# DISTRIBUTED TRAFFIC BY LOAD-BALANCING APPROACH FOR AOMDV IN AD-HOC NETWORKS

Mahamed Abdelmadjid Allalili[#1], Zoulikha Mekkakia Maaza[*2], Ali Kies[*3], Redouane Belbachir[*4]

[#]Department of Data processing

University Hassiba Ben Boualiof, Hay Salem routenationale N°19, 02000 Chlef, Algeria

allali.abdelmadjid@gmail.com

[*#]University of Sciences and the Technology of Oran, USTO

BP 1505 El M'Naouar, Oran, Algeria

{mekkakia@univ-usto.dz, kies_ali@yahoo.fr,belbachir_red@yahoo.fr}[*]

### ABSTRACT

*Mobile ad hoc network is a collection of wireless mobile nodes, which are connected over a wireless medium. There is no pre-existing communication infrastructure (no access points, no base stations) and the nodes can freely move and self-organize into a network topology. Such a network can contain two or more nodes. Hence, balancing the load in an Ad hoc network is important because the nodes have limited communication resources such as bandwidth, buffer space and battery power. This paper presents a new approach to load balancing based on residual energy of nodes for distribute the traffic evenly among the network nodes. We are exploiting the multipath routing protocol AOMDV, which defines link-disjoint paths between the source and the destination in every route discovery. We add the energy metric for load balancing (ELB-AOMDV). The performance is compared between ELB-AOMDV and LB-AOMDV.*

### KEYWORDS

*Ad hoc network, Load balancing, Residual energy, AOMDV protocol.*

## 1. INTRODUCTION

A mobile ad-hoc network or MANET is a collection of mobile nodes sharing a wireless channel without any centralized control or established communication backbone. They have no fixed routers with all nodes capable of movement and arbitrarily dynamic. These nodes can act as both end systems and routers at the same time. When acting as routers, they discover and maintain routes to other nodes in the network. The topology of the ad-hoc network depends on the transmission power of the nodes and the location of the mobile nodes, which may change from time to time [1].

Among the limitations that blame the routing protocols currently used in mobile ad hoc networks face the problem of load balancing distribution in the network. While some nodes may be involved in routing, others are heavily congested and most of the routing network traffic. Because of this inhomogeneous load distribution, the nodes loaded quickly consume their limited material resources and show a high congestion. These effects can significantly degrade the performance of ad hoc network.

Sundarapandian et al. (Eds): ICAITA, SAI, SEAS, CDKP, CMCA, CS & IT 08,
pp. 271–278, 2012. © CS & IT-CSCP 2012 DOI : 10.5121/csit.2012.2524

The main problems are: node mobility and link failure. However, node mobility provides dynamic change topology and route breaks occur frequently providing degradation of upstream on wireless network because not only high loss of packets but also delay occurs to search new route.

The principal metric is load balancing, one idea, inspired by nature, is to simultaneously use all available resources. Indeed, if two or more disjoint paths between a source and destination, we can theoretically achieve throughput equal to the cumulative sum of the rates possible on the roads separately. You need to have a centralized view of customer loads on all nodes. The use of this visibility may influence the choice of intermediate nodes to route traffic to the correct destination. This technique improves network performance. The capacity is thus uniformly spread across the ad hoc network.

Several solutions have been proposed to determine how best to distribute the traffic on various roads in the case of single path routing and multipath routing path. We propose and we interesting approach two is multipath routing.

The rest of the paper is organized as follows. Section II presents and discusses some related work on load balancing in MANETs. Section III explains LB-AOMDV and ELB-AOMDV routing protocol. Finally, section IV presents simulation results before concluding in section V.

## 2. BACKGROAND AND RELATED WORKS

The term “Load balancing” distributes traffic to a nodes set, in order to smooth the network load. That is to say, divide the total load to the various nodes of the network by sending data as nodes in a position to respond.

Load balancing aims to increase capacity and fault tolerance of networks. It is necessary to ensure a good load balancing on all ad hoc network paths. Load balancing to single path routing has been adopted in Ad hoc networks [2], [3], [4].

The load-balancing technique in ad hoc networks can be generally divided into two types. The first type is “Traffic-size” based [5-6], in which the load is balanced by attempting to distribute the traffic evenly among the network nodes. The second type is the “Delay” based [7], in which the load is balanced by attempting to avoid nodes with high delay. In this paper, the proposed scheme is applicable to most on-demand routing protocols, either single-path routing or multi-path routing. It belongs to the “Traffic-size” based type, and will distribute the traffic load evenly among the nodes in ad hoc network.

Distributing processing and communications activity evenly across a computer network so that no single device is overwhelmed. Load balancing is especially important for networks where it's difficult to predict the number of requests that will be issued to a server. Busy Web sites typically employ two or more Web servers in a load balancing scheme. If one server starts to get swamped, requests are forwarded to another server with more capacity. Load balancing can also refer to the communications channels themselves. [8]

In [9], load balancing is Load balancing is a technique to forward the traffic from a source to destination across multiple paths. With equal load balancing, the traffic is balanced across multiple equal-cost paths.This can be done on a per-packet basis (packet are sent N equal-costs paths using a round robbin algorithm).

One of the first solutions provides a simple method, but veryeffective to achieve load balancing in an ad hoc network, is themechanism *LBAR (*Load-Aware Destination-Controlled routing for MANET) [10]is an on-demand routing protocol intended for delay-sensitive applications where users are most concerned with packet transmission delay. Hence, LBAR focuses on how-to find a path, which would reflect least traffic, load so that data packets can be routed with least delay. Thealgorithm has four components: Route Discovery, Path Maintenance, Local Connectivity Management, cost Function Computation.First Route recovery, the route discovery process is initiated whenever asource node needs to communicate with another node for which it does not have a known route. The process is divided into two stages: forward and backward.

The LBAR protocol disadvantage of not considering in the costfunction, that calculates, the number of hops between the sourceand destination. One can envisage scenarios where this protocolcould push the source to choose a route (path) with a largenumber of nodes less loaded instead of a route with lightlyloaded nodes.

Another solution is proposed protocol*WLAR* (Weighted Load Aware Routing) [11] protocol is proposed. This protocol selects the route based on the information from the neighbor nodes which are on the route to the destination. In WLAR, a new term traffic load is defined as the product of average queue size of the interface at the node and the number of sharing nodes which are declared to influence the transmission of their neighbors. (WLAR)protocol adopts basic AODV procedure and packet format.In WLAR, each node has to measure its average number of packets queued in its interface, and then check whether it is a sharing node to its neighbor or not.

Finally, we have another solutions protocol proposed is MALB (Multipath Adaptive Load balancing).The MALB [12] is framework distributes traffic among multiple paths based on path statistics with the goal of minimizing congestion and end-to-end delay. The aim is to minimize total cost (a function of the delay on each node's M/M/1 queue). This is modelled as a constrained optimization problem which the authors solve using a gradient projection algorithm. MALB is located at the source node and assumes that disjoint path have already been established by multipath routing protocol. There are two phases in the load balancing loaded of MALB.

In this paper, we interestingMultipath on-demand protocols try to alleviate these problems by computing multiple paths in a single route discoveryattempt. Multiple paths could be formed at both traffic sourcesas well as at intermediate nodes. New route discovery is needed only when all paths fail. This reduces both routediscovery latency and routing overheads. Multiple paths can alsobe used to balance load by forwarding data packets on multiple paths at the same time.

The main idea in AOMDV is to compute multiple paths during route discovery. It is designed primarily for highly dynamic ad hoc networks where link failures and route breaks occur frequently [13]. The AOMDV protocol has two main components:

*a)* A route update rule to establish and maintain *multiple loop-free* paths at each node.
*b)* A distributed protocol to find *link-disjoint* paths.

The load balancing phase tries to *equalize the congestion measures of the multipath paths*. It uses packet probing techniques to determine path statistics. The imbalance detecting phase detects high congestion and returns the system to the load balancing phase. There is a rate vector for each source destination pair which is dynamically updated using probe packets. Each node measures its traffic arrival rate periodically. Once a node receives a probe packet from the source, it sends a reply packet indicating its traffic arrival rate.

## 3.AOMDV WITH LOAD BANACING

In this section, we present our load balancing implement in routing protocols.

The work of [14] shows that the load is maximum at the network center and the paths most used by the packets pass through the center nodes of the network. As a result, the network load is maxat the center and decreases gradually as one moves away from it.The load balancing mechanism proposed in this section is based on this observation. So it would be sufficient to distribute theload, in a balanced manner on the network, to find a mechanism that pushes the load outside the center of the network, byselecting the least loaded paths.

In article [15], the proposed protocol will make the following changes to the existing AOMDVprotocol

a) Paths are selected depending on the hop countand queue length.

b) Load is to be balanced via alternate paths ifqueue length processes a certain threshold value.
c) RREQ packets are to forwarded or discardeddepending on the queue length.

In article [16], we proposed AODV Therefore, any node that receives a RREQ message, calculatesthe cost of the path announced and it will compare the cost of the existing path in its routing table.

In this article [17], we propose routing AOMDV and AODV interesting were analyzed at varying workload and the energy consumption at nodal level closely monitored.

This is suggesting that at higher data traffic, load will get balanced in more paths resulting in energy preservation of nodes in the network.

# 4. PROPOSED ROUTING PROTCOL

In this section, we present our proactive routing protocol based on the proposed optimized AOMDV structure

## 4.1. LB-AOMDV ROUTING PROTCOL

The protocol LB-AOMDV (Load Balancing-AOMDV) sought to maximize the lifetime of the network and improve the performance obtained by the protocol AOMDV

We propose that any node seeking routes to destinations separated by more than two jumps that are a priori different from the shortest path but less responsible than this. Indeed, for there may be a better route than the shortest path, we suggest that the comparison of the optimality of the routes from the shortest path is done through the following metric:

$$Min \frac{1}{n} \sum_{i \in P} number\_of\_flux(i) \quad (1)$$

Where *nbr_of_flux (i)* denotes the number of flow through a node i participating in the road P. Dividing by n, number of hops, ensures that the metric takes into account the number of hops of the route to adequately assess the burden on roads.

Indeed the number of hops in a route separate two distinguished nodes is different from zero. In addition, the retroactive action of each term of the cost function on the other ensures that the minimum is always a shortest path route minimized n (thus maximizing the term 1 / n) but it also minimizes the sum jumps where the road passes, because these nodes are in the center of the network.

We chose to implement the routing protocol in ns-2.34 which includes a protocol implementation AOMDV. For changes to the libraries, we have essentially redefined the structure of headers and messages RREQ and RREP routing table, to incorporate a new field that will contain the burden of road announced. This charge is expressed as average size of the routing table.

As for the changes to the source code, he discussed ways to redefine the routing messages RREQ and RREP messages generation. Thus any node receives a RREQ already received will no longer automatically refuse, it will calculate the path of the road announced and distribute the data stream allows the route exists in its routing table according to the following routine.

```
Begin
# Initialize routing table
bool Exist =false; bool head=false;
for ( p = p->path_link_next)
     if(Exist == false) then
                if(p->LB==1) then
                                (path=p; p-
>LB=0);
                     if(p->path_link_next!=NULL)
then
    (p->path_link_next->LB=1);
                     else       head=true;
                                Exist=true;
                     End if
                 End if
     End if
     if(head) then
                   (rt_path_list._first->LB=1);
     End if
   return path;
End for
```

## 4.3. ELB-AOMDV ROUTING PROTCOL

The ELB-AOMDV (Energy Load Balancing-AOMDV) is a multipath routing protocol; the different with LB-AOMDV is novel metric energy consumption of the node and energy of the path.

Thus, the goal is to reduce the rate of control packet used to maintain the network by incorporating a mechanism called "LB AOMDV" and to route around nodes have a long lifetime (more energy)

In our approach, we consider only the energy (energy consumption of the node, energy consumption and average energy of the road network). However, we also consider the rate of energy consumption at a time instant i. For each node, we follow the following formula to calculate the rate of energy consumption:

$$Energy_{cons}(i) = Energy_{initial}(i) - Energy_{res}(i) \quad (2)$$

Où $Energy_{cons}$: energy consumed by each node i report, $Energy_{inital}$: initial energy 100 joules and $Energy_{res}$: is the level of residual energy calculated at the instant i.

The average energy consumption

$$Moy_{Energy_{cons}}(i) = \frac{\sum_{i=0}^{n-1} Energy_{cons}(i)}{n} \quad (3)$$

## 5. SIMULATION RESULTS

We conducted extensive simulations, using NS2 [17], to determine the effectiveness of our routing protocol ELB-AOMDV and compared to the well-known routing protocol LB-AOMDVand.

Table 1, gives the simulation parameters,

TABLE I
SIMULATION PARAMETERS

| Parameter | Value |
|---|---|
| Number of nodes | 20 |
| Simulation time | 500s |
| Radio range | 250m |
| Velocity | 2-10 m/s |
| Simulation area | 900 x 900 $m^2$ |
| Physical layer | Bandwidth 2Mb/s |
| MAC | IEEE 802.11b |
| Initial energy | 100 Joule |
| Tx power, Rx power, Idle power | 1.4, 1.2, 0.9 (Watt) |
| Type of traffic | CBR |
| Sendingfrequency | 2 packets/s |
| Packet size | 1024 bytes |

To evaluate the performances of our protocol, we focused on two performance metrics: ratio %, life time and gain % live time. This choice implies that we give the right of way for the nodes that have the greatest connectivity, then the nodes with more energy and at the end nodes with a good link quality.

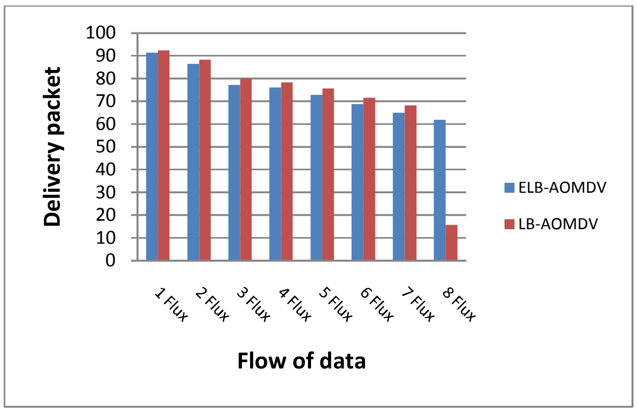


Figure. 1Delivery Ratio % vs. Flow of data.

In the Figure 1shows the simulation results of a topology of 20 nodes, 8 traffic sources and simulation time of 500s, using the protocols LB-AOMDV and ELB-AOMDV. In terms of delivery ratio is Ratio of packets received to packets sent. We note that in 8flow, LB-AOMDV is a relative drop in total from ELB-AOMDV

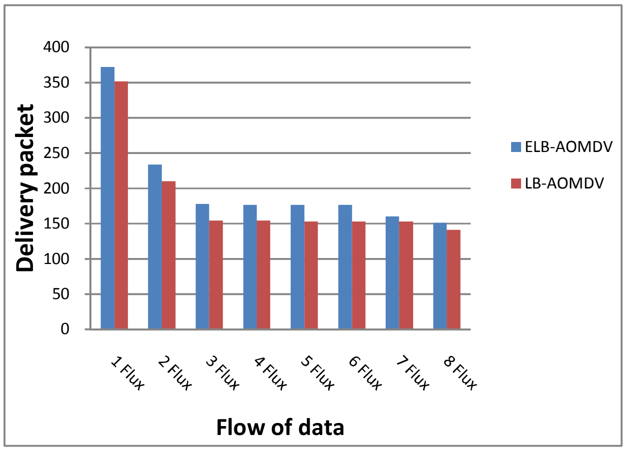


Figure. 2:life time vs.flow of data.

In the figure 2, we note in all cases of flow ELB-AOMDV is the best then LB-AOMDV life time in the network.

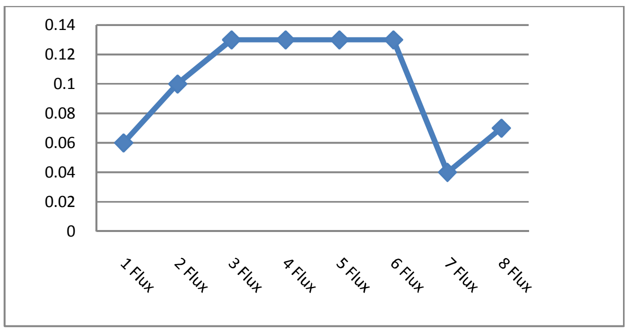


Figure 3Gain (%) LT ELB-AOMDV compared to LB-AOMDVvs.Flow of data.

In terms of mobility, ELB-AOMDV shows more robust when the network density increase, because the mechanism of load balancing and metric energy consumption, traffic pushes outside of the most charges nodes, when even there is a path less charged, avoiding network congestion.

In the terms of life time, we define a better ELB-AOMDV when nodes are mobile, because this existence of multitude path less charged. In the terms Gain live time, we define a in good health second routing ELB-AOMDV

## 6. CONCLUSION

In this study, we proposed a new protocol routing load balancing framework for mobile ad hoc networks based on an optimized distribution traffic construction.

First, we have proposed a new multipath routing protocolcalled LB-AOMDV with a new metric which is flow of data to select the less congested routes.

Then, we add energy to our proposal LB-AOMDV protocol which includesdelay and throughput parameters. It takes advantage ofthe RREQ messages to exchange the essentialinformation to achieve the energy consumption.

The performance characteristic's ELB-AOMDV and LB-AOMDV to life time in the ad hoc network were analyzed at traffic distributed.

To demonstrate the effectiveness of our cybernetic structure, we proposed and implemented a new a routing protocol ELB-AOMDV based on it. Simulation results show that routing protocol

ELB-AOMDV optimizes the energy consumption within the network and also has the advantage of supporting mobility and eliminate thecongestion.

In the prospect work, we would like to present more types of metric to our protocol such as bandwidth constraint.

## ACKNOWLEDGMENT

This work is part of the CAPRAH project 08/U311/4966, supported by the Algerian Ministry of Higher Education and Scientific Research

## REFERENCES

[1] S. K. Sarkar, T. G. Basavaraju, C. Puttamadappa,"Ad Hoc Mobile Wireless Networks, Principles, Protocols, and Application", *Taylor edition*, 2008.

[2] Wenbin Jiang Zhaojing Li Chunqiang Zeng Hai Jin ,2009, *Load Balancing* Routing Algorithm for *Ad Hoc* Networks, 5th Inter*national Confe*rence on Mobile Ad-hoc and Sensor Networks (MSN), 2009

[3] Toh Chai Keong, Le Anh-Ngoc and Cho You-Ze,2009, Load Balanced Routing Protocols for Ad Hoc Mobile Wireless Networks, IEEE Communications Magazine, Institute of Electrical and Electronics Engineers Inc., Vol. 47, No. 8, pp. 78-84.

[4] Y. Yuan, H. Chen, and M. Jia. 2005. An adaptative load balancing approach for Ad Hoc networks. Wireless Communications, Networking and Mobile Computing international Conference, Vol. 2.

[5] Lee, Y. J. and Riley*, G. F.,* "A Workload- Based Ad*aptive* Load-Balancing Technique for Mobile Ad Hoc Networks," IEEE, pp. 2002-2007 (2005).

[6] Pham, P. and Perreau, S., "Multi-Path Routing Protocol with Load Balancing Policy in Mobile Ad Hoc Routing," IEEE, pp. 48-52 (2002).

[7] Zhang, L. F., and etc, "Load Balancing of Multipath Source Routing in Ad Hoc Networks," IEEE, pp. 3197-3201 (2002). 0-7803-

[8] http://www.webopedia.com/TERM/L/load_balancing.html, Consult , November 28, 2011

[9] Jean philippeVasseur, Mario PickavetDemester, "Network Recovery protection and restoration of optical SONET-SDH, IP and MPLS", Elseveur 2009

[10] P. Pham and S. Perreau. 2002. Multi-path routing protocol with load balancing policy in mobile ad hoc network. In IEEE MWCN'02.

[11] . Y.J.Lee, G.F.Riley. 2005. A workload-based adaptative load-balancing technique for mobile Ad Hoc network. IEEE Wireless Communications and Networking Conference (WCNC'2005)

[12] S. Yin and X. Lin. MALB: MANET adaptive load balancing. In Proceedings of the Vehicular Technology Conference, volume 4, pages 2843{2847, 2004.

[13] Mahesh K. Marina, Samir R. Das,"On-demand Multipath Distance Vector Routing in Ad hoc Networks", IEEE 2001.

[14] P.Pham, S. Perreau. 2003. Performance analysis of reactive shortest path and multi-path routing mechanismswith load balance. IEEE Conference on Computer Communications INFOCOM'03.

[15] R. Vinod Kumar, R.S.D.Wahida Banu. Load-balancing Approach for AOMDV in Ad-hoc Networks. IJCA Special Issue on "Mobile Ad-hoc Networks"MANETs, 2010

[16] Mekkakia M Z, Ouali S, Sekrane N, Reactive Routing Protocol to Single Path with Load Balancing, International Journal of Computer Applications (0975 – 8887), Volume 28– No.3, August 2011

[17] S.Malini, E.Kannan, A,Valarathi, C.Daniel Sunder Rajan. Traffic based Energy Consumption Analysis of AOMDV Protcol in a Mobile Ad hoc network, International Journal of Computer Applications (0975-8887), Volume 14-No.6, Februray 2011.

[18] Network Simulator NS2, http://www.isi.edu/nsnam/ns/index.html.