A combined approach of Swarm Intelligence Protocols for Monitoring Network Congestion

Rashmi Singh[1,*] and Dr. Sweta Verma[2]
[1,*]Research Scholar, New Delhi, India
[2]Department of Information Technology, Galgotia's College of Engg & Technology
Greater Noida, India

This paper introduces a hybrid technique by combining more than one protocols of swarm intelligence to obtain better network traffic management. The proposed routing protocol which is a combination of Wireless Ant Network based Routing Protocol (W_AntNet), named as Secure Load Aware Wireless Ant Network (SLAWAN) and Bee Hive based Routing Algorithm for decreasing route discovery latency in real time communications in high dynamic networks. The proposed algorithm splits the network into two parts; one is a fixed network and the other is a mobile ad hoc network (MANET), then applying the Wireless Ant Network based Routing Algorithm on the mobile part and the Bee Hive based Routing Algorithm on the fixed one. This protocol monitors the congestion status of active routes and reconstructs the path when nodes of the route have their network buffer queue overloaded.

Keywords: Wireless Ant Network Routing (W_AntNet), Secure Load Aware Wireless Ant Network (SLAWAN), Bee Hive Based Routing Algorithm, Mobile Ad Hoc Network (MANET).

1. INTRODUCTION

Mobile Ad hoc Networks (MANETs) represent an uncommon way of building and organizing a network of mobile nodes without any kind of infrastructure. When speaking of MANETs in this paper we refer to multi-hop ad hoc networks where intermediary nodes relay traffic for others. Routing protocols in ad hoc networks [1] must manage frequent topology changes caused by node mobility and need to be bandwidth and power efficient. A vital challenge, which is considered as the heart of building a MANET, is finding the best path from a source node to a destination one; this gives raise to the routing problem. Therefore, developing a MANET goes hand in hand with developing a good routing protocol to find the optimal path in such a dynamic network, a good routing protocol increases the performance of the network as a whole [2-6].

Realizing the importance of routing algorithms has attracted researchers to turn towards nature to societies similar to the MANET [7] in terms of the decentralized behavior and the dynamic environmental changes, like ant's and bee's colonies. The Ant colony based Routing Algorithm is inspired by ant's behavior in the real world where it is observed that foraging ants converge to the shortest path between their nest and the food source, depending on a volatile chemical substance called pheromone [1,8,9]. Translating these concepts to a network language, one of the major issues handled by this algorithm is route discovery, where ants are broadcasted from the sender to the neighbors, and each

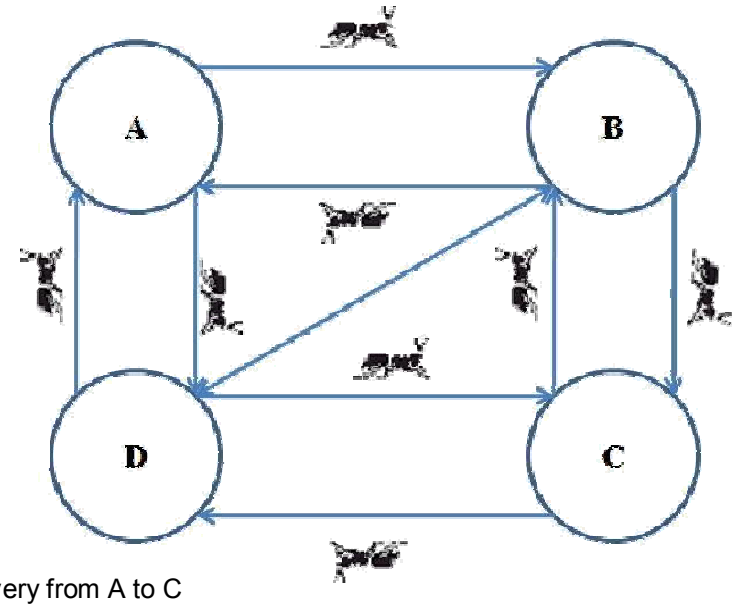
node receives an ant will create a routing table record then relay it to the neighbors and so on until the ant reaches the destination node.

Similarly, the BeeHive routing algorithm is a new method that is inspired by the behavior of bees. Bees find the optimal path to a food source, and they communicate directly via dancing. There are two types of dancing; round dances, which indicate that the food source is near the hive, and the waggle dances, which show the further food sources. The duration and orientation of a dance inform other bees about the exact place of the food source and its goodness [1,10].

Both former algorithms share a common property which is locality. Locality means that there is no need to transmit routing tables and statistics information to all other nodes in the network. This algorithm describes ants exploring the network to find the best path and update the routing tables, so when an ant reaches a destination node it is destroyed and a bee is created to be sent back in the same path to the source node.

2. SLAWAN ROUTING PROTOCOL

In ant routing algorithms implemented so far there is no local connectivity maintenance as in SDLRLA [11]. Hence when a route breaks or a less congested route is already available, the source still keeps on sending data packets to the same route unaware of the link breakage or availability of efficient routes. This leads to a large number of data packets being dropped due to congestion and link breakage. SLAWAN [12] utilizes ants working independently and providing routes to the nodes as shown in Figure 1.



Route discovery from A to C

F ant A: LREQ A C ID NL{L_A}sig_A Fant B: LREQ A C ID NL{L_A, L_B}sig_A

B ant C: LREP A C DHPKC ID NL{L_A, L_B, L_C}sig_A sig_C

Fig. 1: Example network slawan.

The nodes also have capability of launching on-demand route discovery to find routes to destinations for which they do not have a fresh enough route entry.

In this protocol every node builds a Load Table indicating the neighbor nodes with their respective loads [13] as shown in Table 1. At initial state the table remains empty. To initiate the route discovery, a node sends the forward ants FANT to its neighbors with its load information and load request LREQ. These ants are forwarded until they reach the destination or found an entry to the destination in an intermediate node's load table.

Table 1: Example load table.

A's		B's		C's		D's	
Neighbor	**Load**	**Neighbor**	**Load**	**Neighbor**	**Load**	**Neighbor**	**Load**
B	B	A	a	B	b	A	a
D	d	C	c	D	d	B	b
C	b+c or d+c	D	d	A	b+a or d+a	C	c

As soon as an ant encounters destination a backward ant BANT is generated towards the source. The backward ant contains the public key DHPKc of the destination with its load information. During this process ants carry the load information of all the intermediate nodes and update their load tables with fresh entries.

The use of ants with SDLRLA increases the node connectivity (the number of destinations for which a node has unexpired routes), which in turn reduces the amount of route discoveries. Even if a node launches a LREQ (for a destination it does not have a fresh enough route) in this protocol, the probability of its receiving replies quickly (as compared to SDLRLA) from nearby nodes is high due to the increased connectivity of all the nodes resulting in reduced route discovery latency.

Lastly, as ant agents update the routes continuously, a source node can switch from a longer (and stale) route to a newer and shorter route provided by the ants. This leads to a considerable decrease in the average end-to-end delay as compared to both SDLRLA and ant-based routing. Local connectivity in SLAWAN is maintained in a fashion similar to SDLRLA. Neighbor discovery is implemented same as used in W_AntNet algorithm where frequent HELLO broadcasts are used to maintain the neighbor load table. This table is used to select a randomly chosen next hop (avoiding the previously visited node) from the list of neighbors by the ant.

3. PROPOSED ALGORITHM

In this paper we present an on demand routing algorithm based on swarm intelligence. On demand routing networks means that whenever a source node wants to send information to a destination one, it should run this algorithm to discover the best way between the two nodes.

There are two ancestors for this algorithm, Wireless Ant Network Based Routing Algorithm (SLAWAN) and BeeHive Routing Algorithm. The former one is a well know routing algorithm over mobile ad hoc networks, whereas the latter is usually applied on fixed wireless netwoek. Therefore, the merge between the two algorithms is better to be applied on a hybrid network.

At the beginning, we divide the network into two parts; one part, which is the largest part of the network, contains mobile ad hoc nodes (mobile part), whereas the other part contains the fixed nodes only (fixed part).

When a node want to send data to another node, the source node runs the Bees Ants routing algorithm to discover the best way to send data to the destination node. Initially, the BeeHive routing algorithm is used to find a path between the source and the destination nodes as shown in Figure 2. This path is used to figure out the node that resides on the border between the two parts of the network (the mobile and the fixed parts); called border node. After that, the SLAWAN is applied to find (if possible) a better route between the source and the border node, where both nodes are in the mobile part of the network.

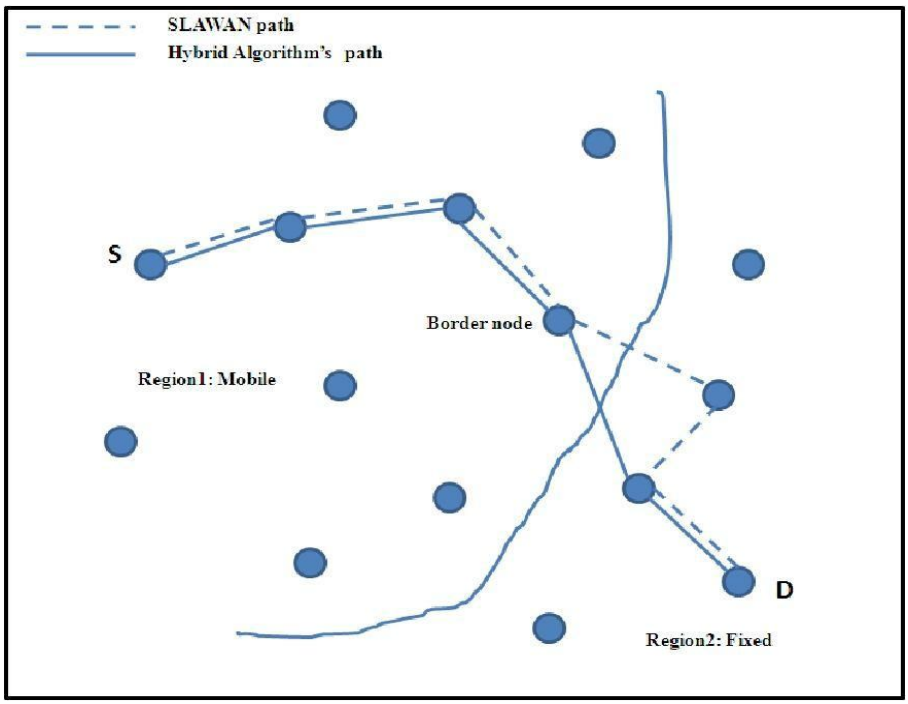


Fig. 2: Example network.

Finally, the path found by SLAWAN (from the source node to the border node) is merged with the rest of that found by BeeHive (from the border node to the destination node). The new path represents the best path between the source and the destination that can be found by this hybrid algorithm.

4. CONCLUSION

The use of ants and bees in a single network and further dividing the network into fixed and mobile parts gives new scopes for further research to prove its goodness. This research can increase the efficiency in terms of propagation delay, queue delay and number of hops.

Moreover, combining two or more methods will give positive results but it might increase the algorithm's design complexity. Adopting bees and ants is a good choice especially for a network mixed of MANET and fixed parts.

This research can be expanded in a way where ants are launched in parallel with the discovery of the border node, so bees are moving to the further nodes and ants are enhancing the path between the source node and the border node simultaneously.

REFERENCES

[1] S. Olariu and A. Y. Zomaya (Eds.); "Handbook Of Bioinspired Algorithms And Applications", Chapman & Hall/CRC, 2005.

[2] L. Layuan, L. Chunlin and Y. Peiyan; "Performance evaluation and simulations of outing protocols in ad hoc networks", Comput. Commun., Vol. 30(8), pp. 1890-1898, 2007.

[3] S. Kurkowski, T. Camp and W. Navidi; "Two Standards for Rigorous MANET Routing Protocol Evaluation", IEEE International Conference on Mobile Adhoc and Sensor Systems (MAHSS), pp. 256-266, 2006.

[4] M. G¨unes, U. Sorges and I. Bouazizi; "ARA - The Ant-Colony Based Routing Algorithm for MANETs", In ICPP Workshops, pp. 79-85, 2002.

[5] S. Kurkowski, T. Camp and M. Colagrosso; "MANET simulation studies: The Incredibles", SIGMOBILE Mob. Comput. Commun. Rev., Vol. 9(4), pp. 50-61, 2005.

[6] M. Abolhasan, T. Wysocki and E. Dutkiewicz; "A review of routing protocols for mobile ad hoc networks", Ad Hoc Networks, Vol. 2(1), pp. 1-22, January 2004.

[7] H. F. Wedde and M. Farooq; "A comprehensive review of nature inspired routing algorithms for fixed telecommunication networks", Journal of Systems Architecture, Vol. 52(8-9), pp. 461-484, 2006.

[8] C. Blum and D. Merkle (Eds.); "Swarm Intelligence: Introduction and Applications", Ser. Natural Computing Series, Springer, 2008.

[9] G. D. Caro and M. Dorigo; "Two Ant Colony Algorithms For Best-Effort Routing In Datagram Networks", In Proceedings of the Tenth IASTED International Conference on Parallel and Distributed Computing and Systems (PDCS98.IASTED/ACTA Press, pp. 541-546, 1998.

[10] H. Wedde, M. Farooq and Y. Zhang; "BeeHive: An Efficient Fault-Tolerant Routing Algorithm Inspired by Honey Bee Behavior", In ANTS Workshop, pp. 83-94, 2004.

[11] Rashmi Singh and Sweta Verma; "Secure Dynamic Load Routing Load-Aware

Protocol", In TICE, 2009.

[12] Rashmi Singh and Sweta Verma; "Simulation of SLAWAN Routing protocol in Mobile Ad-hoc Networks", International Journal of Computer and Electrical Engineering (IJCEE), Vol. 3(3), pp. 349-352, June 2011.

[13] Sung-Ju Lee and Mario Gerla; "Dynamic Load-Aware Routing in Adhoc Networks", In Proceedings of 3rd IEEE Symposium on Application- specific Systems and Software Engineering Technology, 2000.