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Multipath Resource Sharing with Energy Improved (EI-OLSR) Protocol in Datacenter Manet

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ABSTRACT

Mobile datacenter Ad-hoc networks (DCMANET) are a new pattern of wireless communication for mobile technology. Connection points (Nodes) mobility roots frequent changes in topology. So each nodes have to play many roles assigned that of sender, receiver, and router. Sharing of message between nodes to confide on battery energy but it is limited entry and sometimes fails. Consequent research has been made on efficient use of energy. Several challenges arise at datacenter while share the resources such as route discovery, route maintenance, bandwidth constraints, dynamic change of topology, and focus of imprecision of residual energy levels. This paper introduces an algorithm of multipath customized energy efficient - OLSR (Optimized Link State Routing) for energy optimization of the nodes in the ad-hoc network. The method pursues primary value for each node which specifies whether the node should participate in route maintenance or back to somewhere. Although we obtain the solution that increases the number of nodes alive choosing energy optimized routes in the network with some increase in control routing overheads. Finally EE- OLSR results that performance of new protocol EI-OLSR increases terms of energy consumption and packet delivery ratio.

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INTRODUCTION

A datacenter mobile ad-hoc network (DCMANET) is a self-configuring wireless network of mobile hosts connected through arbitrary topology without the aid of any centralized administration. There is an autonomous and no fixed infrastructure such as base stations for mobile switching. Nodes within each other's communicate directly via wireless links in specific distance for share the message one node to another's. Node mobility makes it regular changes in topology. As nodes can travel randomly within the network, routing packets between any pair of nodes become a challenging task. A route that is supposed to be optimal for energy utilization at certain time might not be optimal at all, few moments later. (May Zin Do and Mazliza Othman, 2010) In centralized infrastructure the packet exchange routing architecture is bifurcated as reactive (on demand) and proactive (table driven) (Campbell, A., 2003). Reactive routing protocols are featured by a path discovery mechanism that is triggered on demand, when an information unit wants to get to a given destination. Whereas, proactive routing maintains route tables that store the routing information with any change in the network topology and trigger propagating updates throughout the network in order to maintain a consistent network view.

Traditional proactive routing protocols maintain routes to all nodes. Even if traffic is unchanged, repeated topology interaction happens among nodes. Also, they require periodic control message to maintain routes to every node in the network. Optimized Link State Routing (OLSR) is such a proactive routing protocol. Requirement of bandwidth and energy will increase for higher mobility. The behavior of routing protocol depends on the network size and node mobility. OLSR is an optimization of pure link state routing protocol which inherits the stability of a link state algorithm and takes over the advantage of proactive routing nature to provide routes immediately when needed. Here, to achieve energy optimization of all nodes in the network; first OLSR has been modified to multipath OLSR. Among these multiple paths between the two distant nodes at given time, path containing all

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intermediate nodes with higher energies are considered (Kirti Aniruddha Adoni, 2012).

The core idea used in OLSR is of MPRs (Multi Point Relays). It is optimized to reduce the number of control packets required for the data transmission using MPRs. In OLSR is an only nodes that selected as MPRs are dependable for forwarding control traffic in datacenter. The selected MPRs forward broadcast messages during the overflow process, contrarily to the conventionally link state algorithm, where all nodes forward broadcast messages. So mobile nodes can decrease battery consumption in OLSR compared with other link state algorithms. Thus purpose of selecting MPR is to reduce routing overhead and provide optimal overflow distance. OLSR has the ability to find routes between two nodes in a network in less time, also it is said to be already aware of energy as a limitation. The coming part II explains the multipath customized energy efficient – OLSR for energy conception. Part III explains about the performance of energy efficient route maintenance system and analyzes the bandwidth in datacenter networks. Part iv we examines the datacenter ad-hoc nodes residual energy levels and overhead. Part v at last we conclude our aspects of energy conception and packet delivery ratio.

2. *Multipath customized energy efficient – OLSR protocol:*

In datacenter Manet OLSR is a special as selected as MPRs $A = \pi r^2$ responsible for forwarding control traffic. The selected MPRs forward broadcast messages during the overflow process, defiantly to the classical link state algorithm, where all nodes forward broadcast messages. So mobile nodes can reduce battery consumption in OLSR compared with other link state algorithms. There are three types of control messages: HELLO messages, Topology Control (TC) messages, and Multiple Interface Declaration MID messages. To achieve energy optimized multipath OLSR, HELLO message and TC message format has been customized.

2.1 Route msg table Vs Topology msg table:

As a proactive routing, the routing table has routes for all accessible connection points in the networks. It has Destination Address, Next Hop Address, Local interface address and number of hops.

Table 1: Route MSG Table.

S.No	Destination	Next hob	Intermediate	Distance
A	0	0	64	1
B	4	24	64	2
C	26	40	64	3

Table 2: Topology table.

S.No	Destination	Last hob	Sequence
A	0	36	2
B	63	36	2
C	1	36	2
D	0	65	29

From the above table 1&2 distance, hop, route and intermediate nodes are calculated for multipath data transmission. The topology table provides the information about entire network. It informs about energy levels details of one hop. There is no information about Residual energy of the node in topology table format of OLSR. So energy sharing during the data transmissions fully based on the hob count with respect to sequence. For routing identity we examine the route discovery process for accurate transmission.

2.2 Route discovery:

In datacenter Manet OLSR does not depend on any central entity (Clausen, T. and P. Jacquet). The nodes maintain the network topology information where MPRs provide a shortest path to a destination with declaration and exchange of the link information periodically for their MPR's selectors. The HELLO messages are broadcast periodically for neighbour's detection and MPR selection process. It contains how often node send HELLO messages. It also includes node's MPR motivation and information about neighbour node. The information of node's is in the form of its link type, interface address and neighbour type. OLSR does not require sequenced delivery of messages as each control message contains a sequence number which is incremented for each message.

2.3 Energy-Efficient Route selection metric:

There is different Route selection metric based on transmission power, link distance or residual energy of the node.

2.3.1 Customized OLSR:

OLSR applies shortest hop routing method for the transmitting data. It directs the ongestion on specific path, or rise in energy expenses of particular intermediate nodes. If multiple paths are available, then congestion can be avoided, and energy expenses of all nodes would be uniform. To achieve this,

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following changes are carried out the changes made in OLSR protocol

2.3.2 Changes in control messages:

The allocated field available in HELLO and TC message format is used to pass residual energy. This residual energy is further used to find out appropriate path.

Customized OLSR route msg format and topology control msg format:

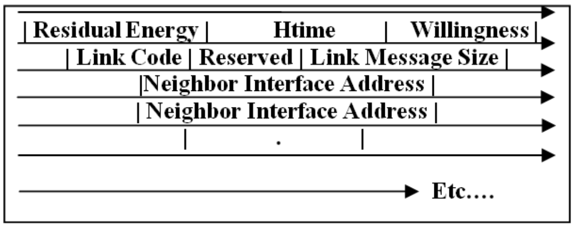

Fig. 1: OLSR Route msg. format .

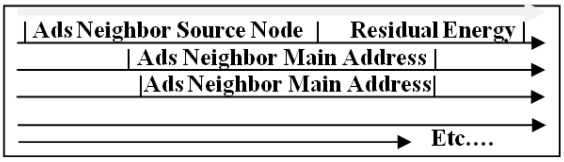

Fig. 2: OLSR Topology control msg. format.

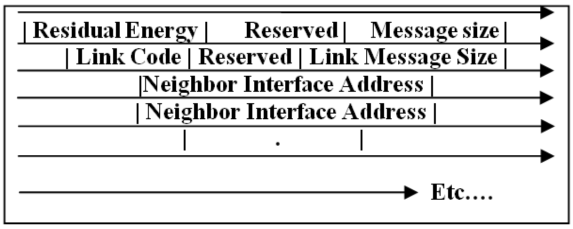

Fig. 3: Customized OLSR Route msg. format.

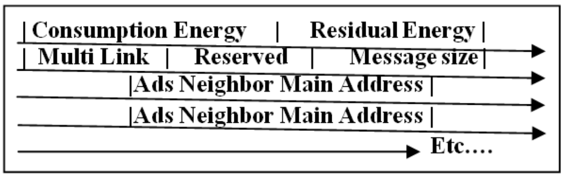

Fig. 4: Customized OLSR TC msg. format.

From the above customized Routing Table has given the source-destination pair, multiple paths are available. Now to select one of the available routes, energy aware metric is applied. The energy expenses (in Joules) needed to transmit a data packet dp is given by, (Dongkyun Kim, J.J., 2002)

$E(dp) = cv * v * dtp$ …….. (1)

Where cv is the current value,
v is the voltage,
dtp the time taken to transmit the data packet dp.
For our simulation, the voltage is chosen as 5 V.

The formula (1) defines the multipath energy efficient OLSR routing in datacenter data transmission. The parameters are calculated from the intermediate nodes. So the effective energy consumptions obtained through E(dp). The current value (cv) taken from source node as well every node contain certain amount of energy to transfer the signal. During the transmission we have to count the hop, intermediate node, size of Data packet (dp), and neighbor addresses, then only we could find the effective residual energy level of each node.

2.4 Algorithm for Customized OLSR:

1. Sustain all in one hoping nodes for each node using customized HELLO message, with the residual energy of the nodes.

- ***Residual Energy scenario:***

a) Send HELLO packets with energy (residual energy) and customize entries. Willingness is obtained by setting threshold value for residual energy.

b) Select MPR nodes using willingness of that node in the network:

- ***Energy Consumption scenario:***

a) Send HELLO packets with energy (energy consumption of node) and customize entries.
b) Willingness is obtained by setting threshold value for energy consumption.

2. Find one hop table; insert the appropriate entries to its routing table.
3. Compare the entries with topology set and add to the routing table.
4. Every node, see recursively its last address until reached to the destination node, record the entire route information in the routing table using customized TC message (with the residual energy of the nodes).
5. Remove the loop entries.
6. G*et al*l the paths for given source-destination pair, with the residual energy of each node to the entire network.
7. Select all route paths, for given source-destination pair
8. Find out low energy of node, E(low), on each selected routes.
9. Find out highest energy of node, E(high), out of that E(low) values.
10. Use this selected route.

The performance of ad-hoc routing protocols greatly depends on the mobility model it runs over (Dimitrios, J., 2007). EE-OLSR protocol execution can be viewed in part V to proof the multipath customized energy conception.

3. Performance of route maintenance and bandwidth analysis:

In autonomous network once the route is initiated, a route maintenance protocol is used to offer feedback regarding the links of the route and to permit the route to be customized in case of any disruption due to movement of one or more nodes all along the route. Maintenance of the discovered/established route is necessary for two main advantages, first to achieve immovability in the network and secondly to reduce the excessive overhead required in discovering new route (Damla Turgut, S.K., 2001). Each time the route is used to forward a data packet, its expiry time is updated to be the current time plus ACTIVE_ROUTE_TIMEOUT (ART) and it is set to 3000 milliseconds (Satyadeva, P.,). ART is a constant value that defines as to how long a new discovered route is to be kept in the routing table of a node after the last transmission of a packet on that route. ART is defined for both the source and intermediate nodes in the network (Claude Richard and C.E. Parkins). If a route is not used for this predefined period, a node (source or intermediate) cannot be sure whether the route is still valid or not and removes the route from its routing table, this is to ensure no unnecessary packet loss.

If the source node moves while having an active session, and loses connectivity with the next hop of the route, it can rebroadcast an RREQ. When either the destination or some intermediate node moves, it initiates an RERR message and broadcasts it to its precursor nodes and marks the entry of the destination in the route table as invalid, by setting its distance to infinity (http://www.ieeesecon.org/2005/abstracts/ARTposter.pdf.).An active neighbor node list is maintained to keep track of the neighboring nodes that are using the entry to route data packets. In case link to the next hop is broken these neighboring nodes are notified with RERR packets. Each such neighbor node, in turn forwards the RERR to its own list of active neighbors, thus invalidating all the routes using the broken link (Parkins, C.E. and E.M. Royer, 1999).

In Energy efficient variation of OLSR we select MPRs on the basis of residual energy levels of nodes. Path determination algorithm is modified, selecting paths based on the residual energy level of intermediate nodes. When an intermediate node forwards a data packet to the next node, the former node should snoop at the latter’s traffic for some pre-defined time. If the former hears no transmission from the latter, it assumes the link to the next node is broken, in which case it will send an error packet (figure 4) to the source node.

<table>
<tr><td>Error Type</td><td>Option Length</td><td>Index</td></tr>
<tr><td colspan="3">Root Address</td></tr>
<tr><td colspan="3">Source Address</td></tr>
<tr><td colspan="3">Next Hop Address</td></tr>
<tr><td colspan="3">Destination</td></tr>
</table>

Fig. 5: The root *address* field indicates the source of the broken route, and the *from hop* and *next hop* identify the two end nodes of the broken link.

Ideal approach is sending more packets than realistic approach in above address diagram. As the traffic rate increases from low to high the Ideal approach send more and more packets.

3.1 Energy efficient route maintenance in MANET:

The core concept used in OLSR is that of Multi Point Relays (MPRs). Figure - 1 shows that MPRs as selected nodes which forward transmit messages during the overflowing process. In OLSR, link state information is generated only by the nodes elected as MPRs. After the MPR election the next hop for data packet forwarding is selected using the Minimum Drain Rate metric. The next step is the overhearing exclusion which is turning off the device when a unicast message exchange happens in its neighborhood. This can hoard a large amount of energy.

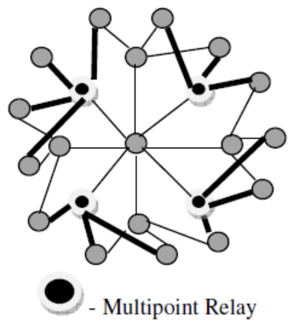

Fig. 6: MPR election in EE-OLSR Protocol.

The advantages of this protocol are that the nodes with residual energy are not stressed. Usage of an energy aware customized selection extends the lifetime of network. Without the listening energy consumption the energy in the network is consumed very slowly, allowing the nodes to send and receive the packets for a longer time. It was observed that EE-OSLR outperforms OSLR in terms of throughput, average nodes lifetime, connection expiration time and preserving the normalized control overhead. The higher bandwidth requirements and extra overhead due to constant route updates makes this method less efficient when compared with other reactive protocols.

3.2 Route and Bandwidth Analysis:

Route caching on one side decreases the route latency but at the same time prolonged caching may results into storing obsolete / invalid routes, which due to frequent progress of the destination or intermediate node(s) in MANETs. Extra traffic overhead and routing delay is incurred when an invalid route is used further it may result in loss of information packets. One approach to minimize the effect of invalid route cache is to flush out the cache entry after some TimetoLive (TTL) interval. If the TTL is set too small, valid routes are likely to be discarded, and large routing delay and traffic overhead may result due to the new route search. On the other hand, if the TTL is set too large, invalid route caches are likely to be used, and additional routing delay and traffic overhead may result before the broken route is discovered (Rajenra, V.,). Thus the efficiency of route caching lay between two contradictory conditions, how long the route has to be stored for subsequent use and how often to purge the same in order to avoid invalid routes. The aim in both cases is to avoid overheads and consequently save bandwidth and route latency

MANETs are characterized by limited bandwidth. With the transfer of intended data considerable bandwidth is also utilized by the control overheads. This bandwidth situation is further aggravated in case of large population networks exhibiting high mobility. Both the proactive and reactive (Ondemand) protocols generate a considerable amount of control overhead traffic for the route discovery and maintenance; this is further increased by the additional overheads used for detection and repair of frequent route breakages due to node mobility. Appropriate route caching not only achieve network stability, but the overhead cost (signaling, computation, etc) associated with route discovery and maintenance is reduced (Ben Liang, 2003).

4. *Datacenter Ad-Hoc residual energy level and Routing overhead:*

Eventually, it resulted in reducing the end to end delay and optimizing packet delivery ratio. Due to which this algorithm is taken into consideration for exploring its effect on protocols, as the research in DCMANETS should expand to match the rapid evolution of latest advancements in wireless communication technologies. For this OLSR protocol which in itself is energy aware protocol has been taken several times for enhancing its energy metric. In energy efficient optimized link state routing protocol (EE-OLSR) was introduced which modified the MPR selection mechanism based on willingness concept. It was noticed that EE-OLSR outperformed traditional OLSR in terms of throughput and average nodes lifetime. Also, a metric based evaluation of OLSR proved to be more energy efficient in (Damla Turgut, S.K., 2001). The overall aim of this work is to design energy efficient EE-OLSR protocol for mobile Ad hoc network. This had to accomplish by taking up proposed algorithm

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[16] known as low power consumption and high lifetime to be implemented over OLSR mechanism. In this, an initial value was taken up before simulation which indicated which node should participate in route discovery for a packet. The node having energy less than the threshold got destroyed from the route to be traversed and optimum route was followed. Adding to it, equal lengths of packets were transmitted so as to attain equal power consumption. According to the algorithm design two things need to be taken care of:

- OLSR should decide the low power consumption in advance. This had to be done by considering the threshold value, and comparing it with nodal energy of each node participating. The one found lower than the value should be removed off from the route.
- For equal power consumption of nodes message with equal packet length should be transmitted. OLSR periodically assessed the residual energy of each node in order to make comparison with initial value.

4.2 *Execution Scenario:*

For implementing the planned routing scheme we simulated datacenter dense wireless network, with 100 nodes moving in 1000 × 1000 M. area. Each node moves randomly in this for 40 ms simulation time. Care of the equal packet size transmission, we have taken 512 bytes packet length.

Energy Model:

Energy Model was setup as per the configuration shown in Table 3 over Energy Improved (EI) OLSR. According to it the initial, sending, receiving, idle and sleep power were taken.

Table 3: Input Configuration.

ENERGY MODEL	
Initial Power	6.8 Joules
Transmitting Power	0.66 Joules
Receiving Power	2.0 Joules
Idle power	0.9 Joules
Sleep power	0.05 Joules

Essential parameters like packet delivery ratio, energy consumption, and throughput were considered for analysis. The entry value was fixed to 1.7395781 joules. In future the nodes having energy below it were automatically destroyed. In contrary of entry parameter degraded in new EI-OLSR. The throughput of the protocols can be seen in below figure 7, where the new EI-OLSR plainly fails to exhibit better results. In the first 20 seconds both protocols peak up to the highest value, but at 20th second new EI-OLSR dips and remains constant for the simulation.

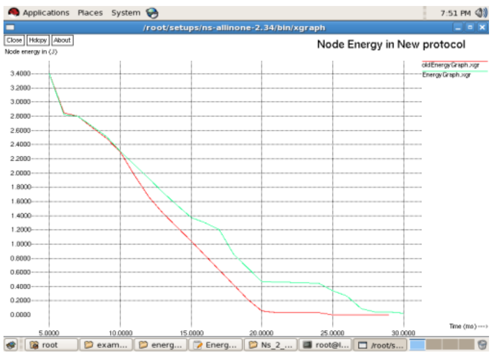

Fig. 7: Energy consumption comparison graph.

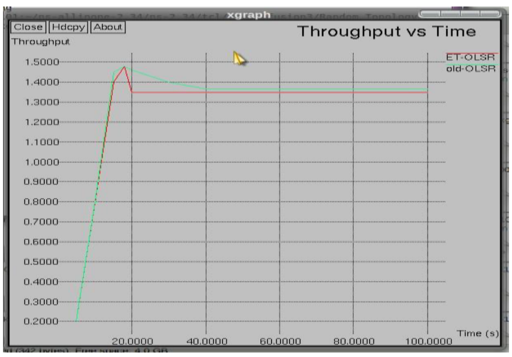

Fig. 8: Throughput comparison graph.

The outcome of new energy based initial OLSR were compared with the traditional OLSR and it was found that proposed OLSR is more efficient from the traditional in energy, network lifetime and Packet delivery ratio, whereas throughput is better in the traditional one.

The usual value of every parameter was taken for both protocols to acquire a clear picture of the outcomes. The values of the computer-generated outcomes are shown in Table 4.

Table 4: Comparison table of EI- OLSR and OLSR.

PARAMETERS	EI-OLSR	OLSR
Energy Consumption	2.122 joules	3.24213joules
Packet Delivery Ratio	88.69 %	83.31%
Throughput	1402.8 kbps	1436.13 kbps

The above table was considered over OLSR, where initial value for energy was taken as 1.8324287 joules. We proposed a new protocol EI-OLSR taking energy enhancement as central issue of concern. From assessment graphs we disguised that EI-OLSR outperforms the traditional OLSR in terms of PDR and energy consumption. As it could not do the same for throughput, it is suitable for environments where the parameter can be ignored.

We have worn this data to evaluate the performance of both traditional OLSR and EI-OLSR from energetic point of view. Figure 9 illustrates the packet delivery ratio (PDR) for both the protocols.PDR of both protocols shoot up in first 5 seconds. Afterwards the old OLSR lowers down. Both protocols show variations in the remaining seconds. The proposed ET-OLSR outshines from traditional in PDR statistics.

Fig. 9: Packet delivery ratio comparison graph.

As significant packets state was taken, the consistency of the routing increased. Due to which the increase in PDR was experienced in EI-OLSR. If you evaluate about the energy efficient variation of OLSR we select MPRs on the basis of residual energy levels of nodes. Route resolve algorithm is customized, selecting routes based on the residual energy level of intermediate nodes. Nodes with low residual energy are passing up. The route & MPR selection is such that to lowest bottleneck residual energy level. That will increase the efficiency of network. If wrong or old information is collected by nodes then efficiency is degraded as route may vanish. But the main issue is how to collect the correct residual energy information. One solution is use of EOLSR that select route and MPRs on basis of residual energy of nodes and number of neighbors.

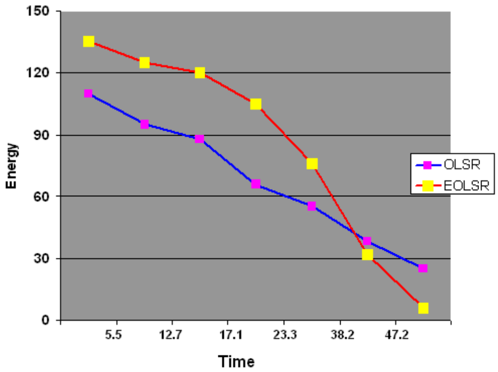

Diagram 3: Comparison of OLSR and EIOLSR Residual Energy Levels.

Ultimate approach is sending more packets than realistic approach in below diagram. As the traffic rate increases from low to high the Ideal advance send more and more packets. Omniscient knowledge of a node's energy level brings more packets than the sensible adaptation. These outcomes are a direct consequence of the increased level of congestion in the network which results in high message loss and delay and hence less accurate state information. We compare OLSR and EI-OLSR and see how energy differs with network life. In OLSR MPRs are not frequently changed & efficiency degraded. But in EI-OLSR MPRs selection depends on residual energy level of nodes. So EIOLSR performs better than OLSR.

Conclusion:

Datacenter Manet is a vast developing in communication industry. Here, our workouts so far show that nodes have inaccurate information about the actual residual energy levels when making routing decisions. Customizing the OLSR protocol limit has very limited impact on this inaccuracy. This means if we increase the frequency of TC and Hello messages improve residual energy information of neighboring nodes a little but increase the traffic overhead. So we need some other method to improve the accuracy of energy state information. According to that we proposed the new technique to increase energy level accuracy. Energy consumption is a major fact to continuous access of every connection points. The graph proves that the energy consumed by traditional OLSR is more as compared to the newly implemented EI-OLSR protocol. According to the algorithm implemented over traditional OLSR, it was expected that the network lifetime will show improvement in the protocol. Eventually, the energy consumption of EI-OLSR is more successfully achieved. Although we obtain the solution that increases the number of nodes breath choosing energy optimized routes in the network with some increase in control routing overheads and end to end delivery. Finally EI- OLSR outcome that performance of new protocol increases terms of energy consumption and packet delivery ratio.

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