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Evaluation of ad hoc network protocol: Lar vs DSR in communication of robot using statistical technique

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Abstract
Communications among mobile robots has become a practical proposition. However, in a large system with many mobile robots, it becomes difficult for all robots to exchange information at a time because of their limited communication capacities. In this case, an ad-hoc robot networking scheme is more promising. The Robot of tomorrow will be the effective consequence of the examination work of today. Robotics headway is going on in practically all innovative zones. Controlling and managing of robots and their information communication to each other is an important issue, and wireless technologies without infrastructure like Ad hoc networks due to their quick trigger and costs lightness can play efficiently. Various protocols have been used in this field and in the recent study, two famous Ad hoc network protocols have been simulated for 5 km work areas with changes of the same elements in types of robots like speed, pause time, number of nodes, important parameters that show network optimization rate and include PDR, Throughput, End-To-End Delay by using simulation in GloMoSim software. In this paper, output has been calculated by making the same chance and then, obtained information was investigated statistically using one way ANOVAs. In total, LAR protocol was recognized to be better than DSR and could be used as an optimum protocol in robotic industries.

Keywords: GloMoSim, Ad Hock; LAR, DSR, PDR, MANET

Introduction
Today, robotic systems have influenced drastically different aspects of human life and we can see their footprints almost everywhere. Controlling robots or machines is one the most important issues which has been researched and investigated in robotic areas. Wireless controlling and robotic communication has great advantages like better maneuverability, lower cost, and faster preparation in different area. Moreover, by using wireless facilities, a network of robots can be acted in performing the given missions as a team and by setting the wireless connection between any of robots to each other, very novel capabilities can be obtained, practically. The robots are often equipped with low-cost, low-power short-range wireless network interfaces, which only

Permit direct communication with their close neighbors. Therefore, it is practically impossible for each node to know the entire network topology at any given time. Under these situations the only useful approach to distributed command, control and sensing is to employ an ad hoc wireless networking scheme

Manet Protocols
Many protocols have been proposed for MANETs. These protocols can be divided into three categories: proactive, reactive, and hybrid, Proactive methods maintain routes to all nodes, including nodes to which no packets are sent. Such methods react to topology changes, even if no traffics affected by the changes. They are also called table-driven methods. Reactive methods are based on demand for data transmission. Routes between hosts are determined only when they are explicitly needed to forward packets. Reactive methods are also called on-demand methods. They can significantly reduce routing overhead when the traffic is lightweight and the topology changes less dramatically, since they do not need to update route information periodically and do not need to find and maintain routes on which there is no traffic. Hybrid methods combine proactive and reactive methods to find efficient routes, without much control overhead An ad hoc routing protocol is a convention, or standard, that controls how nodes decide which way to route packets between computing devices in a

network. In ad hoc networks, nodes are not familiar with the topology of their networks. Instead, they have to discover it: typically, a new node announces its presence and listens for announcements broadcast by its neighbors. Each node learns about others nearby and how to reach them, and may announce that it too can reach them.

Table-driven (proactive) routing

This type of protocols maintains fresh lists of destinations and their routes by periodically distributing routing tables throughout the network. The main disadvantages of such algorithms are:

1. Respective amount of data for maintenance.
2. Slow reaction on restructuring and failures.

Examples of proactive algorithms are

- Optimized Link State Routing Protocol (OLSR) RFC 3626, RFC 7181.
- Babel RFC 6126
- Destination Sequence Distance Vector (DSDV)
- DREAM
- B.A.T.M.A.N.

On-demand (reactive) routing

This type of protocol finds a route on demand by flooding the network with Route Request packets. The main disadvantages of such algorithms are:

1. High latency time in route finding.
2. Excessive flooding can lead to network clogging.

Examples of on-demand algorithms are:

- ABR - Associatively-Based Routing
- Ad hoc On-demand Distance Vector(AODV)
- Dynamic Source Routing
- Power-Aware DSR-based

Hybrid (both proactive and reactive) routing

This type of protocol combines the advantages of proactive and reactive routing. The routing is initially established with some proactively prospected routes and then serves the demand from additionally activated nodes through reactive flooding. The choice of one or the other method requires predetermination for typical cases. The main disadvantages of such algorithms are:

1. Advantage depends on number of other nodes activated.
2. Reaction to traffic demand depends on gradient of traffic volume.

Examples of hybrid algorithms are

- ZRP (Zone Routing Protocol) ZRP uses IARP as pro-active and IERP as reactive component.
- ZHLS (Zone-based Hierarchical Link State Routing Protocol)

Hierarchical routing protocols

With this type of protocol the choice of proactive and of reactive routing depends on the hierarchic level in which a node resides. The routing is initially established with some proactively prospected routes and then serves the demand from additionally activated nodes through reactive flooding on the lower levels. The choice for one or the other method requires proper attribution for respective levels. The main disadvantages of such algorithms are:

1. Advantage depends on depth of nesting and addressing scheme.
2. Reaction to traffic demand depends on meshing parameters.

Examples of hierarchical routing algorithms are:

- CBRP (Cluster Based Routing Protocol)
- FSR (Fisheye State Routing protocol)
- Order One Network Protocol; Fast logarithm-of-2 maximum times to contact nodes. Supports large groups.
- ZHLS (Zone-based Hierarchical Link State Routing

Methodology

The overarching goal of GloMoSim was to develop technology for robust end-to-end information systems in a global mobile environment by exploiting commercial products and generating new technologies with applications in both commercial and military domains. The program supported a wide range of research projects, which are identified, based on the priorities of GloMosim managers rather than on a systems approach to the development of top-down solutions. Global Mobile Information System Simulator is a popular network simulation tool, which is frequently used in the study of the behavior of large-scale hybrid networks that include wireless, wired, and satellite based communications are becoming common in both in military and commercial situations. It is freely available without fee for education, or research, or to non-profit agencies. It is simple to install and use. The simulations carried out AODV routing protocol using GloMoSim network simulator could help in setting up such networks in real-life scenarios. Providing security to the MANET would help in establishing "on demand wireless networks" without the fear of any menace. The MANET could then be used in number of communication purposes.

Experiment Result

Different testing parameter was shown in figures and Table below End to End Delay factor, DSR protocol was significantly better than LAR protocol in this regard of one way ANOVAs ($p< 0.05$). Interestingly, by increasing node numbers from 150 and above, LAR showed similar outcomes like DSR protocol. Increasing pause time also could improve End to End delay of LAR protocol. By increasing max speed in this simulation test, End to End Delay factor increased drastically for LAR protocol, so we conclude LAR is better than DSR for Robots

Table 1: Comparison of protocols in end to end delay based on node number

Node Number	DSR	LAR
50	0.0169	0.4025
100	0.0135	2.1251
150	0.0156	0.0864
200	0.0163	0.0659

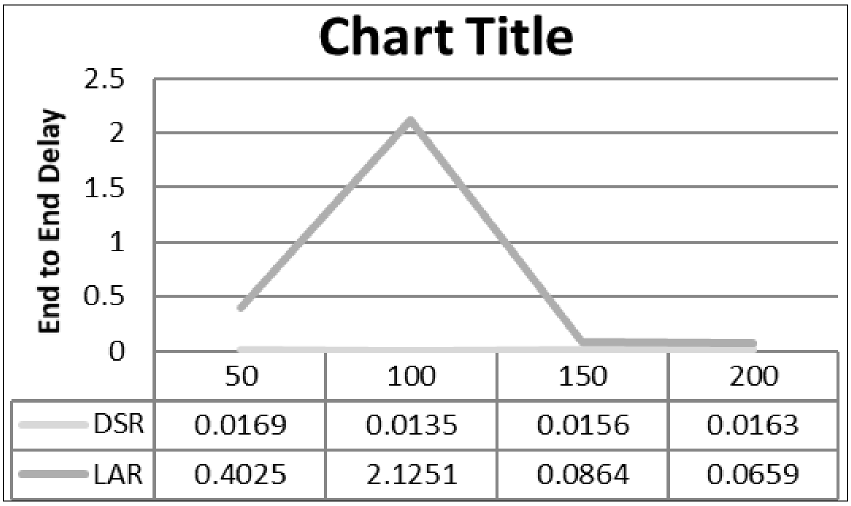

Fig 1.1 Comparison of protocols in end to end delay based on node number

Table 2: Comparison of protocols in end to end delay based on node number by ANOVAs test

Source of variation	Sum of square	Degree of freedom	MSS	F-RATIO
Between columns	83337.02	2	41668.51	41668.51/4904.41=8.496
Between rows	18884.2115	3	6294.73	6294.73/4909.41=1.283
Residual	48272.64	6	8045.44	8045.44/4904.41=1.640
Total	53948.59	11	4904.41	

Table 3: Comparison of protocols in end to end delay based on pause time

Pause Time	DSR	LAR
0	0.0222	0.3015
10	0.0172	0.6817
20	0.0175	1.0546
30	0.0166	0.4025

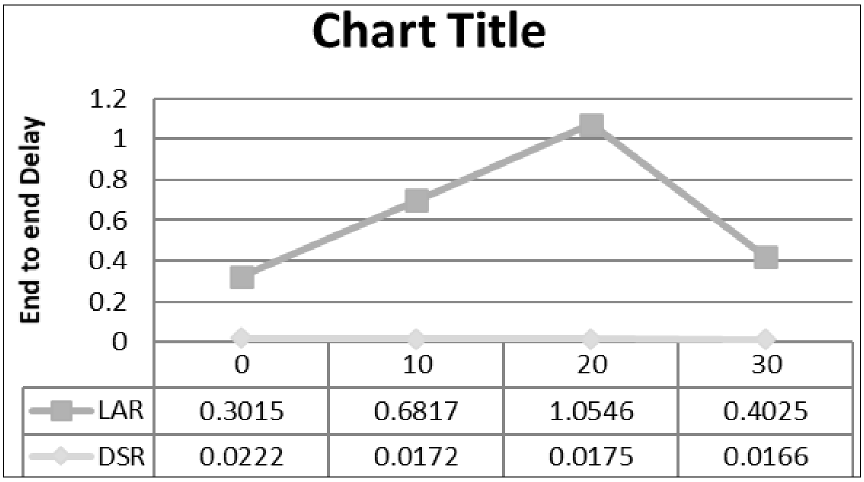

Fig 2: Comparison of protocols in end to end delay based on pause time

Table 4: Comparison of protocols in end to end delay based on pause time by ANOVA test

Sum of variation	Sum of Sqaure	Dergree of freedom	MSS	F – RATIO
Between Columns	1203.78	2	601.89	601.89 / 97.9577=6.1443
Between rows	370.87	3	123.62	123.62 / 97.9577=1.2619
Residual	497.115	6	82.8525	82.8525 / 97.9577=0.8457
Total	1077.535	11	97.9577	

Table 5: Comparision of protocol in end to end delay based on max speed

Max Speed	DSR	LAR
0	0.0070	0.0069
10	0.0166	0.4025
20	0.2082	2.3087

30	0.0182	2.9109

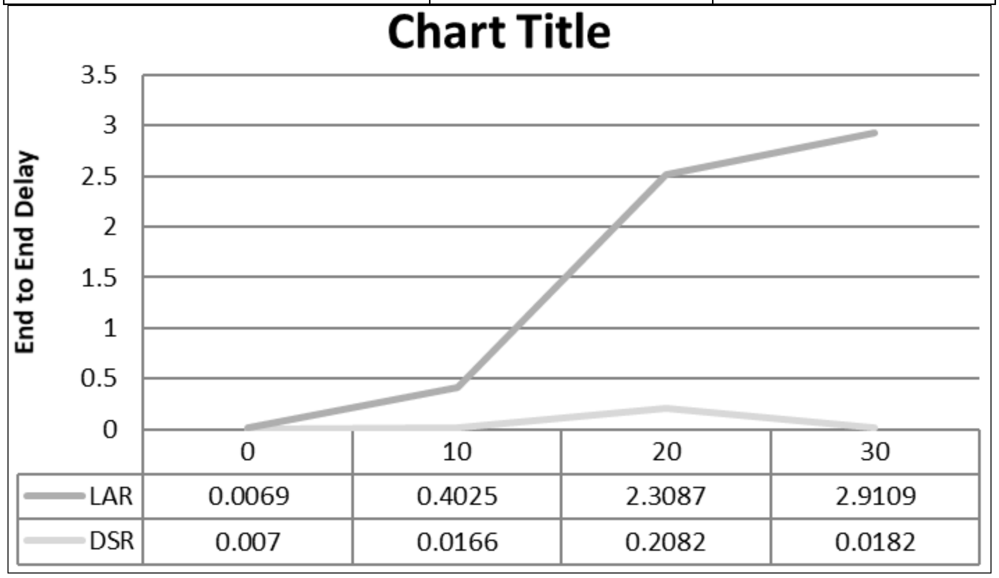

Fig 3: Comparison of protocol in end to end delay based on max speed

Table 6: Comparison of protocol in end to end delay based on max speed by ANOVA test

Source of variation	Sum of square	Degree of freedom	MSS	F - Ratio
Between columns	1210.58	2	605.29	605.29 / 95.66=6.327
Between rows	425.38	3	141.79	141.79 / 95.66=1.4822
Residual	583.63	6	97.27	97.27 / 95.66=1.016
Total	1052.33	11	95.66	

Table 7: Comparison of protocol in PDR based on node numbers

Node Number	DSR	LAR
50	0.5075	0.8177
100	0.4735	0.9300
150	0.5085	0.9666
200	0.5570	0.9700

Table 8: Comparison of protocol in PDR based on node numbers by ANOVA test

Source of variation	Sum of square	Degree of freedom	MSS	F-Ratio
Between columns	83339.25	2	41669.62	41669.62 /4880.98=8.537
Between rows	19118.515	3	6372.83	6372.83/4880.98=1.3056
Residual	48766.945	6	8127.82	8127.82/4880.98=1.6652
Total	53690.82	11	4880.98	

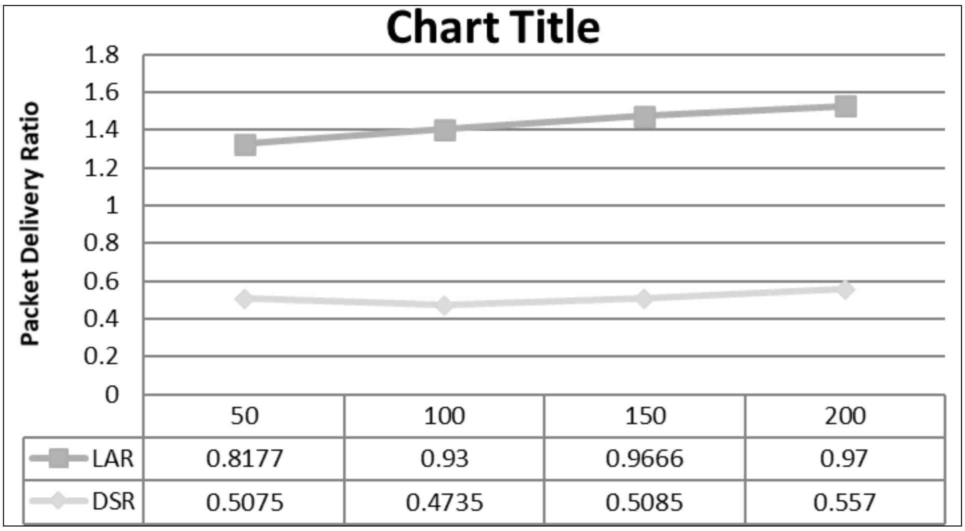

Fig 4: Comparison of protocol in PDR based on node numbers

Table 9: Comparison of different protocol in PDR based on pause time

Pause Time (s)	DSR	LAR
0	0.5365	0.8400
10	0.4685	0.8388
20	0.5010	0.8400
30	0.5075	0.8177

Table 10: Comparison of different protocol in PDR based on pause time by ANOVA test

Source of variation	Sum of square	Degree og freedom	MSS	F-Ratio
Between columns	1205.062	2	602.531	602.531/95.26=6.3251
Between Rows	391.528	3	130.509	130.509/95.26=1.3700
Residual	548.68	6	91.446	91.446/95.26=0.9599
Total	1047.91	11	95.26	

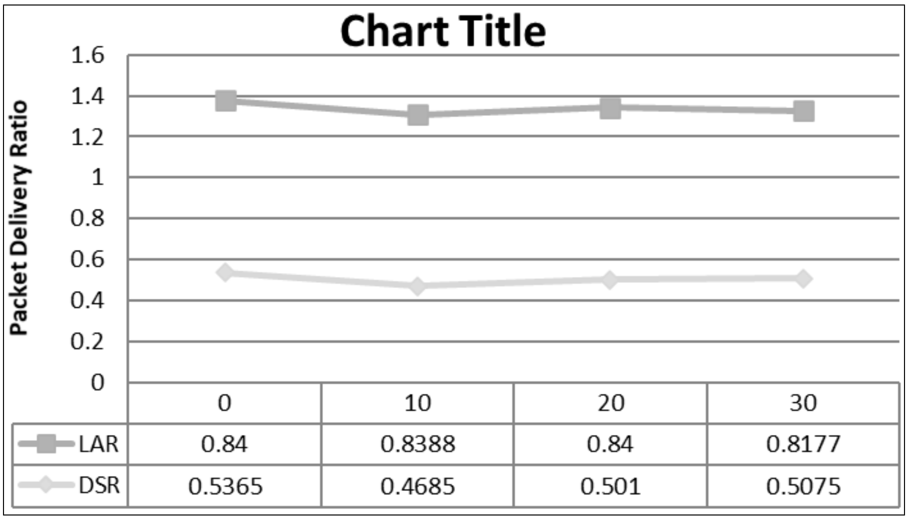

Fig 5: Comparison of different protocol in PDR based on pause time

Table 11: Comparison of protocol in PDR based on max speed

Max Speed (m/s)	DSR	LAR
0	1	1
10	0.5075	0.8177
20	0.4465	0.8855
30	0.5165	0.9677

Table 12: Comparison of protocol in PDR based on max speed by ANOVA test

Source of variation	Sum of square	Degree of freedom	MSS	F-RATIO
Between columns	1206.52	2	603.26	603.26/94.595=6.377
Between Rows	394.635	3	131.545	131.545/94.595=1.3906
Residual	560.605	6	93.434	93.434/94.595=0.9877
Total	1040.55	11	94.595	

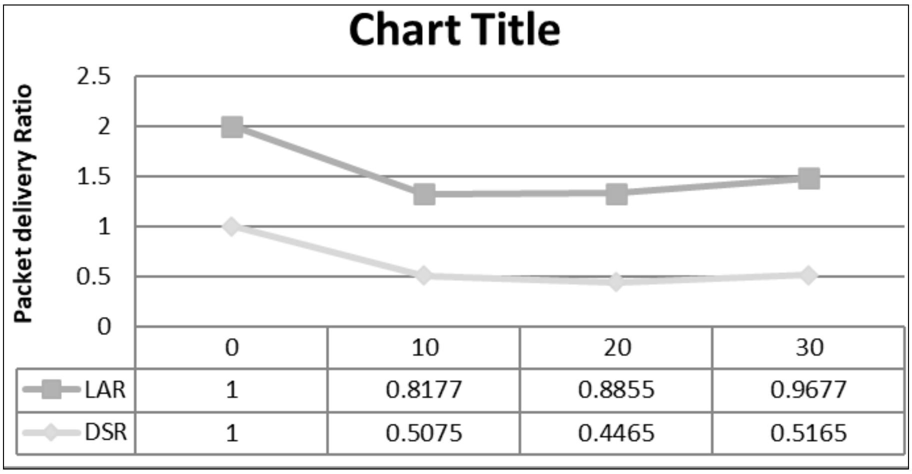

Fig 6: Comparison of protocol in PDR based on max speed

Conclusion

End-to-End delay means the average time taken by a data packet to be transmitted across a network arrive in the destination. It also includes the delay caused by route discovery process and the queue in data packet transmission as well as containing all possible delays affected during route discovery latency, propagation and transfer times, and retransmission delays at the MAC. DSR protocol showed significantly better performance than LAR. Increasing the node numbers, LAR had similar results like DSR. But LAR has shown significantly lower End to End delay than DSR both graph and one way ANOVAs prove this Therefore, LAR protocol is suitable for wireless robotic systems. Scalability and throughput are two very important factors for mobile ad-hoc network protocols, increasing movement speed of the robot, or in other words, more softness in movement of robot in response to commands in different conditions needs higher speed of the robot processor unit which improves efficiency of the network and helps the performance of protocols. Even in this case, by increasing the speed of robot movement consequently network topology will change faster, which might cause errors in robot movement management. To prevent such crises choosing correct network protocols will be very effective in managing them. Even though, on simulation basis, it was concluded that the LAR routing protocol gives the best performance compare to DSR routing protocol,

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