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Shortest Paths Routing Problem in MANETs

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Abstract: The need for communication services is rapidly increasing, because the mobile communication service is synonymous with an ideal communication style realizing communication anytime, anywhere and with anyone. The availability of a path depends on the number of links and the reliability of each link forming 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 the destination node. Shortest path routing algorithm selection depends on direct traffic form source to destination, maximizing the network performance and minimizing the cost. 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 that are selected for the shortest path routing. The primary goal of such an ad-hoc network routing protocol is correct and efficient route establishment between a pair of nodes so that messages may be delivered in a timely manner. Route construction should be done with a minimum of cost, overhead and bandwidth consumption. Some of researchers explored the concept of shortest path routing over ad hoc network. Each one uses his own parameters with different topology. No one uses all parameters. In this paper, we will discuss the solutions ideas that have been proposed by them.

Keywords: Ad-hoc network, Routing Algorithms, Bellman Ford, Dijkstra, MANET Routing Protocol problems, Shortest Path

1 Introduction

The wireless networks have become increasingly popular in communication industry since 1970. These networks rapidly increased in recent years this type of networks provide mobile users with ubiquitous computing capability and information access regardless of the users' location. There are currently two variations of mobile wireless networks: infrastructured and infrastructureless networks. The infrastructure networks have fixed and wired gateways or the fixed Base-Stations which are connected to other Base-Stations through wires. Each node is within the range of a Base-Station. A "Hand-off" occurs as mobile host travels out of range of one Base-Station and into the range of another and thus, mobile host is able to continue communication seamlessly throughout the network. Example applications of this type include wireless local area networks and Mobile Phone. The other type of wireless network, infrastructureless networks, is knows as Mobile Ad-hoc Networks (MANET). These networks have no fixed routers, every node could be router. All nodes are capable of movement and can be connected dynamically in arbitrary manner. The responsibilities for organizing and controlling the network are distributed among the terminals themselves. The entire network is mobile, and the individual terminals are allowed to move freely. In this type of networks, some pairs of terminals may not be able to communicate directly with each other and have to relay on some terminals so that the messages are delivered to their destinations. Such networks are often referred to as multi-hop or store-and forward networks. The nodes of these networks act as routers, which discover and maintain routes to the destination nodes in the networks. The nodes may be located in or on airplanes, ships, trucks, cars, perhaps even on people or very small devices. Mobile Ad-hoc Networks are supposed to be used for disaster recovery, battlefield communications, and rescue operations when the wired network cannot work there.

The protocols in MANET can be classified into three different groups: proactive, on demand or reactive, and hybrid. In proactive routing protocols, the routes to all the destinations are determined at the start-up and maintained by using a periodic route update process. In reactive protocols, routes are determined when they are required by the source using a route discovery process. Hybrid routing protocols combine the basic properties of two proactive and reactive protocols into one. That is, they are

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both reactive and proactive in nature. Each group has a number of different routing strategies, which employ a flat or a hierarchical routing structure. To compare and analyze mobile Ad Hoc network routing protocols, suitable classification methods are needed. Classification manner help researchers and designers to understand distinct characteristics of a routing protocol and find its relationship with others. These characteristics at most are related to the information which is hard-done by routing, when this information is obtained, and the roles which nodes may take in the routing process [1]. In this paper, we investigate the Shortest Path (SP) routing problems in MANETs by presented a lot of researchers view and the methods that have been presented. The rest of the paper is organized as follows. Section 2 looked at routing algorithms. Section 3 Ad Hoc Routing Protocol problem is presented. Conclusion is presented in section 4.

2 Routing Algorithms

AThe main function of the network layer is routing packets from source to destination. The algorithms that chooses the routes and the data structures that they use area major area of network layer design. The routing algorithm is that part of the network layer software responsible for deciding which output line an incoming packet should be transmitted on. If the subnet uses datagrams internally, this decision must be made anew for every arriving data packet since the best route may have changed since last time. In the subnet using virtual circuits such decision is made ones per session. Routing algorithms can be grouped into two major classes: non adaptive and adaptive [2].

Non adaptive algorithms do not base their routing decisions on measurements or estimates of the current traffic and topology. Instead, the choice of the route to use to get from I to J is computed in advance, of-line, and downloaded to the routers when the network is booted. This procedure is sometimes called static routing. Adaptive algorithms, in contrast, change their routing decisions to reflect changes in the topology, and usually the traffic as well. Adaptive algorithms differ in where the get their information, when they change the routes, and what metric is used for optimization. They are also called dynamic. Modern computer networks generally use dynamic routing algorithms rather than static routing algorithms. Two dynamic algorithms in particular, distance vector & link state routing are the most popular [2].

3 Distance Vector Routing

Distance vector routing algorithms operate by having each router maintain a table giving the best known distance to each destination and which line to use to get there. These tables are updated by exchanging information with the neighbors. The distance vector routing algorithm is sometimes called by other names including Bellman-Ford or Ford-Fulkerson. It was the original ARPANET routing algorithm and was also used in the Internet under the name RIP and in early versions of DECnet and Novell's IPX. AppleTalk & CISCO routers use improved distance vector protocols. In that algorithm each router maintains a routing table indexed by and containing one entry for each router in the subnet. This entry contains two parts: the preferred outgoing line to use for that destination and an estimate of the time or distance to that destination. The metric used might be number of hops, time delay in milliseconds, and total number of packets queued along the path or something similar. The router is assumed to know the "distance" to each of its neighbors. In the hops metric the distance is one hop, for queue length metrics the router examines each queue, for the delay metric the route can measure it directly with special ECHO packets that the receiver just timestamps and sends back as fast as it can [2].

4 Link State Routing

The idea behind link state routing is simple and can be stated as five parts. Each router must: " Discover its neighbors and learn their network addresses. " Measure the delay or cost to each of its neighbors. " Construct a packet telling to all it has just learned. " Send the packet to all other routers. " Compute the shortest path route to every other router. In effect, the complete topology and all delays re experimentally measured and distributed to every router [2].

5 Ad Hoc Routing Protocol Problem

Routing plays an important role in various types of networks. There are two main ways to route the packets. One is unicast and the other is multicast. Unicast refers to one-to-one communication between a source and a destination. Multicast refers to one-to-many communication where the same source sends the same packets to a set of destinations. In most cases, the unicast routing problem is to find the shortest path between two nodes in the network and the multicast routing problem is to find an optimal tree spanning the source and all the destinations. In recent years, both the shortest path routing and the multicast routing have been well addressed using intelligent optimization techniques, e.g., artificial neural networks, genetic algorithms (GAs), and particle swarm optimization (PSO), etc. The SP routing problem aims to find the shortest path from a source to a destination in a given network while minimizing the total cost associated with the path. The SP routing problem is a classical combinatorial optimization problem arising in

many designs and planning contexts [3]. There are several deterministic search algorithms for the SP problem: the Dijkstra's algorithm, the breadth-first search algorithm, and the Bellman-Ford algorithm, etc. All these algorithms have a polynomial time complexity. They are effective in fixed infrastructure wireless or wired networks. But, they exhibit an unacceptable high computational complexity for real-time communications involving rapidly changing network topologies [4]. Therefore, for the dynamic shortest path routing problem (DSPRP) in a changing network environment, we need to employ appropriate new approaches. The DSPRP has become a topic of interest in recent years. In Ad Hoc network 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. " 2. 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. Destination Sequenced Distance Vector (DSDV) routing protocol has been developed for Ad Hoc network. It is based upon the distributed Bellman-Ford algorithm [5, 6, 7].

6 Background

In MANETs, the unicast routing establishes a multi-hop forwarding path for two nodes beyond the direct wireless communication range. Routing protocols also maintain connectivity when links on these paths break due to effects such as node movement, battery evacuation, radio propagation, and wireless interference. In multi-hop networks, routing is one of the most important issues that have high effects on the performance of networks [5]. Shortest path can be used with any routing algorithm but the result will depend upon the nature of the protocol and the parameters are used. Lots of research work has been done using shortest path routing over wireless Ad Hoc network with the different constraints and with different protocols [6]. we will introduce some studies on shortest path route.

W. Ahn and R. S. Ramakrishna [4] proposed a genetic algorithmic approach to the shortest path (SP) routing problem. 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.

A. C. Valera and K.G. Seah [8] 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. It was proposed 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 [9] presented and studied a new model for information gathering in stochastic networks is the gossip networks. Gossiping could lead to some unusual phenomena, where the optimal routing policy may direct travelers to make a detour in order to gather information and minimize their expected path cost. The optimal traveling policy in gossip networks is expressed by a dynamic programming equation. Although the algorithm that solves the equations, GOSSIP DP, is intractable in general, they presented two special scenarios where the optimal solution is polynomial in respect to the network size. Then they analyzed the relation between the parameters that influence gossiping and produce a state diagram that predicts the network regime. Gossip network can operate in three regimes. Travellers then use the gossip information to recourse their path and find the shortest path to their destination. They studied optimal routing in stochastic; time in dependent gossip networks, and demonstrate that an optimal routing policy may direct travellers 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 travellers 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 [10] introduced a prediction-based link availability estimation to quantify the link reliability. 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. However, how to measure link availability or reliability in order to find more reliable paths has not been addressed adequately in the literature. This quantity that has been introduced 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 [11] 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 $pf = 2_0 : 86$ 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 [12] 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 oops within small constant time. To the best of our knowledge, at this time, the LSRP is the first protocol that achieves local stabilization in shortest path routing.

Y. Shen, Y. Cai, X. Li, and X. Xu [13] 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 [14] introduced density based any cast routing, a new any cast routing paradigm particularly suitable for wireless Ad Hoc networks. Instead of routing packets merely on proximity information to the closest member, density-based any cast routing considers the number of available any cast 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 any cast 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 trade-off 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 any cast routing.

H. Dubois-Ferriere, M. Grossglauser, M. Vetterli [15] introduced opportunistic routing protocols by using single-path routing metrics to assign to each node a group of candidate relays for a particular destination. This paper addresses the least-cost any path routing (LCAR) problem: how to assign a set of candidate relays at each node for a given destination such that the expected cost of forwarding a packet to the destination is minimized. The key is the following trade-off: On one hand, increasing the number of candidate relays decreases the forwarding cost, but on the other, it increases the likelihood of ”veering” away from the shortest-path. Simulations show significant reductions in transmission cost to opportunistic routing using single-path metrics.

R.Rameshkumar and Dr. A.Damodaram [16] 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.

Nithin Michael, Ao Tang and Dahai Xu [17] proposed a new sub-optimal distributed link-state routing protocols with hop-by-hop forwarding like OSPF and IS-IS are the dominant intra-domain routing solutions on the Internet. These algorithms have become global as their potentially very large performance loss because of the volcanic growth of the Internet. The main idea of these schemes is to centrally assign weights to links and locally calculate shortest paths this made them easier to implement and manage compared to the optimal solutions that had been proposed. Some of the lost performance was getting back through extensive capital cost. For instance, due to the poor resource utilization resulting from these protocols, many of the ”backbone” links of the internet are so over-provisioned to support peak traffic that they run at very low utilizations on average. Unsurprisingly, the search for an optimal routing algorithm that has the same ease of management and implementation as OSPF has continued unabated. The [16] paper presented HALO (Hop-by-hop Adaptive Link state Optimal) algorithm. For our knowledge, some algorithms depending on hop by hop routing like OLSR, AODV and HALO.

Arti?cial Bee Colony (ABC) algorithm is one of the most recently introduced swarm-based algorithms. ABC simulates the intelligent foraging behavior of a honey bee swarm. Dervis Karaboga and Bahriye Akay [18] used ABC for optimizing a large set of numerical test functions and the results produced by ABC algorithm are compared with the results obtained by genetic algorithm, particle swarm optimization algorithm, and differential evolution algorithm and evolution strategies. Results show that the performance of the ABC is better than or similar to those

of other population-based algorithms with the advantage of employing fewer control parameters. E. Hemalatha Jai Kumari and Dr. Kannammal [19] shows that the most necessary characteristic in mobile ad hoc networks is topology transformation. Finding the shortest path for the routing problem in Mobile Ad hoc Networks (MANETs) will become a dynamic optimization problem. They proposed the Modified Artificial Bee Colony Optimization (MABCO) algorithmic techniques that used to find the global optimum value in a given space. The Modified Artificial Bee Colony Optimization (MABCO) algorithm has shown to be a good technique for identifying multiple stable paths between source and destination nodes.

Nature-inspired algorithms are among the most powerful algorithms to solve optimization problems. P. Mansouri, B. Asady and N. Gupta [20] intends to provide a detailed description of a new iterative method to solve the shortest path problem for given directed graph (dgraph) G = (V, E) from source node s to target node t. Each edge(i,j)E has an associated weight wij. This problem is known as NP-hard problems, so an efficient solution is not likely to exist. Weights are assigned by the network operator. A path cost is the sum of the weights of the edges in the path. The efficiency of this approach is shown with some numerical simulations. For large data network, this method reaches to shortest path from s to t in polynomial time.

Many conventional routing algorithms have been proposed for MANETs in early years. And also many meta heuristic optimization techniques like swarm intelligence algorithms are addressing the static shortest path in the realm of wireless network routing. The motion of MANET is dynamic and hence, the shortest path routing problem in MANET manifests into a dynamic optimization problem. The nodes are instilled with an awareness of the environmental conditions by making them operational through intelligence routing becomes a key concern, as it has a significant impact towards network performance. Hema Lawin and Kannammal [21] proposed a study to solve the shortest path problem in MANETs using enhanced artificial bee colony optimization algorithm. MANETs are kept and considered target systems because they do represent the next generation wireless network. The results of experiment explicate that enhanced artificial bee colony is steadfast to adapt to the gradations in the environment.

Ashita S. Bhagade and Parag. V. Puranik [22] proposed a new method to solve the travelling salesman problem for VRP is optimized by using nearest neighbor method; evaluation results are presented which are then compared by the artificial bee colony algorithm. The pursued approach gives the best results for finding the shortest path in a shortest time for moving towards the goal. Thus the optimal distance with the tour length is obtained in a more effective way.

Routing in mobile ad-hoc network (MANETs) becomes more sophisticated issue especially when a certain quality of service (QOS) requirement is to be satisfied. Marghny H.Mohamed, Mahmoud.A Mofaddel and Hamdy.H El-Sayed [23] address the problem of routing in mobile ad-hoc network under a new ad-hoc network characteristics. They concentrate on two parameter hop count and path distance changes with some ad-hoc network characteristics characteristics like topology changes, average number of neighbor nodes, number of nodes and transmission range. Different topologies are compared like circle, square and rectangle. The results are compared the effects of these characteristics on the Ad-Hoc On Demand Distance Vector (AODV) and the proposed algorithm Bee-Dijkstra Algorithm (BDA). BDA is more accurate for finding the shortest path from source to target.

Mis Rigi C.R, Ms. Ancy Antony.C, Ms.Shalinu Saju and Mr.Sachin Padikkal [24] explores the potential of using genetic algorithm to solve the shortest path problem in wireless sensor network. In multihop networks, such as the Internet and the Mobile Ad-hoc Networks, routing is one of the most important issues that has a significant impact on the network's performance. An ideal routing algorithm should strive to find an optimum path for packet transmission within a specified time so as to satisfy the Quality of Service (QoS). There are several search algorithms for the shortest path (SP) problem: the breadth-first search algorithm, the Dijkstra's algorithm and the Bellman-Ford algorithm, to name a few. Intelligent analysis and designing of network routing provides an edge in this increasingly faster. The energy efficient genetic algorithm routing prolongs the network lifetime Genetic Algorithm is a problem solving method which is based on the concept of natural selection and genetic. They are introduced an overview of shortest path algorithm with genetic algorithm and some existing algorithm.

Mobile ad-hoc network does not have any infrastructure or central administration, hence it is called infrastructure less network. Isha Nagpal [25] presents in his paper an alternative path between nodes in mobile ad hoc network. The paper generally chooses the shortest path to transmit the data which is not safe due to the probability of attack of the intruder. There are number of intrusion detection and prevention technique to overcome with different types of attacks. An alternate path scheme provides a security oriented approach for designing the routing protocol Mobile Ad-hoc networks. It proposes the new cluster based security architecture which starts from the initialization of the network.

7 Conclusion

Mobile Ad Hoc Network (MANET) is a collection of wireless mobile nodes that are able to dynamically form a temporary network without any fixed infrastructure or centralized administration. In this paper, a brief survey on shortest path routing has been introduced. Different

researchers discussed various solutions and each researcher used a different parameter for the shortest path for routing. So we are conclude that the result of the shortest path routing also depends upon the selected parameters and as well as on the selected routing protocols used for ad hoc network. Each author worked on a specific parameter but no one has considered all the parameters in a particular solution.

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