A Performance Comparison of Various Routing Protocols Based on Load-Balance in Mobile Ad Hoc Networks

Ali Hassan Muosa
Department of Computer Science, Faculty Science Computers and Mathematic, Thi-Qar University, Iraq
alibox21@gmail.com

Abstract

The purpose of this paper is to comparison between five routing protocols, which have central role in any Mobile Ad-hoc Networks (MANETs) as Ad hoc On-demand Distance Vector (AODV), Dynamic Source Routing (DSR), Load-Balance Ad hoc Routing (LBAR), Optimized Link State Routing (OLSR), and Load Balancing Routing Mechanism (LBRM) protocols. That may generally be categorized as Table-Driven and On-Demand routing, and decide what are the best operational conditions, for each protocol and explain how the pause time and number of nodes affect their based Load-Balance. Also, performance is measured based on the metrics Average End-to-End delay, Packet Delivery Fraction (PDF) ratio, and Normalized Routing Load (NRL). To implement this comparison between these routing protocols we used simulation to evaluate performance of this comparison. The simulation is performed under Network Simulator 2 (NS-2) to provide on the results agree with awaited search results based on Load-Balancing.

Keywords: Routing Protocols, Load Balanced, and MANETs.

1. Introduction

We propose in this paper an efficient routing protocol, based on the concept of the Load-Balancing. A major challenge in the design of MANETs is the development of efficient routing protocols that can provide high quality of communication between two mobile nodes, the update of the routing information in each node propagating through the network. To facilitate communication between mobile nodes that are not in the wireless range of each other, an efficient routing protocol is used to detect roads between the nodes so that messages can be delivered in a timely manner. Many protocols [1] presents the results of a detailed packet-level simulation comparing MANETs routing protocols. The best-known routing protocols are DSR and AODV [2], these protocols use the principle of best-effort in transporting and do not take into consideration of the quality service.

One of service method is guaranteed Load-Balancing, OLSR in variable pause time for a constant number of nodes. Routing protocols like LBAR and LBRM are based on the notion of the Load-Balance, this protocol is supported by DSR and AODV in the routing function packages, many routing protocols have been developed in MANETs, each protocol tries to maximize network performance by minimizing the packet delivery delay, using of the bandwidth and power consumption [3]. The routing algorithms for MANETs can be classified into three categories; the table-driven protocols, On-Demand protocols and Hybrid protocols [3, 4].

2. The Analysis of Load Balancing in Mobile Ad Hoc Networks

The MANETs have limited communication bandwidth and range than other wireless networks. Routing is one of the most challenging aspects of the network and all the limitations associated with dynamic network topology, include the complexity of routing in MANET is low bandwidth devices with high probability means that there is Load-Balancing. Several routing protocols for MANETs with emphasis on Load-Balancing have been proposed. The main aim of the Load-Balance protocols is to distract traffic from congested paths and nodes that currently exist in large number of data is going to passage other nodes or other host routes. If there is not Load-Balance mechanism, caused delayed will be increases [5].

The collection of nodes are mobile ad hoc network with high mobility that not central management they are dynamic topology, because of mobility of nodes be possible reason the network topology change constantly, thus creating a high reliability routing is one of the important challenge of these networks. Network Load-Balance and congestion are a major problem in MANETs number of mission and several routing protocols for Load-balancing are suggested [6].

The characteristic self-creating, self-organizing and self-administer in MANETs. The autonomy and mobility are great influence on the flow of data management routing. The routing algorithm is to provide a strategy which guarantees, at any time, the connection between any pair of nodes belonging to the network. This strategy must take into account the changes in the network topology and other characteristics such as bandwidth, the number of links, limited energy, etc. [7].

3. Description of Load-Balancing Problem in MANETs

The load balancing is a Quality of service (QoS) model without resource reservation, where a routing protocol is improved to meet the requirements of sensitive user applications has a parameter such as delay, bandwidth and jitter. To improve service quality by minimizing delays to satisfy interested users in packet transmission delays. A node with high processing power finishes its work quickly with less time it is estimated. Multi-path routing can load balance better than single-path routing in MANETs, where the shortest path is used for routing selection [8]. This is possible only with a large number of nodes in the network between any source destination pair of nodes, because it is impossible to build such systems affordable for a large number of route discovery and maintenance [9].

An important part of a good network is load balancing. For example, if a full load to the other and the useless data processing capabilities to share in their time, finishing covered. There are possible load imbalance with regard to processing/computing power on systems that are non-uniform, if a lot of data work, and other nodes are also very full load [10]. The AODV and DSR routing protocols is a routing protocol for the MANETs mode to integrate the functionality of OLSR, LBAR and LBRM routing protocols, these protocols are part of the most used and it suffers from some problem. One known problem is the overload of certain nodes because of increasing nodal activity. An overloaded node has multiple entries in its routing table, while passing through that node, the data packets will suffer too long because of load balancing and entire route in the routing table.

4. Overview of Routing Protocols in MANETs

Classification of routing protocols in MANETs can be done in many ways; the routing protocols can be categorized as Proactive (Table Driven), Reactive (On-Demand), and Hybrid depending on the network structure [11]. The MANETs can be divided into Table-Driven and On-Demand Routing protocol where Table Driven protocols are proactive and maintain a routing table and On-Demand are active and do not maintain a routing table [12]. The following routing protocols are analyzed in this study. We had selected five reactive routing protocols as AODV, SDR, LBAR, OLSR, and LBRM for evaluation.

4.1. Ad hoc On-demand Distance Vector Routing (AODV) [13]**:** This protocol shows better qualification. AODV is representative of various techniques and is the most advanced on the path to normalization. It belongs to a family of reactive protocols. It uses a diffusion mechanism (broadcast) in the network to discover the valid routes.

4.1.Dynamic Source Routing (DSR) [13]: Is an on-demand routing protocol which is based on the thought of source routing. Operation of DSR is segmented into two functions, route discovery and route maintenance.

4.2.Optimized Link State Routing (OLSR) [14]: Is a proactive link-state routing protocol, nodes report only a subset of their neighborhood through technical multipoint relay. This technique allows to optimize the distribution of routing messages saving much of the network bandwidth.

4.3.Load Balanced Ad Hoc Routing (LBAR) [15]: Is an on-demand routing protocol designed for delay sensitive applications when users are more concerned with the period of packet transmissions. Therefore, LBAR focuses to find a path that would work with least traffic, load so that data packets possibly routed with least delay. The algorithm has four components; Route Discovery, Path Maintenance, Local Connectivity Management, and Cost Function Computation

4.4.Load Balancing Routing Mechanism (LBRM) [16]: This protocol can appropriate formulate for the load balancing and traffic distribution, weight values and the average number of hops along the length of queue interface to be defined. In this protocol, calculate the weight among all the possible paths for each route that selected is will distribute the weight of traffic. While the using the continue function is less than the values to give the weight to the weight in the direction which finding the shortest route and less congestion in the network while the initial route discovery process than is to the broadcast the packets and then transport the packets through the chosen path with the weight values.

5. Proposed optimization

The idea of what is to Load-Balance the in the network by choosing the least cumbersome way and therefore take minimum delay. The AODV and DSR routing protocols are based on two algorithms (the route discovery and maintenance of road), to minimize the data transmission delay, changes have been made on it by adding functions "Managing local connectivity" and "calculating cost" of OLSR, LBAR and LBRM routing protocols.

The AODV protocol is the most popular of reactive protocols, its operation is based on the route discovery and maintenance of these roads by using control packets: route request, reply Highway, Highway error. To optimize this protocol, an improvement has been proposed: OLSR, LBAR and LBRM routing protocols of what we will introduce one of its operating algorithms, AODV and DSR routing protocols to minimize delay.

Delayed with the suitable for the transfer of traffic on proceeded along relatively less press in that can be in the total power and reduced time delay in general Load-Balance increase including the rate of losing closed End-To-End Delay consumption and battery power consumption. This motivates cause a large study of Load-Balance routing protocols [17, 18] to dissipate the confluence with selecting the appropriate path in the routing phase.

6. Performance Evaluation and Simulation Result

The simulation was performed using packet-level Network Simulator 2 (NS-2), the simulation results are shown in the following results in order to compare between five routing protocols by changing different numbers of (10, 20, 30, and 40) sources the performance of line graphs as a function of pause time.

For best calculations, simulations were made in different communication scenarios with variations in key parameters that can influence the results directly, which allowed us to push the limits of the simulation in order to analyze the smallest changes. For each scenario we changing the main parameter that can affect in behavior and the simulation results which is the break time. Also, represents for each node of immobility time before moving again. A simulation study was carried out to appraise the performance of MANETs routing protocols such as AODV, DSR, OLSR, LBAR, and LBRM based on the metrics Average End-to-End Delay, Packet Delivery Fraction (PDF) ratio and, Normalized Routing Load, with the following table 1 parameters:

Table 1. Parameter Values for Simulation

Simulation Parameter	Values
Number of Nodes	50 nodes
Number of Pairs	10, 20, 30 and 40 sources
Transmission Rate	5 Packets per Second
Packet Rate	512 bytes
Environment Size	1500m x 300m
Maximum Speed	20m / s
Simulation Time	900 Seconds
Pause Time	0sec, 100sec... 900sec
Traffic Type	CBR, UDP and TCP
Mobility Model	Random Waypoint
Routing Protocols	AODV, DSR, OLSR, LBAR, and LBRM
MAC Layer Protocol	IEEE802.11
Network Simulator	NS 2.35

The study set the number of entries in the routing table. Three metric were chosen:

A. **Average End-to-End Delay** [19]: This includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the selected routing protocols, and propagation and transfer times.

B. **Packet Delivery Fraction Ratio** [20]: The ratio of the data packets delivered to the destinations to those generated by the DSR sources.

C. **Normalized Routing Load Comparison** [21]: The number of routing packets transmitted per data packet delivered at the destination. Each favor of smaller path lengths and thus have less delay.

6.1. Average End-to-End Delay

Awaited Average End-to-End Delay expansion with the increase in buffer size, the effect of buffer size is not that distinguished for performance metrics like Packet Delivery Fraction ratio and Normalized routing load, as is for average End-to-End Delay. That is lowest for smallest value of buffer size, the cause is quite apparent, packets don't have to wait for long in the queue and they obtain early resulting in low value of Average End-To-End Delay.

The results of each scenario in this metric based on pause time are shown on the following Figure 1, with 10 and 20 sources worsen than both AODV and DSR. For 30 and 40 sources, OLSR, LBAR and LBRM achieves meaningfully higher delay than AODV and DSR. Moreover, the delays decrease with lower mobility for OLSR, LBAR, and LBRM in all four scenarios while it lower with 30 and 40 sources for both AODV and DSR. This is due to a high level of network Load-Balance and multiple access interference in certain regions of the ad hoc network. Further, delays decrease when there is less mobility in AODV and DSR for scenarios 30 and 40 sources because it has less Load-Balance on the nodes in the network then the waiting time at each node will decrease. OLSR, LBAR, and LBRM choose a mechanism for Load-Balance, which attempt to route packets along a less Load-Balance path to escape overloading some nodes.

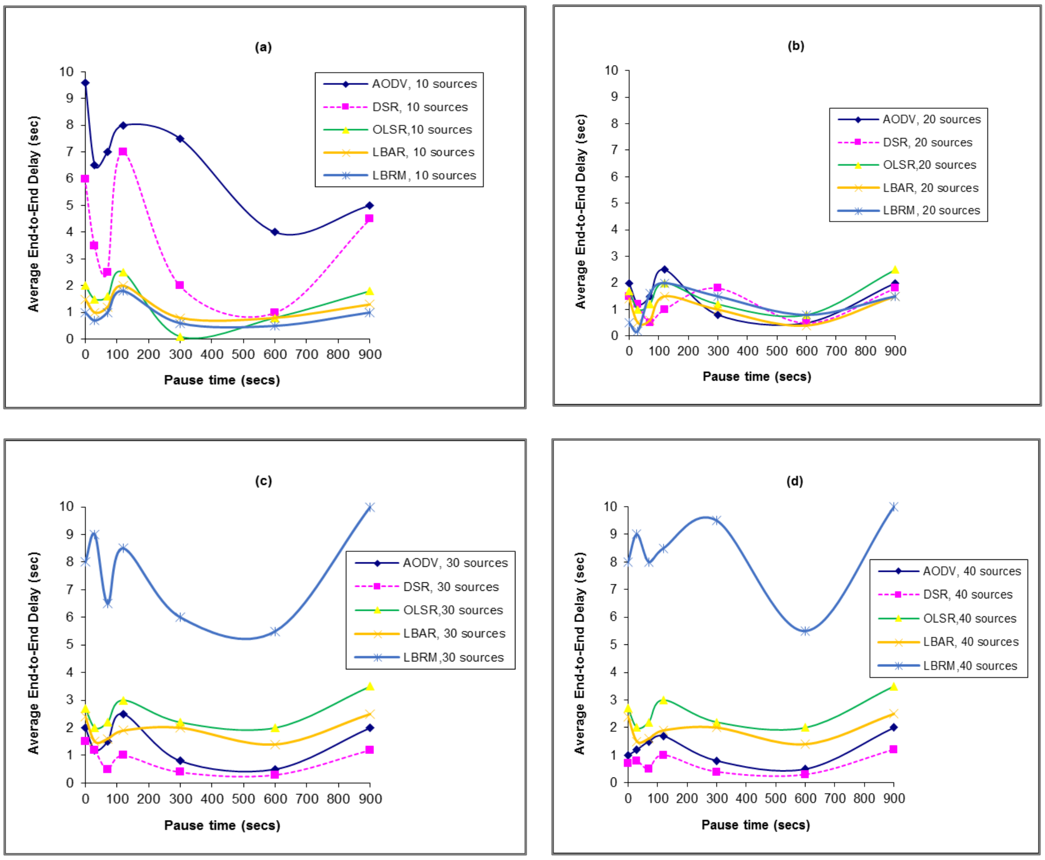


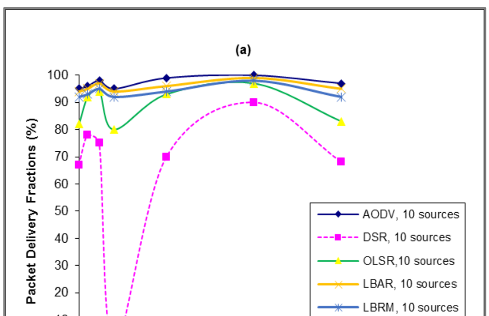
Figure 1. Average end-to-end delay vs. Pause time for 50-nodes model with (a) 10 sources, (b) 20 sources, (c) 30 sources, and (d) 40 sources.

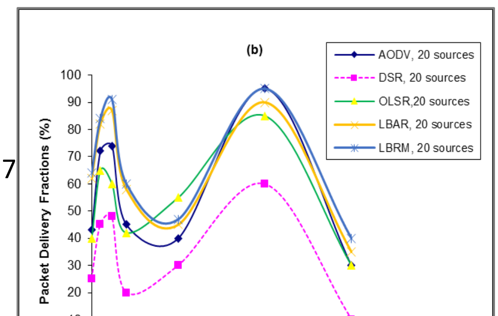
6.2. Packet Delivery Fraction (PDF)

Packet Delivery Fractions is the ratio between the numbers of packets develop by the layer of application sources and the number of packets taken in by invest at the final destination. It will depict the loss rate that will be seen by the transport protocols, which in turn affects the maximum Load-Balance that the network can support. AODV when we did a traffic Load-Balance with degradation, the unconstrained work network.

Figure 2 shows the packet delivery fractions for rate is calculated by dividing the number of data packets received on one of the packets sent by the source application of the pause time for AODV, DSR OLSR, LBAR, and LBRM. That the packet delivery fractions for LBAR, AODV, and LBRM are very similar for both 10 and 20 sources. With 30 and 40 sources, LBRM, LBAR, and OLSR outperforms AODV and DSR. In fact LBAR achieves the highest packet delivery fraction for all pause time values. For 30 sources, LBRM achieves up to higher packet delivery fractions than both AODV and DSR. LBAR has superior performance to both AODV and DSR in the case of 40 sources, DSR routing protocol encounters most of the delay during the simulation than AODV, OLSR, LBAR, and LBRM. As the number of mobiles is expanding DSR protocol performs worse than AODV, OLSR, LBAR, and LBRM.

Packet Delivery Fractions, DSR present well when the number of nodes is less as the traffic Load-Balance will be less. However, its present declines with multiplied number of nodes right to more traffic Load-Balance in the network. The present of OLSR are best with more number of nodes than in comparison with the LBAR and LBRM protocols. The present of AODV is better at the beginning and reduce slightly with growth in number of nodes.





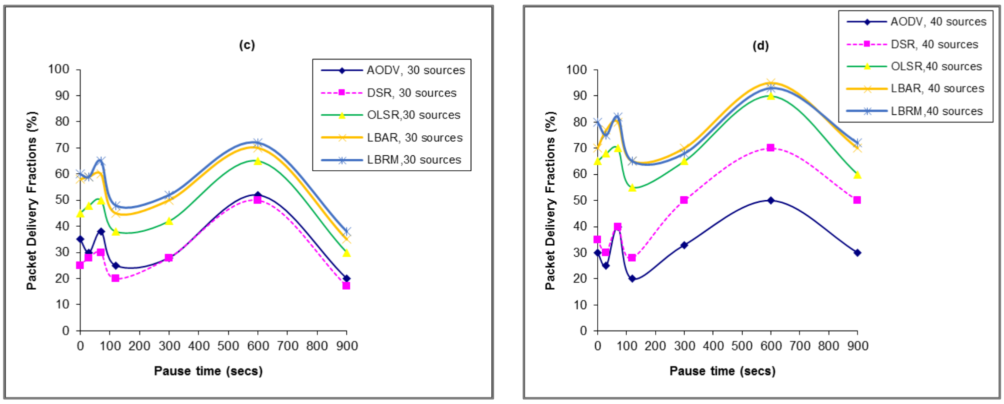
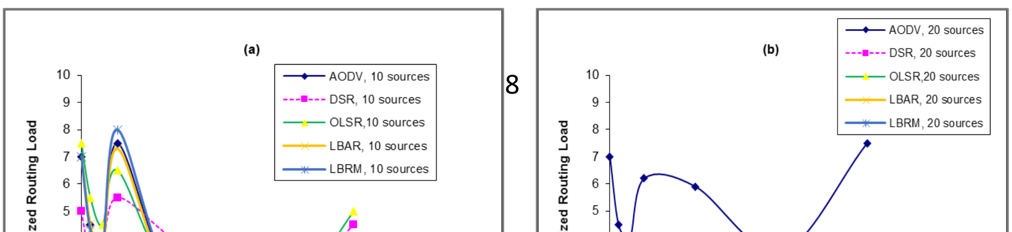


Figure 2. Packet Delivery Fractions vs. Pause time for 50-nodes model with (a) 10 sources, (b) 20 sources, (c) 30 sources, and (d) 40 sources.

6.3. Normalized Routing Load (NRL):

We observe that for highly dynamic topologies the Normalized Routing Load is almost constant for all values of interface queue length. But for addition stable topologies the graphs we obtain need a curve like structure, but it reduce as the interface queue length increases till a certain value of interface queue length is arrived and again starts expanding with the increase in interface queue length. The Normalized Routing Load results, Figure 3 shows that the Normalized Routing Load of all five protocols increases with expanding the number of sources. AODV demonstrates a higher routing load than both DSR, OLSR, LBAR, and LBRM protocols. The method that from this statistics we can get the better interface queue length that will give the best specific performance and can reduce the routing load to a considerable amount. AODV display emotion a higher routing load than OLSR, DSR, LBAR, and LBRM. DSR and OLSR only accept the first request message at each node, a node has already view a request message for a particular packet, and it will not accept a second message of the similar packet. On the other side, AODV, LBRM, and LBAR accepts request messages as long as they are not looping through the node. Destination nodes keep a record of various route information from request messages as reserve for use during the path maintenance protocol. Hence, AODV, LBRM, and LBAR will almost always have an alternative path to indirect way packets in case of link failure. This enables AODV, LBRM, and LBAR to obtain higher Packet Delivery Fractions and lower Average End-to-End Delays.



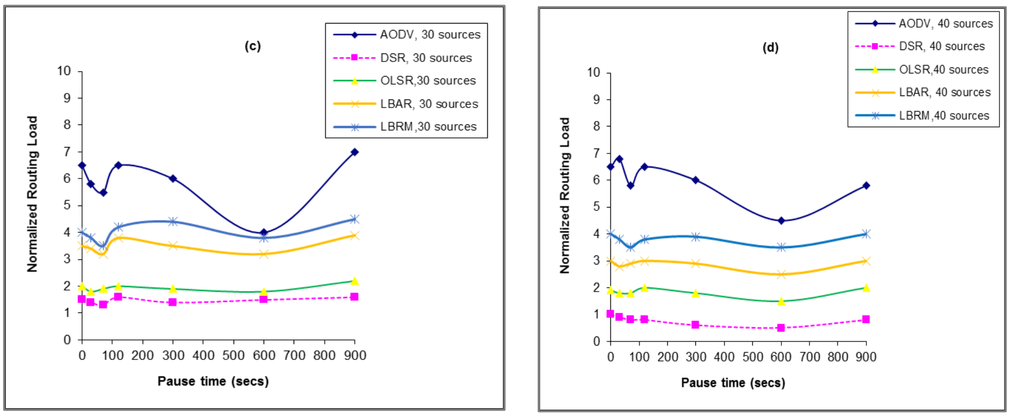


Figure 3. Normalized Routing Load vs. Pause time for 50-nodes model with (a) 10 sources, (b) 20 sources, (c) 30 sources, and (d) 40 sources.

7. Conclusion

The routing protocols in MANETs are protocols that ensures optimal search path without guaranteed service, but with the expansion of multimedia data in MANETs, service quality has become an obligation. A QoS methods is Load-Balancing, we proposed that simulations have been done autonomous of one another using different metrics and using different simulators. This paper explain the practical comparison of five routing protocols as AODV, SDR, LBAR, OLSR, and LBRM, for MANETs using NS-2 simulation.

The results have been retrieved, processed and represented in graphs to better understand the behavior of the routing protocols, the important observation is, simulation results agree with awaited results based on Load-Balancing. As awaited, reactive routing protocols AODV and DSR performance is the best considering its capacity to support connection by recurrent exchange of information, which is needed for TCP, based Load-Balancing. AODV and DSR performs forecasting, the Load-Balancing algorithm used in the case where the network is overloaded, otherwise it will complicate the situation.

In higher rates of node mobility it’s practically more load balancing than DSR, Compared the routing protocols On-Demand DSR, AODV and Table-Driven LBAR, OLSR, and LBRM by varying the number of nodes and measured the based on the metrics Average End-to-End Delay, Packet Delivery Fraction ratio, and Normalized Routing Load are interested, DSR and AODV performs better than LBAR, OLSR, and LBRM with large number of nodes. Hence for load balancing AODV is preferred over DSR and LBAR, OLSR, and LBRM. For less number of nodes and less mobility, LBAR's performance is better.

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مقارنة الأداء لبروتوكولات التوجيه المختلفة بناءاً على موازنة التحميل في الشبكات المخصصة المتنقلة

علي حسن موسى

الخلاصة

الغرض من هذه البحث هو تقديم مقارنة بين خمسة من بروتوكولات التوجيه واالتي لها دور اساسي في أي شبكة مخصصة متنقلة مثل بروتوكولات، المخصص بناء على الطلب المسافة المتجهات (AODV)، توجيه المصدر الديناميكي (DSR)، موازنة التحميل للتوجيه المخصص (LBAR)، تحسين حالة ارتباط التوجيه

(OLSR)، وموازنة تحميل آلية التوجيه (LBRM). التي هي بالعموم يتم تصنيفها على أنها التوجيه بالجدولة و التوجيه عند الطلب ، وتقرير ما هي أفضل الظروف التشغيلية لكل بروتوكول وتوضيح كيف أن الوقت وعدد العقد تؤثر على أساس موازنة التحميل. أيضا، يتم قياس الأداء على أساس مقاييس متوسط الزمن بين النهايات، حزم تسليم الجزء (PDF) النسبية، وتطبيع توجيه التحميل (NRL). لتنفيذ هذه المقارنة بين أن هذه البروتوكولات الخاصة بالتوجيه نستخدم محاكاة لتقييم أداء هذه المقارنة. يتم تنفيذ المحاكاة بواسطة شبكة محاكاة 2 (NS-2) لتقديم نتائج تتفق مع نتائج البحث المنتظرة على أساس موازنة التحميل.

الكلمات المفتاحية : بروتوكولات التوجيه ، موازنة التحميل ، و الشبكات المخصصة المتنقلة.