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LAR-1-Affirmative Effects with TCP on Energy-Conservation in Ad-Hoc Network

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Abstract – Presently accelerating the energy-conservation in Mobile Ad-Hoc Networks (MANETs) has been a herculean task. The LAR-1 (Location-Aided Routing-1) position-based routing scheme in network has recently invoked interest in the domain of energy-conservation as it extends the network lifetime of the networks. This paper has especially studied and investigated the N-LAR-1 (New-LAR-1) methodology given via TCP packets for reliability and security in Ad-Hoc network. TCP with ACK signals is frequently used in the field of data streaming or communication than UDP. Prominent results have been accomplished through same routing approach by utilizing the sleep mode condition of mobile nodes in Ad-Hoc Network. Thorough analysis of performance metrics using the above mentioned approach have been reported with TCP-Reno, TCP-New Reno, TCP-Vegas and TCP-SACK. An exemplary result from TCP-Vegas and TCP-New Reno is being achieved in this paper.

Keywords: Position-based Routing, TCP-variants, LAR-1, Energy-conservation

I. INTRODUCTION

Tremendous applications of wireless Ad-Hoc networks range from broadband home networking, community networking and enterprise networking to medical systems, security surveillance systems, transportation systems, defense and building automation [13]. Deployment of Ad-Hoc network leads to several technical challenges such as limited energy, limited bandwidth, multi-hop routing, dynamic topology, security and so on. Numerous routing protocols have been proposed for MANET, with the goal of achieving efficient routing [1]. Position-based routing reduces some of the restrictions of proactive and reactive routing in Ad-Hoc network by using additional location information using GPS system [11]. These can be categorized into Greedy Forwarding, Restricted Directional-Flooding and Hierarchical type of routing. Earlier several Position-based protocols had been proposed such as LAR, Distance Routing Effect Algorithm for Mobility (DREAM) and Most Forward within Distance R (MFR) etc. LAR is a source routing position-based protocol, as a DSR. Initially it starts flooding in all the directions by the source. After expecting the destination the routing is so easy in network that will be only in the direction of the destination. Consequently the routing overhead is to be reduced and better performance of LAR-1 protocol is obtained. This is the basic principle of this LAR-1 routing. TCP guarantees actual data transmission without any loss whereas UDP does not guarantee for this.

But, the major issue in MANET is energy consumption since nodes are usually mobile and battery-operated. To prolong network lifetime of the network, routing protocol should consider achieving less energy consumption [5]. An interface in the sleep state can neither transmit nor receive any packets, and thus this state consumes the lowest energy. Thus, this mentioned new approach depends on mobile nodes staying in the sleep state most of the time.

In this paper, optimizations of Ad-Hoc network performance metrics are revealed via this energy-conserving routing approach with TCP variants. In the second section, related work is presented. Overview of LAR-1 protocol is shown in the next section. After that above mentioned approach is elaborated in next part. In the fourth section simulation results on scheme are shown. The last section concludes the paper.

II. RELATED WORK

A larger number of researchers have been devoted their contribution in the field of energy-conservation in MANET. Several researchers observed that mobile computing performance can be developed using location information via GPS. At first optimization in route discovery overhead was proposed by Ko Y.B. et al. [6] in the form of LAR protocol in MANETs. They recommended two algorithms LAR-1 and LAR-2. Their simulation results indicate that using location information less routing overhead is obtained as compared to another algorithm that does not use any

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location information. Ahvar E. et al. [1] evaluated the performance of LAR-1, DSR and AODV routing protocols for MANETs that is based upon energy consumption in Ad-Hoc networks. The performances are analyzed using varying network load, node mobility and network size. They produce results that LAR-1 performs much better than others and provides energy-conservation generally in high-density networks. Xu Y. et al. [15] announced a Geographic Adaptive Fidelity (GAF) algorithm that enlarges energy saving in MANETs. It focuses on turning the radio off as much as possible in network. In GAF, fixed square grids are to be prepared by splitting the area of network. Nodes within a square grid, switch between sleeping and listening modes with the assurance that one node in each grid stays up to route packets. Their investigation shows that GAF can consume 40-60% less energy than conventional routing protocol.

Patel A. et al. [10] recognized the unreachable corner of GAF scheme and its effect in the network. They introduced GAF-Hexagonal (GAF-h) algorithm and tested with different speed and traffic. It replaces virtual square grid into hexagonal grid. Their results indicate that proposed GAF-h improves PDF ratio and throughput by keeping energy consumption almost same as GAF. Chen B. et al. [2] proposed SPAN (a power saving protocol) to form a Connected Dominating Set (CDS) and change the coordinator nodes periodically. It adaptively selects coordinators to form a backbone and has several rules based on the nodes remaining energy and number of neighbors for coordinator announcement and withdrawal. Generally it is a power saving technique for MANETs that reduces energy consumption without diminishing the capacity or connectivity of the network. Joshi N. et al. [5] modified LAR-1 for energy conservation in MANET known as Variable Range Energy-aware Location-Aided Routing (ELAR1-VAR). It controls the transmission power of a node according to the distances between the mobile nodes. They compared ELAR1-VAR with LAR-1 in view of some performance metrics. This protocol improves the network lifetime by reducing energy consumption by 20% for dense mobile network while maintaining the packet delivery ratio above 90%.

Ramkrishnan S. et al. [12] presented a power-aware routing protocol and implement for a MANET of small to medium size. It is seen that Power-Aware Dynamic Source Routing (PADSR) protocol, outperforms than DSR protocol by a power saving of as much as 30%. An Energy Efficient Location-Aided Routing (EELAR) Protocol for MANETs is introduced by Mikki M [8] researcher. Routing overhead is significantly reduced using EELAR by limiting the area of discovering a route to a smaller region. An energy-aware routing scheme in location based Ad-Hoc network has proposed by Jangsu Lee et al. [7]. This method modifies the LAR-1 protocol in which the virtual grid is applied to Ad-Hoc network region and higher energy node is selected as header for each grid which communicates information about nodes in that particular grid. Their results show that network lifetime is improved compared with simple LAR-1 approach.

III. LAR-1 APPROACH

In recent developments, Position-based routing protocols exhibit better scalability, performance and robustness against frequent topological changes. Ko Y.B. et al [6] presented the idea of utilizing the location information for mobile nodes in terms of route discovery optimization, is called LAR protocol. Under LAR two approaches appear LAR-1 and LAR-2. LAR-1 uses a request zone that is rectangular in shape. Consider a node S (Source) that needs to find a route to node D (Destination). Assume that node S knows that node D was at location (Xd, Yd) at time t_1. At time t_1, node S initiates a new route discovery for destination D. It assumes that node S also knows the average speed v with which D can move. Using this, node S defines the expected zone at time t_2 to be the circle of radius v (t_2-t_1) at location (Xd, Yd). In Fig. 1, $t_2–t_1$ is the elapsed time between two successive route requests from the source node. When a node receives a route request, it discards the request if the node is not within the request region. For instance, in Fig.1, if node M receives the route request from another node, node M forwards the request to its neighbors, because M is within the rectangular request zone. However, when node N receives the route request, node N discards the request, as node N is not within the request zone [3], [4], and [6].

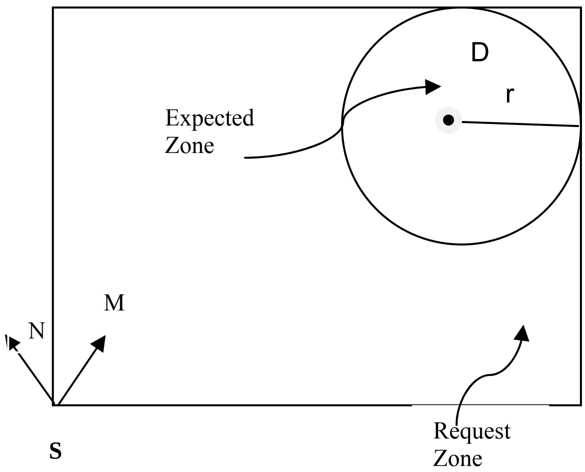

Fig.1 LAR-1 Approach

IV. TCP VARIANTS

TCP is being used as a highly reliable end-to-end protocol. It's meaning that the sending data is reached by the receiving party, which is not an entity in UDP. It provides several features like flow control, reliability and congestion control. TCP gives guarantee that a packet will reach on the destination without any duplication and the order of data will be same. For instance, in mobile handsets obtain message delivery report during SMS. On the other hand UDP does not give guarantee that data will reach on destination. Depending on the scenario selection of TCP variant has to be done. TCP-Reno, TCP-New Reno, TCP-SACK and TCP-Vegas are the some of the most important variants of TCP [14].

A.TCP-Reno:

TCP-Reno retains slow starts and the coarse grain retransmit timer. The Fast Recovery algorithm was implemented in TCP Reno. Fast Recovery algorithm considers a duplicate acknowledgement as an indication that a packet has left the network [13].

B. TCP-New Reno:

New Reno is a slight modification over TCP-Reno. It overcomes the drawback of TCP Reno by modifying the Fast Recovery algorithm that is able to detect multiple packet losses and is much more efficient than TCP-Reno in the event of multiple packet losses [14].

C. TCP-SACK:

It retains the Slow-Start and Fast Re-Transmit parts of Reno. It improves overall throughput of the network by avoiding unnecessary delays in retransmitting the lost packets [13].

D. TCP-Vegas:

TCP Vegas implementation tries to detect the incipient stages of congestion before packet losses occur. Bandwidth Estimation scheme used by TCP Vegas is more efficient than other TCP variants. It extends TCP-Reno by modifying its Congestion Avoidance mechanism. Also retransmission mechanism used by TCP-Vegas is more efficient as compared to TCP-Reno as it retransmits the corresponding packet as soon as it receives a single duplicate ACK and does not wait for three ACKs. [13], [14].

V. A NEW LAR-1 (N-LAR-1) ROUTING

A. General Criteria for Technique:

[a] At first, Source node (S) broadcasts (B) RREQ packets to nodes within their individual radio range (Rj).

[b] Whole area in request region from S to D (Destination) is divided into numerous hexagonal grids (according to Hexagonal GAF Architecture) within the radio range of mobile nodes in network.

[c] At the time of flooding, only the higher energy of nodes are selected, are called Coordinators.

[d] At the same time other remaining nodes will go into the sleep mode and save their energy in the network.

[e] Through these coordinators D is achieved and after some time acknowledgement (ACK) goes to the S from D that contains the information of destination. Otherwise the process gets restarted.

[f] Now destination is achieved in flooding as a DSR. Henceforth, the computing the new route occurs through LAR-1 schemes again only the direction of expected region of destination node.

[g] New route computation condition is achieved also due to the attainment of the survival condition of nodes in network.

[h] At a moment the route is established in the direction of destination through the selected coordinators under LAR-1 scheme.

In this way an energy-conserving technique using LAR-1 can be invented via sleep mode condition of mobile nodes. After energy-conservation, conserved energy can be utilized in network for data communication, is called energy-aware routing. This routing technique can be useful for optimizing the performance metrics of the Ad-Hoc network. Descriptions for the same are in following points:

B. Algorithm:

Stage-1

```
1.   Create mobile node mj;
2.   Set Source Node S, S Є mj;
3.   Set Destination Node D, D Є mj;
4.   Set routing protocol, DSR & LAR-1;
5.   Set radio range, Rj;
6.   Compute _ route (RREQ_B, S, D)
     {
      if (next _ neighbour node = = true, energy ≥ 10 J  & next_
      neighbour ≤ Rj
      }
7. Next _neighbour_ node_ table (A, B, C, D - - - -);

Check_Eng = max (A_Eng, B_Eng, C_Eng, --- - - - - ) ;

8. Set C = = Max_Eng _Node // for coordinator selection;

if ( next_destination_node = = D)
  {
find destination_node ;
create routing table ;
send ACK to S via RREP through selected coordinator route ;
   }
9.   Else
  {
Go to Step-7
  }
10.  Else
   {
Neighbour_node_out of range

     Or
Survival condition // energy < 10J.
     }
```

Stage-2

```
 // If Node move from one place to another place & search the New
Route
              Or
           call to LAR-1
1. Destination D sends ACK to S;
Information_ D (elapsed time, speed, radius) _ expected region,
send to S;
2. S Broadcast (B) new RREQ only in D_ expected-region;
3. Compute_ route
(RREQ_ B_ expected_ region, S, D);
   {
If (next _ neighbour node = = true, energy ≥ 10 J & next_
neighbour ≤ Rj
     }
4. Next _neighbour_ node_ table (A, B, C, D - - - -);
Check-Eng = max (A_Eng, B_Eng, C_Eng, --- - - - - -);
5. Set C = = Max_Eng_Node // for coordinator selection;
If (next_destination_node = = D)
```

```
    {
find destination_node ;
create routing table ;
send ACK to S via RREP through selected coordinator route ;
    }
6.     Else
    {
Go to Step-4
    }
7.     Else
   {
Neighbour_node_out of range
          Or

Survival condition // energy < 10J.
}
```

Arrangement of nodes in network under this new technique is revealed in Fig. 2. In this figure, route-establishment from S to D via coordinators (A, F, H, K, J) has been presented. A circle with radius R shows the expected region of destination node.

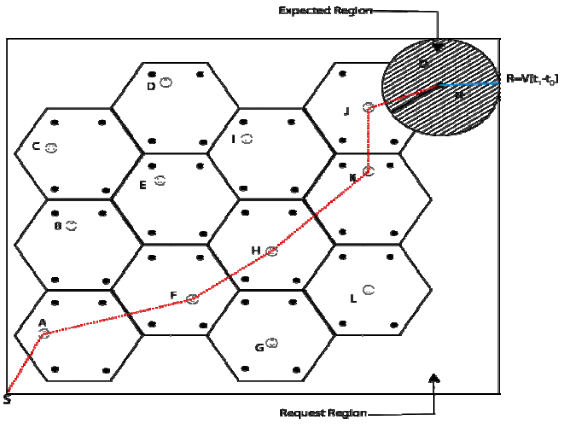

Fig.2 N-LAR-1 Scheme

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 600 m^2
Bandwidth	2 Mb/s
Traffic type	CBR
Transport Agents	TCP
Pause Time	0 -100 s in steps of 20s
Node Speed	0-25 m/s
Packet Size	512bytes
Initial Energy	18-100 J

VI. SIMULATION AND RESULTS

The simulation study was conducted in the "Network Simulator" (NS2) environment and it used the Ad-Hoc networking extensions provided by CMU. All simulations were performed on Intel (R) core (TM) i3 CPU, 2.3 GHZ, 3072 MB of RAM running on Inspiron N5010 configuration. The Distributed Coordination Function (DCF) of IEEE 802.11 has been used to model the contention of nodes for the wireless medium. The radio model uses characteristics similar to Lucent's WaveLAN direct sequence spread spectrum radio [9]. The value of network parameters is given below in Table 1, separately under the network simulation.

A. Simulation Results and Parameters:

The simulation results are revealed in the following section in the form of line graphs. Graphs show comparison among the New-LAR-1(N-LAR-1) with TCP-Reno, TCP-New Reno, TCP-Vegas and TCP-SACK scheme on the basis of the performance metrics of Ad-Hoc Network such as energy consumption per received packets, routing overhead, NRL, End to End (E2E) delay, Packet Delivery Fraction (PDF), throughput and TCP-Packet analysis as a function of pause time. The random waypoint mobility model has been used in rectangular filed area with a number of mobile nodes. In this model, a mobile node moves from its current location to a randomly chosen new location within the network area using a random speed uniformly distributed between the maximum and minimum speed. The number of nodes (n) in network has been taken 25, 50, 75, 100 and located in an 800x600 square meter region having 550m of a transmission range. This model is often simplified by using a uniformly distributed.

A.I PDF-Comparison:

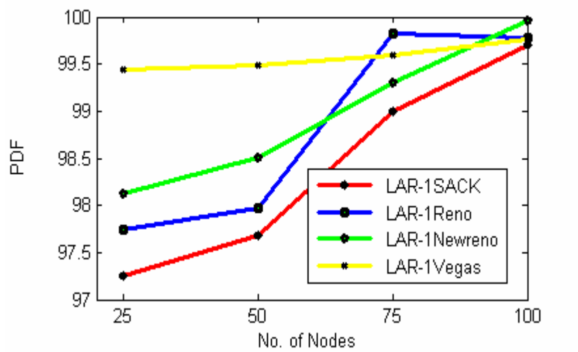

Fig. 3 PDF Comparison

A.II Routing Overhead Comparison:

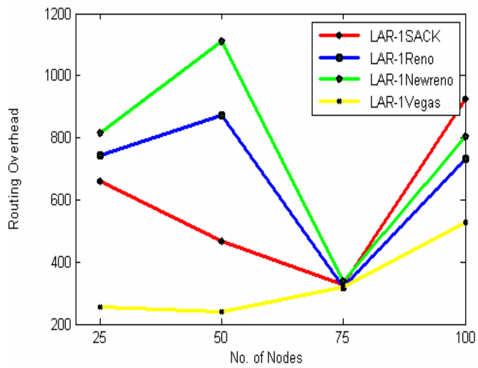

Fig. 4 Routing overhead comparison

Fig. 3 to 8 shows the comparison of PDF, Routing Overhead, NRL ratio, E2E Delay, Throughput and energy consumption per received packets among N-

LAR-1 with TCP-Reno, TCP-New Reno, TCP-Vegas and TCP-SACK.

A.III NRL & E2E Delay Comparison:

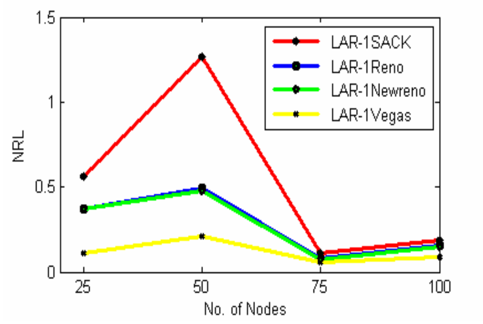

Fig. 5 NRL ratio comparison

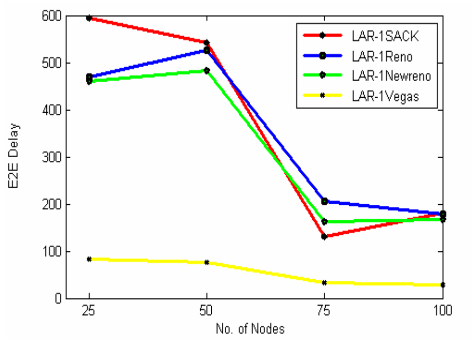

Fig. 6 E2E delay comparison

A.IV Throughput & energy consumption Comparison:

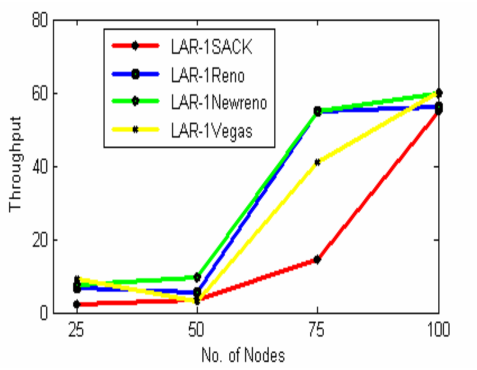

Fig. 7 Throughput comparison

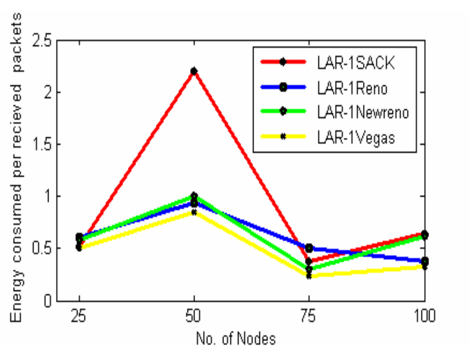

Fig. 8 Energy consumed per received packets

Using the simulation all following Performance Metrics are optimized.

(a) Energy Saving: Applying this work in Ad-Hoc network amount of energy saving is increased due to the sleep mode. Correspondingly energy will be conserved. Further this saved or conserved energy can be utilized in N-LAR-1 effectively for establishing the route discovery in the network. Overall network lifetime is also enhanced.

(b) Routing Overhead: Due to this reduced searching area routing overhead in the network is to be minimized in N-LAR-1 scheme. NRL is also affected and it is to be reduced in case of N-LAR-1 with TCP-Vegas.

(d) End-To-End Delay: End-To-End Delay in the routing will be less with TCP-Vegas.

(e) Throughput: It is usually defined as the number of data packets successfully delivered to their final destination per unit of time. It is clear from the Fig. 7 that throughput is highest In case of N-LAR-1 with New Reno from other three variants.

(f) PDF: The ratio of the data packets delivered to the destinations to packets generated by the sources. For efficient routing protocol PDF should be more. Value of PDF in case of N-LAR-1 with TCP-Vegas and New Reno are almost same but higher than other two.

It is seen that in case of N-LAR-1 with TCP-Vegas node energy are more exhausted and further utilized in routing is called energy-aware routing. As a result, overall network lifetime is increased with transmission and reception of highest number of TCP-Packet with their ACK. All above mentioned results illustrate that N-LAR-1 with TCP-Vegas & TCP-New Reno generate better results than other.

VII. CONCLUSION

The TCP protocol is considered to be a complete protocol and therefore is used many times over in systems than the unreliable UDP protocol. TCP provides stream data transfer, reliability, efficient flow control. It detects data duplication but UDP does not. UDP provides fast and unguaranteed communication and is valuable at the time of video streaming. This paper has especially studied and researched the N-LAR-1 approach given via TCP packets. This approach with divergent TCP- variants, has arrived at a conclusion that some performance metrics such as energy consumption per received packets, routing overhead, PDF, E2E Delay, Network lifetime, NRL and throughput beget optimized results when the sleep mode condition of the mobile nodes in the networks are utilized. This approach is an ameliorated view, where the TCP-Vegas and TCP-New Reno are definitely advanced in comparison to TCP-Reno and TCP-SACK along with some energy-aware routing approach and hence is preferable.

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