IMPROVED AODV BASED ON LINK QUALITY METRICS

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ABSTRACT

The wireless interfaces in mobile ad-hoc networks (MANET) have limited transmission range; communication traffic is relayed over several intermediate nodes to ensure a communication link between two nodes. Since the destination is reached using multiple hops from the source, routing plays an important role in Ad hoc network reliability. Since the network is dynamic in nature, conventional routing protocol may not perform well during adverse conditions like poor link quality, high mobility. In this paper, a new MANET routing method based on Ad hoc On demand Distance Vector (AODV) and Ant Colony Optimization (ACO) is proposed for networks with varying levels of link quality. ACO is inspired from the biological behaviour of ants. Achievement of complex solutions with limited intelligence and individual capacity within these communities can be emulated in ad hoc networks. A new link quality metric is defined to enhance AODV routing algorithm so that it can handle link quality between nodes to evaluate routes.

KEYWORDS: *Mobile ad hoc network (MANET), Ad hoc On demand Distance Vector (AODV), Ant Colony Optimization (ACO), Link quality, Metrics.*

I. INTRODUCTION

A mobile ad hoc network (MANET) is a decentralized group of mobile nodes which exchange information temporarily by means of wireless transmission. Since the nodes are mobile, the network topology will modify rapidly and randomly over time. Since the topology is not a structured one, the nodes tend to enter or move away the network at there own. The network topology is unstructured and nodes may enter or leave at their will. A node can exchange information to other nodes which are within its broadcast range. Such networks are flexible and suit several situations and applications, thereby allowing the establishment of temporary communication sans pre-installed infrastructure [1]. Because of wireless interfaces limited transmission range communication traffic is relayed over several intermediate nodes to ensure a communication link between two nodes. Hence, such networks are also known as mobile multi-hop ad-hoc networks. Nodes fulfil the functionality of hosts and also have to be routers, forwarding packets for other nodes. The main issue in MANETs is finding of routes between communication end-points, aggravated through node mobility. Literature reveals different approaches that try to handle this problem [2], but there is still no routing algorithm that suits all cases.

Routing plays an important role in Ad hoc network reliability. Routing can be classified into proactive and reactive routing protocols. The former routing protocols discover routes for every node pair through continuous updation of routing tables at a specific time intervals irrespective of data traffic between source/destination. A route must be available when communication is proposed between source and destination. Popular pro-active routing protocols are Distance Sequenced Distance Vector (DSDV) routing [3], Optimized Link State Routing (OLSR) [4] and Fish Eye State Routing (FSR) [5]. Proactive routing protocol based wireless networks have additional network overheads because of constant updating of route traffic with minimum end to end delay. But reactive routing protocols establish a destination route only when needed. Though, network control packet overheads are lower in reactive routing protocols, end to end delay increases because of route discovery procedures [6]. Common reactive routing protocol includes Ad Hoc on Demand Distance Vector (AODV) routing [7], Dynamic Source Routing (DSR) [8], Associativity Based Routing (ABR) [9].

The routing algorithms for Mobile Ad hoc networks (MANET) are inherited from conventional algorithms which are subject to much criticism as they do not consider all ad hoc network characteristics including mobility and resource constraints. This paper proposes a new MANET routing method inspired from the biological behaviour of ants. Achievement of complex solutions with limited intelligence and individual capacity within these communities can be emulated in ad hoc networks that are composed of small limited capacity nodes moving randomly in unpredictable environments. New metrics have been defined to enhance AODV routing algorithm so that it can handle link quality between nodes to evaluate routes. Performance of the suggested algorithm is compared to AODV.

This paper is organized into the following sections. Section 2 looks into related work available in literature, section 3 gives a brief discussion on AODV routing protocol. Section 4 discusses about link metrics with section 5 discussing the proposed method. Section 6 concludes this paper with scope for future work.

II. RELATED WORKS

For mobile, multi-hop ad-hoc networks, Mesut Güneş et al., [10] introduced a novel on-demand routing algorithm. On the basis of swarm intelligence the protocol is developed and the main emphasis is on ant colony based metaheuristic. The result of the capability of swarms to mathematical and engineering problems in order to map it is processed by this proposed approach. The proposed routing protocol is very flexible, effective and also scalable. Decreasing the overhead for routing is the major aim of the proposed protocol. The proposed protocol is termed as Ant-Colony-Based Routing Algorithm (ARA). The better performance of ARA is revealed through simulation experiments.

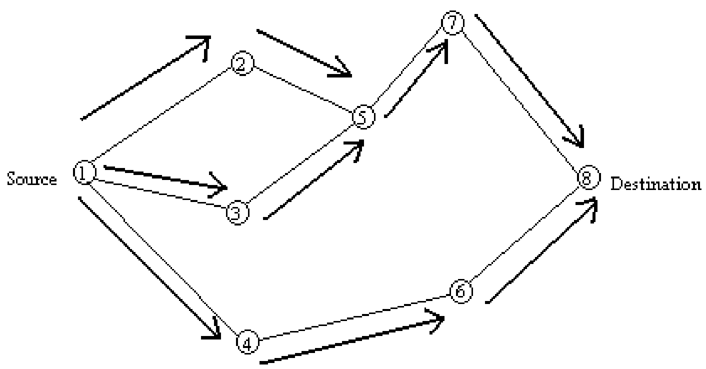
Hsin-Mu Tsai, et al., [11] examines about routing a protocol based on hop count that comprises the quality of the links employed in the protocol. The current ad hoc wireless routing protocols usually select the route with the shortest-path or minimum hop count to the destination. But this choosing of routes in this criterion tends to include longer hop length links. These links that are involved tend to be of bad signal quality. These links possess usually a poor signal-to-noise ratio (SNR) that causes higher frame error rates and lower throughput. The elimination of routing through bad links must be done to enhance the routing protocols. A modification in the Ad hoc On-demand Distance Vector (AODV) routing protocol to evade routing through links that are of bad quality is proposed. The "hand-off" concept is also incorporated during route maintenance to prevent link breakages in the proposed protocol. From the OPNET stimulation, a promising result is obtained which provides the protocol a much lower routing overhead. But still, in terms of throughput and delay OPNET stimulation provides a better performance than the original AODV protocol.

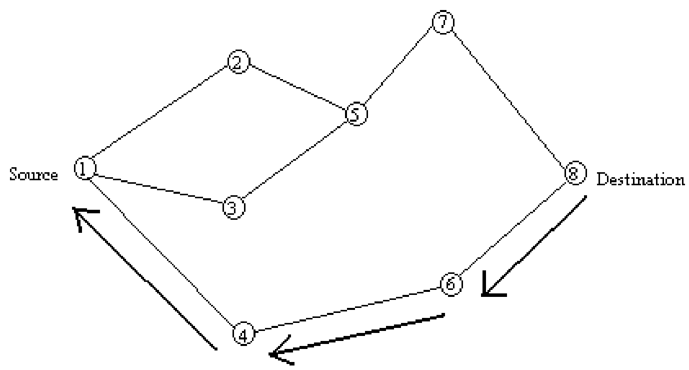
Several problems in system optimization are experienced by designers during the construction of distributed systems. Designers conventionally depended on optimization methods that neither need prior knowledge nor centrally managed runtime knowledge about the system's environment, since these methods are feasible in dynamic networks there is often and unpredictable modifications in topology, resource, and node availability. Jim Dowling et al., [12] proposed a technique that facilitates solving of system optimization problems online in dynamic, decentralized networks called collaborative reinforcement learning (CRL) in order to deal the above issue. In the SAMPLE, an implementation of CRL in a routing protocol for MANET, the performance of the proposed CRL is estimated. The results obtained by simulation shows the role of feedback in selecting the links by routing agents that allows SAMPLE to adjust and optimize the routing behaviour to differing network environment, ensuing optimization of throughput. Emergent properties like traffic flows which utilize

stable routes and reroute around congestion are displayed by the SAMPLE in the experiments. A complex adaptive distributed system is cited by SAMPLE as an exemplar.
In a wireless network when few services are implemented, a node used is necessarily supposed to be in good conditions. Network partitioning, is the first criterion in a wireless environment, while the host of the service it is using cannot be attained by the client. Handling this criterion or QoS attribute efficiently by the use of predicting partitioning and implementing service replication that comprises a novel host election for the service and duplication of it on the provided novel host. By means of service replication, the wireless networks QoS involving many criteria's are handled. Then the time at which the replication must occur is the major issue concerned. Michaël Hauspie et al., [13] introduced a metric for link quality estimation and a quick and consistent protocol to compute it practically is also presented. Simulations are performed and analysis of the proposed method reveals robustness of the metric of a link that does not brings down the effectiveness of the network like a "broadcast storm". Topology is also handled as the algorithm is totally decentralized.

III. AD HOC ON-DEMAND DISTANCE VECTOR (AODV)

If a node uses Ad hoc On-demand Distance Vector (AODV) [7] routing protocol and has no route to its destination with which it wants to communicate, then that node starts route discovery to locate a destination node. During this process, the source node broadcasts a route request (RREQ) packet to neighbours as seen in Figure 1 (a). When a RREQ packet is received by the node, it is forwarded to neighbours till either the destination node/intermediate node having a route to the destination is finally reached. When the destination node/intermediate node with a route to a destination gets the RREQ message, it replies through route reply (RREP) packet to a source node as revealed in Figure 1 (b). Sequence numbers are used in AODV to enable routes to be loop free.





(a) Propagation of Route Request (RREQ) Packet

(b) Path Taken by Route Reply (RREP) Packet

Figure 1 Route Discovery in AODV

IV. LINK QUALITY

Link quality is a dominant parameter, as it defines a given link's and devices ability to support traffic density for the connected period. Link state between two neighbours is affected by parameters like distance, battery power and mobility. The next parameter in route selection is connections number in the same path, to choose save resources of intermediate nodes over this stretch by distributing network traffic over other nodes. Hence this increases system lifetime and also end to end delay.

Link quality between two neighbours is the ability of the link to be stable as long as possible, have less bit errors and reach the destination with high signal strength. Literature evaluates link quality according to received signal strength, as transmission power of a wireless medium is directly proportional to link quality, as a high strength signal is stable and has less bit errors. The following equation gives reception power Pr for a transmitted signal with power Pt for a distance d:

$$P_r = P_t * G_r * G_t * \frac{\lambda}{(4 * \pi * d)^2} \tag{1}$$

Where G_t is antenna gain of the transmitter, G_r is antenna gain of the receiver, and λ is wavelength. From this equation, evaluating link quality based on received signal strength is also descriptive for other network factors like:

- Battery power: This is important as a node with low energy in its battery has limited transmission range affecting its link quality with the neighbourhood. But on the other hand, it cannot forward data for long. When battery level is low transmission power is also low proportionately leading to low reception power. Hence this is not a high quality link..
- The distance: Reception power is relative to distance between nodes as when distance increase, link quality decreases.
- The mobility: Link between two nodes is affected by nodes' mobility as link quality decreases when neighbours move away from each other and increases when they come closer.

V. EXPERIMENTAL SETUP AND RESULTS

The simulations are run to evaluate the performance of the proposed routing on the basis of end to end delay, routing traffic and throughput using NS-2 simulation tools [14]. A network area of 670 by 670 m2 is built on the simulation platform. The simulation is run for 300 sec. The performance of the proposed routing is compared with the traditional AODV. Figures 2, 3 and 4 show the simulation results for end to end delay, routing traffic and throughput.

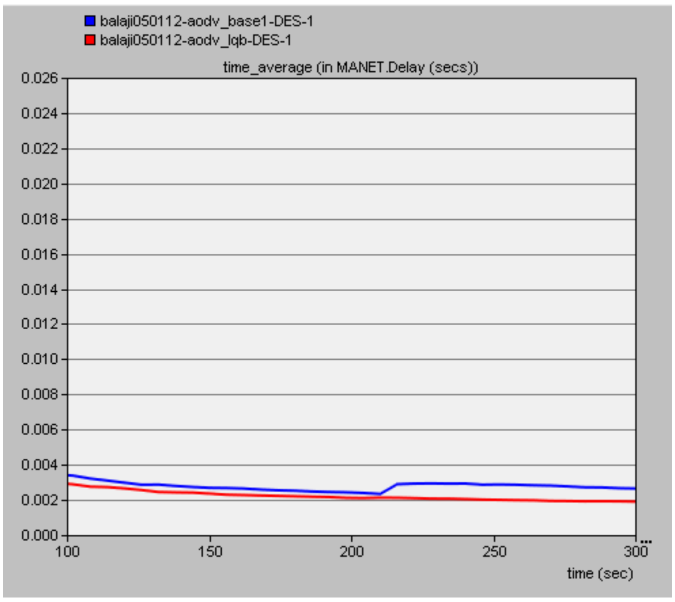


Figure 2: End to end delay in seconds

From figure 2 it can be seen that end to end delay in the proposed system reduces significantly which has advantages for multimedia traffic. Due to the inclusion of additional overhead parameters, the control packet overheads in finding the optimized route increases as seen in figure 3.

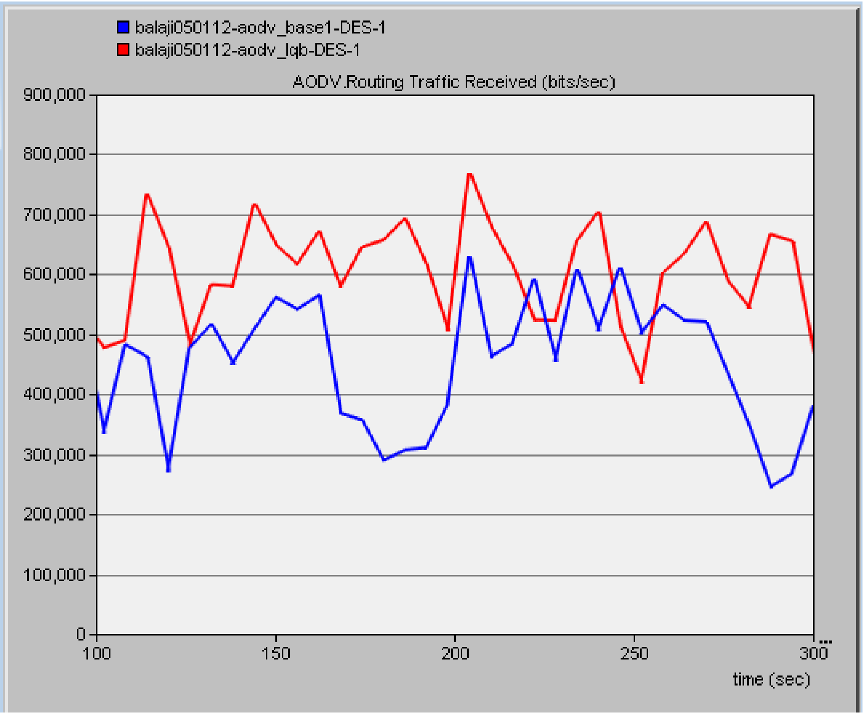


Figure 3: Routing Traffic bits/ sec

In the proposed routing, the ants tend to distribute the traffic through multiple paths ensuring decreased end to end delay. Though the routing traffic is increased in the proposed routing, throughput is better than that of AODV.

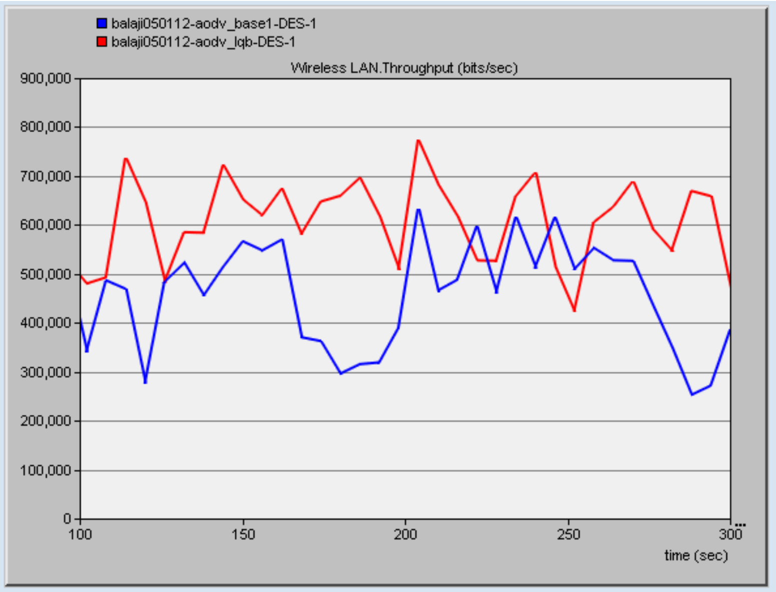


Figure 4: Throughput in bits/sec

VI. CONCLUSION

In this paper, it was proposed to improve the link quality by incorporating ant colony optimization with ad hoc on demand distance vector routing protocol. A new link quality metric is defined to enhance AODV routing algorithm so that it can handle link quality between nodes to evaluate routes. Simulations were run and the proposed routing was compared with AODV. An 4% improvement in the end to end delay along with an average improvement of 6% in the throughput was observed. Further work needs to be carried out to reduce the control packet overheads.

REFERENCES

[1]. Bibhash Roy, Suman Banik, Parthi Dey, Sugata Sanyal,Nabendu Chaki "Ant Colony based Routing for Mobile Ad-Hoc Networks towards Improved Quality of Services", Journal of Emerging Trends in Computing and Information Sciences, VOL. 3, NO. 1, January 2012 ISSN 2079-8407
[2]. C.-K. Toh. Ad hoc mobile wireless networks: protocols and systems. Prentice Hall, 2002.
[3]. Perkins.C.E. and P. Bhagwat, 1994.Highly Dynamic Destination-Sequenced Distance-Vector Routing (DSDV) for Mobile Computers.Proc. ACM SIGCOMM'94, vol. 24, Oct. 1994, pp. 234–244.
[4]. T. Clausen and P. Jacquet. "Optimized link state routing protocol (OLSR)". RFC 3626: Optimized link state routing protocol (OLSR), Oct 2003.
[5]. Pei.G, M. Gerla, and T.-W. Chen,2000.Fisheye State Routing: A Routing Scheme for Ad Hoc Wireless Networks.Proc. IEEE ICC 2000, vol. 1, 2000, pp. 70–74.
[6]. Valerie Alandzi and Alejandro Quintero,2007. Proximity Aware Routing in Ad Hoc Networks. Journal of Computer Science 3 (7): 533-539, 2007.
[7]. C. E. Perkins, E. M. Royer and S. R. Das, "Ad Hoc On-Demand Distance Vector (AODV) Routing," Proc. Of IEEE Workshop on Mobile Computing Systems and Applications, pp. 90-100, Feb. 1999
[8]. .Johnson, D. B., Maltz, D. A. and Hu, Y. (2003): The Dynamic Source Routing Protocol for Mobile Ad hoc Networks (DSR), IETF MANET.
[9]. Toh. C. K, 1997. Associativity-Based Routing For Ad Hoc Mobile Networks. Wireless Personal Communications Journal, Special Issue on Mobile Net-working and Computing Systems, Kluwer Academic Publishers, vol. 4, no. 2, pp. 103–139.
[10]. M. Gunes, U. Sorges, I. Bouazizi, "ARA – The Ant-Colony Based Routing Algorithm for MANETs", in: Proceedings of the International Conference on Parallel Processing Workshops (ICPPW'02) on Ad Hoc Networks (IWAHN 2002), August 2002, pp. 79–85.
[11]. Tsai, H.-M.; Wisitpongphan, N.; Tonguz, O. K. "Link-quality aware ad hoc on demand distance vector routing protocol." In: International Symposium on Wireless Pervasive Computing 2006, p. 6.
[12]. Jim Dowling, Eoin Curran, Raymond Cunningham, and Vinny Cahill, "Using Feedback in Collaborative Reinforcement Learning to Adaptively Optimize MANET Routing" IEEE Transactions on Systems, Man, And Cybernetics—Part A: Systems And Humans, Vol. 35, No. 3, May 2005.
[13]. Hauspie, M., Simplot, D., Carle, J.: Replication decision algorithm based on link evaluation services in MANET. CNRS UPRESA 8022 — LIFL University Lille (2002)
[14]. Dorigo M. and G. Di Caro. "Ant colony optimization: a new meta-heuristic". In Proceedings of the Congress on Evolutionary Computation, 1999.
[15]. The Network simulator The Network Simulator ns-2. Project web page available at http://www.isi.edu/nsnam/ns/

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