A SURVEY OF SWARM INTELLIGENCE BASED ANT AD HOC ROUTING PROTOCOLS

Purneshwari Varshney[1], Kapil Dave[2]

[1]*Research Scholar, Department of Electronics & Communication Engineering,*
MBM Engineering College, JNVU, Jodhpur, (India)
[2]*Assistant Professor, Department of Electronics & Communication Engineering,*
JIET Group of Institutions, Jodhpur, (India)

ABSTRACT

A Mobile Ad-Hoc Network (MANET) is a collection of self-organizing wireless mobile nodes forming a temporary network without using centralized access points. In MANET, each node can act as a node as well as a router. But due to non-availability of centralized administration, there is a problem of routing optimization. There are various protocols like AODV, DSDV, ZRP etc. available for routing in MANET. Swarm Intelligence (SI) is an artificial intelligence technique based around on the study of collective behaviour in decentralized, self-organized systems. Ant Colony Optimization is popular among other Swarm Intelligent Techniques. Ants-based routing algorithms have attracted the attention of researchers because they are more robust and reliable than other conventional routing algorithms. They are suitable for mobile ad-hoc networks where nodes move dynamically and topology changes frequently. In this paper, different ant based routing protocols are studied.

Keywards*: *Ant Based Routing Protocol, MANET, ACO, PERA

I INTRODUCTION

Wireless networks have become increasingly popular in the computing industry. This is particularly true within the past decade, which has seen wireless networks being adapted to enable mobility. There are currently two types of mobile wireless networks. The first is known as the infrastructure network (i.e., a network with fixed and wired gateways). The bridges for infrastructure networks are known as base stations. A mobile unit within these networks connects to, and communicates with nearest base station that is within its communication radius. When the mobile travels out of range of one base station and into the range of another, then a "handoff" occurs from the old base station to the new base station and the mobile is able to continue communication seamlessly throughout the network. Typical applications of this type of network include office wireless local area networks (WLANs). The second type of mobile wireless network is the infrastructure less mobile network, commonly known as an ad hoc network. These networks have no fixed routers; all nodes are capable of movement and can be connected dynamically in an arbitrary manner. Nodes of these networks function as node as well as routers which discover and maintain routes to other nodes in the network. Example applications of ad hoc networks are sensor nodes send to route events (images) captured to a particular destination (sink) using the most efficient path. The power

and bandwidth for transmitting video data from hundreds of cameras to a central location for processing at a high success rate would be enormous. In this, captured packets were routed from different sensors placed at different locations to the sink using the best path. Since the captured images (packets) need to be routed to the destination (sink) at regular interval and within a predefined interval of time, while consuming low energy without performance degradation, Ant based routing which utilizes the behaviour of real ants searching for food through pheromone deposition, while dealing with problems that need to find paths to goals, through the simulating behaviour of ant colony is adopted. Other examples are emergency search-and rescue operations, meetings or conventions in which persons wish to quickly share information, and data acquisition operations in inhospitable terrain. In recent years, several wireless routing protocols are designed to provide communication in wireless environment, such as AODV, DSDV, ZRP, LAR, OLSR and DYMO etc.

II GENERAL FRAMEWORK FOR SWARM INTELLIGENCE BASED ROUTING

The framework consists of five top level modules. The ensemble of these modules and sub modules implements the architecture and the operations at the node router. The top level modules are:

- Mobile agents generation and management
- Routing information database (RID)
- Agent communications
- Packet forwarding.

2.1 Mobile agent generation and management

SI-based routing protocols commonly use two types of agents to collect routing information. ACO-based protocols call them forward and backward ants. Forward ants are launched by source nodes to determine a path to an intended destination – we call them forward agents in framework. Once a forward agent reaches at its destination, it travels back to the source node as a backward agent. Some protocols use other types of agents to participate in routing process.

- Forward agents control

The main duty of a forward agent is to discover a path leading from the source to a given destination node. Also, they collect routing information on their way to the destination (e.g. experienced delay, minimum remaining energy

- Backward agent control

The backward agent control module consists of a generation block, and a forwarding engine. The generation block reactively decides whether to generate or not a backward agent in response to a forward agent received at the destination. Backward agents can be also generated proactively. Backward agent inherits all the information gathered by the forward agent and retraces its path back to the source node. Retracing in ACO-based schemes is executed using a source-routing approach.

2.2 Routing information database (RID)

This is a set of locally maintained data structures that includes the routing tables for agents and data, as well as possible additional data structures holding statistics of interest about node and network status used for path evaluation and for taking decisions. For instance, data concerning the expected queuing time is maintained in the RID. Routing tables, called pheromone tables in ACO. The routing information database can also serve to hold sequence numbers and other information related to passing by agents. This can be used to avoid agents carrying on the complete list of visited nodes (e.g., this is the case of ACO's backward ants), that can result heavily resource-consuming or even infeasible in very large networks. Maintaining sequence numbers at the nodes also serves to avoid the multiple forwarding of an agent originated from a route setup and that has been duplicated through repeated broadcast (this is a typical problem in MANETs protocols based on some form of flooding to find a path).

2.3 Agent communications

The mobile agents share network data as well as sampled and collected paths quality information e.g. using a stigmergic approach, as in ACO-based protocols. The Agent communications module provides the logical and functional interface to mediate agent communications inside the router. It has direct access to the data in the RID and implements the 'formulae' to update routing tables and statistics. So, it is central to control the degree of adaptivity of the system.

2.4 Packet forwarding

This module deals with the local forwarding of data packets. It makes use of the information built by the agents and available in the RID. It consists of a path selection unit and a forwarding unit. Data packets can be routed either through multiple paths or through the best path. In multipath approach, the selection of a path among the set of available next hops is done at the source node (as in case of source routing) or at intermediate nodes (next hop routing) in a stochastic or deterministic fashion.

III ANT BASED ROUTING PROTOCOL

ANT Based Routing Protocol has taken the inspiration from real ants which are wandering around their nests to forage for search of food. Upon finding food they will return back to their nests and simultaneously deposit pheromone trails along the paths. The ant selects its next hop based on the amount of pheromone deposited on the path to the next node. The problem of finding shortest paths maps quite well to the problem of routing in networks. The ants are nothing but small control packets, which have the task to find a path towards their destination and gather information about it. Ant-like mobile software agents, who are analogous to the ones used real ant colony's biological behaviour, are employed for discovering network topologies and thus efficient routing in the networks. Ant-like mobile agents are an effective means to discover the network topology in particular in circumstances such as MANET in which the network topology frequently changes. Routing based on ant-like agents does not require frequent exchanges of update messages for routing tables. As the population of the network becomes dense, an ant-like agent becomes more effective for load balancing in the network. Ant-like agents are a known means to mitigate congestion.

Table 1: Comparison between Mobile Ad Hoc Networks and Ants

Parameters	MANETs	Ants
Physical structure	Unstructured, dynamic & distributed	Unstructured, dynamic & distributed
Origin of route	Route requests are sent from source to get local information	Pheromones are used to build new routes
Multipath support	Single path, partially multipath	Provide multipath
Basic System	Self-Configuring and self-organizing	Self-Configuring and self-organizing
Goal	To find the shortest path	Guaranteed shortest path

The pheromones may be used as a measure for any metric under consideration such as average delay, bandwidth and jitter. The basic principle of all these algorithms is that current traffic conditions and link costs are measured by transmitting "artificial ants" into the network. These ant packets mark the travelled path with an "artificial pheromone," that is, update the routing table depending on the collected information. Therefore, they increase the probability of choosing a certain link for a given destination. Results from ant based routing applications in fixed and wired network are very promising.

3.1 Ant Net

AntNet is an algorithm conceived for fixed, wired networks, which derives features to use two different network exploration agents, i.e. forward and backward ants (BANTs), which collect information about delay, congestion status and the followed path in the network. Forward ants (FANTs) are emitted at regular time intervals from each node to a randomly selected destination. This transmission occurs asynchronously and concurrently with the data traffic. As soon as a FANT arrives at the destination, a BANT moves back to the source node reverse the path taken by the FANT. The subdivision in forward and BANTs has the following reasons. The FANTs are just employed for data aggregation of trip times and node numbers of the path taken without performing any routing table updates at the nodes. The BANTs get their information from the FANTs and use it to achieve routing updates at the nodes. Each node in the network maintains two structures, which the agents co-operate with and concurrently read and write to routing table.

3.1.1 Ant Based Control

Ant based control (ABC) is another stigmergy based ant algorithm designed for telephone networks. It shares many similarities with AntNet, but also incorporates certain differences. The basic principle relies on mobile routing agents, which randomly explore the network and update the routing tables according to the current network state. The routing table, storing probabilities instead of pheromone concentrations, is exactly the same as in AntNet. Also, probability balanced randomness of the ants‟ path selection is employed to favour the detection of new routes. One important difference applies to the use of the routing agents is; ABC only uses a single class

of ants (i.e. FANTs), which are initiated at regular time intervals from every source to a randomly chosen destination. After arriving at a node they immediately update the routing table entries for their source node, meaning that the pheromone pointing to the previous node is increased. It is important to see that only the backward path is influenced, and just packets travelling towards the ant's source profit from that route update.

3.1.2 Probabilistic Emergent Routing Algorithm (PERA)

This algorithm works in an on-demand way, with ants being broadcast towards the destination at the start of a data session. Multiple paths are set up, but only the one with the highest pheromone value is used by data and the other paths are available for backup. The route discovery and maintenance is done by flooding the network with ants. Both forward and backward ants are used to fill the routing tables with probabilities. These probabilities reflect the likelihood that a neighbour will forward a packet to the given destination. Multiple paths between source and destination are created. First of all, neighbours are discovered using HELLO messages, but entries are only inserted in the routing table after receiving a backward ant from the destination node. Each neighbour receives an equi- probable value for destination. This value is increased as a backward ant comes from that node, establishing a path towards destination. As ants are flooded, the algorithm uses sequence numbers to avoid duplicate packets. Only the greater sequence number from the same previous hop is taken into account. Forward ants with a lower sequence number are dropped. This approach is similar to AODV Route Request packets, but discovers a set of routes instead of one. Data packets can be routed according to the highest probability in the routing table for the next hop.

3.1.3 Ant Agents for Hybrid Multipath Routing [AntHocNet]

AntHocNet is a multipath routing algorithm for mobile ad-hoc networks that combines both proactive and reactive components. It maintains routes only for the open data sessions. This is done in a Reactive Route Setup phase, where reactive forward ants are sent by the source node to find multiple paths towards the destination node. Backward ants are used to actually setup the route. While the data session is open, paths are monitored, maintained and improved proactively using different agents, called proactive forward ants.

IV CONCLUSION

Ants-based routing algorithms have attracted the attention of researchers because they are more robust, reliable, and scalable than other conventional routing algorithms. Moreover, ant based protocols are biological derived which developed after thousands of years practical experiences. The researches done have shown that ant based routing protocols can remove at least one or several problems in the area such as battery life, scalability, maintainability, survivability, adaptability and so on. As such, ant based approaches are attracted by much researchers than other approaches.

REFERENCES

[1] Sudarshan D Shirkande and Rambabu A Vatti, ACO Based Routing Algorithms for Ad-hoc Network (WSN,MANETs):A Survey, IEEE 2013 International Conference on Communication Systems and Network Technologies.

[2] B.M.G. and P.V.S. Srinivas,SAMR: Swarm Adaptive Multipath Routing Topology for Load balancing and Congestion Endurance in Mobile Ad hoc Networks, 2013 Third International Conference on Advanced Computing & Communication Technologies.

[3] E.Christopher Siddarth1 and K. Seetharaman2, A Cluster Based QoS-Aware Service Discovery Architecture for Mobile Ad hoc Networks, 2012 IEEE International Conference on Computational Intelligence and Computing Research.

[4] D. Karthikeyan aand M. Dharmalingam, Ant based Intelligent Routing Protocol for MANET, Proceedings of the 2013 International Conference on Pattern Recognition, Informatics and Mobile Engineering (PRIME) February, 2013 IEEE.

[5] Praveenkumar G Hoolimath, Kiran M, G Ram Mohana Reddy Department of Information, Optimized TERMITE: A Bio-inspired RoutingAlgorithm for MANET's, 2012 IEEE

[6] Vivekanand Jha, Kritika Khetarpal , Meghna Sharma, A Survey of Nature Inspired Routing Algorithms for MANETs, 978-1-4244-8679-3, 2011 IEEE.

[7] Eslam Al Maghayreh, Salam Abu Al-Haija, Faisal Alkhateeb and Shadi Aljawarneh , Bees Ants Based Routing Algorithm, 2010 International Conference on Intelligent Systems, Modelling and Simulation.

[8] L.J.G. Villalba D.R. Can˜as A.L.S. Orozco , Bio-inspired routing protocol for mobile ad hoc networks, Published in IET Communications,Received on 23rd December 2009 Revised on 30th May 2010doi: 10.1049/iet-com.2009.0826ISSN.

[9] M.M.Goswami, R.V. Dharaskar and V.M.Thakare, Fuzzy Ant Colony Based Routing Protocol For Mobile Ad Hoc Network, 2009 International Conference on Computer Engineering and Technology, 978-0-7695-3521-0/09 $25.00 © 2009 IEEE, DOI 10.1109/ICCET.2009.168

[10] A K Daniel and R Singh, Swarm Intelligence Based Multicast Routing and Bandwidth Management Protocol for AD-hoc Wireless Network Using Backpressure Restoration, 2010 IEEE.

[11] ZAFAR H., HARLE D., ANDONOVIC I., KHAWAJA Y.: 'Performance evaluation of shortest multipath source routing scheme', IET Commun., 2009, 3, (5), pp. 700–713

[12] WANG J., OSAGIE E., THULASIRAMAN P., THULASIRAM R.K.: 'HOPNET: a hybrid ant colony optimization routing algorithm for mobile ad hoc network', Ad Hoc Netw., 2009, 7, (4), pp. 690–705.

[13] DORIGO M., STU¨ TZLE T.: 'Ant colony optimization' (The MIT Press, 2004).

[14] HOSSEIN O., SAADAWI T.: 'Ant routing algorithm for mobile ad hoc networks (ARAMA)'. Proc. 22nd IEEE Int. Performance, Computing, and Communications Conf., Phoenix, Arizona, USA, April 2003, pp. 281–290

[15] LIU L., FENG G.: 'A novel ant colony based QoS-aware routing algorithm for MANETs' (Springer, Berlin, Heidelberg, 2005), ICNC, 2005, LNCS, 3612, pp. 457–466

[16] DI CARO G.A., DUCATELLE F., GAMBARDELLA L.M.: 'AntHocNet: an adaptive nature-inspired algorithm for routing in mobile ad hoc networks', Eur. Trans. Telecommun. (Special Issue on Self-organization in Mobile Networking), 2005, 16, (5), pp. 443–455

[17] DI CARO G., DUCATELLE F., GAMBARDELLA L.M.: 'AntHocNet: an ant-based hybrid routing algorithm for mobile ad hoc networks'. Proc. Eight Int. Conf. on Parallel Problem Solving from Nature (PPSN VIII), Birmingham, UK, 18–22 September 2004, (LNCS, 3242)

[18] G.A. Di Caro, F. Ducatelle, L.M. Gambardella. Swarm intelligence for routing in mobile ad hoc networks. In Proceedings of the IEEE Swarm Intelligence Symposium, pages 76–83, Pasadena, USA, June 2005. IEEE Press.