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AN IMPROVED METHOD FOR DISTRIBUTED STABLE ROUTING AND CHANNEL ASSIGNMENT IN MOBILE AD-HOC COGNITIVE NETWORKS

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Abstract

Mobile communication in MACNets suffers instability due to channel disturbances in network. It also suffers from speed reduction due to channel congestion. The efficiency of the MAC Net depends not only on primary nodes but also on other factors like channel congestion, channel conflict among the cognitive nodes. In a network with huge number of nodes this problem is magnified because of multiple nodes trying to access the same channel at the same time. In this project, we propose a distributed approach called Transition Predicting-Cognitive Routing and Channel Assignment (TP-CRCA) to maximize the network throughput by avoiding channel conflict, congestion and determining the life time of the primary node availability in the network range. To numerically measure the network quality, a new metric named Channel Quality Test (CQT) that captures the mobility of the nodes, impact to primary nodes, channel conflict and life time of the primary node in the range among the cognitive nodes is included.

Keywords: MACNETs; channel congestion; channel conflict; lifetime of the node.

I. Introduction

Mobile Ad Hoc Cognitive Networks (MAC Nets) is a type of technology that uses the cutting edge technology from several research areas because they can address channel disturbances and the delay in transfer of the data packets. They can solve the problem of frequency scarcity problem through dynamic channel access. The cognitive Network is different from the traditional wireless Mobile ad hoc Network where it can intelligently detect and make use of the unused primary nodes. The primary nodes have the highest priority in the channel that can be accessed to vacate the prior node so that the transfer of the packets activates again.

The delay of data transfer and the packet loss is the fundamental issue in MACNets .The stable routing can significantly reduce the problems in the data transfer but in the mobile communication it requires the route reconstruction .The frequent changing of the activities makes the finding of the optimal route set up more difficult. The connectivity depends not only on the node mobility but also on the other factors like channel interference caused by the conflict of the other nodes. It is more challenging when there is a conflict by equally potential nodes. As a result the routing and channel assignment is based on the channel prediction. In this paper we propose a distributed approach called Transition Predicting-Cognitive Routing and Channel Assignment (TP-CRCA) to maximize the network throughput by avoiding channel conflict, congestion by the neighbor nodes and determining the life time of the primary node availability in the network range. To numerically measure the network quality, a new metric named Channel Quality Test (CQT) that captures the mobility of the nodes, impact to primary nodes, channel conflict and life time of the primary node in the range among the cognitive nodes is included.

Our TP-CRCA can benefit many intensive industrial operations which involves data transmission with minimal time and minimal data packet loss. We specifically illustrate our model in the real time industrial application. Let a group of workers transmit a set of data through the licensed assigned channel to expedite the transmission. They need frequent communication through a quality channel. For this purpose our TP-CRCA benefits the process by selecting the route with the critical values assigned by the CQT metric. The CQT metric is calculated using the above mentioned factors. By this they get the optimal path to be selected for the data transmission. When a packet loss occurs, the node searches for another optimal path and the updating of the details to the neighbor nodes also takes place for the future use.

The remainder of this paper is organized as follows. Section2 briefly discusses about the existing literatures. Section 3 introduces the proposed system framework. Section 4 discusses the experimental and performance analysis and Section 5 concludes the proposed work.

II. Related Works

Feilong Tang et el. [4] has proposed a system to maximize network throughput by selecting jointly the stable routes for checking how stable the nodes are and assignment of the channels to avoid the inter and intra flow interferences. This system does not reduce channel congestion and packet loss. L.F.Akyildiz et al. [5] has proposed a system to rectify the limited availability of spectrum and inefficiency in the spectrum usage. This system does not use a reliable communication protocol.

A.Abbagrale et al. [6] has proposed a system to computer routing scheme for cognitive radio Ad Hoc networks which interprets the extent to which the connectivity of possible paths towards the destination. This system contains network collision and complex working.

P.T.A.Quang et al. [7] has proposed a system which shows end to end delay reduction and enhanced energy efficiency. This system does not enhance real time performance and multichannel access. G.Carofiglio et al. [8] has proposed a system to select the optimal route in terms of path availability between two sensor nodes. Bevish and Komathi [9] has suggested the dissemination of the messages in a similar vehicular network. The improved routing strategy proposed in [10] and [11] suggests a method on improving the routing and channel assignment.

To summarize, the existing scheme suffers channel conflict during channel assignment and routing.

III. Proposed System Framework

This section gives a clear idea about the working of our system**.** To overcome the limitations in the existing approaches we propose an approach called Transition Predicting-Cognitive Routing and Channel Assignment (TP-CRCA) protocol which uses Channel Quality Test(CQT) metric for the assignment of route.

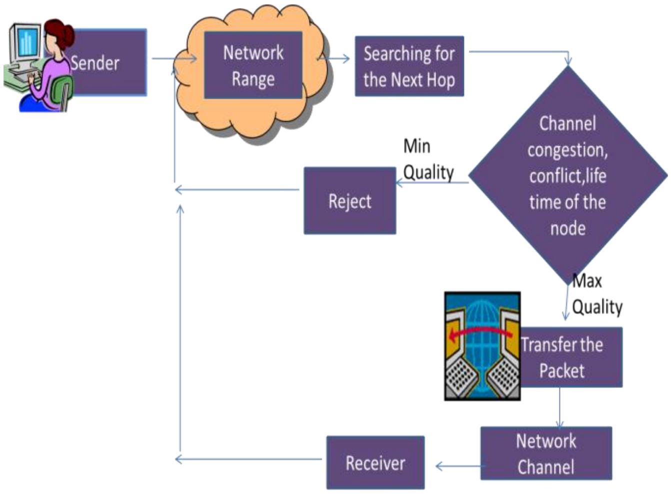

Fig. 1 System Architecture.

Fig.1 shows the system architecture of our system. The sender is transferring a packet to the receiver in the network. It will search for a next hop for transferring the packet. The next hop will be selected based on the following conditions:

- Channel congestion
- Channel conflict
- Lifetime of the node

For selecting a particular node as next hop the channel congestion of the channel for reaching that node is measured. If the channel congestion is minimal, then the condition for channel selection is satisfied. The next condition for selection is lifetime of the node. Lifetime of the node is the calculated value for each node that for how long a particular node will be inside the network range. If the lifetime of the node inside the range is more, then the next condition is also satisfied.

If all the conditions are satisfied by a particular node, then that node will be selected as the next hope, else that node will be rejected and the search will be continued for the selection of next hop. This process of selection of next hop is done at all the nodes till the packet reaches the destination point.

A. *TP-CRCA Algorithm*

During the assigning of the routes, our TP-CRCA carries out its optimization procedure at its every hop until the data reaches the destination node. By doing this, always the best link is selected and jointly solves the stable routing and channel assignment.

With the node mobility in mind, the TP-CRCA algorithm uses on demand routing techniques. Our protocol uses the GPS system. Any node can detect the location and the velocity of the neighboring nodes using the GPS device. For sustenance, the periodic beacon mechanism through the MAC- layer hardware is applied.

The TP-CRCA protocol runs hop by hop in the distributed network. The source node and each of the relay nodes directly determines the next hop using the lowest CQT metric. The TP-CRCA works in two phases: route discovering and route acknowledgement of the data to be transferred.At the beginning, i is set as $i=s_k$. The protocol stops when $j=d_k$.

B. *Algorithm*

Input: RSP from the last hop, ɏ$_i$ Є N (j,R_T)

Output: Cumulative RSP

1: CQT [j] = ∞

2: for all i Є R_T^j do

3: i.visited = false;

4: end for

5: V = R_T^j \ {i|i.visited = true };

6: for (ɏ$_i$ Є V) do

7: if (i is outside the sector region) V=V-i;

8: end for

9: while (V ≠ ø) do

i <- the firt of V;

$C_M^{l\,(i,\,j)} = \Upsilon$ / MLTi, j* $w^c_{i,\,j}$;

$C_I^{l\,(i,j)} = C_{I:PN}^{l\,(i,j)} + C_{I:CN}^{l\,(i,j)}$ $\quad C_{I:CN}^{l\,(i,j)} = \sum_{1 \le i \le N} C_{I:CNi}^{(i,j)}$;

$\omega C_L^{l\,(i,\,j)} = 1/\,T \int |v(i, j, t)| dt$;

$CQT\,(l_{i,\,j}) = \alpha C_M^{l\,(i,\,j)} + \beta C_I^{l\,(i,\,j)} + \omega C_L^{l\,(i,\,j)}$;

if ($CQT\,(l_{i,\,j}) < CQT\,[j]$) {

$CQT\,[j] = CQT\,(l_{i,\,j})$;

w = i ; }

V=V-i;

end while

$P_S^D = P_S^D + w$;

w.visited = true ;

w.active = true ;

update RSP with P_S^D and $C_{j,w}$;

unicast RSP packet to the next hp w ;

C. Route Discovery

In this the next hop selection and the message forwarding takes place. In the next hop selection the CQT is calculated and the lowest CQT value is determined as the next hop. Each of the selected node calls for the TP-CRCA algorithm and the transmission of data takes place. The message packets consists of the unique packet ID, unique flow ID,2-D node coordinate, selected sub-path, assigned channel, sender and destination. On receiving the RSP packet. The message passing is done by transferring of the RSP packets. The TP-CRCA protocol updates the RSP packet in its every hop.

IV. Proposed System Framework

We propose a quantitative metric to evaluate the quality of communication links. We then develop the TP-CRCA protocol with the aid of this quantitative metric.

D. Performance Matrix

During the data transmission there might be possible hindrance in transmitting data due to issues like the mobility of nodes, channel interference by other co channels and lifetime of the nodes in the network range. Keeping these in mind we have developed a new quality testing metric, Channel Quality Test (CQT) as given in (1).

$CQT\ (l_{i,j}) = \alpha C_M^{l\,(i,j)} + \beta C_I^{l\,(i,j)} + \omega C_L^{l\,(i,j)}$(1)

where $C_M^{l\,(i,j),}$ $C_I^{l\,(i,j)}$ and $C_L^{l\,(i,j)\ are}$ the cost of mobility of nodes, cost of channel interference by other co channels and lifetime of the nodes inside the network range respectively.CQT is the final transaction cost of the data and α, β and ω are adjustable coefficients .We set their value as 1 in this paper.

E. Stability Prediction

In this we define how we are predicting the $MLT_{i,j}$.This is done using the model called random waypoint model. In this model, the nodes move both uniformly and randomly. The nodes moves in the direction it chooses and the speed chosen from the range [$V_{min,}$ V_{max}] here the V_{min} and V_{max} are the minimum allowable speed and maximum allowable speeds respectively.

We consider the assumption that the CNS are equipped with a GPS system. and it always communicated to the neighboring CNs.As a result of this all the CNs can easily know the location and velocity of its immediate hop node.

The distance $d_{i,j}$ (t) between i and j is calculated using the formula:

$(d_{i,j}(t))^2 = ((x_i(t)-(x_j(t))^2 + (y_i(t))-y_j(t))^2$ (2)

F. Node Mobility

To get the longer communication between the pair of nodes ,we use the stability factor to measure the maximal lifetime, $MLT_{i,j}$.It is defined at the start up time till the connection is lost due to $d_{(i,j)}(t)>R_{T.}$ Higher the relative movements between the nodes shorter the $MLT_{i,j}$ will be. Also the link with higher bandwidth can transmit the data in a shorter period of time.

The node mobility is formalized as

$C_M^{l\,(i,j)} = \Upsilon\ /\ MLTi,\ j^*\ w^c_{i,j}$ (3)

Where w is the bandwidth and ϒ is an adjustable coefficient.

G. *Channel Conflict*

The channel conflict occurs due to conflict in both the primary nodes and the cognitive nodes. The $C_I^{l\,(i,j)}$ can be calculated as

$C_I^{l\,(i,j)} = C_{I:PN}^{l\,(i,j)} + C_{I:CN}^{l\,(i,j)}$ $\quad C_{I:CN}^{l\,(i,j)} = \sum_{1\leq i\leq N} C_{I:CNi}^{(i,j)}$ (4)

Where the interference cost imposed on all the CNs and PNs are defined.

H. Lifetime of the Nodes

In the mobile nodes, the mobility metric is used to define each node. Here we have made use of the metric to evaluate the speed of the nodes related to the mobility.In this paper we have used the relative speed and the repetitive behavior of the nodes to calculate the lifetime of the nodes inside the network range.

The first one which is the relative speed is the value that is calculated for a pair of nodes in the simulation field. The average of the relative speed over the simulation time is observed as the absolute relative speed. This parameter is defined as

$$\omega C_L^{l\,(i,\,j)} = 1/\,T \int |v(i, j, t)|dt \qquad (5)$$

Where T is the time and v(i, j, t) are the relative speed between the nodes i, j in time t.

This metric is a good indicator of the connection formation and the disconnection between the nodes. When two nodes are travelling at the same speed and have the relative speed equal then the value is set to zero. The number of changes in the link equals to the increase in the relative speeds of the nodes.

V. Performance Evaluation

In MACNets, the mobility of nodes decreases the qualityof wireless links. To evaluate ourTP-CRCA protocol, we developed a simulation system,which is built on the NS2 simulator. Here, we present our simulation results to evaluate our TP-CRCA. First, we describe the simulation system setting. We then demonstrate the performance of our TP-CRCA by comparing it with existing system delay and average delay.

I. Delay

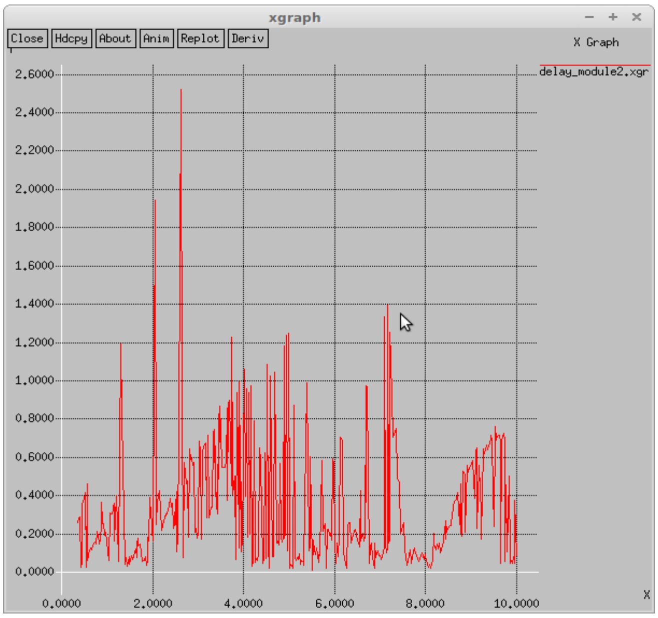

Fig. 2 Graph of existing delay.

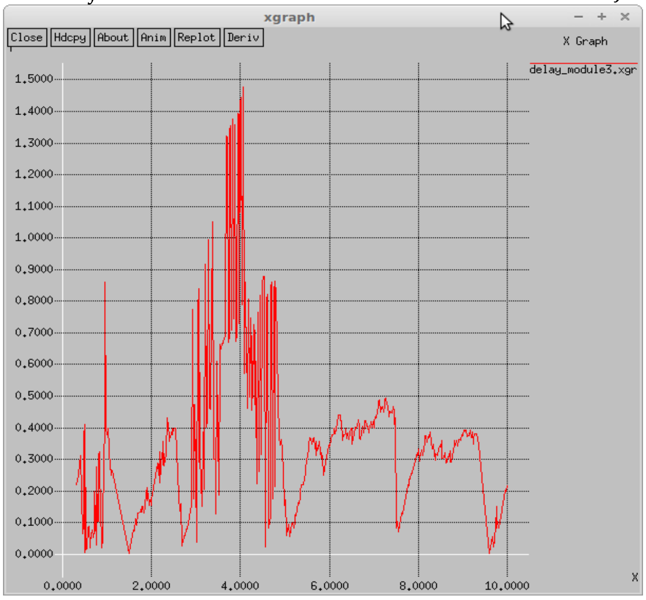

Fig. 3 Delay graph of proposed system.

Fig. 2 shows the delay graph of the existing system and Fig. 3 shows the delay graph of the proposed system. On comparing both the graphs it is observed that the delay of the proposed system is less than the existing system.

J. Average Delay

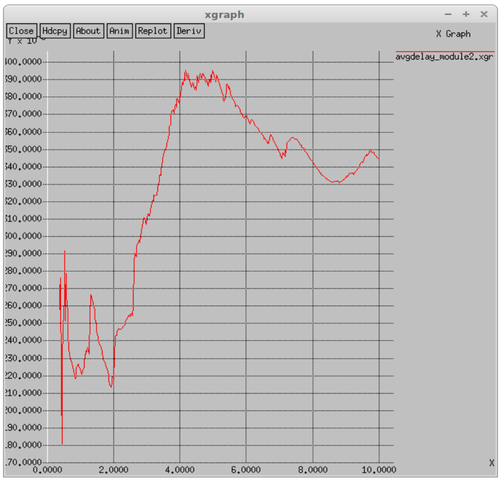

Fig. 4 Average Delay Graph of Existing System.

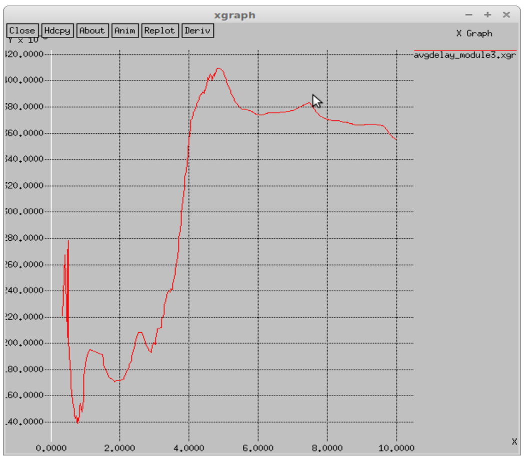

Fig. 5 Average Delay Graph of Proposed System.

Fig. 4 shows the graph of average delay in the existing system. Fig. 5 shows the graph of average delay in the proposed system. On comparing both the graphs it is observed that the average delay of the proposed system is less than the existing system. Hence, the throughput of the system is increased. The packet delivery ratio has increased from 95.6% to 97.8%.

VI. Conclusion

In this paper, we present the TP-CRCA protocol for MACNets, which jointly take transition prediction-based stable routing and interference-avoiding channel assignment into account. First, we design a transition prediction based measure metric CQT that captures the node mobility, the impact to PNs, and lifetime of the PNs. Next, we present channel assignment approaches for different channel interference patterns. Finally, we develop the TP-CRCA protocol that jointly selects stable routes and assigns channels by discovering the link with the highest CQT, which significantly improves the network throughput. NS2-based experiment results validate that our TP-CRCA significantly improves the network throughput.

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