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Improved OLSR Protocol for VANETs and Comparison with State of Art DSR and AODV Protocols

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Abstract: The aim of this work is to show the design of our work and analyse the performance of our Improved Optimized Link State Routing (I-OLSR) with the current state of art Ad hoc On Demand Distance Vector (AODV) routing, Dynamic Source Routing (DSR) and standard Optimized Link Stare Routing (OLSR) Ad hoc routing protocol using OPNET. The analysis is performed by varying the number, speed and transmits power level of nodes for the considered performance metrics that is throughput, end to end delay and network load, and show their impact on the performance of AODV, DSR and OLSR ad hoc routing protocols. The results concluded that the OLSR protocol shows better performance as compare to AODV and DSR for end to end delay and throughput but it suffers with high network load with the default configuration of control messages in OLSR. This is due to the reason that it requires to maintain routing table at each node which causes the extra load on the network and hence the network get loaded. The further experiments showed that the optimization of OLSR control messages parameters (Hello interval, TC interval, Network hold time and Topology hold time) leads to the improvement in OLSR network load.

Keywords: Ad hoc routing protocols, OPNET, Performance analysis, DSR, AODV, OLSR, Improvement

1. INTRODUCTION

Wireless networks are of two main types. The first one is the infrastructure based wireless networks while the second one is the infrastructure less wireless networks. The infrastructure based wireless network consists of a central node and the client nodes. On such networks the client nodes communicates to other neighboring nodes through the central node. The infrastructure less network (ad hoc network) is decentralized network. In such networks, the communication takes place among the mobile nodes without any central administration (Hosek, 2012). Each mobile node works as a router to receive and forward packets to the neighbouring nodes. (Vadhwani *et al.,* 2013; Abdule *et al.,* 2010).

The VANET is the more challenging form of MANET to link between themselves and other vehicles with high speed through wireless communication (Erritali and Bouabid., 2013; Zukarnain *et al.,* 2014).

For the efficiency measurement of the routing protocol, using considered performance metrics, it is required to analyse the Ad hoc On Demand Distance Vector (AODV), Dynamic Source Routing (DSR) and Optimized Link State Routing (OLSR) routing protocols comparatively, which one of the routing protocol is more suited to the VANET environment? Which elements have most impact on the results of the routing protocols in VANET?

How the results of routing protocols can be improved for VANET?

The remaining paper is arranged as, Part 2 briefly review the earlier work. Part 3 explores an overview of the Ad-hoc routing protocol. Part 4 gives a brief description of the Simulation parameters. Part 5 provides the simulation results and discussions. Finally there is conclusion at the end.

2. RELATED WORK

For the improvement in the selection of the routing protocol for VANET out of different available situations, some parameters has been proposed i.e. delay, throughput and network load that improve their performance while maintaining required constraint. On practicing this, the end to end delay and network load is decreased while the throughput is increased.

The authors (Amith., 2012) compared AODV and DSR ad hoc routing protocols. Simulation results showed that AODV has a stable and low End to End Delay despite speed as compare to DSR and the Routing load was higher in DSR than AODV.

The authors (Lalitha and Rajesh., 2013) work explored the impact of the routing protocol performance against varying transmission power of the mobile nodes and concluded that there was a significant effect of the transmission power of nodes on the routing protocols performance.

The authors (Singh and Mahajan., 2013) work analysed that OLSR showed best results in terms of network load and throughput, AODV showedd worst response in terms of throughput and network load while

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AODV showed better response for delay out of three parameters.

The authors (Rajesh and Siva 2013) analysed the comparative study of DSR, AODV and DSDV routing protocols with conclusions that the performance varied widely across different number of nodes and different types of speed in node mobility.

The authors (Mohammad *et al.,* 2006) showed that the overall performance of DSR in terms of network load is best as compared to AODV and OLSR.

The authors (Gupta and Verma 2013) presented the impact of OLSR performance on "Hello interval" value. It concluded that the OLSR performance improved with the increase in the value of "Hello interval".

3. AD HOC ROUTING PROTOCOLS

In VANET, routing is the process where the vehicles continuously exchange the topology and link state information by communicating with each other for searching the best routes.

VANET routing protocols can be categorized as.

- Reactive routing protocols
- Proactive routing protocols
- Hybrid routing protocols

3.1 Reactive Routing Protocols

It is the type of routing protocol in which the routes are discovered as required or demanded therefore sometimes also named as on demand routing protocols. The common reactive protocols are DSR, TORA and AODV.

3.2 Proactive Routing Protocols

In the proactive routing protocols (table driven), the routes are built before they need it (Toutouh *et al.,* 2013). The routes are discovered by continuously processing the known routes and trying to build new routes. The most common proactive routing protocol is OLSR.

3.2.1 Optimized Links State Routing Protocols (OLSR)

OLSR (link state) maintains routing table at each node. The routes are already stored in the cache and are immediately provided when required therefore it offers very low delay. OLSR uses an important concept that is known as "multipoint relays" (MPRs).

3.3 Hybrid routing protocol

In hybrid protocols, the reactive as well as the proactive protocols are combined to utilize the features of both the types of routing protocols. It establishes routes more quickly in the routing zone. The common protocol includes ZRP.

4. IMPROVED OLSR DESIGN AND WORKING

4.1 Improvements in OLSR Control Message Parameters

In OLSR routing protocol, different control messages are exchanged periodically to maintain the topology information of the entire network with highly dynamic nature. These control messages which include Hello interval, Topology control (TC) interval, Topology hold time, and Neighborhood time perform the core functions. The Adjustment of these OLSR parameters leads to the improvement on OLSR network load.

4.1.1 Hello Interval Impact on Network load

OLSR network load is high if smaller is the value of Hello interval. This is due to the increase in the number of sent Hello messages. On the other hand the OLSR network load is low if larger is the value of Hello interval. This is due to the decrease in the number of sent Hello messages.

4.1.2 TC interval Impact on Network Load

OLSR network load is high if smaller is the value of TC interval. This is due to the increase in the number of sent TC messages. On the other hand the OLSR network load is low if larger is the value of TC interval. This is due to the decrease in the number of sent TC messages. It is also evident from the figure below that the value of TC interval affects the network load but less than it is less than the Hello message interval.

4.1.3 Neighbor Hold Time Interval Impact on Network Load

When the neighbor hold time interval value is low, it has low network load due to small value of link expiry time. The network load is increasing with the increase of the neighbor hold time interval value due to high value of link expiry time.

4.1.4 Topology hold time interval Impact on Network Load

When the topology hold time interval is set low, the network load will be higher and vice versa.

4.2 Improvements in OLSR Transmit Power of Nodes

The transmit power of a node affects the throughput, E-E delay and network load in vehicular ad-hoc networks. The network load can be improved by setting the proper transmit power of nodes.

4.1.2 Throughput:

During the low transmit power of nodes, the OLSR protocol has low throughput but beyond the power range about .01W, the throughput level increases and about constant. This happens due to the increase in the no. of nodes with increase in transmit.

4.2.3 End to End delay:

During the low transmit power of nodes; the OLSR protocol has large End to End delay as the packets are routed through multi hops but beyond the power range about .01W, the End to End delay level decreases and about constant.

5 SIMULATION ENVIRNMENT

The simulations are performed using OPNET 14.5 Simulator. For all the simulations, the simulation time is 300 sec, the maximum speed of the nodes is set to 300Km/h and the density of nodes is set as 20, 40, 60 and 80 nodes.

6 SIMULATION RESULTS AND ANALYSIS

The aim of this work is to analyse the performance of AODV, DSR and OLSR Ad hoc routing protocols using OPNET. This analysis is performed by varying the number, speed and transmits power level of nodes for the considered performance metrics and sketches their impact on the performance of AODV, DSR and OLSR ad hoc routing protocols. The results could lead to the selection of routing protocol which is the most suitable to the VANET scenario.

6.1 Throughput

In this case, OLSR outperforms DSR as well as AODV as it maintains all routes inside the cache memory where routes are immediately available if required. AODV has high throughput than DSR. **(Fig.1,2)**

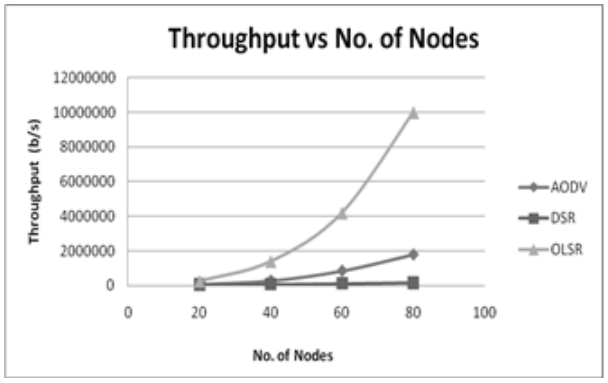


Fig. 1: Throughput vs. No. of nodes

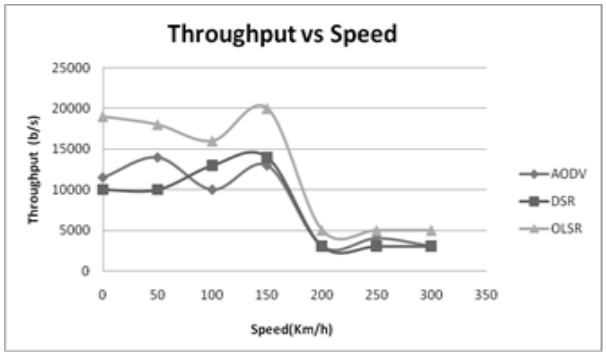


Fig.2: Throughput vs. Speed of nodes

Overall OLSR shows better throughput performance as compare to DSR and AODV.

6.2 End- to- end delay

The end to end delay is directly related to the number of nodes as shown by **(Fig.3)**

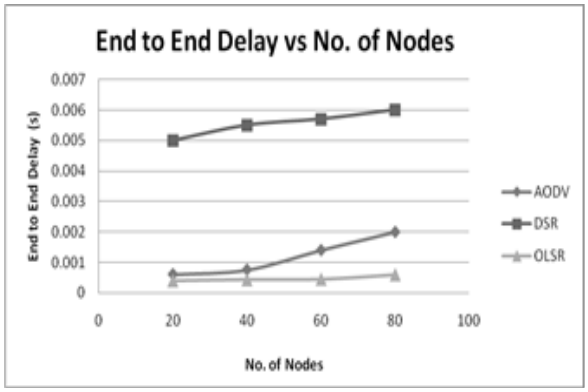


Fig. 3: End to End Delay vs. No. of Nodes

DSR offers higher delay than AODV and OLSR either speed or number of nodes is varied as evident from **(Fig.4)**

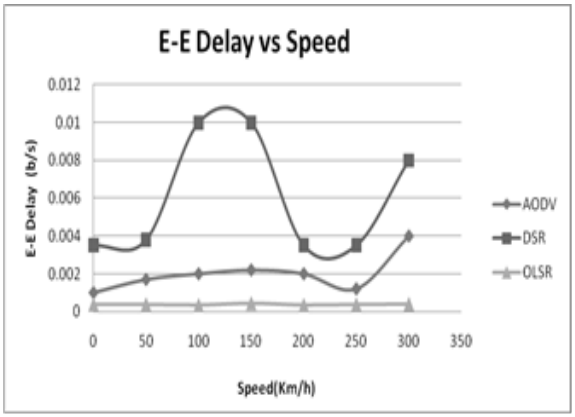


Fig. 4: E-E Delay vs. Speed of Nodes

This happens due to the reason that in DSR least congested route is determined which makes its route discovery process slow. On the other hand, the OLSR has low delay as compare to AODV and DSR as routes are immediately available when required. In this scenario, it is also shown that the OLSR has stable and also less delay as compare to AODV and DSR either number or speed of nodes is set high. Overall OLSR shows better performance as compared to DSR and AODV as for as the end to end delay is considered.

6.3 Network load

DSR choose only one route for the packet delivery. OLSR has higher network load than DSR and AODV because there is need to maintain the routing table at each node .It causes the extra load on the network.

In **(Fig.5)** scenarios, it is clearly shown that the network load is directly related to the number of nodes. DSR has lowest network load as it use only route for the packet delivery, while on the other side OLSR has the highest network load as it needs to maintain routing table at each node. This causes the extra load on the network.

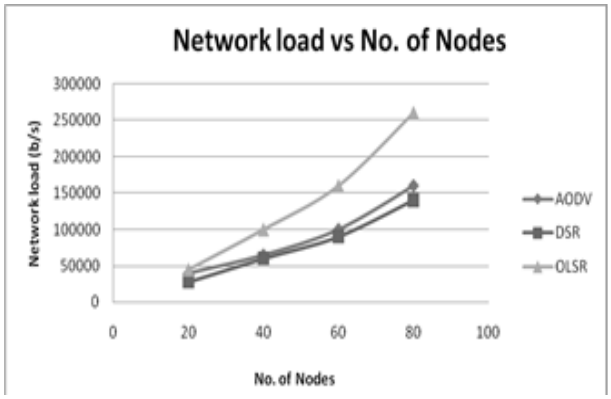


Fig. 5:.Network Load vs. no. of nodes

In **(Fig.6)**, it is shown that the DRS has lowest network load while the OLSR has the highest network load even if node are moving with very low or very high speed.

It is concluded here on the basis of the simulation results that OLSR protocol is most suitable to the VANET scenario as it results high throughput and low delay time but it suffers with high network load which is required to be minimized.

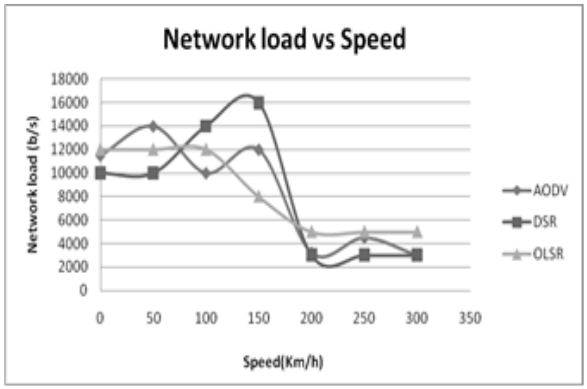


Fig. 6: Network Load Vs. Speed

7 CONCLUSIONS

The OLSR is the most suitable protocol for VANET, but it has high network load which is required to be less, being a needful performance metric. The network load in OLSR is improved by the optimization of the control message parameters, most importantly Hello interval and TC interval. The optimum transmit power of nodes in OLSR also leads to the improvement in its network load.

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