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Improving Routing Efficiency Based On Random Direction Mobility Model In Manets

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ABSTRACT: Major issue arising in mobile ad hoc networks (MANETs) is the selection of the optimal path between any two nodes. A method that has been advocated to improve routing efficiency is to select the most stable path so as to reduce the latency and the overhead due to re-routing instability problem. We study both the availability and the duration probability of a routing path that is subject to link failures caused by node mobility. In particular, we focus on the case where the network nodes move according to the (RD) Random Direction model, and we derive both exact and simple and approximate expressions of these probabilities. By obtained results, we study the problem of selecting an optimal route in terms of path availability. Finally, we propose an approach to improve the efficiency of Reactive Routing protocols. The problem of link and route stability has been widely addressed in the literature. Routing protocols accounting for route stability while selecting the source-destination path can be found, just to name a few. Studies on link and path availability and duration are presented. A partially deterministic and a Brownian motion, where nodes start moving from the same location, are considered. Our objective is to derive the probability of path duration till time t and the probability of path availability at time t and Simulate with NS-2 Simulator at each and every node independently through out the path and observe results of path availability and path duration with respective to time t , Compare probability and simulator results to obtain route stability, so as to Improve routing efficiency as well by RD-Mobility Model.

KEYWORDS: RD-Mobility Model, Optimal path, NS-2 Simulator, Brownian motion, stable path, path duration, path availability, MANETS, Reactive routing protocols, link failures, node mobility.

1. INTRODUCTION:

MOBILE wireless networks are receiving an increasing interest due to the possibility of ubiquitous communications they offer. In particular, mobile ad hoc networks (MANETs) enable users to maintain connectivity to the fixed network or exchange information when no infrastructure, such as a base station or an access point, is available. This is achieved through multihop communications, which allow a node to reach far away destinations by using intermediate nodes as relays.

The selection and maintenance of a multihop path, however, is a fundamental problem in MANETs. Node mobility, signal interference, and power outages make the network topology frequently change; as a consequence, the links along a path may fail and an alternate path must be found. To avoid the degradation of the system performance,

several solutions have been proposed in the literature, taking into account various metrics of interest. A method that has been advocated to improve routing efficiency is to select the most stable path [1], [2], [3],[6], so as to avoid packet losses and limit the latency and overhead [5] due to path reconstruction (*routing instability*).

In this work, we focus on the stability of a routing path, which is subject to link failures caused by node mobility? We define the path duration as the time interval from when the route is established until one of the links along the route becomes unavailable, while we say that a path is available at a given time instant t when all links along the path are active at time t . Then, our objective is to derive the probability of path duration till time t and the probability of path availability at time t [2], [3]. Clearly, the probabilities of path duration and path availability strongly depend on the mobility pattern of the network nodes. Indeed, the path duration (availability) is determined by the duration (availability) of its links, which on its turn depends on the movement of a node with respect to the other. To characterize the nodes position with respect to each other, we need the spatial distribution of a single node over time. One would like to be able to evaluate these quantities in presence of various mobility models; however the analysis is extremely difficult even under simple mobility patterns.

Here we focus on bidimensional random mobility [1], and we consider nodes moving according to the Random Direction (RD) mobility model, According to such model, each node alternates periods of movement (move phase) to periods during which it pauses (pause phase); at the beginning of each move phase, a node independently selects its new direction and speed of movement [1], [2], Speed and direction are kept constant for the whole duration of the node move phase.

We then propose an approach to find and select routes, which accounts for the expected data transfer time over the path and allows reducing the overhead of reactive routing protocols, in deed tends to improve routing efficiency and we use RD-Model to optimal path selection.

2. RD-Mobility Model:

Mobility models play an important role in the simulation of mobile ad-hoc networks (MANET), including protocol performance evaluation, power control, connectivity analysis, and capacity planning, etc. Generally speaking, there are two types of mobility models [1]. The one is called entity mobility model in which mobiles' movements are independent of each other. Actually, as is to be proved, nonuniform node distribution and speed decay are also problems of random direction model (RD). This model was proposed by Royer in 2001. Like RWP, RD's mobile moves by a zigzag way. Its speed keeps constant during each segment but varies uniformly on $[V_{min}, V_{max}]$ at endpoints. The endpoints of RD must be on the boundary, which is to say that nodes cannot stop in the middle of the region (see fig.1). we apply geometric probability to analyze node distribution of RD model. In the case of circular regions, a closed form node distribution is obtained. Furthermore, we analyze the speed distribution of RD by the method of palm calculus and give a general explanation to the hypostasis of speed decay phenomenon. At last, it should be noted that the appellation "random direction model" is also used to emulate Brownian motions.

Fig (1): Illustration of RD-Mobility Model in a) Circle Region b) Square Region.

2.1 ANALYSIS TO STATIONARY NODE DISTRIBUTION:

Geometric probability, also being called integral geometry, applies the idea of probability to random geometric objects, such as points, lines or motions. A straight line on the plane is determined by its distance

p from the origin and angle of the normal with x-
 θ

$$x \cos \theta + y \sin \theta - p = 0$$

Figure 2. A line on the plane is determined by coordinates (p, θ) .

RD model compared with uniform distribution in which $CDF(r) = r^2/R^2$ and $pdf(r) = 2r/R^2$. It is found that stationary node distribution of RD model is very close to uniform except for the region near boundary.

To support mathematical analysis, we make a simulation in which a node moves with speed 0.5m/s for 1000 periods in the unit circle. It's location at every second is recorded.

Fig (2): Pdf(r) with $R=1$. Line is the case of uniform distribution. Line with Symbols is the case of RD.

Fig (3): Probability density functions of RD model in the unit circular region.

Why Is Route Stability Analysis Needed?

We focus on route stability, which is an aspect of fundamental importance as one can judge from the following considerations.

Stable routes: To maximize throughput and reduce traffic latency, it is essential to ensure reliable source-destination connections over time [2], [3]. A route should therefore be selected based on some knowledge of the nodes motion and on a probability model of the path future availability.

Efficient route repair: If an estimate of the path duration is available, service disruption due to route failure can be avoided by creating an alternative path before the current one breaks [3]. Note that having some information on the path duration avoids waste of radio resources due to preallocation of backup paths.

Network connectivity: Connectivity and topology characteristics of a MANET are determined by the link dynamics. These are fundamental issues to network design, since they determine the system capability to support user communications and their reliability level. Performance evaluation. The performances achieved by high-layer protocols, such as transport and application protocols, heavily depend on the quality-of-service metrics obtained at the network layer. As an example, the duration and frequency of route disruptions have a significant impact on TCP behavior, as well as on video streaming and VoIP services. Thus, characterizing route stability is the basis to evaluate the quality of service perceived by the users. This approach enables us to effectively analyze the link and path transient behavior, which is essential to the study of the Communication performance between mobile nodes. The use of random mobility models is justified not only by the need for analytically tractable results, but also by their capability to

Capture in a simple manner the aggregate behavior of independent users.

3. LINK AVAILABILITY AND LINK DURATION UNDER THE RD MODEL:

Random Direction model [6], i.e., each node alternates periods of movement (move phase) to periods during which it pauses (pause phase); at the beginning of each move phase, a node independently selects its new direction and speed of movement. Speed and direction are kept constant

for the whole duration of the node move phase; the durations of move and pause phases are, in general, distributed according to independent random variables. Under the RD model, the temporal evolution of the node position, either in the move or in the pause phase, can be described through a system of partial differential equations (PDE's) [1].

We consider the dynamics of nodes moving over an infinite bidimensional domain, and we obtain a closed expression for the general (weak) solution of the RD equations in the frequency domain (i.e., the moment-generating function under the assumption that move and pause times are exponentially distributed. Even if a direct analytical inverse transform of the obtained moment-generating function appears to be prohibitive, closed expressions for the moments of the spatial probability density function (pdf) can easily be derived. By using the node spatial distribution, we write an exact expression for the probability of link availability, and then propose a simple approximation to evaluate this metric based on the second moment of the spatial distribution, which provides satisfactory results.

3.1 LINK DURATION:

An exact expression for the link duration probability under the RD model appears prohibitive for the following reasons:

The relative motion between two nodes moving according to independent RD motions is no longer an RD motion.

Fig (4): Probability of link availability versus time in case of the RD model. Different curves correspond to different values of the average duration of the move and pause phases.

- 1) The phases of the nodes $P_A(t) \in \mathcal{P} = \{\text{move}, \text{pause}\}$ and $P_B(t) \in \mathcal{P} = \{\text{move}, \text{pause}\}$; position
- 2) The instantaneous relative n $\mathbf{X}_A(t) - \mathbf{X}_B(t)$;
- 3) The current speed of the two nodes $\mathbf{V}_A(t)$ and $\mathbf{V}_B(t)$.

3.2 LINK AVAILABILITY:

The probability of link availability between the two nodes can be expressed as

$$A_{link}(d_{A,B}(0), t) = \int_{\mathbf{x}_A} \int_{\mathbf{x}_B} [M_A(\mathbf{x}_A, t) + p_A(\mathbf{x}_A, t)] \cdot [M_B(\mathbf{x}_B, t) + p_B(\mathbf{x}_B, t)] \mathbb{I}_{\|\mathbf{x}_A - \mathbf{x}_B\| < R} d\mathbf{x}_A d\mathbf{x}_B,$$

We observe that the link availability is quite sensitive to the initial distance between the nodes forming the link. As expected, the smaller the initial distance, the higher the link availability, probability of link availability computed through the approximation in [1], [2] for a bidimensional RD model.

Fig (5): Probability of link availability versus time in case of the RD model, for different values of the initial distance between the nodes forming the link.

4. ROUTING PROTOCOL FOR MANET:

Routing protocols for MANETs typically fall under two classifications; first one is unicast Routing Protocol, second one is multicast Routing Protocol. Different routing protocols try to solve the problem of routing in mobile ad hoc network in one way or other.

Fig (6): Classification of routing protocols.

Unicast routing protocols are divided into proactive, reactive and hybrid routing protocols, and the multicast routing protocol are divided into proactive, reactive, and hybrid routing protocol. Figure. 1 gives a classification on routing protocol is based on unicast and multicast routing protocol. Proactive

routing that means route available immediately. Reactive routing that means discovers the route when needed [3], [4], [2].

The key motivation behind the development of reactive routing protocols like DSR and AODV is the reduction of routing load. There will be impact on

performance for low bandwidth wireless link if high routing load is there. There are many simulation study has been done so far for the routing protocols. This paper has been organized as follows: In the following section we briefly review the three protocols DSDV, DSR and AODV. Then we described the performance metrics on the basis of which we compared the protocols. Next to this a simulation model has been explained on which basis results are obtained and graphs are generated to compare and analyze the results with the help of performance metrics. we have presented the simulation based comparative performance analysis of routing protocols DSR, AODV (Reactive) and DSDV (Proactive) and finally concluded which protocol is better under certain traffic conditions and scenarios.

4.1 ROUTING OVERHEAD:

Routing overhead has been calculated at the MAC layer which is defined as the ratio of total number of routing packets to data packets. From the critiques point of view DSR makes use of caching aggressively and replies to all requests reaching the destination from a single request cycle. Thus source learns many alternate routes to destination. Having access to many alternate routes saves flooding of route discovery which is a performance bottleneck. In comparison of AODV, DSR has performed well and supported the previous work. Conceptually routing overheads are negligible in case of DSDV and our results supported the same. DSR performed well in most of the cases when number of nodes was less and around 100 for the particular scenario but AODV out performs DSR when number of nodes are above 100. Since AODV is having more routing control packets than DSR, routing overhead of AODV is always higher even in stressful environment. It has been concluded from the results that AODV outperforms DSR under heavy load, as routing overheads are more for DSR when number of nodes are more[4],[2].

5. MULTIHOP PATHS:

Consider $n+1$ nodes moving according to an RD

motion, and assume th. $d_{i,i+1}(0) < R, 1 \leq i \leq n$. Then, consider the path of n (bidirectional) links obtained traversing the $n+1$ node in sequence. Since nodes' movements are assumed to be independent, processes.

Links' dynamics are independent:

$$A_{path}(d_0, t) = \prod_{i=1}^n A_{link}(d_{i,i+1}(0), t),$$

3-Link path:

$$\begin{aligned} A_{path}(d_0, t) &= \mathbb{P}(d_{1,2}(t) < R, d_{2,3}(t) < R, d_{3,4}(t) < R) \\ &= \mathbb{P}(d_{1,2}(t) < R, d_{3,4}(t) < R | d_{2,3}(t) < R) \\ &\quad \times \mathbb{P}(d_{2,3}(t) < R), \end{aligned}$$

Fig (7): Multihop in Manets, independence paths (b-directional links).

Note that we consider a sequence of nodes, but we do not assume a line topology. Indeed, when the route connecting a source with a destination is fixed, the sequence of nodes just represents the sequence of hops between the source and the destination.

Fig (8): Probability of path availability under the Brownian motion, in case of three links and different values of initial hop lengths.

We can do better than the independence assumption among the links by accounting at least for the correlation between adjacent links. We now evaluate the accuracy of our approximations for the path availability, comparing analytical and simulation results. So as to assess the impact of the approximations introduced for multihop paths without any additional source of error.

Note that in this case, we have the combination of two approximations: one due to the normal approximation to compute the probability that a single link is available, the other due to our approximations (considering either independent or pair wise correlated links) to compute the probability that a multihop path is available. This time, we keep the initial length of each hop fixed to 20 m and vary the parameters for the RD model considering three scenarios:

2 links, $E[\text{move}] = E[\text{pause}] = 10$ s, speed uniformly distributed in $[-5,5]$ m/s.

5 links, $E[\text{move}] = E[\text{pause}] = 30$ s, speed uniformly distributed in $[-2,2]$ m/s.

10 links, $E[\text{move}] = E[\text{pause}] = 10$ s, speed uniformly distributed in $[-2,2]$ m/s.

Fig (9): Probability of path availability in case of the RD model for three different values of initial hop lengths.

We observe that both approximations are satisfactory when the probability of path availability is not too low. Indeed, the use of the refined approximation that partially accounts for link correlation does not

provide significant improvements with respect to the one based on the independence assumption.

5.1 PATH SELECTION:

We address the problem of finding optimal paths in a MANET in terms of path availability. Having analyzed the probabilities of link availability and duration, we have moved to the study of the same metrics in the case of multihop paths, again under the RD mobility model. We have discussed the validity of the link independence assumption.

Fig. (10): Path selection between nodes A and B.

6. OPTIMAL PATH SELECTION:

The parameters of the mobility model as nodes are fixed, under range R. The problem of path selection, suppose node A wants to communicate with node B, possibly using intermediate nodes as relays. [1],[2],[3].

To maximize the stability of the route in response to node mobility, one can think of two different strategies: 1) a few long hops 2) many short hops. On the one hand, considering that the entire path fails if just a single link fails and that nodes move independently of each other, it seems better to minimize the number of hops. On the other hand, short links are much more stable than long links Ref; Fig (10).

we turn to the problem of finding the optimal number of hops we check our analytical results against simulation and we outline a routing scheme to apply our results to the problem of path selection in a real network.

Fig (11) : Path availability at different time instants, as a function of n ; bidimensional RD model with $L = 2.5R$.

On the one hand if entire path fails or else just a single link fails and that nodes move independently of each other, it seems better to minimize the number of hops. On the other hand, short links are much more stable than long links.

Example for Optimal Path:

Ant colony optimization for Manets

7. PERFORMANCE ANALYSIS BASED ON SIMULATION:

Simulation is performed based on Routing protocols in MANETS at each and every node during its mobility using RD-Mobility model by using Network Simulator-2, for sample probable results of its path from source to destination to gain Optimal (stable) path, its availability, duration and Number of hops etc..

7.1 SIMULATION ENVIRONMENT:

The simulation experiment is carried out in Windows Xp Professional. The detailed simulation model is based on network simulator -2 (ver-2.31) [8], [9],[2] is used in the evaluation. The NS instructions can be used to define the topology structure of the network and the motion mode of the nodes, to configure the service source and the receiver, to create the statistical data track file and so on.

7.2 SIMULATION SETUP:

This simulation is using RD mobility models that will be tested on AODV routing protocol scheme. The simulation periods for each scenario are conduct in 900 seconds and the simulated mobility network area is 800 m x 500 m rectangle with 250m transmission range. The simulation will conducted in two different scenarios to gain a good result and shows the differences of the performance for each mobility model.[1],[2],[3],[10],[11].

- The first scenario is to compare the mobility models in various numbers of nodes; 5, 10, 15, 20 and 25 nodes with fixed speed 15 m/s.
- The second scenario is to evaluate the mobility models in different node speed; 5, 10, 15 and 20 m/s with fixed the number of node to 50 nodes.

7.3 Experimental Results:

The simulation results are focusing in analyzing the performance on routing overhead, throughput and packet delivery ratio. The results also compared with different mobility model that we had chosen in the early chapter. The result are based on the two scenario that we will decided to shows the performance for every mobility model that had been selected.

7.4 Various Numbers of Nodes:

In this scenario, all the RD mobility models were tested on AODV routing scheme to get the results based on three performances metric which are Routing Overhead, Throughput and Packet Delivery Ratio with fixed value of speed and various number of nodes. Based on Fig: (12) it shows that the Random Direction Model is generated the highest routing overhead compared with the other mobility model due to the movement of the each MN are being forced to the border of the simulation area

Fig: (12) Routing overheads versus number of nodes

Figure 13 shows that Random Direction Model performed better in delivering packet data to destination by considering the pause time every time changing their directions. All mobility models are decreased significant with the increasing of the number of nodes because the number of load is small and the traffic is not heavy. Based on this result, it shows that at node 15 all models are become stable and consistent with packet delivery ratio until node 25.

Fig: (13) Packet delivery versus no: of nodes

By below result, Random Direction Model in calculating the throughput which measured the hops performed by each packet. The higher throughput is contributed the lower delay because of the lower number of hop. The result also shows, after node 10 the value of throughput are started to decreased and at certain number of nodes and they are not consistent for other models...

In this scenario, the number of nodes is fixed to 50 nodes and will be compared with different value of speed; 5, 10, 15 and 20 m/s. Figure 15 shows the effect on the routing overhead is less with Random Direction. These results exist since MNs using the Random Direction are often traveling through the centre of the simulation area so it not caused the higher overhead. RD is suffered a lot from routing overhead packets. The routing overhead are increasing when the number of speed average are increasing.

Fig: (15) Routing overhead versus speed

Random Direction Model is perform better compared to the other mobility model but the result also show the throughput of Random Direction Model is consistency which is the increasing of the speed are not effected the performance. Mean while, the other models show the increasing of throughput when the number of speed average is increased.

Fig. (16) Packet delivery ratio versus speed

Random Direction Model is perform better compared to the other mobility model but the result also show the throughput of Random Direction Model is consistency which is the increasing of the speed are not effected the performance.

Fig. (17) Throughput versus speed

CONCLUSION:

Finally, our main objective is to derive the probability of path duration till time and the probability of path (link) availability at time to get stable path, Simulation by NS2 is done at each node of Random Direction Travel and compare both the results from probability expressions and simulation results (speed, Throughput at their respective nodes), finalize the best optimal path which is required stable route by RD-Model, so as to improve routing efficiency to determine stable path under RD mobility model.

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