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Shortest Path Routing Over Scalable Mobile Ad Hoc Networks

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Abstract- Over the past decade or so, there has been rapid growth in wireless and mobile applications technologies. More recently, an increasing emphasis has been on the potential of infrastructure less wireless mobile networks that are easy, fast and in-expensive to set up, with the view that such technologies will enable numerous new applications in a wide range of areas. Such networks are commonly referred to as mobile ad hoc networks. In MANET, data is sent from one node to another node by using links, called path. Routing protocol is responsible to find out the path to be followed by the packets from source to destination. For MANET, there are different type of protocols are available and as per the requirement, we can use any one. Each protocol has its own criteria to find the path from source to destination. Some of researchers explored the concept of shortest path routing over ad hoc network. In this paper, we will analyse the impact of scalability over the mobile ad hoc network and the behaviour of shortest path routing algorithm.

Keywords- Ad-hoc network, MANET, Shortest Path, routing protocol, Bellman Ford, Dijkstra, DSDV

I. INTRODUCTION

Ad hoc network consists of autonomous devices that can directly communicate to their nearby nodes. Nodes that are not within direct communication range use other nodes to relay messages between them. Routing in such an ad hoc network is challenging due to the lack of central control and the high dynamics of the network. Nodes are free to move in any direction and organize themselves arbitrarily. They can join or leave the network at any time. Due to the dynamic network topology there is a frequent change in the status of routing table which adds the complexity to routing among the various mobile nodes. Routing protocols for MANETs are usually classified into proactive and reactive protocols, and hybrid protocols based on how routing information is acquired and maintained by mobile nodes. Table proactive protocols use a proactive Routing scheme, in which every network node maintains consistent up-to-date routing information from each node to all other nodes in the network. On-demand-reactive protocols are based on a reactive routing scheme, in which at least one route is established only when needed. A hybrid routing protocol is a combination of proactive and reactive schemes with the aim of exploiting the advantages of both types of protocols [1][12].

Shortest Path algorithm

There are two basic shortest path algorithms are available i.e. Bellman ford algorithm and Dijkstra's algorithm for shortest path problem. We can use one of them to solve the routing problem. Routing based on these algorithms performs the following steps:

- Each node calculates the distances between itself and all other nodes within the network and stores this information as a table.
- Each node sends its table to all neighboring nodes.

When a node receives distance tables from its neighbors, it calculates the shortest routes to all other nodes and updates its own table to reflect any changes. Distance sequenced Distance Vector (DSDV) routing protocol has been developed for ad hoc network. It is based upon the distributed Bellman-Ford algorithm [1][13].

II. LITERATURE REVIEW

Concept of shortest path can be used with any routing algorithm but the result will depends upon the nature of the protocol and the parameter used. Lot of research work has been done using shortest path routing over wireless ad hoc network with the different constraints and with different protocols.

W. Ahn and R. S. Ramakrishna [2] presented a genetic algorithmic approach to the shortest path (SP) routing problem. Variable-length chromosomes (strings) and their genes (parameters) have been used for encoding the problem. The crossover operation exchanges partial chromosomes (partial routes) at positionally independent crossing sites and the mutation operation maintains the genetic diversity of the population. The proposed algorithm can cure all the infeasible chromosomes with a simple repair function. Crossover and mutation together provide a search capability that results in improved quality of solution and enhanced rate of convergence. They also developed a population-sizing equation that facilitates a solution with desired quality. It is based on the gambler's ruin model; the equation has been further enhanced and generalized, however. The equation relates the size of the population, the quality of solution, the cardinality of the alphabet, and other parameters of the proposed algorithm. Computer simulations show that the proposed algorithm exhibits a much better quality of solution (route optimality) and a much higher rate of convergence than other algorithms. The results are relatively independent of problem types (network sizes and topologies) for almost all source–destination pairs. Furthermore, simulation studies emphasize the usefulness of the population-sizing equation. The equation scales to larger networks. It is felt that it can be used for determining an adequate population size (for a desired quality of solution) in the SP routing problem.

A. C. Valera and K.G. Seah [3] proposed a new routing protocol named CHAMP (CacHing And Multiple Path) routing protocol. CHAMP uses cooperative packet caching and shortest multipath routing to reduce packet loss due to frequent route failures. Extensive simulation results that these two techniques yield significant improvement in terms of packet delivery, end-to-end delay and routing overhead. They presented that existing protocol optimizations employed to reduce packet loss due to frequent route failures, namely local repair in AODV and packet salvaging in DSR, are not effective at high mobility rates and high network traffic.

Y. Shavitt and A.Shay [4] introduced the Gossip Network model where travelers can obtain information about the state of dynamic networks by gossiping with peer travelers using ad hoc communication. Travelers then use the gossip information to recourse their path and find the shortest path to their destination. They studied optimal routing in stochastic, time-independent gossip networks, and demonstrate that an optimal routing policy may direct travelers to make detours to gather information. A dynamic programming equation that produces the optimal policy for routing in gossip networks is presented. In general, the dynamic programming algorithm is intractable; however, for two special cases a polynomial optimal solution is presented. Results show that ordinarily gossiping helps travelers decrease their expected path cost. However, in some scenarios, depending on the network parameters, gossiping could increase the expected path cost. The parameters that determine the effect of gossiping on the path costs are identified and their influence is analyzed. This dependency is fairly complex and was confirmed numerically on grid networks.

S. Jiang and J. Rao [5] introduced a prediction-based link availability estimation to quantify the link reliability. This quantity makes use of some instantly available information and also considers the dynamic nature of link status in order to properly reflect the link reliability. Then, this quantity has been further used to develop routing metrics for path selection in terms of path reliability to improve routing performances. The proposed schemes have been investigated through computer simulation. J. Gao and Li Zhang [6] studied routing algorithms on wireless networks that use only short paths, for minimizing latency, and achieve good load balance, for balancing the energy use. They considered the special case when all the nodes are located in a narrow strip with width at most pffi3ffiffi=2 _ 0:86 times the communication radius. They presented algorithms that achieve good performance in terms of both measures simultaneously. In particular, the routing path is at most four times the shortest path length and the maximum load on any node is at most three times that of the most load-balanced algorithm without path-length constraint. In addition, our routing algorithms make routing decisions by only local information and, as a consequence, are more adaptive to topology changes due to dynamic node insertions/deletions or due to mobility.

A. Arora and H. Zhang [7] formulated a notion of local stabilization, by which a system self-stabilizes in time proportional to the size of any perturbation that changes the network topology or the state of nodes. The notion implies that the part of the network involved in the stabilization includes at most the nodes whose distance from the perturbed nodes is proportional to the perturbation size. Also, they presented LSRP, a protocol for local stabilization in shortest path routing. LSRP achieves local stabilization via two techniques. First, it layers system computation into three diffusing waves each having a different propagation speed, i.e., “stabilization wave” with the lowest speed, “containment wave” with intermediate speed, and “super-containment wave” with the highest speed. The containment wave contains the mistakenly initiated stabilization wave, the super-containment wave contains the mistakenly initiated containment wave, and the super-containment wave self-stabilizes itself locally. Second, LSRP avoids forming loops during stabilization, and it removes all transient loops within small constant time. To the best of our knowledge, LSRP is the first protocol that achieves local stabilization in shortest path routing. Y. Shen, Y. Cai, X. Li, and X. Xu [8] presented an energy-efficient topology control algorithm named RLSP. The algorithm first tries to preserve the minimum-energy paths. However, when a node finds it needs a large transmission power to cover some of its logical neighbors, it uses two-hop paths to reach them instead of using single links. Simulation results show that RLSP can effectively decrease the transmission power and reduce the energy consumption when transmitting.

V. Lenders, M. May and B. Plattner [9] introduced density based anycast routing, a new anycast routing paradigm particularly suitable for wireless ad hoc networks. Instead of routing packets merely on proximity information to the closest member, density-based anycast routing considers the number of available anycast group members for its routing decision. They present a unified model based on potential fields that allows for instantiation of pure proximity-based, pure density-based, as well as hybrid routing strategies. They implemented anycast using this model and simulate the performance of the different approaches for mobile as well as static ad hoc networks with frequent link failures. Our results show that the best performance lies in a tradeoff between proximity and density. In this combined routing strategy, the packet delivery ratio is considerably higher and the path length remains almost as low than with traditional shortest-path anycast routing. L. Ying, S. Shakkottai, A. Reddy, and S. Liu [10] proposed a new routing/scheduling back-pressure algorithm that not only guarantees network stability (throughput optimality), but also adaptively selects a set of optimal routes based on shortest-path information in order to minimize average path lengths between each source and destination pair.

Results indicate that under the traditional back-pressure algorithm, the end-to-end packet delay first decreases and then increases as a function of the network load (arrival rate). This surprising low-load behavior is explained due to the fact that the traditional back-pressure algorithm exploits all paths (including very long ones) even when the traffic load is light. On the other-hand, the proposed algorithm adaptively selects a set of routes according to the traffic load so that long paths are used only when necessary, thus resulting in much smaller end-to-end packet delays as compared to the traditional back-pressure algorithm.

III. PROBLEM FORMULATION

Mobile Ad hoc Network (MANET) is a collection of wireless mobile terminals that are able to dynamically form a temporary network without any aid from fixed infrastructure or centralized administration. One critical issue for routing in MANETs is how to select reliable paths that can last as long as possible since radio links may be broken frequently. The reliability of a path depends on the number of links and the reliability of each link constituting the path. Many routing metrics in terms of number of links have been proposed, such as the shortest path routing. Shortest path routing selects a path having minimum cost to forward the data to next node. Shortest path selection may be done on then basis of different parameters like transmission cost which can be calculated on the basis of routing table information, link stability factor, power consumption factor etc. Performance of the network can be enhanced through shortest path routing but it also depends upon the functionality of the routing protocol and the parameters selected for the shortest path routing.

IV. IMPLEMENTATION

We used DSDV routing protocol to analyze the impact of scalability over mobile ad hoc network. We used NS-2 for simulation. Simulation results show that with minimum number of nodes, Throughput is maximum and with the maximum number of nodes, it is minimum. In case of 10 nodes Throughput is 10.22, which is the highest value as compared to others. In case of 20 nodes, it is 9.66, which can be considered as an average Throughput and in case of 30 nodes, it is low (8.55).

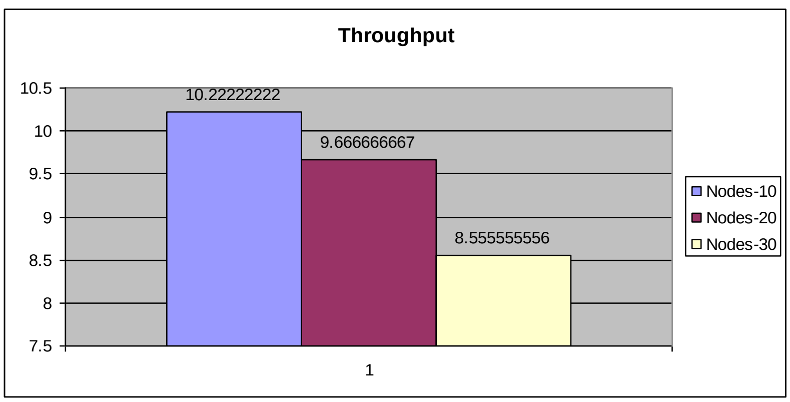

Fig. 1 Throughput

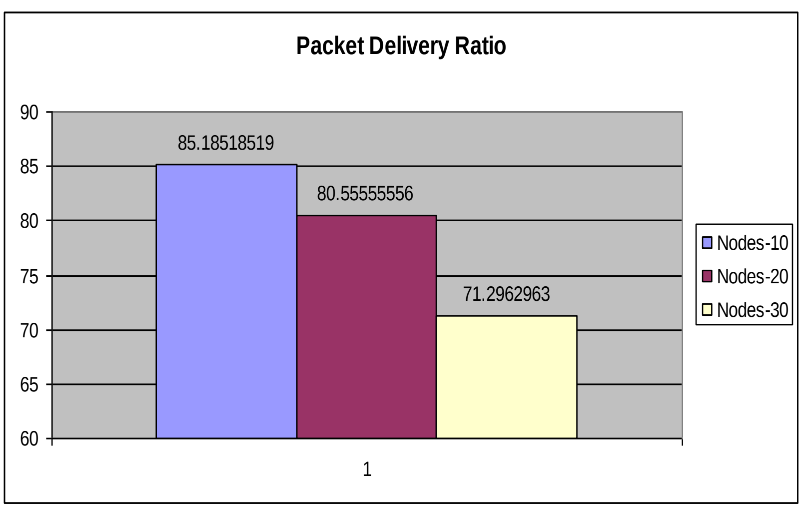

Fig. 2 Packet Delivery Ratio

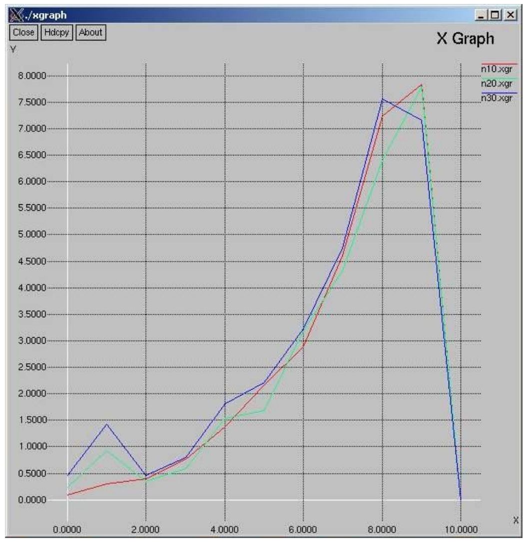

Fig. 3 Routing Load

Fig. 2 above shows the PDR, with minimum number of nodes, PDR is maximum and with the maximum number of nodes, PDR is minimum. In case of 10 nodes PDR is 85.18, which is the highest value as compared to others. In case of 20 nodes, it is 80.55, which can be considered as an average PDR and in case of 30 nodes, it is low (71.29).

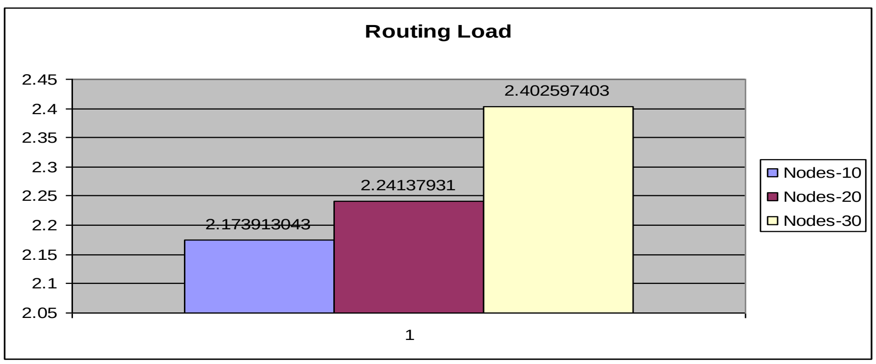

Fig. 4 Energy Consumption Comparison

Figure 3 above shows the routing load, with minimum number of nodes, Routing Load is less and it is increasing as the number of nodes increase. In case of 10 nodes Routing Load is 2.17, which is the minimum value as compared to others. In case of 20 nodes, it is 2.24, which can be considered as an average Routing Load and in case of 30 nodes, it is high (2.40). Figure 4 above shows that in starting of simulation, 20 and 30 nodes consumed more energy as compared to the 10 nodes. There is variation in the energy consumption of 20 and 30 nodes but in case of 10 nodes, it is gradually increased. In all cases, energy consumption reached to its peak value and finally decreased till the end of simulation.

TABLE 1
PERFORMANCE ANALYSIS TABLE

Protocol: DSDV			
Nodes	**N-10**	**N-20**	**N-30**
Throughput	10.22222222	9.666666667	8.555555556
PDR	85.18518519	80.55555556	71.2962963
Routing Load	2.173913043	2.24137931	2.402597403
Energy Consumption	2704.3	2775.28	3424.15

V. CONCLUSION

In this paper, we analysed the impact of scalability over the mobile ad hoc network and the behaviour of shortest path routing algorithm. We used DSDV protocol that uses the highest sequence number from routing table to find out the next path. We analyzed the performance of shortest path routing method over mobile ad hoc network as well as we computed the energy consumption by the scalable ad hoc network and the impact of scalability on the energy consumption and on the shortest path routing. Finally we analyzed the performance of entire network using different parameters like throughput, delay, energy consumption, scalability factor, routing load etc. In case of 10 nodes Throughput is 10.22, which is the highest value as compared to others and if there are 20 nodes, then Throughput is 9.66, which can be considered as an average Throughput and in case of 30 nodes, it is low (8.55). We can say that the Throughput is maximum with the minimum nodes in the network. In case of 10 nodes Packet Delivery Ratio is 85.18, which is the highest value as compared to others. In case of 20 nodes, it is 80.55, which can be considered as an average PDR and in case of 30 nodes, it is low (71.29).

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In case of 10 nodes Energy Consumption is 2704.3, which is the minimum value as compared to others. In case of 20 nodes, it is 2775.28, which can be considered as an average Routing Load and in case of 30 nodes, it is high (3424.15). As per the results and discussion, we can analyze that with the minimum number of nodes, performance of the entire network is much better but as the number of nodes increased, performance decreases gradually and in case of dense network, performance of the network reduces. On the basis of the results and discussion, we can conclude that scalability has an impact over the shortest path routing and the performance of entire network is affected by the scalability factor.

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