Path Stability Prediction based on Grey Model (PSPGM) for Reliable Unicast Routing in MANET

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Abstract--- Path stability is considered to receive maximum attention in ad-hoc networks as its reliability in data communication depends on the mobility rate of their interacting nodes. The dynamic mobility rate of mobile nodes in ad hoc networks make it difficult for predicting the conditions of routing path due to the loss of connectivity between the mobile nodes of the path. Hence a Path Stability Prediction based on Grey Model (PSPGM) is formulated as a prediction technique for facilitating path stability during data delivery based on the incorporation of Grey theory. Grey Model GM (1,1) under unicast routing is proposed based on multi-constraints like energy and the number of new neighbors interacting with a mobile node known as Active Interaction Rate (AIR) as they potentially influence the path reliability under the event of routing. The experimental analysis has proved that GM (1,1) prediction model can be utilized for predicting the path stability in MANET with more accuracy.

Keywords--- Active Interaction Rate, Grey Model, Path Potential Rate, Integrated Path Reliability Estimation Factor.

I. Introduction

Mobility is considered as the principal issue in MANET as the mobile nodes has the possibility of reaching out of range in communication from its antecedent node of interaction that may end up in link failure [1]. The reduced deployment time, self-configurable and self-organizing characteristics of MANET make its more suitable for data communication. In MANET, multi-hop communication is considered as the reliable method of achieving faster rate of transmission based on the process of forwarding data packets from the intermediate routing nodes that exists between the source and destination pairs [2-4]. Unicast routing with link stability is predominant in terms of reduced time of transmission rate, effective bandwidth utilization and minimized energy resource usage [5]. A significant path stability estimation mechanism is essential for maintain and reconfiguring paths of the network when mobility of nodes results in dynamic change in topology [6-8]. In this paper, stable path refers to the maintained connectivity of nodes during active routes in par with the links that are requesting for connection in the entire routing period [9]. This stability of paths is influenced by factors like residual energy, mobility and interaction rate of mobile nodes under mobility. The stability of paths needs to be accurately predicted based on residual energy, mobility and interaction rate of mobile nodes for improvising the performance of the network in terms of packet dissemination [10]. The characteristic features of Grey prediction model is found to be the significant method of predicting path stability.

PSPGM is propounded as a Grey prediction mechanism which aids in estimating the reliable paths that are necessary for constructing paths until the construction of next optimal routes. PSPGM is reliable in forecasting the stability of paths based on the computation of integrated factor that combines energy and node interacting tendencies of mobile nodes. The significant features of Grey theory are incorporated for facilitating accurate forecasting of path stability. Simulation experiments are conducted and the results are investigated under different number of network nodes, mobility speed and data rate for investigating its potential attributed towards the possibility of determining stable paths. The roadmap of the forthcoming sections of the paper is structured as follows: The stability path estimation techniques existing in the literature attributed for determining stability of paths under unicasting is detailed with their merits and limitations. In section 2, the link stability and path stability estimation techniques existing in the literature under unicasting is detailed with their merits and limitations. In section 3, the steps

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Research paper

Path Stability Prediction for Stable Routing using Markov Chain Model in MANETs

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Abstract

The mobility factor and the energy level of a node during data transmission in MANET are considered to be the most important challenges amongst several other issues like link stability, security and QoS factors in the designing of routing protocols. Forecasting the path stability, leads to an effective and reliable communication between the nodes in a highly dynamic scenario. Subsequently, in most of the work metrics namely hop count and energy are considered for stable path selection and mobility is handled in few works. Therefore, in this paper a prediction model with bi-objective optimization using Active Interactive Neighbour Rate (AINR) and Energy (E) have been considered for stable path selection. Markov models are widely used for depicting random behaviour in several processes related with time series. However, this model has not been utilized for predicting the stable path in a highly mobile network, taking into consideration the issues of mobility and energy. Hence, in this work a new Path Stability Prediction model, using Markov chain namely PSPM has been proposed, using two metrics namely AINR and E. The proposed model is incorporated in a multipath routing protocol, which identifies the optimal path in terms of minimum AINR and minimum energy consumption, which has been evaluated using NS 2.35. From the simulation, it has been found that the new protocol shows enhancement in results than the existing protocols namely AODV and AOMDV, in terms of various parameters such as Packet Delivery Ratio, Throughput, End-to-End Delay, Energy consumption and Routing Overhead.

Keywords: *MANET, Path Stability, Energy, Markov chain, Active Interactive Rate, Path Reliability Factor.*

1. Introduction

Mobile Ad-hoc network (MANET) is an infrastructure less network with dynamic topology in which all the mobile nodes are in random motion. It is an unbiased system of mobile nodes which are connected by wireless links. MANETs are very much suitable in various environments where there is no fixed infra structure such as military, rescue operations, mining, video conferencing and emergency situations. There are many issues and challenges in MANET such as Link Stability, Energy, Node mobility, Trust, Fault Tolerance and Security.

Each node has a limited battery power, using which it is able to communicate with other nodes via wireless connections. In order to perform the data transmission, nodes along the path need sufficient battery power. There are various factors which affects the battery power of a node namely, transmission power, receiving power, number of neighbours, node density, etc. Hence, designing an energy efficient routing protocol is a challenging task [1]. Since, there is a limitation with regards to the range of transmission for communication, the mobility of the intermediate nodes must also be taken into account for the effectiveness. The high mobility of the node, in a dynamically changing topology, results in poor performance of routing protocolin MANET[2]. In an emergency situation such as in military barracks or at times of disasters, time taken for communication of the message plays a major role for determining the reliability of the path. Hence, it becomes necessary to predict the stability of the path, to transmit the data within a short duration of time.

The path selection in MANET can be implemented using single factor or multiple factors. When a single objective is used for path selection there is a chance of getting a biased output. In most of the research works done,the path selection has been done using the metric hop count, in which the path with minimum number of hop count is selected [3]. In addition to this metric, several other metrics namely, mobility of the node, residual energy of the node, bandwidth availability, etc. are analysed for finding an effective solution in case of single objective optimization problem. The drawback with the hop count metric is, buffer overhead, that results in the maintenance of a long queue for storing the neighbourhood nodes. Hence, a new metric namely Active Interactive Neighbour Rate [4] has been used as a replacement of the hop count metric. Active Encounter Rate is the number of new active neighbours encountered at an interval of time. When AINR of a node is lesser, it indicates that the lesser number of control packets will be generated and thereby makes this metric useful for mobility control in MANET. In case of bi-objective optimization problem, the optimal path is selected by using two metrics such as number of hops and energy or other combinations of hop count [5]. In our work, the bi-objective optimization problem has been tackled using AINR and E metrics. Prediction is the process of forecasting the future value based on the past and present data. Prediction models find their applications in numerous zones namely prediction of price indexes in stock markets, prediction of exchange rates between foreign currencies, prediction of increase in population, prediction of safety measures in road traffic, prediction of accidents and so on.

Prediction model grounded on time is known as 'Time Series Prediction Model' (TSPM). Time series prediction is defined as a

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RESEARCH ARTICLE

An Efficient Evaluation of Bi-Objective Optimization of Path Stability Model for Mobile Ad Hoc Networks Using EN²RP

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The effective data communication between the nodes in Mobile Ad hoc Network (MANET) results in extensive node mobility, thereby the selection of suitable node for data transfer is a challenging task in terms of node energy, node mobility and other QoS related issues. When path stability optimization problem is to be tackled based on two constraints, it is considered as a bi-objective optimization scenario. In most of the works, single objective path stability optimization problem was resolved with link stability metric between the nodes. The same metric was combined with energy related metrics to find the optimal solution by considering it as a bi-objective one. There is a trade-off between these parameters and it results in major problems in critical cases like an emergency scenario. In MANET, high mobility of the nodes results in breakage of link between the nodes and overhead of route maintenance. In some of the routing protocols the metric called 'Mobility Factor (MF)' has been used which monitors the neighbors encountered within the transmission range and maintains the neighbor's history. This results in the overhead of resource wastage and computational complexity. In this work we study the existing MANET protocols based on the issues of path stability and evaluate the bi-objective path stability optimization problem. The analysis has been carried out with two metrics namely Energy (*E*) and Active new Neighbor Rate (ANR) and it has been proved that the performance of our bi-objective protocol namely Energy and active New Neighbor Rate based routing protocol (EN²RP) has resulted in high efficiency over the existing protocols. It has been found that performance evaluation metrics such as Throughput is increased by 21% and 12%, Packet delivery ratio is increased by 13% and 10%, End to end delay is reduced by 14% and 16%, Energy consumption is reduced by 12% and 18% and Normalized routing overhead is decreased by 18% and 29% than AODV and AOMDV routing Protocols.

Keywords: Active New Neighbor Rate, Bi-Objective Optimization, Energy Consumption, Mobile Ad Hoc Networks, Path Stability.

1. INTRODUCTION

Information sharing between the communicating parties is an indispensable operation in the Mobile Ad hoc Network (MANET) to achieve the set-out goals. In MANET, there is no fixed infrastructure between the communicating entities. Because of the self-configuring and organizing ability that is inherently available in the network, users are able to communicate by means of the neighborhood nodes, treating them as relay partners. By virtue of their mobile nature the nodes not only behave as a host but also as a router. The dynamic nature of MANET demands effective decision making in terms of neighborhood selection. The route establishment for data dissemination between any two nodes in the network highly relies on the nodes which lie within the range of transmission.

In general, the classification of routing protocols based on route discovery is of two types namely proactive and reactive routing protocols. In the proactive routing (table driven) protocol, for every node there is a routing table which contains routing details which are updated at regular intervals of time irrespective of their requirement. The route will be available as and when it is required. Some of the proactive routing protocols are DSDV, FSR, OLSR. The disadvantages of these protocols are additional overhead cost and low latency. In the reactive type which is also called as on demand routing protocol, route discovery is based on demand by sending the route request packet to all the nodes in the network. Some of the reactive routing protocols are AODV, DSR, ABR. The advantage of these protocols is that they have lesser routing information overhead than proactive protocols. However, they have the disadvantage of more control packets and high

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Fuzzy Logic Based Path Stability Forecasting Scheme for Improving Data Dissemination in MANETs

Calarany C., Manoharan R.

Abstract: Path stability of the mobile nodes in MANET plays a vital role in effective data dissemination as it depends on factors such as mobility, energy, signal strength. Several studies reveal that the prediction of path stability might provide solutions thereby routing performance can be increased. In most of the protocols route selection is based on metrics namely hop count, energy, etc. The metric namely mobility factor "MF" is used in some of the protocols. These protocols include nodes with less energy or nodes with high mobility which results in loss of path in a short period of time. Since it preserves the neighbor's history, more control overhead and maintenance complexity exist. Hence, a new metric namely Active Interactive new Neighbor Rate (AINR) has been considered for optimum path selection. In scenarios of path loss, there is an immediate need for alternative paths for continuous data transfer. From literature it is evident that fuzzy logic is more significant in exploring different possible states under path stability determination. Hence a new prediction mechanism based on fuzzy logic has been proposed by considering the Residual Energy (RE), Hop count (Hop) and proposed metric Active Interactive new Neighbor Rate (AINR) as the factors for the prediction of the optimal path. This prediction mechanism is leveraged in MANET scenarios where alternate paths should be available on hand in situations such as battlefield and natural disaster. From the simulation, it has been proved that fuzzy logic prediction model provides better results in terms of various performance metrics such as Throughput, Packet delivery ratio, End-to-end delay, Energy consumption and routing overhead than the existing protocols.

Keywords: Active interactive new Neighbor rate, Energy, Fuzzy logic, Mobile Ad hoc Networks, Path Stability.

I. INTRODUCTION

Infrastructure less network with dynamic topology makes routing in mobile ad hoc networks as a difficult task. All the nodes are highly mobile in nature which results in a dynamic topology. But they act both as a host as well as a router. The nodes in the network can organize themselves when they are within the transmission range. Due to this transmission limitation, the nodes may not connect to the destination directly. Selection of the intermediate node has a great impact on path stability. There are many influential factors which affects the stability of the path such as mobility, battery power of the node, Received signal strength,, security, fault tolerance and so on. In the applications such as military tactical networks, emergency networks, etc. connectivity is an essential factor. Many routing protocols have been proposed to solve this issue. However, the hop count metric [1] is used in many of them to select the shortest path which includes lossy links or slow nodes and hence results in poor performance in data transmission. Hence, a new metric, namely Average Encounter Rate [2] has been proposed to predict the node mobility. Multi objective routing protocols provide more better results than single objective or bi-objective protocols [3]. To avoid the packet loss due to the breakage in the path and to minimize discovery of new routes latency, multipath routing is used. In order to predict the path before it expires either due to node's energy depletion or node mobility, a prediction technique is essential. It has been found that there are many time series prediction techniques such as Bayesian theorem, Markov chain, grey prediction model, Fuzzy logic etc. to predict the stability of the path [19-20]. In this paper, fuzzy logic is used to predict the path stability for effective data transmission. In this work, section II analyses about the related work, section III about the proposed work, section IV algorithm, section V simulation results and evaluation and in section VI conclusion and future enhancements.

II. RELATED WORK

The existing problems in MANET such as the available energy of the node after the consumption in terms of transmission power, receiving power, over hearing power, idle power, link breakage due to node mobility makes data transmission as a challenging task. Most of the researchers are dealing with the issues to identify the optimal route, maintenance of the route etc. In the following section idea of the work done in optimization of energy and stability of the nodes along the path in data transmission in MANET.

In Paper [2] a new metric namely Average Encounter Rate (AER) is used instead of hop count to find a reliable path. This metric identifies nodes which has lesser in mobility or which lies in lesser dense area. These are not considered while hop count is used as a metric. During the selection of optimal node, AER^2 value has been taken instead of AER to minimize the least mean square error. However, energy is not included in this paper. In paper [3] a bi-objective optimization model is used to find the link stability and energy of the node. Single path is determined for data transmission.

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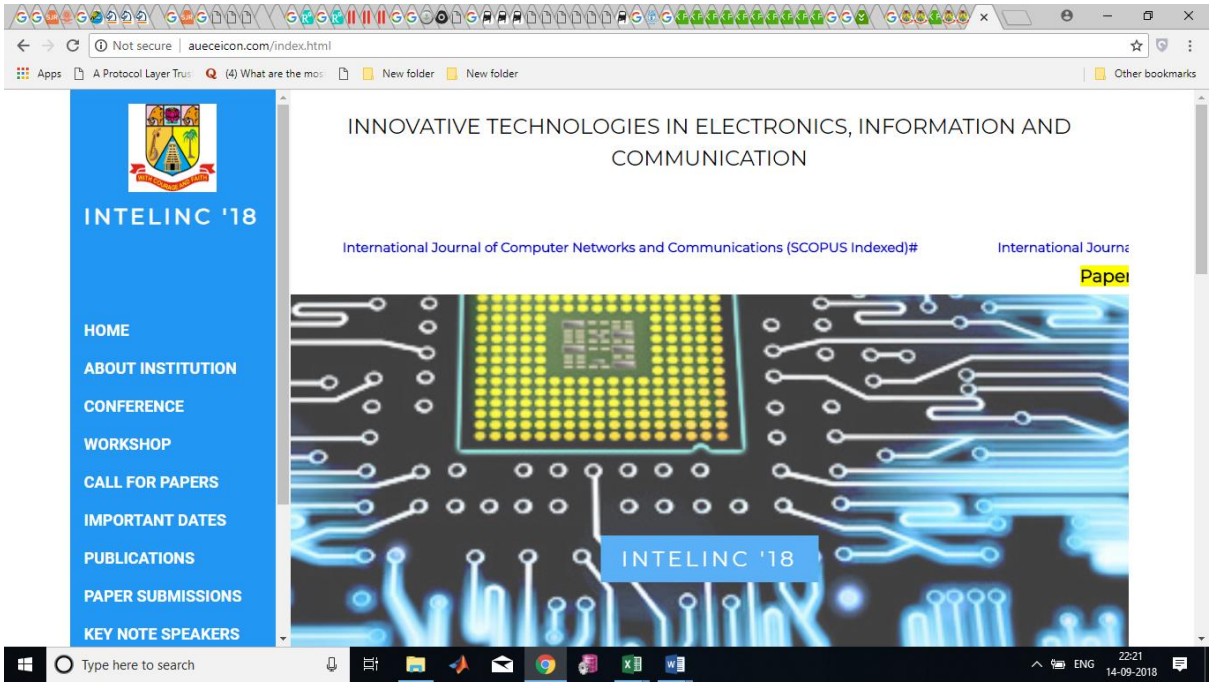
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AN EFFICIENT EVALUATION OF BI-OBJECTIVE OPTIMIZATION OF PATH STABILITY MODEL FOR MANET USING EN^{2}RP

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ABSTRACT :

The effective data communication between the nodes in Mobile Ad hoc Network(MANET) results in extensive node mobility, thereby the selection of suitable node for data transfer is a challenging task in terms of node energy, node mobility and other QoS related issues. When path stability optimization problem is to be tackled based on two constraints, it is considered as a bi-objective optimization scenario. In most of the works, single objective path stability optimization problem was resolved with link stability metric between the nodes. The same metric was combined with energy related metrics to find the optimal solution by considering it as a bi-objective one. There is a trade-off between these parameters and it results in major problems in critical cases like an emergency scenario. In MANET, high mobility of the nodes results in breakage of link between the nodes and overhead of route maintenance. In some of the routing protocols the metric called 'Mobility Factor(MF)' has been used which monitors the neighbors encountered within the transmission range and maintains the neighbor's history. This results in the overhead of resource wastage and computational complexity. In this work we study the existing MANET protocols based on the issues of path stability and evaluate the bi-objective path stability optimization problem. The analysis has been carried out with two metrics namely Energy(E) and Active New Neighbor Rate (ANR) and it has been proved that the performance of our bi-objective protocol has resulted in high efficiency over the existing protocols. It has been found that performance evaluation metrics such as Throughput is increased by 21%, Packet delivery ratio is increased by 10%. End to end delay is reduced by 15%. Energy consumption is reduced by 18% and Normalized routing overhead is decreased by 20% than AODV Protocol.

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