proposed a protocol with an enhanced route discovery mechanism that avoids the congestion in the route which ensures shortest routing path with respect to time, so the source send packets to the destination quickly than basic AODV. Instead of transmitting entire data through one route, new efficient path are discovered from time to time during transmission. In this technique sharing of load decreases the network congestion which directly leads to the decrease of overflowing of queuing buffer and packet loss, results increases the packet delivery ratio and throughput.

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 of objects located in the sections of the membrane architecture as shown in Figure 1. A structure of membrane is arranged from a hierarchical set of membranes. Objects inside the membranes develop through a set of rules which may unite objects, transform objects, remove objects, or pass objects via membranes. Rules potentially can modify membrane structures [8] [9].

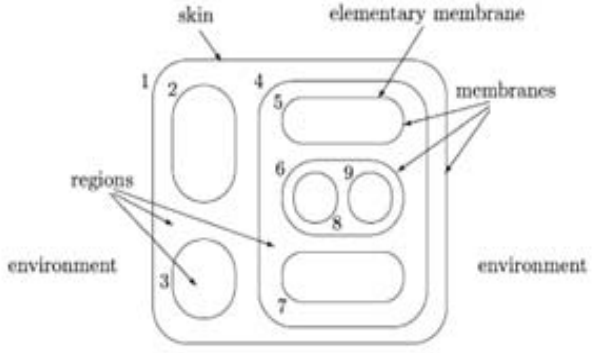

Figure 2: Architecture of Membrane Computing [10]

Membrane systems are representations of computation which are stimulated by a number of essential features of biological membranes. In a membrane scheme, multi-sets of objects are positioned in the compartments defined by the structure of membrane and the objects develop by means of "reaction rules" which also connected with the compartments, and applied in a maximally parallel, nondeterministic manner. The objects can surpass via membranes and the membranes can adjust their permeability [11]. Membrane computing is an arrangement which concerns with distributed and parallel computing models. This model also deals with the processing of multi-sets of symbol objects in a localized approach. Consequently, evolution rules permit for evolving objects to be enclosed into compartments described by membranes [12]. The conveyance of messages or information between compartments and with the environment plays an indispensable role in the processes. It must be put into consideration that the membrane systems which are also called P systems are not proposed to model the operation of biological membranes. An important component of a P system is its membrane arrangement. This structure can be a hierarchical collection of membranes [13] [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.

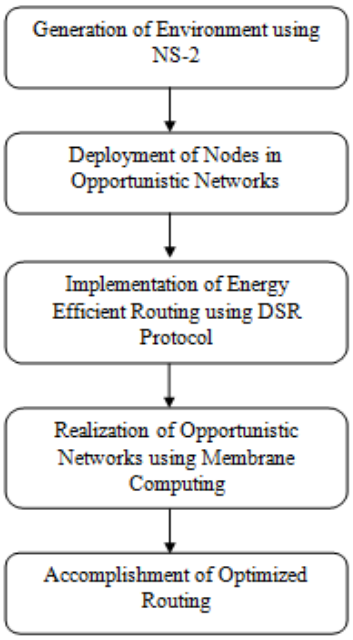

Figure 3: Flow of Work

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.

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

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:

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

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.

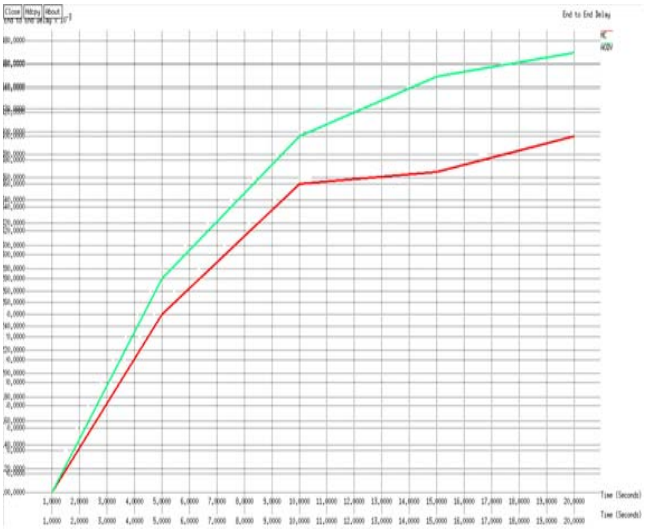

Figure 5: Comparison of MC and AODV on the basis of Packet Delay

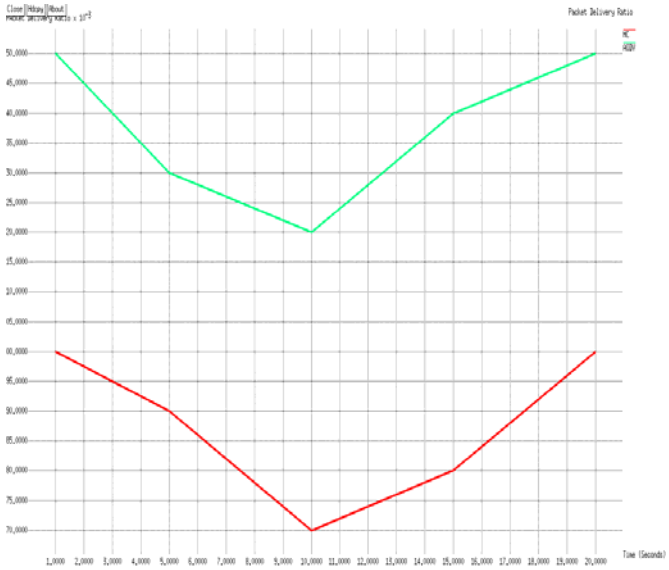

Figure 6: Comparison of MC and AODV on the basic of PDR

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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