SAHR: Swarm Adaptive Hybrid Routing Protocol for Mobile Ad hoc Networks

B. M. G. Prasad[1] and P.V.S. Srinivas[2]
[1]Associate Professor & Head, Department of Information Technology, Brindavan Institute of Technology and Science, Kurnool, Andhrapradesh, India – 518218.

[2] Professor & Head, Department of Computer Science & Engineering Geethanjali College of Engineering & Technology, Keesara, Hyderabad, Andhrapradesh, India

Abstract

The nodes in the Ad hoc networks are independent and well structured. We know that a couple of nodes can interact with one another, if they have entered into the opponent transition region. For this purpose wireless means is being utilized by the nodes. The tiniest creature in the world visible to the eye is ant. It is also found that they have a special character called as swarm intelligence. This is because of their intricate and communicative character. Some of the characters of ant such as finding the path and moving in a queue depending on the neighboring atmosphere show the astuteness of them. Apart from that they have also the character of determining the nearest path, and perform together in a set. By considering these things, we have designed our approach from the organically stimulated feature and utilized in MANETs routing. Here our approach has been designed with an algorithm that has been motivated from the Swarm intelligence to attain these features. Considering the external collection of experiments, we have made a contrast of the proposed algorithm and the state-of-the-art algorithm and it has been illustrated that our proposed one gives the enhanced results in the entire variant situations for a variant calculations and parameters. The main feature that is to be presented is that this method balances all the nodes in the network.
***Keywords*:** *MANET, Swarm intelligence, hybrid routing, unicast routing, ACO*

1. Introduction

By utilizing the multi-hop wireless communications, mobile ad hoc networks load up with mobile nodes that set up a connection in parallel. They are utilized in number of places where spontaneous communication is needed immediately like the warfare interactions and calamity reprieve tasks, especially not depending on the prevailing and loaded networks and their transmissions. We can see a big amount of routing methods for ad hoc have been introduced in [1], [2], [3], [4], [5]. In the periodical methods like [5], the nodes those are present in the network have the capacity to preserve the routing data by interchanging the data among themselves occasionally. Coming to the immediate methods like [1], [2], there is an impediment in achieving the route till the route is highly preferred. But there are some fusion methods which utilize the actions that are present in practical as well as immediate methods in order to congregate the routes from origin to the end nodes in the network. For an illustration consider the nodes that utilize ZRP some of the nodes are grouped as practical (proactive) and others are immediate (reactive).In [6], the point of selecting the practical and immediate methods is done in parallel and the practical method is visible at the desired nodes at the end only. Coming to the conventional methods such as [1], [2] if the route crashes and could not be recovered on itself, then the method strategies recover the crash. But in truth, worsening of the route in general is not a rapid action, but it occurs in slow and the accessible routes also recover or worsen slowly not rapidly. As a result the methodology must regularly preserve the data regarding the nodes in a region to function efficiently and evade the collapses in the links that occur frequently.

The remaining article is dealt as given- Section II discovers the recurrently referred associated approaches, section 3 i include the outline of presented methodology SAHR protocol. Section IV explains the identification of the route and information transferring in SAHR, section V reveals the final outputs of the experiments and later by the sections VI and VII includes conclusion and bibliography.

2. Related Work

Swarm systems have motivated and simulated many for the disseminated model of algorithms, especially in the routing algorithms. Routing is the process of allowing the data transfer from origin to the end and increasing the functionality of the network. This is the central part of the total network actions. Numerous flourishing algorithms for routing are put forward getting motivated by the ant colony conduct and the associated outline of Ant Colony Optimization (ACO) [8]. Some of the illustrations of ACO routing algorithms are Ant-Net [6] and ABC [19]. The ACO routing algorithms exposed earlier are enhanced for wired networks. They progress in disseminated and contained method, and are capable to scrutinize and acclimatize to alterations in transfer prototypes. On the other hand, alterations in MANETs are greatly severe: Besides disparities in transfer, mutually topology and amount of nodes can alter incessantly. Additional complexities are created by the restricted realistic bandwidth of the common wireless means: even though the information speed of wireless transmission is elevated, algorithms utilized for medium access control, like IEEE 802.11 DCF[12] (a large amount utilized universally in MANETs), produce a huge transparency mutually in provisions of manageable packets and delay, reducing the efficiently accessible bandwidth. Confronts of autonomic organizing are consequently more higher, and novel proposing is essential to assure still the fundamental network tasks.

3. Outline of the SAHR

1) If a route to the target end D is necessary, but not has been recognized near S, S puts out a Root Trace Swarm Agent RTSA to determine the path to D.

2) After D take delivery of the RTSA as of S, it commences to transfer TRSA in form of Root Confirmation Swarm Agent RCSA that transfers in reverse mode along the path that was identified by parent RTSA. The RCSA revises the routing record and emission records for every node in the path of S and D, permitting for information transmission from S to D. Here emission record is kept by every node n to accumulate emission characteristic value sav_{ni} of its every advancing neighbor ni. The emission characteristic value is alike of the pheromone warehouse of the organic swarm member.

3) If a path collapses near the transitional node X then SAHR restarts root detection procedure.

4) If a path near D is recognized by S, SAHR derivatively selects the pathway by picking the preeminent advancing hop stage neighbor ni depending on hop stage delay and count of hops to attain the end.

4. Swarm Adaptive Hybrid Routing Protocol

In case of wired networks SAHR's technique is stimulated by Swarm Agent Optimized routing algorithms. It utilizes swarm member that tag along and revise emission records in a meandering member interface in view of altering the environs educating technique. Information packets are routed generally constant with the erudite records.

An imperative separation with substitute Swarm Agent Optimized routing algorithms is that SAHR may perhaps be a mixture of algorithms, in order to transact advanced ones with the accurate confronts of MANET's surroundings. It's immediate, in a way to say that nodes exclusively assemble routing information for target ends that they're presently corresponding with, while it's practical consequently of nodes attempt and preserve and advance path information providing transmission continues. We have a tendency to put up a difference among the trace system, that the immediate method to obtain preliminary path information a pair of end near the commencement of a assemblage, and pathway preservation and development, that the conventional method of procedure all through the way of a assemblage in order to practically acclimatize to network alterations.

The path information acquired through circuitous member interface extended among the nodes in MANET in hop stage adjacent information swap technique to provide inferior steerage for the swarm members. Contained by the next we put forward a widen explanation about SAHR.

A. Explanation of the algorithm projected

SAHR's model is stimulated by swarm member desired routing algorithms in case of networks that are wired. It utilizes swarm members that tag along and revise emission records in a circuitous member interface regarding the alteration of surroundings educating procedure. Information packets are given the route considering their educating records. A major disparity among Swarm Agent Optimized routing algorithms is that SAHR is a mixture of algorithms, so as to transact enhanced with the detailed confronts of MANET surroundings. It is immediate in a way that the nodes simply congregate routing material for target ends which they are at present conversing with, whereas it is practical since the nodes seek to preserve and advance routing material providing conversation continues. We create a difference among the path system that is the immediate procedure to get hold of preliminary routing material regarding the target end near the beginning of the assemblage, and path preservation and development that is the usual manner of function throughout the line of a assemblage to practically acclimatize to network alterations. The routing material attained through circuitous member interface educating is broadened among the nodes of MANET in a hop stage adjacent data swap procedure in order to present resultant management for the swarm members. Give below is the explanation for every of these workings.

B.Pheromone displayer:

The emission records that are reserved at each node delineate the paths completely. An ingress g_{ni} of the emission record (secretion table) ST_i near node i that regard as pheromone displaying the integrity of routing beginning at node i to through instantaneous node ni includes a value showing the predictable integrity of departing from i above adjacent ni to attain target end d. This integrity is derivative of arrangement of path peer-to-peer delay and series of hops. These eminent procedures are generally utilized in MANETs. Merging the count of hops including peer-to-peer delay among instantaneous node ni to present node i and target end node d is a method of rustling out most probably massive swings in time approximates congregated by swarm agents. The filling of the secretion tables is dynamic in view of the fact that SAHR exclusively retain information concerning target ends that are on duty throughout a conversation assemblage and because of constant alteration near the adjacent nodes.

C.Route Detection:

The origin node s derives the path to node d through propagation of Root Trace Swarm Agent $RTSA$. Near every adjacent hop that acknowledged $RTSA$, propagates the identical one to their adjacent hops. This procedure repeats on itself for every $RTSA$ until it is acknowledged by ending node d. Once RTSA tracks a path for communication, the swarm agent RCSA transfers in the same path but in reverse order. In this course, on attending each peer *i* in the considered track, RCSA changes the pheromone indicator value g_{ni} of the previous peer *ni* of the considered peer. RCSA changes the pheromone indicator value in the following manner:

In the process of transferring swarm agent RCSA from the hop peer, *ni*, to the peer, *i*, the time taken $t_{ni\text{->}I}$ is noted. Now , the next step is to calculate the expected time $t_{i\text{->}d}$ to transfer an information from peer *i* to the destination peer *d* following the path {ni, ni+1 ,ni+2, …, ni+n}. This can be calculated using the following equation…

$$t_{i\to d}^{ni} = t_{(ni+n)\to d} + \sum_{k=n}^{1} t_{(ni+k-1)\to(ni+k)} \quad \text{……} \quad (1)$$

Now, the final step of calculating the pheromone indicator value of the peer *ni* is performed using the following two equations 2, 3.

$$\left(t_{i\to d}^{ni}\right)' = \left(t_{i\to d}^{ni}\right)^{-1} * 100 \quad \text{…..} \quad (2)$$

$$g_{ni} = \frac{\left(t_{i\to d}^{ni}\right)'}{hc_{i\to d}^{ni}} \quad \text{….} \quad (3)$$

In the above equations, $hc_{i\to d}^{ni}$ stands for the number of hops in path from current node i to destination peer d via relay hop peer ni.

Here, equation 2 makes its importance, as the inverse value of the expected time $t_{i\to d}^{ni}$ for the information to be transferred between peer *I* to the destination peer *d* depicts the best of the paths that can be followed from the peer, *i* to the destination peer *d* through the relay peer *ni*.

Source peer s, once gathering swarm agent RCSA, updates the secretion table with the pheromone indicator value g_{ni} of every relay hope peer *ni* which transferred the swarm agent RCSA.

4. Data Transmission and Routing-path maintenance

The maintenance of the chosen track, starting from the destination peer d, is conducted in a proactive way. The information transfer and the maintenance of the chosen track are carried out in certain methods which are explained as follows.

i. Data Transmission

The process of transmission starts at source peer s. Every peer including the source peer chooses the relay hop, ni expected to follow it dynamically. The choice of the successor peer is done by examining the pheromone indicator value of all the surrounding peers from the secretion table. The peer with the optimal pheromone indicator value will be chosen to transfer the information packet.

The successor will store the data regarding the preceding peer in the routing cache. This whole procedure is continued for every peer, the data packet is transferred to until it reaches the destination peer.

ii. **Routing path maintenance**

It is carried out by examining the time delay at each peer and updating the pheromone indicator value. It is done as, destination peer, d, examines the time $t(dp_i)$ taken for the information packet, (dp_i), to reach destination peer from the source peer. Later, the time delay with respect to each and every peer is calculated for (dp_i). This is termed as end-to-end delay, which, if crosses the threshold delay, τ will leads to the initiation of swarm agent RCSA and it moves towards the source peer. Thus RCSA updates the pheromone indicator value at every hop stage. It can be done by using the equations 2 and 3.

iii. Handling link failures

The pheromone indicator value of every peer keeps on changing in the secretion table after a particular period of time. It is because, the destination peer d, initiates swarm agents RCSA for every neighbor relay hope peers after every time period.

The pheromone indicator value becomes irrelevant and invalid for any besiding relay hop, ni, in the secretion table of a peer I, if the update time of the previous one is more than that of now. It results in the link breakage between peer i and the destination peer d.

5. Experimental results

The SAHR is analyzed based on various tests. The standard and state of art protocol of Local repair strategy [1] of Manet called AODV is used to compare the efficiency of the SAHR. NS2 is used as the simulation software. Several routing protocol analyzing strategies are used to verify the protocol and the test is conducted by changing the various parameters according to a particular criteria. Here, 100 peers move in the area 3000 X 1000m^2. RWP [13], Random Waypoint mobility model, is used to create movement patterns. Here, a temporary destination with a temporary speed is chosen and they wait there for some break time and again continue their journey by choosing another destination and speed. The speed may vary between 0 to 20 m/s and the break time can be 30 seconds. Every simulation continues for about 900 seconds. 20 various constant bit rate sources initiate sending the data packets for a time interval of 0 to 180 seconds and continue it to the end. IEEE 802.11b DCF protocol is used at the medium access control layer. The delay jitter i.e. the mean of the difference in inter-arrival time among packets. To calculate performance, the no. of control packets transferred successfully as the overhead.

SAHR's efficiency can be calculated considering different levels of mobility and peer density, various network sizes and various information traffic patterns.

For various levels of mobility, the break time is changes. For less mobility, the break time is increased and vice versa. Lower mobility also refers to less connectivity based on characteristics of RWP mobility [2]. SHAR has better performance compared to AODV in various aspects which can be seen in the following diagrams. AODV seems better in case of routing overhead but only at a slight difference. The performance due to decreased connectivity rises in the case of more break time.

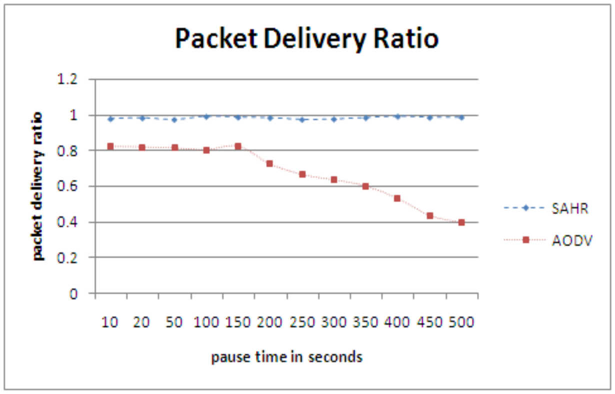

Fig 1: Packet Delivery ratio comparison between AODV and SAHR

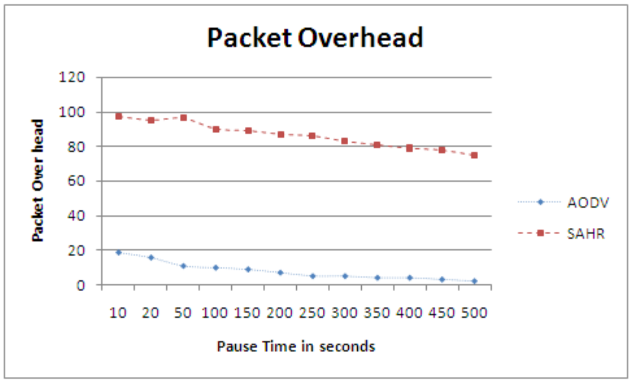

Fig 2: Packet overhead comparison between AODV and SAHR

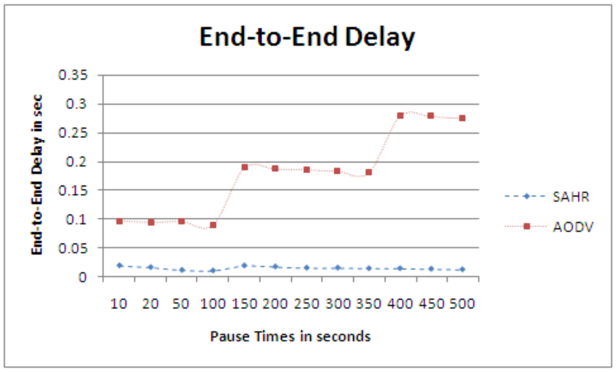

Fig 3: End-to-End delay comparison between AODV and SAHR

The node density can be changed by changing the no. of peers per unit area. It can be seen in the figure 3. Even in these cases, SAHR has performance better than AODV when considered peer-to-peer delay and delivery ratio. The different in the performance increases with the density. SAHR has lower efficiency than AODV in case of overhead, but it gets better with the increase in density. All the reports are not depicted here. The delay and the delivery ratio is clearly visible with respect to the differences in performance of SAHR and AODV. While considering various network sizes, the peer density is kept constant and all other dimensions regarding size are varied. It can be seen in the figure 4.

SHAR's performance gets better as its overhead increases slowly compared to the AODV indicating that SHAR is more scalable when no. of peers are considered. In all the above cases, we considered about 20 various placed CBR sessions. Test results of carious tests considering traffic loads and patterns are shown in figure 5. The sessions are constructed over many hot spots may be 20 or 50 randomly picked CBR sources and constant no. of destinations. The destination can be 1 or as much as the no. of sessions. When much traffic is occurred near the communicating peers, it becomes necessary to conduct traffic sessions for such hotspots. Even here, SAHR show better results. The benefits of SAHR can be seen better when the no. of peers in the hot spots increase i.e. SAHR may have more overhead than AODV in case of 20 sessions. But the overhead of both seem to be similar in case of 50 sessions.

6. Conclusion

Here, SAHR (Swarm Adaptive Hybrid Routing) protocol is explained and how it gets influenced by Swarm intelligence. This is used to provide a better solution for the cons faced during the Manet routing by combining reactive and proactive nature. Here, even the information transfer and the route maintenance are discussed with a better solution of proactive method based on effective swarm agent which can be used to update pheromone. This will be helpful to select the optimal peer which can be added to the track to carry on transmission of the data packets. It also clears linkage based conflicts.

7. References

[1] C. E. Perkins, E. M. Royer, and S. R. Das, “Ad hoc On-Demand Distance Vector (AODV)Routing, Internet Draft (draft-ietf-manet-aodv-09.txt),” November 2001, work in Progress.
[2] D. B. Johnson, D. A. Maltz, Y.-C. Hu, and J. G. Jetcheva, “The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks (DSR), Internet Draft (draft-ietf-manet-dsr-07.txt),” February 21 2002.
[3] C. Perkins and P. Bhagwat, “Highly dynamic destinationsequenced distance-vector routing (DSDV) for mobile computers,” in ACM SIGCOMM'94 Conference on Communications Architectures, Protocols and Applications, 1994, pp. 234–244 [Online] Available: citeseer.nj.nec.com/perkins94highly.html
[4] Z. J. Haas, M. R. Pearlman, and P. Samar, “The Zone Routing Protocol (ZRP) for Ad Hoc Networks,” July 2002, iETF Internet Draft, draft-ietfmanet- zone-zrp-04.txt.
[5] C. Adjih, T. Clausen, P. Jacquet, A. Laouiti, P. Minet, P. Muhlethaler, A. Qayyum, and L. Viennot, “Optimized Link State Routing Protocol,” INRIA Rocquencourt,” Internet Draft (draft-ietf-manet-olsr-09.txt), April 15 2003, work in Progress.
[6] V. Ramasubramaniam, Z. J. Haas, and E. G. Sirer, “SHARP: A Hybrid Adaptive Routing Protocol for Mobile Ad Hoc Networks,” in The ACM Symposium on Mobile Adhoc Networking and Computing (MobiHoc 2003), Annapolis, Maryland, June 1–3 2003.
[7] E. Bonabeau, M. Dorigo, and G. Theraulaz, Swarm Intelligence – From Natural to Artificial Systems. New York: Oxford University Press, 1999.
[8] J. P. Sterbenz, R. Krishnan, R. R. Hain, A. W. Jackson, D. Levin, R. Ramanathan, and J. Zao, “Survivable Mobile Wireless Networks: Issues, Challenges, and Research

Directions," BBN Technologies, Cambridge, MA, September 2002.
[9] J. S. Baras and H. Mehta, "A Probabilistic Emergent Routing Algorithm for Mobile Ad hoc Networks," in WiOpt'03: Modeling and Optimization in Mobile, Ad Hoc and Wireless Networks, March 3-5, 2003.
[10] G. D. Caro and M. Dorigo, "AntNet: A Mobile Agents Approach to Adaptive Routing," Universite Libre de Bruxelles, Belgium, Tech. Rep. IRIDIA/97-12, 1997.
[11] D. Camara and A. A. F. Loureiro, "A GPS/Ant-Like Routing Algorithm for Ad Hoc Networks," in IEEE Wireless Communications and Networking Conference (WCNC?00), Chicago, IL, September 2000.
[12] M. Heissenbttel and T. Braun, "Ants-Based Routing in Large Scale Mobile Ad-Hoc Networks," University of Bern, Tech. Rep., 2003.
[13] M. Gunes, U. Sorges, and I. Bouazizi, "ARA – The Ant-Colony Based Routing Algorithm for MANETs," in International Conference on Parallel Processing Workshops (ICPPW'02), Vancouver, B.C., Canada, August 18– 21 2001.
[14] F. Ducatelle, G. Di Caro, and L. M. Gambardella, "Using Ant Agents to Combine Reactive and Proactive Strategies for Routing in Mobile Ad- Hoc Networks," International Journal of Computational Intelligence and Applications, Special Issue on Nature-Inspired Approaches to Networks and Telecommunications, 2005, to appear. Also Technical Report IDSIA 28-04.
[15] G. Di Caro, F. Ducatelle, and L. M. Gambardella, "AntHocNet: an ant-based hybrid routing algorithm for mobile ad hoc networks," in In Proceedings of PPSN VIII - Eight International Conference on Parallel Problem Solving from Nature, ser. Lecture Notes in Computer Science, no. 3242. Birmingham, UK: Springer-Verlag, Sept. 2004, best paper award.
[16] M. Dorigo, G. D. Caro, and L. M. Gambardella, "Ant Algorithms for Discrete Optimization," Universite Libre de Bruxelles, Tech. Rep. IRIDIA/98-10, 1999.
[17] E.M. Royer and C.-K. Toh. A review of current routing protocols for ad hoc mobile wireless networks. IEEE Personal Communications, 1999.
[18] Scalable Network Technologies, Inc., Culver City, CA, USA. Qualnet Simulator, Version 3.6, 2003. http://stargate.ornl.gov/trb/tft.html.
[19] R. Schoonderwoerd, O. Holland, J. Bruten, and L. Rothkrantz. Ant-based load balancing in telecommunications networks. Adaptive Behavior, 5(2):169– 207, 1996.
[20] R.S. Sutton and A.G. Barto. Reinforcement Learning: An Introduction. MIT Press, 1998.
[21] G. Theraulaz and E. Bonabeau. A brief history of stigmergy. Artificial Life, Special Issue on Stigmergy, 5:97–116, 1999.

About Authors:

Dr. P.V.S. Srinivas is presently serving as a Professor & Head, Department of Computer Science and Engineering, at Geethanjali College of Engineering and Technology, Hyderabad. He has got his Masters followed by Ph.D. in computer Science and Engineering in the area of Computer Networks from JNTU Hyderabad in the year 2003 and 2009 respectively. His main research interests are Wireless Communication, Mobile Computing and Mobile Ad hoc Networks. His research focuses in on "Designing an Effective and Assured Communication in MANETs" and improving QoS in MANETs. He is also serving as a Chief Panel Consultant in the area of wireless communications for a Hyderabad based company by name a SCADA METER SOLUTIONS Pvt Ltd. He has published 32 research papers in different refereed International Journals and conferences in India as well as abroad. He is also serving as an Editor-in-Chief for an International Journal IJWNC and also a peer reviewer for 3 International Journals.

Mr. B.M.G. Prasad presently serving as Associate Professor & Head, Department of Informantion Technology, at Brindavan Institute of Technology & Science, Kurnool, AP. He is having 14 years of teaching experience in various Engineering Colleges. He has done his B.Tech at Vijaya Nagar Engineering College, Bellary in 1997. He completed his M.Tech at J.N.T.U College of Engineering, Anatapur in 2003 and now he is persuing his Ph.D in Computer Science and engineering under the guidence of Dr. P.V.S. Srinivas,, in CMJ University, Shillong, Meghalaya State. He has published papers in the I-Manager's International Journal and Indian National Science Congress, Tiruvananthapuram in the Computer Networks area. And his areas of interest are Software Engineering, Wireless Networks, Image Processing etc.