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LAR-1: Affirmative Influences on Energy-Conservation and Network Lifetime in MANET

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Abstract: Nowadays, reduction of energy-consumption in Mobile Ad-Hoc Networks (MANETs) has been a herculean task. Appropriate location-based routing protocols like Location-Aided Routing-1 (LAR-1) can be incorporated for reducing the energy consumption as it extends the network lifetime in dynamic network. The research work proposed integrating energy-conservation along with LAR-1 route-discovery mechanism, named as New-Location-Aided Routing-1 (N-LAR-1). In this paper, developments of performance-metrics using this N-LAR-1 approach have been reported. Affirmative results have been achieved through N-LAR-1 by utilizing the sleep or inactive mode condition of mobile nodes in Ad-Hoc Networks. It has been observed that performance of N-LAR-1 is better than N-DSR approach.
Keywords: MANETs, LAR-1, Energy Conservation, Network lifetime.

1 Introduction

MANET is a self-configuring, self-organizing infrastructure less network. For instance in military application, enemy tank can be tracked within the network at the time of battle. Similarly, local community can use an Ad-Hoc network to detect moving car and its speed along with direction. Presently limited energy, limited bandwidth, multi-hop routing, dynamic topology and security are the leading technical challenges in MANETs. Numerous routing protocols have been proposed to overcome these challenges in Ad-Hoc networks [1]. Routing protocols play an important role in dynamic network communication. Commonly, routing protocols are divided into topological and position-based protocols. Further topological-based routing protocols may be classified mainly into proactive, reactive and hybrid types. On the other hand, position-based routing protocols diminish the limitations of topological-based routing protocols using location information via GPS [2]. There are three position-based routing approaches such as, Greedy, Restricted Directional-Flooding and Hierarchical type techniques. Earlier several position-based protocols had been projected such as LAR-1, Distance Routing Effect Algorithm for Mobility (DREAM), Most Forward within Distance R (MFR) and so on.

LAR-1 is widely used source routing protocol, like a DSR. It is a type of restricted directional flooding based position-based routing protocol. Initially it starts flooding in network by the source but after expecting destination, the routing will be only in the direction of the destination. Since nodes in MANET are battery dependent. To extend network lifetime, routing protocol should concentrate for achieving energy conservation in the network [3] [4]. In this paper, N-LAR-1 technique has been developed with association of Power-Aware Dynamic Source Routing (PADSR) energy model in MANET. This proposed work is an endeavour to address challenging

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the issue of developing an effective energy-conserving technique for MANET. This paper also shows optimization of Ad-Hoc network performance metrics using proposed N-LAR-1 technique. In second section, literature survey has been presented. The short description of conventional LAR-1 protocol is shown in next section.

Afterward N-LAR-1 is elaborated in next portion. In fifth section, simulation results and its effect on proposed technique have been displayed. Last part concludes the paper.

2 Preliminaries

MANET is the group of wireless mobile nodes without any pre-defined infrastructure. Each mobile device has a limited energy and additional energy is required to forward the packets during route discovery mechanism in Ad-Hoc Network. Therefore, energy-conservation is required in network. Several researchers have been contributed in the era of energy-conservation. This section shows literature survey of work on LAR-1, energy-conservation on LAR-1 along with comparison amongst various routing protocols and energy-conserving routing techniques in MANET.

At first optimization in route discovery overhead was given by Ko Y.B. et al. [5] in the form of Location-Aided Routing (LAR) protocols in MANETs. They suggested an approach to utilize the location information via GPS to improve performance of routing protocols in the network. They developed two location-aided routing algorithms LAR-1 and LAR-2. Both use directional forwarding flooding, in which the source node floods data packets in the direction of the destination node. Both limit the search for a route in restricted area. They had concluded that routing overhead is reduced using LAR-1 scheme.

Ahvar E. et al. [1] analysed the performances of LAR-1, Dynamic Source Routing (DSR) and Ad-Hoc On-demand Distance Vector (AODV) routing protocols on the basis of energy consumption in Ad-Hoc networks. This analysis was accomplished by varying the network load, size and node mobility of the network. They concluded that LAR-1 is much better than others and affords energy-conservation in high node density networks. Xu Y. et al. [6] proposed an energy saving Geographic Adaptive Fidelity (GAF) algorithm. It concentrates on turning the radio off as much as possible. GAF nodes utilize geographic location information to segregate into fixed square grids. Nodes within a grid, switch between sleeping and listening state with the guarantee that one node in each grid stays up to route packets. Their results show that it can save 40-60% more energy than conventional protocol. Patel A. et al. [7] recognized an unreachable corner of GAF scheme and its effect in the network. GAF-h (Hexagonal) algorithm has been derived and checked with different traffics by them. It replaces virtual square grid into hexagonal grid. They concluded that it optimizes the Packet Delivery Fraction (PDF) and throughput of the network.

Chen B. et al. [8] proposed a power saving protocol SPAN that reduces energy consumption without shrinking the capacity or connectivity of an Ad-Hoc network. It adaptively elects coordinators and to form a fundamental structure that has set defined rules that are primarily based on the residual energy at nodes plus the number of nodal neighbours for coordinator announcement and withdrawal. Further Joshi N. et al. [3] modified LAR-1 scheme in terms of energy-constrained operations is known as Variable Range Energy aware Location-Aided Routing (ELAR-1VAR). It controls the transmission power of a node according to the distance between the nodes. They evaluated ELAR-1-VAR with LAR-1 in the terms of PDF, End-to-End (E2E) Delay and average energy consumption. In conclusion, it improves the network lifetime by reducing energy consumption in the network. Ramkrishnan S. et al. [9] exposed PADSR protocol and implemented on small to medium size network. It is concluded by them that PADSR protocol outperforms than DSR protocol by power saving of 30% in MANET.

3 Conventional LAR-1

The dynamic nature of MANET results in frequent and unpredictable changes of network topology, adding complexity to routing among the mobile nodes. The chief aim of routing is to find and maintain route between nodes in a dynamic topology with possibly unidirectional links using minimum resources in Ad-Hoc Network.

Several routing protocols have been proposed for MANETs to accomplish effectual routing. One such example is LAR-1 scheme that was utilized for reducing the transfer range of broadcasting during route discovery in networks. The objective of LAR-1 is to perform more efficient route discovery and limit the flooding of route request packets. At first Ko Y.B. et al [5] presented the idea of utilizing the location information for mobile nodes in terms of route discovery optimization, is called LAR-1. LAR is one of the most popular amongst location-based routing protocol. Conventional LAR-1 is an on-demand restricted direction flooding location-based routing protocol. It uses source routing like a DSR, but after expecting the destination packets have flooded in the direction of destination only. Source routing has been used with statically and dynamically configured routes for routing in MANET. Concept of LAR-1 routing depends upon request and expected region. Request region comprises of source node and expected region. If location is available, a request region (including the expected region) is formed that is defined as the region containing set of nodes that should forward the route discovery packet. Request region is also defined by location information of destination node. Size of this region depends upon movement of destination, elapsed time in which prior location of destination is included. As a result, the routing overhead reduces and better performance of LAR-1 protocol is achieved in the network [5] [10]. LAR-1 can be effectively used when an infinite queue of data packets is to be sent in the network.

4 Proposed Technique

Proposed technique integrates the method of energy-conservation of mobile nodes and route-discovery mechanism via LAR-1, is named as, N-LAR-1 technique.

4.1 General Criterion of the technique

1. At first, Source node (S) broadcasts (B) RREQ packets to nodes within their individual radio range (Rj).
2. Whole area in request region from S to D (Destination) is divided into numerous hexagonal grids within the radio range of mobile nodes in the network.
3. At the time of flooding, only having higher energy (non-survival condition of energy) of nodes are selected, called Coordinators.
4. At the same time, other remaining nodes will go into the sleep mode correspondingly and save their energy in the network.
5. Through these coordinators D is achieved and after some time Acknowledgment(ACK)goes to the S from D that contains the information of destination. Otherwise, the process is restarted.
6. Now, destination is achieved in flooding as a DSR. Hence, the computing the new route occurs through LAR-1 schemes again only in the direction of an expected region of destination node.
7. At a moment, the route is established in the direction of destination through the selected coordinators under LAR-1 scheme within the request region of an Ad-Hoc network.

4.2 Algorithm

STAGE-1

1. Create mobile node mj;
2. Set Source Node S, $S\xi mj$;
3. Set Destination Node D, $D\xi mj$;
4. Set routing protocol, DSR & LAR-1;
5. Set radio range Rj // Rj=550 m;
6. Compute _ route (RREQ_B, S, D);
7. If (next_neighbor node == true, energy≥10 J & next_neighbor≤Rj);
8. Next_neighbour_node_table (A, B, C, D - - - -);
9. Check_Eng = Max (A_Eng, B_Eng, C_Eng, — - - - - - -) ;
10. Set C = = Max_Eng_Node // for coordinators selection;
11. If (next_neighbour_node = = D);
12. find destination_node;
13. send ACK to S via RREP through selected route ;
14. Call to LAR-1;
15. Else Go to Step-7

STAGE-2

1. Call to LAR-1;
2. Information_D (elapsed time, speed, radius)_ expected region, send to S;
3. S Broadcast (B), RREQ only in D_expected-region;
4. Compute_route (RREQ_B_expected_region, S, D);
5. If (next_neighbour node = = true, energy≥ 10 J & next_neighbour≤ Rj;
6. Next_neighbour_node_table (A, B, C, D - - - -);
7. Check_Eng = max (A_Eng, B_Eng, C_Eng, — - - - - - -) ;
8. Set C = = Max_Eng_Node //for coordinator selection;
9. If (next_destination_node = = D);
10. Route is established;
11. send ACK to S via RREP from D;
12. Else Go to Step-5.

In figure 1, the expected region shows circular area radius of R = V $(t_1 - t_0)$. The request region is divided into number of hexagonal grids 1,2,3,4,5,6,7,8,9,10,11,12 (shown above in figure 1). A, e, F, w, q, I, K, a, v, m, O, s are the route forwarding nodes having the higher energy values than other nodes in their respective grids. Other remaining nodes will be in sleep or inactive mode at the same time and save their energy in MANET. Finally, dashed line in figure 1 shows the route from S to D using proposed N-LAR-1 energy-conserving routing technique. Thus, number of hexagonal grids is to be monitored and forward route tracing is more reduced with decreased routing overhead, E2E Delay and energy consumption in the network. In such a way, energy conserves and network lifetime is enhanced in Ad-Hoc networks.

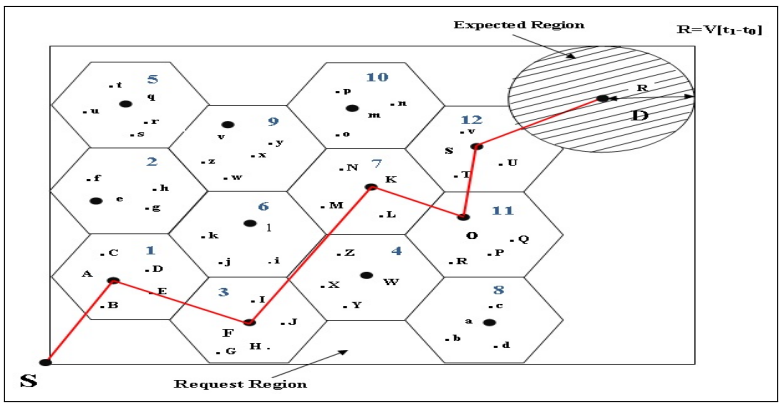

Figure 1: N-LAR-1 Routing Technique

5 Simulation and Results

The simulation was conducted in the Network Simulator (NS2) environment. All simulations were performed on Intel (R) core i3 CPU, 2.3 GHZ, 3072 MB of RAM running on Inspiron N5010 configuration. Simulation includes physical, data-link and Medium Access Control (MAC) Layer models. The Distributed Coordination Function (DCF) of IEEE 802.11 is used to model the contention of nodes for the wireless medium. The radio model uses characteristics similar to Lucents Wave LAN direct sequence spread spectrum radio [11]. The simulations were run for 100 seconds. The number of nodes (n) in network is 25, 50, 75, 100 and situated in a network area of 800 x 600 square meter region having a transmission range of 550m. In implementation, simulator setup (Radio Propagation Model, Random Waypoint Mobility Model) and all simulation parameters with simulation environment has been shown in table1 separately.

Table 1: Simulation Environment

Network Parameter	**Value**
Simulator	NS-2.31
Simulation time	100 Seconds
Transmission range	550 m
Node movement model	Random way point
Routing Protocols	DSR and LAR-1
Simulation area	800 x 600m^2
Bandwidth	2 Mb/s
Traffic type	CBR
Transport Agents	TCP
Node Speed	0-20 m/s
Energy value	18-100 J

5.1 Simulation Results and Discussion

If the concept of proposed technique is applied separately on DSR protocol, is named as N-DSR approach. In this simulation, implementation has accomplished between N-LAR-1 and N-DSR approaches for 25, 50, 75 and 100 nodes. Comparison of performance metrics like PDF, throughput, Normalized Routing Load (NRL), E2E delay and average node energy consumption is displayed in figures 2, 3, 4, 5 and 6 respectively.

5.2 Results

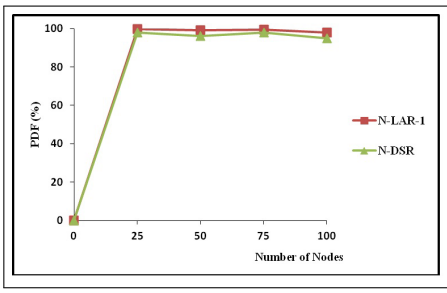

Figure 2: PDF Comparison

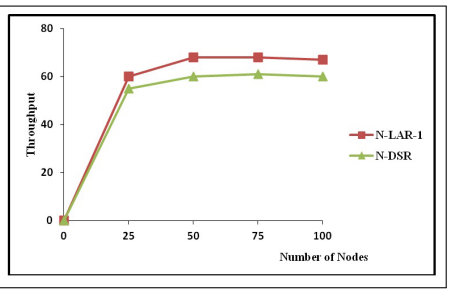

Figure 3:Throughput Comparison

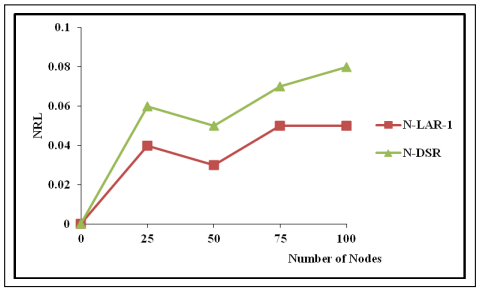

Figure 4:NRL Comparison

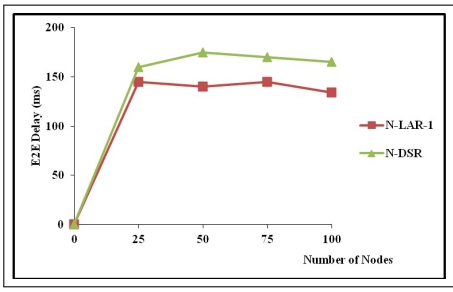

Figure 5:E2E Delay Comparison

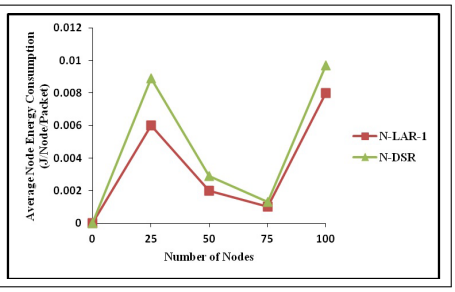

Figure 6:Average node energy consumption comparison

5.3 Analysis of Performance Metrics

1. **PDF:** PDF is consistent in N-LAR-1 and N-DSR techniques with increasing the number of nodes. It is clear from figure 2 that PDF ratio is higher using N-LAR-1 than N-DSR approach.
2. **Throughput:** N-LAR-1 technique provides better throughput than N-DSR scheme. This analysis presents consistent behaviour in both techniques on 50, 75 and 100 nodes.
3. **NRL:** NRL ratio increases in both techniques till 25 nodes. Further, it varies with increasing the number of nodes in the network. NRL ratio is reduced using N-LAR-1 in comparison to N-DSR.
4. **E2E Delay:** E2E Delay analysis illustrates linear variation in both approaches till 25 nodes. E2E delay is less in N-LAR-1 than N-DSR and can be optimized when the number of nodes is 75 in the network.

5. **Average Node Energy Consumption:** Figure 6 depicts the average node energy consumption analysis for N-LAR-1 and N-DSR techniques. This parameter varies with increasing the number of nodes in network. Average node energy consumption using N-LAR-1 is less than N-DSR and can be optimized on 75 nodes.

It is concluded from the analysis, N-LAR-1 technique achieves energy conservation along with sending successfully higher data packets to the destination. All above-mentioned performance metrics are optimized and overall network lifetime of network is improved using N-LAR-1 in comparison to N-DSR.

6 Conclusion and Future Work

LAR-1 extends the on-demand routing approach in MANETs and packets have flooded towards the destination only instead of entire Ad-Hoc network. This research work shows development of an effective energy-conserving technique N-LAR-1 for MANET. Proposed N-LAR-1 technique has arrived at a conclusion that performance metrics such as average node energy consumption, PDF, E2E Delay, NRL, throughput and Network lifetime have been improved when the sleep or inactive mode of the nodes in the networks are utilized. It has been analysed that performance of N-LAR-1 is better than N-DSR approach. These improvements in the performance of N-LAR-1 are possible due to the flooding of data in the direction of expected destination only. Research can be extended to integrate such type of work like proposed N-LAR-1 technique using other reactive routing protocols like AODV, OLSR, TORA and position-based routing protocols like GLS, DREAM in future. Further this proposed technique can be implemented and analyzed for wireless sensor networks, Vehicular Ad-Hoc networks and cognitive radio networks.

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