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Partition and Recovery Based Model for Congestion Control in Wireless Networks

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Abstract: *Network partitioning is a form of network failure. A single connected network topology breaks apart into two or more network topologies separated from each other due to the node mobility. Nodes within each partition are still able to communicate with each other but nodes in other partitions are unreachable. This paper proposes a MCD (Mobility, Congestion and Nodal Degree) model which assigns the weights to all nodes on the basis of mobility, congestion and average nodal degree of the node. Here, the high-weight nodes must maintain connections against those of low-priority nodes. It also propose a solution for the above mentioned problem, a system which detects and recovers from network partitioning using additional mobile nodes. We are using MATLAB to simulate the node and test the effectiveness of this model. Network partitioning is a form of network failure.*
Keywords: *MANET, Network Partition, Partitioning Detection, Partitioning Recovery.*

I. Introduction

Wireless communication technology is playing an important role in access networks as evidenced by the widespread adoption of wireless local area networks Although wireless networks are quite different from wired networks, popular protocols, such as TCP, designed for and implemented in wired networks are being used in wireless networks in their original form. Hence, they fail to perform well in wireless networks. The congestion control algorithm used in the TCP/IP protocol suite is a nodal degree mechanism that uses segment loss to detect partition.

Mobile Networks are very useful as much as fixed position network because it is very comfortable to human beings.it can be built with or without terrestrial infrastructure. One specific use case of MANETs (Mobile Ad hoc networks) is providing communication services in difficult situation. In such situation, human beings may be depending on the proper functioning of the communication network. A typical problem of MANETs is network partitioning, when some network part is isolated from the remaining network. It very important to judge the network partition is true or it has only network failure. Also it is important to discuss the node weight on the basis of Mobile, Congestion and Nodal degree of the node (MCD). After that how we can recover the route from network partitioning. By placing an addition node with highest degree in partition network can solve the problem of network partition. The rest of the paper is organized as follows:

In section II, to discuss review of literature in which previous work on the same topic have been discussed. After that in section III, proposed method and methodology will be discussed, in this proposed approach it has to use the MATLAB simulator and the result of this simulation will discuss in section IV. Finally section V will explain the conclusion for the overall paper.

II. Literature Review

Killijian et al. [11], They only briefly describe their system, which consists of 3 entities: a failure anticipator, a movement planner and an environment evaluator. Obviously these components heavily rely on some form of sensing equipment and a huge amount of information exchange. Especially the sensing equipment cannot be assumed for all participating nodes. This approach appears to be quite heavy weight and the authors do not mention how they intend to detect that partitioning has taken place. They also do not show any facts and figures that demonstrate the accuracy of their anticipation scheme.

In [2] simple heartbeat messages are used. Partitioning is suspected in the absence of an expected heartbeat. Clearly, this scheme does not allow distinguishing between node failure and network partitioning.

Guo and Yang [5] proposed a novel method for MANETs, which uses the network survivability concept to detect the critical link. Once the critical link is detected, it uses two methods namely, change the trajectory of one or both nodes forming the critical link and bring in another node to reinforce the link. The model assumes that the node knows its location and periodically updates to the neighbour nodes. It does not contain efficient routing information over the network.

In order to detect the network partition (Wu and Yu), it uses a set of metrics such as the number of partition and size of partition, separation time for pairs of nodes and the rate at which partition occurs to detect the network partition. The results show that the network partition occurred frequently even with reasonably higher node density in the network.

There are also post-detection systems, which are monitoring the whole network continuously. Such systems are presented in [7], [8], [9]. These systems build either some structured overlay network where different types of nodes with different tasks are selected, or some central node, as a base station, is present in the system. In the first case, more communication overhead is necessary to maintain the network structure. The second case can only be used in WSNs or in wireless networks with an existing infrastructure but not in MANETs, where there are no base stations.

Approaches to recover from network partitioning are also presented in the literature. The authors of [10] propose a recovery protocol for a disaster information system, but this system should be established and working before the disaster happens, otherwise the proposed protocol is useless. In this system, the nodes should be rearranged to provide connectivity which is not desirable in our system.

III. Proposed Method

Identify the Network Partition

Mobile ad-hoc networks are restricted in terms of bandwidth and their nodal degree of multi hop capability. It can count the participating nodes and the size of the network topology. The less nodal degree node assumed as an edge node which play the important role to identify the partition. Sometimes false partition detected due to network failure between edge nodes.

Every node always sends the alive message to its neighbor nodes. Nodal degree of each node can check the number of connected nodes. If number of alive message is less than nodal degree of that node then it is the indication of the partition of the network.Therefor the active node (or edge node) detection is very important. The criteria for becoming an active node is the nodal degree count, all nodes in the network have to monitor their immediate network neighborhood periodically. Every node sends a broadcast alive which in turn send an acknowledgement. By this way, all nodes always have a relatively up-to-date view of its immediate network environment. Our approach uses a fixed threshold_degree. Here a node becomes active if it has equal or less nodal degree than the threshold_degree. It developed the two sets of nodes. One set consists of nodes not actively taking part in the network partition identification system. The other set of nodes actively participates in the network as part of the system. The nodes periodically send out the "hello" messages serving as keep-alive messages. Every active node monitors a certain amount of other active nodes. If a "hello" message from one of these monitored nodes is not overheard for a certain amount of time, network partition may be present. In this case active nodes should be placed far apart so that the "hello" messages travel through large parts of the network, thereby increasing the nodal degree of active node.

In order to differentiate whether the absence of the "hello" message is due to node failure or due to network partition, a local validation (threshold_degree) is used, as already mentioned. The nodes sending "hello" messages emitted. This "hello" messages is one hop neighbor monitoring the node sending the "hello" message. If the "hello" messages node cannot find its one hop neighbor any more, it starts a local route request for it. If it finds the node over a multi-hop path, it asks that node to emit a new "hello" messages. If it does not find the node, it assumes the node failure and notifies the other active nodes about that incidence. Using this "hello" messages mechanism the chances for a false partition is significantly reduced. Since the criteria for becoming an active node is the nodal degrees of neighbor hops count, all nodes in the network have to monitor their immediate network neighborhood periodically. Every node sends a "hello" message with a time-to-live (in hops) of one so that the message is only received by direct neighbors, which in turn send an acknowledgement. This way, every node always has a relatively up-to-date view of its immediate network environment.

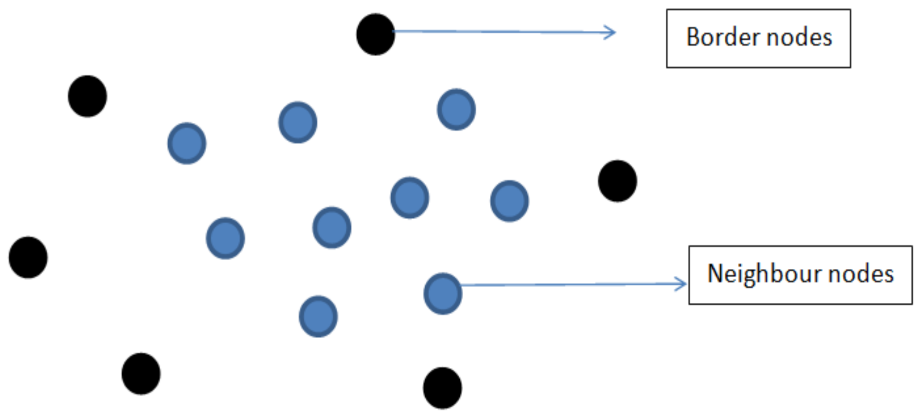

Figure: 3.1 Border Node Detection

For the moving border hops identification approach, every hops picked a node at random every 5 seconds and sent a packet with its own neighbor nodal degree count and it we wanted to evaluate whether the system still works with applications that generate only little Congestion. The threshold_degree itself was then generated out of the last 20 application data packets a node received. The dark nodes are the border nodes (active node) monitoring the network. The figure clearly shows that the border node detection scheme reliably identifies border nodes within the topology.

Node preference to reduce the partition in the MANET *(M/C/D)*:

Network partition is very critical situation in mobile ad hoc network, which cause the loss of important data. The proposed model assigns weights to the different hopes based on the MCD (Mobility, Congestion and nodal degree). The node with higher priority must maintain the connection among all the nodes in the network.

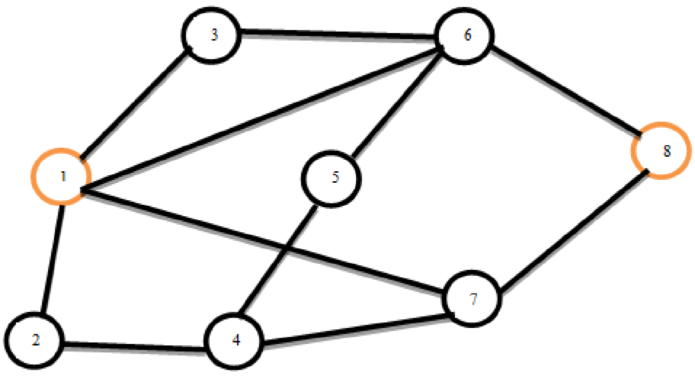

Figure: 3.2 Mobility, Congestion and nodal degree based network model

In this Figure 3.2, a graph G= (V, E) is collection of nodes and of links. V is a set of nodes {1,2,3,4,5,6,7,8} and E is a set links {(1,2) (1,3) (1,6) (1,7) (2 ,1) (2 ,4) (3,1) (3,6) (4 ,2) (4,5) (4,7) (5,4) (5,6) (6,1) (6,3) (6,5) (6,8) (7,4) (7,8)}.

In the network G = (V, E), the flow (f) from the source (s) is equal to flow (f) into the destination (d), if the network has sufficient buffer, bandwidth and nodal degree of active nodes. The proposed model gets the information such as node mobility, Congestion and higher nodal degree of the node.The model assigns the weight to the nodes based on the node mobility, node Congestion and nodal degree of the nodes. The weight factor of the node calculated as follows:

$$W_i (t) = \sum w - 0.1 * m + D (n); \qquad (1)$$

In equation (1), m indicates the mobility of the node i at time t. W is constant variable. D(n) is the nodal degree of node.

The arrival rate of the data packets (Congestion factor) at node i is calculated as follows:

$$T_i(t)=b_i-c_i-d_i \qquad (2)$$

Here, Ti(t) is the Congestion factor of the node i and bi is the number of data packets transmitted by the node n, ci is the number of data packets received by the node n. di indicates the number of data packets transmitted by node V as an intermediate node up to time t.

In the proposed work, every node maintains the global connectivity information to detain the communication in the network. At first, when a network begins, all the nodes are aware of their neighbours and they will aware about the other nodes by counting the nodal degree of nodes in the network. Periodically, each node broadcasts its global connectivity information to its neighbours. Then the nodes will get information about other nodes based on the received-update packets from the neighbours. In the network, each node is initialized with a constant value (Reff Eq. 1). If any pair of nodes is involved in higher priority communication, then all the nodes in the directional transmission zone of the sender towards receiver will set with high/low. The priority of the node is the summation of the weight factor of the node, Congestion factor of the node and nodal degree of the node calculated as follows:

$$TW_i = W_i(t) + T_i(t) + D(t) \qquad (3)$$

Based on equation (3), it assigns the weight to all the nodes to reduce the network congestion and increase the network throughput.

Simulation of proposed work (MATLAB)

In this section, some of the parameters, which are used in the simulation, are given. Then we present the simulation results and compare the performances of all the three terms (MCD). The simulation parameters are shown in Table 3.1.

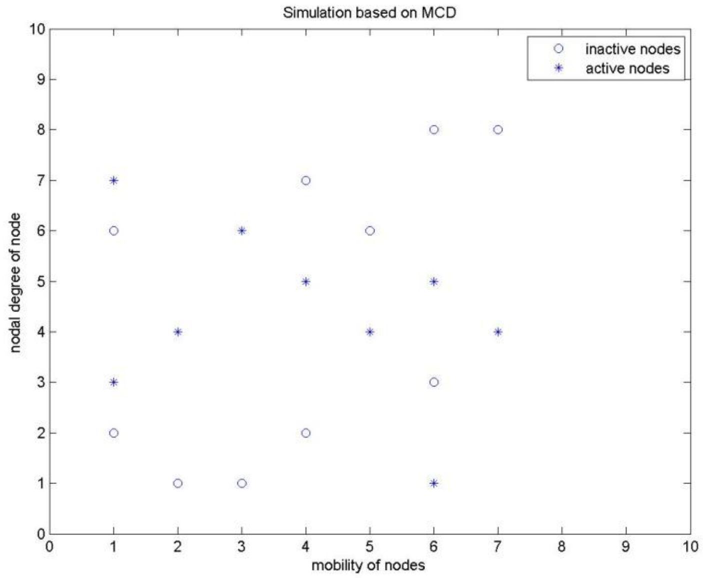

Figure: 3.3 simulation of mobile nodes

The proposed model simulated an area of 10 m × 10 m with 20 mobile nodes and used and the transmission range of each node was 10 m. We used Constant Bit Rate (CBR) Congestion over the network and the data packet size was fixed with 256 bytes. The data transmission rate was set to 2 Mbps. Total simulation time was conducted for 50 sec.

Simulation Code:

```
X=initialize;
y=initialize;
for i=1:length(x)
if mod(i,2)~=0
plot(x(i),y(i),'o');
legend( 'inactive nodes','active nodes');
title('Simulation based on MCD');
xlabel('mobility of nodes');
ylabel(' nodal degree of node');
axis([0,10, 0,10]);
pause(2);
elseif mod(i,2)==0
plot(x(i),y(i),'*');
end
%%scatter(x,y)
hold on;
end
hold off;
```

Table 3.1 Simulation Parameters

Parameters	*Value*
Simulator	MATLAB R2010a
Topology area	10 m × 10 m
Simulation time	10 sec
Congestion type	CBR
Packet size	256 bytes
Hello_packet_interval	1 sec
Node mobility	0–4 m/ sec
Mobility	Random
Transmission range	10 m
Pause time	1 sec
Weight	1.2
ND_min, ND_min	2,5

Partition Recovery Process

This system becomes active when a communication problem occurs. Like, when a link breaks down, such system is efficient than a pro-active one because the pro-active behaviour would lead to additional packets being sent without knowing that we really need to re-routing in the network. We have discussed the detection of partition in previous section, when the mobile node reaches the computed initial position; it has to process two tasks in parallel: firstly, the new node should recover communication between the parts of the network, and secondly, the new node has to optimize its own local position with respect to the effects in the local environment. The position should be adapted to changes in the network topology, especially the arrivals and departures of the network nodes. These two processes are working as long as it is necessary for the recovery system. At this stage, it define a set of constrains and requirements for our system. We assume that some routing mechanism is already present in the network, and our system should be independent of the kind of this routing mechanism. As mentioned before, each node in the network collects information about its communication partners. This information is stored in a tracking table as pairs of IP address of the communication partner and its position. The position information of the communication partners is provided via an extended IP header. The three mathematical coordinates (latitude, longitude and altitude) of the node will be transmitted in a special options field of the IP header for each IP packet originated by this node. The mathematical coordinate’s data option takes additional 12 bytes in header and consists of 2 bytes of option header, of 2 bytes signed integer for altitude and of two 4 bytes fields for latitude and longitude in the floating point number format. There are many ways to minimize the overhead produced by the extension of the IP-headers. The simplest one is to put the mathematical coordinate information only into one IP packet within a given time interval. Another way is to transmit the position only if the node’s position changed and to avoid unnecessary packet fragmentations, the header extension can be limited to the packet size.

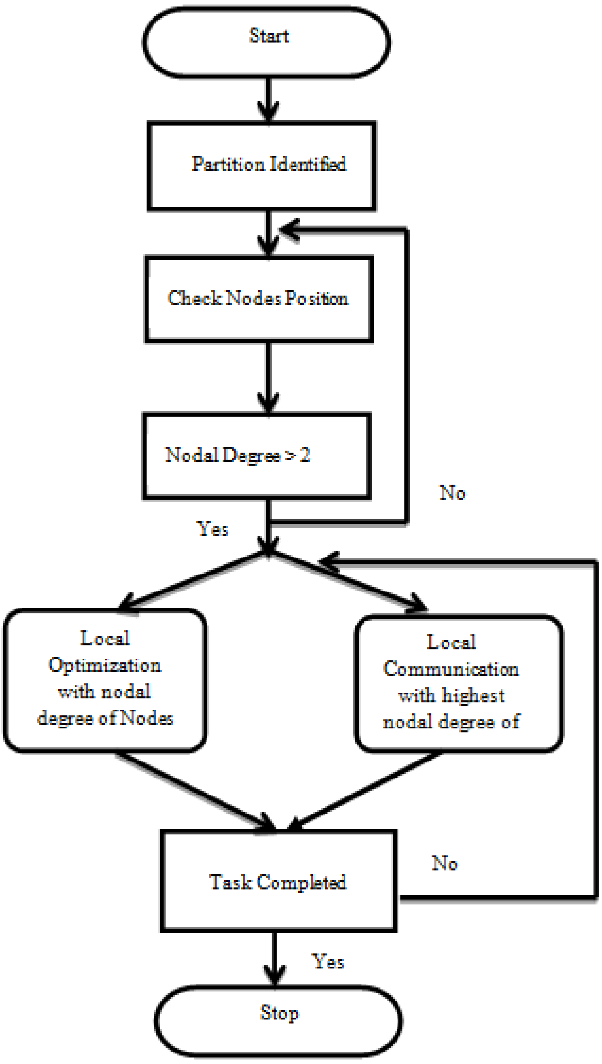

Figure: 3.4 Network rcovery process

Initial Placement of Nodes

Going to describe the initial placement procedure of nodes on the basis of link (nodal degree). Let's assume that some communication processes between any arbitrary nodes are established in the network. At some interval of time, some node detects that it cannot reach one of its communication partners. As a result, the system tries to find an alternative route between the nodes with high nodal degree and, if it was successful, no more operations will be required and system returns to its passive state. Otherwise, the system tries to find some nodes which are closer to the last known position of the communication partner. The last known position is provided by the communication partner's IP tracking table described above.

The nodes which have greatest nodal degree within a reference communication radius from the destination point are found or not. It defines the reference communication radius R_{in} as a maximum distance between two nodes within which a bidirectional communication is possible with a given probability. This radius can be obtained from an experiment with two devices as a distance, on which the transmission error rate does not exceeds some given value.

If at least one node within this radius can be found, it means that the communication with the destination node is potentially possible according to the distance. Therefore, we assume that the communication partner node has failed (nodal degree zero) but the network is not partitioned (at least concerning this communication) and the placement of additional nodes is not necessary. Otherwise, we assume that the network is divided into partitions which cannot communicate with each other and the placement of additional nodes can be solved this problem. The additional node should be available in one of the network partitions.

IV. Result and Discussion

Here, we have considered 20 nodes and the number of packets sent between 0 and 70 packets/sec and each node travels constantly with 1 m/sec. The experimental set-up was executed 10 times with different arrival rate of the packets in a given topology.

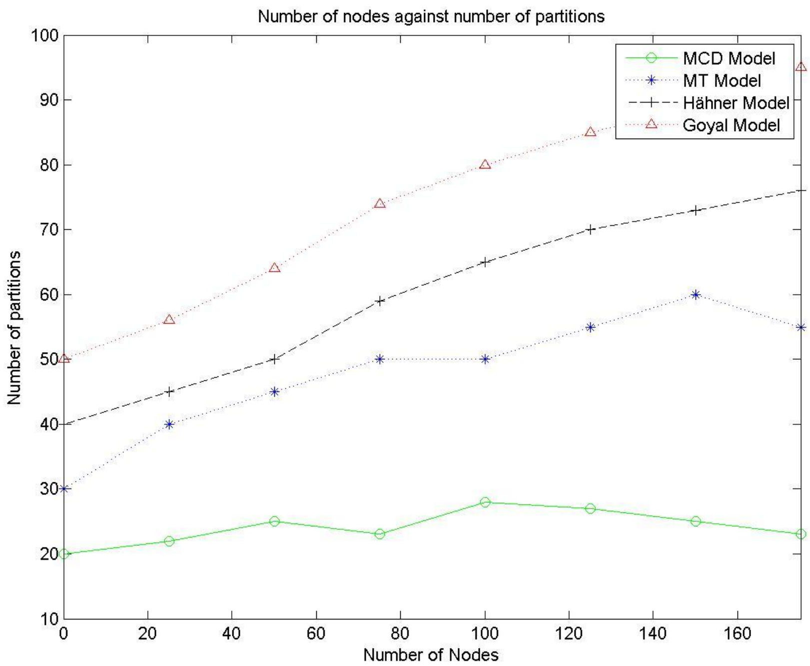

Figure: 4.1 Network Partition due to mobility

Figure 4.1 shows the network partition size for dissimilar node densities. In all situations, there is occurrence of little partition, e.g. separated nodes and partitions of five nodes are general. For low density, the small size of the network partition dominates the distribution. For large node density, the occurrence of large partition becomes more frequent and leads to a large standard deviation for the partition. The result is that the average partition size rarely leads to the conclusions. If the node is not located inside a small partition, there is high probability that it is located in a large partition. Detecting whether a node is in a small partition is possible with relatively low communication overhead by calculating n-hop neighbourhood.

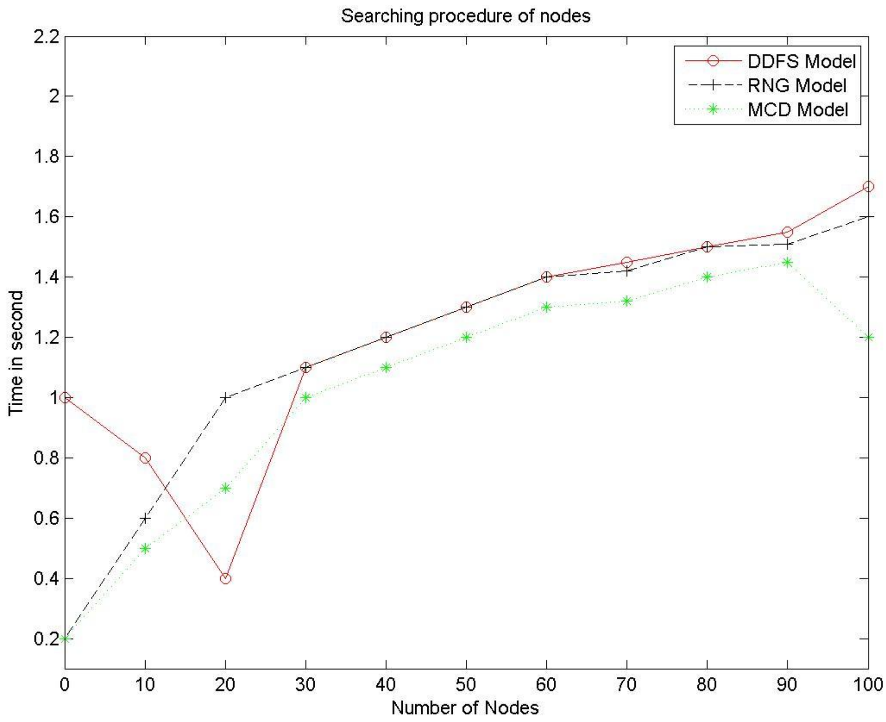

Figure: 4.2 Height weight nodes searching process

From Fig. 4.2 obtained a mean searching time and a packets count (communication overhead) depending on the number of nodes. The packets count considers only the packets sent by our communication instance directly, without counting packets generated by the routing discovery mechanism and "hello" messages.it is presented in figures 2 for mean search time and packets count, respectively. Besides, these results are worse than the results presented here almost for all measurements. As you can see in fig 4.2, all of the presented approaches take a comparable amount of time for the searching nodes.

V. Conclusion

In this paper we have proposed and evaluated to detect network partitioning. This system is able to distinguish node failure from network partition. To the best of our knowledge there are no partition detection mechanisms currently being employed in ad-hoc environments which explicitly select the best suited nodes and are also able to distinguish node failure from network partitioning. For example during the time between server failure and the time when all active nodes registered at the new server the network is completely unmonitored. The same problem occurs during the time when a new server has to be elected in a separated partition. The server election phase itself could be a complex and costly task in terms of network load and system downtime. To reduce the partition we have selected the high weight node which has monitored for low weight monitor. If partition will held we can recover, using recovery of network partitioning system using additional nodes. The new system also is able to short out the big gaps between network partitions which can be covered only by using two or more additional nodes.

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