Optimization based Efficient Load Balancing Routing for Mobile Ad hoc Networks

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ABSTRACT *The effective load balancing for wireless communication always plays the significant role in optimizing the network performances. The congestion situations in Mobile Ad hoc Networks (MANETs) may leads to the QoS performance degradations due to the communication failures, node failures etc. For MANET, the situation becomes sever due dynamic behaviour of mobile nodes. Thus the load balancing at routing layer is essential for wireless communications. In the given paper we display the novel load balancing algorithm to enhance the routing QoS performance for MANET communications using the optimization algorithm called Ant Bee Colony (ABC). The ABC algorithm exploited to select the optimum node based on the parameters such as bandwidth requirements and energy requirements to prevent the congestion conditions on mobile nodes. This approach not only helps to keep the minimum routing overhead but also improves the QoS performance for different types of MANETs. The ABC approach designed to construct the optimum the way for the information transmission from the source hub to destination hub by assessing middle hubs according to the current necessities as far as required data transfer bandwidth and required energy level. The simulation comes about shows that the proposed routing protocol improves the general QoS execution when contrasted with existing AODV and DSR routing protocols.*

Keywords: *Load balancing, Ant bee colony, bandwidth requirements, energy level, quality of service, AODV*

Introduction

The MANET is widely used in recent days due to number of advantages such as wireless communications without need of any physical infrastructure, fast monitoring of required services etc. There different layers included for designing of MANETs. The main communication among mobile nodes is done using the routing methods. For such routing methods, the main challenge is to deal with dynamic nature of mobile nodes and changing topology [1]. For MANET, there are number of routing protocol are designed and developed for communication purpose. This kind of routing protocols in MANET required addressing the conventional limitations such as more energy consumption, more error rate, less bandwidth efficient. There are different types for routing protocols in MANETs [2]; they are categories according to the way of working and communication patterns. Basic classification comes under tow main categories such as multipath and unipath routing methods. As name indicating for multipath routing methods, there are multiple routes utilized for sending data from source node to destination node, whereas for unipath routing methods, only one route is constructed for transmitting data from source node to destination node [3].

As mobile nodes in MANET is frequently changing their position in network, there is possibilities of node failures, radio channel having dynamic characteristics, frequent links failure and construction is going on. The current route links may unavailable which is resulted into the current route is converted into invalid route [4]. The frequent routes failure leads the frequent route searching and finding for communication which resulting the extra routing overhead, increase delay for source to destination data communication is required. This problem is addressed by multipath routing methods in which multiple concurrent paths are provided for transmitting the data from source to destination. However, using the multipath routing solutions, the problem of QoS efficiency does completely resolves as multipath communications may leads to the excessive energy consumption, more routing overhead, and congestion in network. Therefore, designing routing protocol by considering the load balancing among the network communications is crucial for MANET routing protocols [5].

Load balancing routing method is best approach to address such problems in MANET. The term load balancing in routing is nothing but the technique of distributing current workload among multiple routing links in order to achieve the efficient resource utilization, increased average throughput, minimized end to end delay, extending the network lifetime, and keeping the less overhead on mobile nodes. The methods of load balancing are having below two important features: (1*) Asymmetric Load*: Here the communication data is mutually assigned to available paths in order to achieve the more share of workload as compared to others. (2) *Priority Activation*: As per the priority assigned to every path in communication, the workload is divided according to those priorities. Also, the load balancing term for routing is treated as

the mitigating the congestion situations by selecting the healthy and non-congestive nodes for data transmission.

In this paper, we proposed the novel load balancing algorithm for MANET using the ABC optimization technique to select the efficient routing path using two key parameters for load balancing such as bandwidth requirements and energy level. It has been discovered that Artificial Bee Colony Optimization (ABC) [15] is an extraordinary sort of streamlining system having the portrayal of Swarm Intelligence (SI) which is exceptionally appropriate for finding the adaptive routing for such kind of networks. ABC is a probabilistic strategy for taking care of computational issues which can be lessened by discovering great ways through charts [15].

ABC algorithms are enlivened by the conduct of bees in a bee colony which can discover ideal association of the honey bee province with the source of food. ABC routing algorithms utilize straightforward operators called forager bee and utilized bee which set up ideal ways amongst source and destination that discuss by implication with each other. ABC is utilized in light of the fact that they are more vigorous, dependable, and adaptable than other customary routing algorithms. In segment II, the related works on load balancing briefly discussed. In section III, proposed algorithm presented. In section IV, the simulation parameters and results are discussed. Finally in section V, conclusion and future work presented.

Related work

The review of different works presented recently for load balancing in wireless communications based various methodologies. Further we presented the ABC based routing protocols.

R. Senthil Kumar et.al (2013) [6], proposed another cross-layer scheme based algorithm to diminish the connection break in MANETs. This present three plans to decrease packet retransmission proportion by partitioning signal data between the PHYSICAL LAYER and MAC LAYER, and to convey the continuous route disappointments in MANET by distinguish without further ado to be broken connections instead of forecast of approaching sign power, To discover the advanced route support by taking into the thought of Bandwidth, Postpone which outcomes about by change of QoS.

P. Elayarasu et.al (2013) [7] consolidated approach for QoS development and asset use were proposed by the creator for MANET and WIMAX networks. Creator outlined the asset use based load balancing strategy tailored for Mobile WIMAX was planned and three upgrade recommendations were made. This was the principal approach for consequently tuning the load adjusting activating limit and in addition to empowering BS controlled load adjusting for Best Effort Mobile Stations.

S.Venkatasubramanian et. al (2013) [8] proposed the multi-way routing for load balancing as it limits the greatest use and conveying similar movement requests. With this approach, at first Route Disclosure was started at whatever point the source hubs are endeavors to find routes to the destination by flooding request packets (RREQs). The RREP is sent based on first start things out served premise. After few time accepting the RREPs, middle of the road hubs separating the route way data and sending them as per the predetermined route. A short time later balancing capacity and in addition, sending capacity for every way was computed. For balancing function and sending function creator utilized the threshold value. In the event that the edge values are fulfilled then just the load dispersion was handled, generally, the comparable route was used for information transmission.

Teerapat Sanguankotchakorn et.al (2013) [9], another heuristic technique planned in view of the on cross-layer outline strategy so as to enhance execution of OLSR by utilizing Bit Error Rate (BER) clarified from the physical layer alongside the network layer parameter characterized weighted Connectivity Index (CI) which was the blend among the connection availability and limit. The planned approach was exhibited to discover the streamlined way as far as most elevated weighted CI and additionally least BER keeping in mind the end goal to upgrade the execution of Multipoint Relays (MPR) choice strategy and route calculation. Creator explored the execution of composed strategy as far as throughput, normal deferral, packet conveyance proportion and overhead.

Mr.M.D.Nikose et.al (2014) [10] proposed the cross-layer based algorithm which was utilized to upgrade the execution of TCP of the ad hoc network and in addition to limit the packet drop rate. Anyway, with this approach, a rehashed detachment of mobile hub can cause some packet misfortunes and postponements in a few situations. The viable simulation comes about were appeared as far as throughput, jitter, and packet delivery proportion.

Surendran. S et. al (2015) [11], the latest QoS developement strategy proposed by the creator. At first, they did the broad audit of fault tolerant routing protocols and afterward proposed the ant colony based algorithm for MANET routing. They proposed the QoS compelled fault tolerant ant to look ahead

routing technique. This approach endeavoured to distinguish the legitimate way and also look ahead way matches which might be bits of help in choosing the backup course of action in the event of current route disappointment. The advantage of this strategy is that they are thinking about the protected information discussion and additionally in which they utilized the cryptography based algorithms for information security among source and destination node.

Gaurav Pathak et.al (2017) [12], the recent method for load balancing in MANET proposed based on AOMDV routing protocol. They design routing protocol that improves the network QoS by selecting routes based on temporal load of intermediate nodes and via dividing the load amongst the free nodes while transmission of data. However, the performance of these not shows the significant improvement, also the routing overhead is not evaluated hence it may lead to extra overhead while selecting the optimum path for data transmission.

Vallikannu R. et al (2015) [13] presents the ACO based routing protocol for MANET communications. Our proposed work is inspired from this method. They designed the route selection approach by considering the energy parameter only. They selected the energetic paths for data transmissions using the forward ant (FANT) and backward ant (BANT) terminologies. However, this method evaluated using the indoor network scenarios only with the mobility speed at max 5 m/s. Also, there is no provision for load balancing if there is any congestion in network.

Alexey V. Leonov (2016) [14] presents the ACO based and ABC based routing solutions to improve the performance as compared to existing DSR, DSDV, and AODV routing protocols for Flying Ad Hoc Networks (FANETs). However, the load balancing is yet to solve using the optimization methods.

In this paper, we designed the load balancing routing protocol using the ABC technique to organize the efficient routing paths for MANETs. The proposed work is different than existing methods in terms of possibility of node selection is not only based on hop count, but also considers the two vital parameters to prevent the congestion conditions in network such as bandwidth requirement and energy level of nodes. Next section presents the design of proposed solution.

Proposed methodology

In this paper, as we discussed above sections we proposed the novel ABC based routing protocol to handle the load balancing in MANETs. The proposed protocol utilized the two key parameters while selecting the next scout of ABC phase such as bandwidth requirement and energy requirements for current transmission. Figure 1 shows the methodology of route selection using ABC algorithm. As observed in figure, the routing procedure is formalized in form of ABC optimization technique where the route discovery started by RREQ broadcasting in bee phase for the discovery the scout bee (efficient path) for the data transmission if it satisfy the energy and bandwidth requirements.

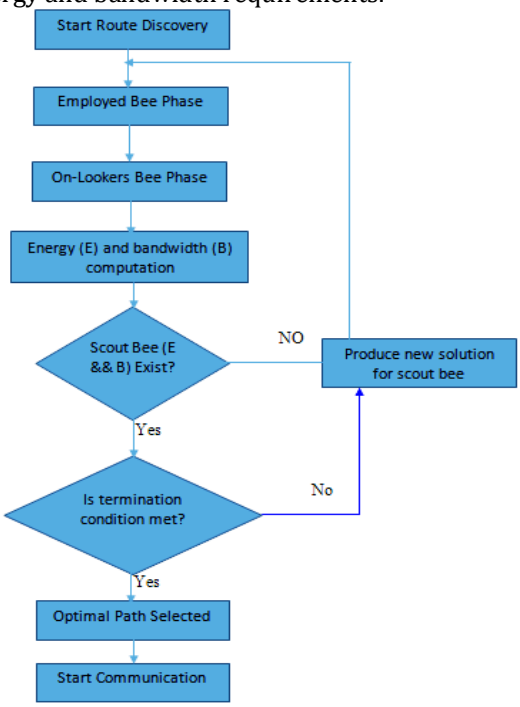

Figure 1: Proposed load balancing routing protocol architecture

The working of proposed method is elaborated in algorithm 1 as well.

Algorithm 1: ABC based route selection

Inputs:

S: source node
D: destination node
ε: energy threshold
σ: lower bandwidth limit

Output: scout bee

1. S triggers the data transmission to D
2. S broadcasts the $RREQ$
3. Routing employs the bee phase
4. On-lookers bee phase for selection of scout bee
5. Selection of bees based on conditions:

If (E^{cond} => ε || B^{cond} <= σ)
  Scout bee exists and selected
Else
  Produce new solution for scout bee
End

6. All scout bees collected and sorted according to minimum hop count.
7. Update routing table
8. The scout bee with minimum hop count selected for data transmission
9. Return scout bee

As observed in algorithm the scout bee is nothing but the eligible node with requirements of energy condition and bandwidth conditions for QoS efficiency. Once the bee selected, the iterative process performs till the destination node. All possible routes selected and updated in routing table with minimum hop count order. The scout bee with less hop count is selected for data transmission. The conditions for energy and bandwidth at each node are evaluated as: The computations of energy based next hop selection are based on below three equations:

$$RE_{node} - E_{needed} > \varepsilon, then\ Path_{ij} = 1 \quad (1)$$
$$RE_{node} - E_{needed} = \varepsilon, then\ Path_{ij} = 0 \quad (2)$$
$$RE_{node} - E_{needed} < \varepsilon, then\ Path_{ij} = -1 \quad (3)$$

Where RE_{node} remaining energy of next hop, E_{needed} is required energy to transmit the current data and ε is threshold to satisfy. If the equation 1 satisfied then $Path_{ij}$ is set to true from current node i to next node j. Else if equation 3 is satisfied then $Path_{ij}$ is set to false from current node i to next node j. Otherwise in rare case, equation 2 satisfied and there is no other near nodes available to select as next hop, then the outcome of the equation 2 is utilized during the data transmission phase. This helps to improve overall QoS and energy efficiency performance. Similarly the bandwidth is evaluated as:

$$O_{node} + B_{needed} < \sigma, then\ Path_{ij} = 1 \quad (4)$$
$$O_{node} + B_{needed} = \sigma, then\ Path_{ij} = 0 \quad (5)$$
$$O_{node} + B_{needed} > \sigma, then\ Path_{ij} = -1 \quad (6)$$

Where O_{node} bandwidth occupancy at current node, B_{needed} is required bandwidth to transmit the current data and σ is lower bandwidth limit to satisfy. With combination of above equations, the bee is selected if the node satisfying eq. (1), (2) and eq. (4) (5). Once the efficient path selection, the data transmission initiated. If any of the intermediate node moves at other position, then the process of route discovery is started again and selects the new path for data transmission. In next section we present the simulation analysis of proposed method.

Simulation results

The proposed routing protocol is designed, simulated, and evaluated using the NS2 tool under the ubuntu OS. The performance of proposed protocol called LBRP (Load Balanced Routing Protocol) is compared with AODV and DSR routing protocols. Table 1 shows the complete list of simulation parameters used for the evaluation. The networks are designed with varying size start from 20 to 70 nodes. The comparative analysis of protocols is performed using the key parameters such as average throughput, average delay, routing overhead, and energy consumption.

Number of nodes	20, 30, 40, 50, 60, 70
Number of Connections	5
Simulation Time	100 second
Mobility (m/s)	10
Routing Protocols	AODV, DSR, and LBRP
MAC	802.11
Propagation Model	Two-Ray Ground
Mobility	Random
Antenna	Omni Antenna
Traffic	CBR
Initial energy	0.5nJ/bit

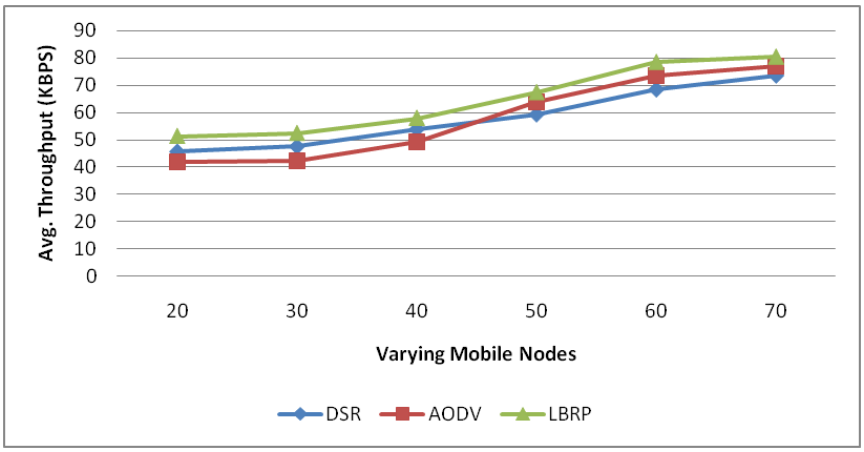

Figure 2: Average throughput performance evaluation

As one can see from Fig. 2, when the nodes amount increases, the throughput of the protocols AODV, DSR, and LBRP increases as there is more opportunities available of instant path selection. The performance of DSR is better as compared to AODV up to 40 nodes, whereas its get lower afterwards. However, the proposed LBRP which is modified version of AODV able to achieve the better performance under all the cases of networks.

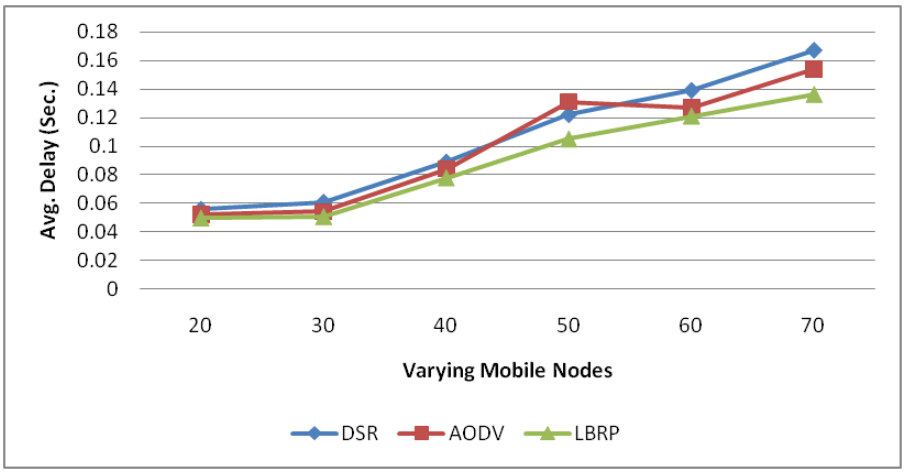

Figure 3: Average end to end delay performance evaluation

Similarly, the total average end to end delay performance it is exact opposite to the performance of average throughput in figure 3. The proposed protocol takes minimum time for data transmission due to the load balancing approach.

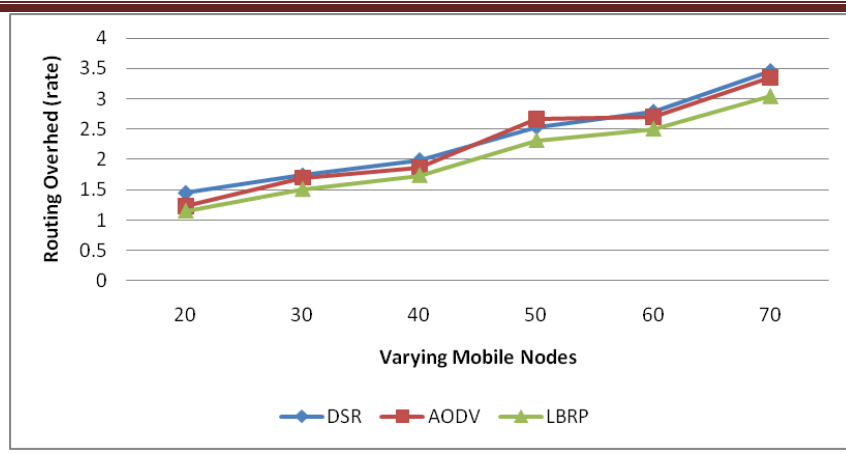

Figure 4: Routing overhead performance evaluation

Figure 4 demonstrates the effectiveness of load balancing approach in routing performance called routing overhead. As the ABC approach selects the nodes by considering the energy level and bandwidth requirements, the load on any specific node is prevented and hence the overhead of routing is minimized as compared to AODV and DSR protocols.

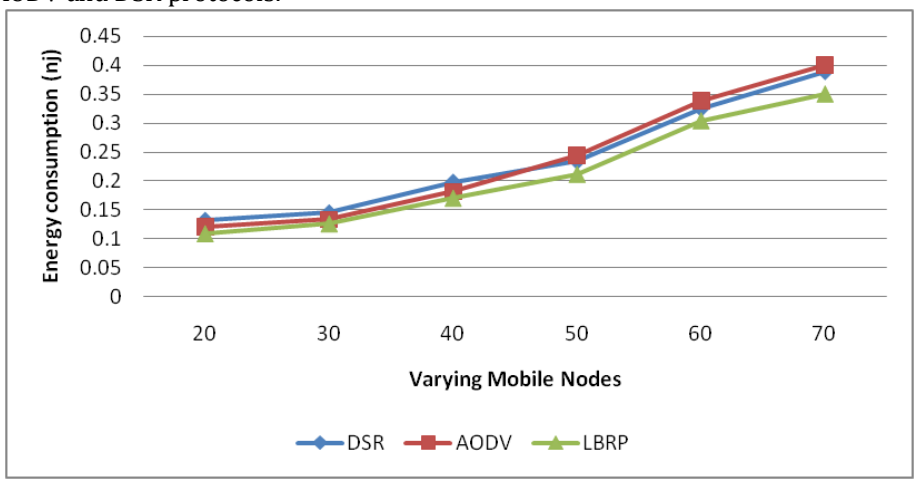

Figure 5: Average energy consumption performance evaluation

In existing methods there is no provision to mitigate congestion conditions, hence such conditions leads to unnecessary energy utilization of specific hubs and in addition having all the more overhead to deliver the packets. The energy consumption performance demonstrated in figure 5 shows the LBRP delivers minimum energy consumption as compared AODV and DSR routing protocols.

Conclusion and future work

In this paper, we designed novel lightweight and simple ABC optimization technique based MANET routing protocol to select the load balancing based routing paths for information transmission from the source hub to the expected destination. The load balancing is accomplished through the efficient path selection approach. The next hop node is selected based on its capabilities in terms of available energy and available bandwidth according to demand. The performance of proposed protocol presented in this paper shows efficiency for any size of network. For future work it will be interesting to work on mobility aware load balancing approach in order to deliver the reliability for highly mobile networks.

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