An Implementation of Routing Protocol for Topology Control in MANET

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Abstract: *In this paper, we propose an enhanced MPR selection algorithm of OLSR protocol that conserve the benefits of the original algorithm and add other parameters to select MPR nodes by using local databases of neighbor nodes extended to three hops. These improvements reduce the number of TC packets. The new proposed algorithm uses a simple modification in OLSR protocol without additional overheads. That is, we designed and implemented an initial routing protocol IOLSR that extends the well-studied OLSR protocol. IOLSR is designed for mobile multicast routers, and works in a heterogeneous network composed of simple unicast OLSR routers, IOLSR routers and hosts. Wireless Internet Group Management Protocol (WIGMP) offers the possibility for OLSR nodes (without multicast capabilities) to join multicast groups and receive multicast data. IOLSR protocol takes benefit of the topology knowledge gathered by the OLSR protocol with its topology control messages exchange to build multicast trees. It works even when not all nodes are multicast capable. A multicast tree is built and maintained for any tuple (source, multicast group) in a distributed manner without any central entity and provides shortest routes from the source to the multicast group members. The multicast trees are updated whenever a topology change is detected.*

Simulation Results Shows that IOLSR protocol shows 26.35% improved results than OLSR protocol in terms of PDR. It also shows improved results for Throughput and Residual Energy but it has 8.76% high Delay as compared to OLSR protocol. The algorithm preserves capacity and connectivity of network, decreases latency and also provides significant energy conservation.

Keywords: *MANET, Topology Control , OLSR and IOLSR Routing Protocols, NS-2.35.*

1. INTRODUCTION

A mobile ad-hoc network (MANET) is a self-configuring infrastructure less network of mobile devices connected by wireless. Ad-hoc is Latin and means “for this purpose” or “unplanned”. Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices regularly. Each must forward traffic not related to its own utilization, and therefore be a router. The primary challenge in building a MANET is equipping each device to constantly maintain the information required to suitably route traffic. Such network may supervise by them or may be connected to the larger Internet [14]. MANET is a kind of wireless ad hoc networks that usually has a routable networking environment on top of a Link Layer ad hoc network. There are two ways of classification of routing protocols of MANET; based on network routing strategy it is classified as table-driven (proactive) and source initiated (reactive) while based on the network structure it is classified as flat routing, hierarchical routing and geographic position assisted routing [15].

Topology control is the art of coordinating nodes decisions regarding their transmitting ranges, in order to generate a network with the most wanted properties (e.g. connectivity) while reducing node energy consumption and/or increasing network capacity. Topology control is an additional protocol layer positioned between the routing and MAC layer (Figure.1.1).The routing layer is responsible for finding and maintaining the routes between source/ destination pairs in the network: when node uhas to send a message to node v, it invokes the routing protocol, which checks whether a(possibly multi-hop) route to v is known; if not it starts a route discovery phase, whose purpose is to identify a route to v; if no route to v is found, the communication is delayed or aborted. The routing layer is also responsible for forwarding packets toward the destination at the intermediate nodes on the route.

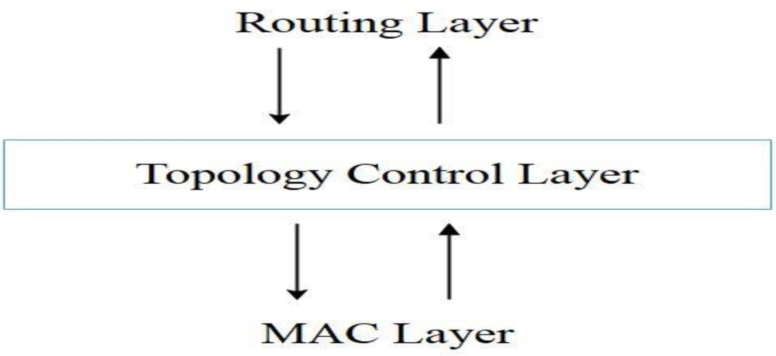


Figure 1.1 Topology Control in Protocol Stack

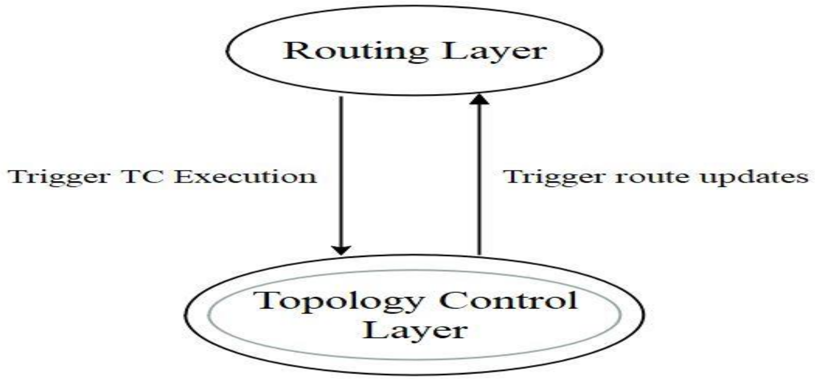


Figure 1.2 Interactions between Topology Control and Routing [18].

The two-way interaction between the routing protocol and topology control is depicted in Figure 2.2. The topology control protocol, which creates and maintains the list of the immediate neighbors of a node, can trigger a route update phase in case it detects that the neighbor list is considerably changed. In fact, the many leave/join in the neighbor list are likely to indicate that many routes to far away nodes are also changed.
So, instead of passively waiting for the routing protocol to update each route separately, a route update phase can be triggered, leading to a faster response time to topology changes and to a reduced packet-loss rate. On the other hand, the routing layer can trigger there-execution of the topology control protocol in case it detects many routes breakages in the network, since this fact is probably indicative that the actual network topology has changed a lot since the last execution of topology control.

2. Optimized Link State Routing Protocol (OLSR)

Optimized Link State Routing (OLSR) is a proactive routing protocol for mobile ad hoc networks. The protocol has the benefit of having routes instantly available when needed due to its proactive nature. OLSR reduces the routing overhead which is caused due to flooding of control traffic by using the method of only selected nodes, called as Multi-Point Relays (MPR), to retransmit control messages in the network. This technique efficiently decreases the number of retransmissions which is required to flood messages to all nodes in the network. When a node receives an update message it determines the routes (sequence of hops) toward its known nodes. Each node selects its MPRs from the set of its neighbors saved in the Neighbor's table. This neighbors set covers nodes within a distance of only two hops. The technique is that whenever the node broadcasts the message, only the nodes selected as its MPR set are responsible for the further broadcasting of the message [3] [1]. OLSR uses HELLO and TC messages for the diffusion of these control messages. The Topology Control (TC) messages provides for continuous information of the routes to destinations in the network. OLSR protocol is very significant for traffic patterns where a large number of nodes are communicating with another large number of nodes, and where the [source, destination] changes frequently over time. The HELLO messages are sent periodically among the neighbor node which detects the identity of neighbors and helps in MPR selection. The protocol is particularly suited for large and dense networks, as the optimization is done by using MPRs which work well in this environment. The large and dense network achieves more optimization as compared to classic link state algorithm. OLSR uses hop-by-hop routing, i.e., each node uses its local information to route packets from source to destination [4].

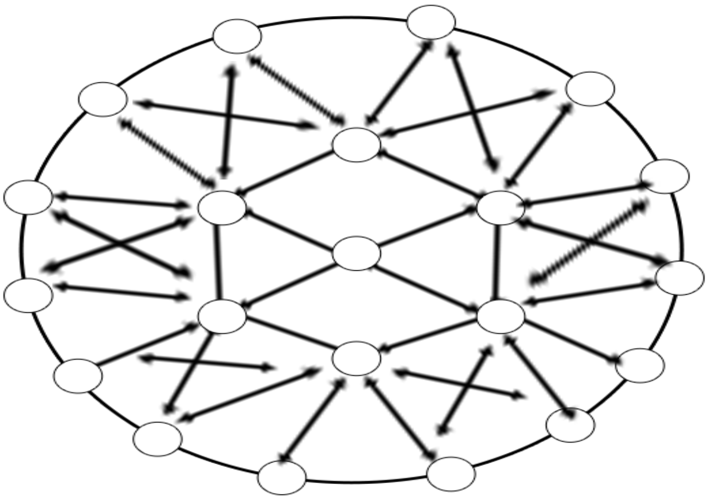


Fig.2.1 Flooding a packet in a wireless multi-hop network

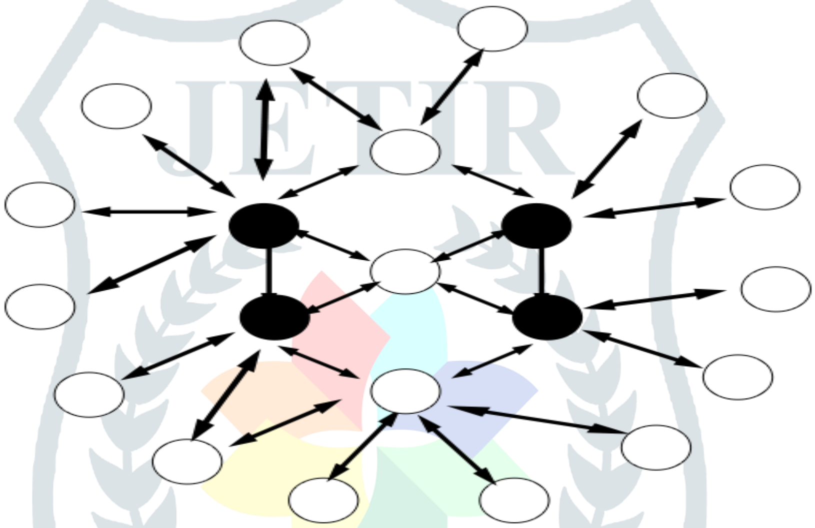
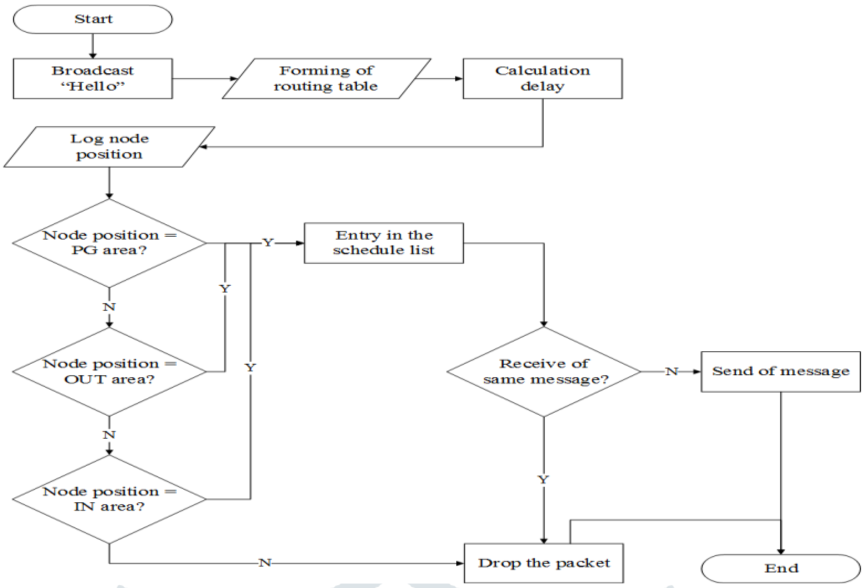


Fig.2.2 Flooding a Packet in wireless multi-hop network from the centre node using MPR

3. PROPOSED PROTOCOL

The research methodology used is simulation-based prototyping. That is, we designed and implemented an initial routing protocol IOLSR that extends the well-studied OLSR protocol. The new protocol is validated, and the performance is measured using the NS2 standard discrete event network simulator. We revise the protocol based on these performance measurements to produce the final protocol, IOLSR. IOLSR is designed for mobile multicast routers, and works in a heterogeneous network composed of simple unicast OLSR routers, IOLSR routers and hosts. Wireless Internet Group Management Protocol (WIGMP) offers the possibility for OLSR nodes (without multicast capabilities) to join multicast groups and receive multicast data. IOLSR protocol takes benefit of the topology knowledge gathered by the OLSR protocol with its topology control messages exchange to build multicast trees. It works even when not all nodes are multicast capable provided that multicast nodes offer the minimal connectivity between the sources and the members of the multicast group. A multicast tree is built and maintained for any tuple (source, multicast group) in a distributed manner without any central entity and provides shortest routes from the source to the multicast group members. The multicast trees are updated whenever a topology change is detected.

- **FLOW CHART**



4. NETWORK SIMULATION

Generally network simulators try to model the real world networks. The principle idea is that if a system can be modelled, then future of the model can be changed and the corresponding results can be analyzed. Following features are provided by simulator.

- Easy network topology setup
- Protocols and application implementation
- UDP
- FTP, Telnet, Web, CBR, VBR
- Routing protocols
- Queue management protocols
- Configurability
- Extensibility

Table 4.1 Simulation Parameters

Simulation Tools	NS-2.35
IEEE Scenario	802.11(MANET)
Propagation	Two Ray Ground
No. of Nodes	10, 20, 30, 40, 50 Nodes
Channel	Wireless Channel
Traffic Type	TCP
Antenna	Omni Directional Antenna
MAC Type	IEEE 802.11
Routing Protocol	OLSR and IOLSR
Queue Limit	50 Packets
Queue Type	Droptail
Simulation Time and Area	100 seconds, 2000M

5. IMPLEMENTATION AND RESULTS

Packet Delivery Ratio

This is the fraction of the data packets created by the CBR sources to those successively delivered to the destination. This evaluates the ability of the protocol to discover the routes. Figure 5.1 shows the Packet Delivery ratio under various mobility networks with OLSR and IOLSR routing protocol.

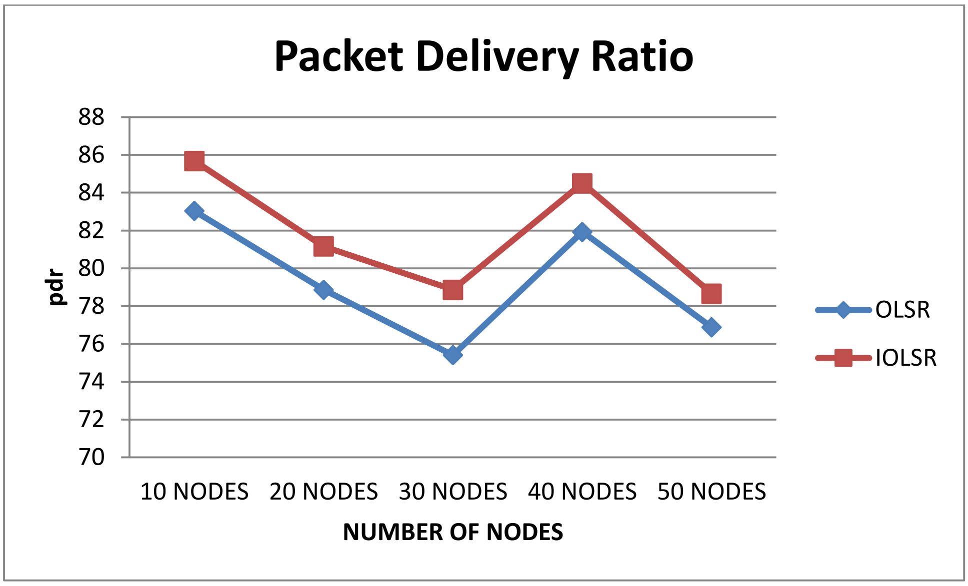


Figure: 5.1 Packet Delivery Ratio Results

Table 5.1 Packet Delivery Ratio

NODES	OLSR	IOLSR
10 NODES	83.04	85.69
20 NODES	78.87	81.16
30 NODES	75.41	78.87
40 NODES	81.93	84.5
50 NODES	76.88	78.67

Analysis of Packet Delivery Ratio: - From the above figure it is analyzed that Topology controlled IOLSR has better Packet Delivery ratio as compare to the OLSR.

Throughput

The average rate at which the data packet is delivered successfully from one node to another over a communication network is known as throughput. The throughput is usually measured in bits per second (bits/sec). A throughput with a higher value is more often an absolute choice in every network. Figure 5.2 shows the Throughput under various mobility networks with OLSR and IOLSR routing protocol.

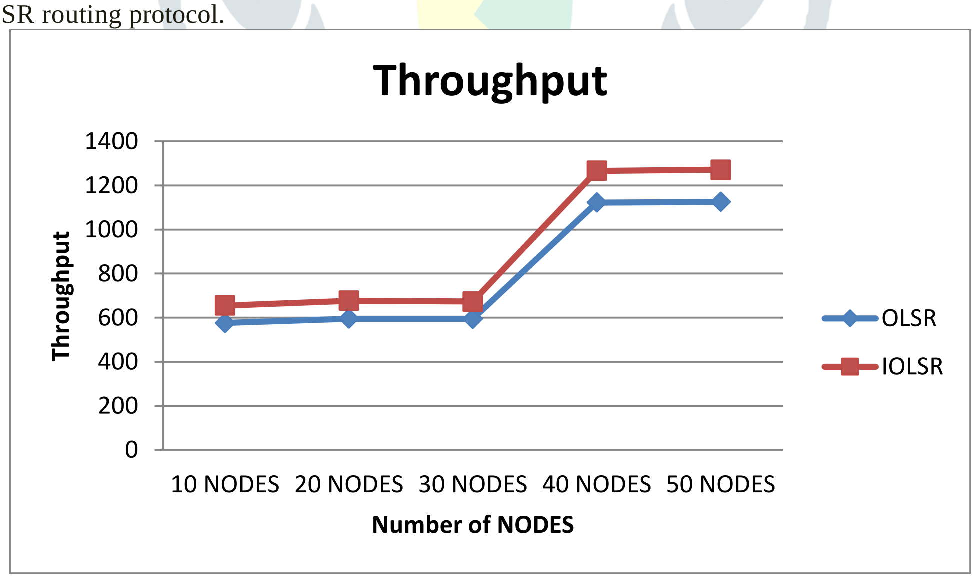


Figure: 5.2 Throughput Results

Table 5.2 Throughput

NODES	OLSR	IOLSR
10 NODES	575.63	655.05
20 NODES	595.77	677.11
30 NODES	595.07	672.91
40 NODES	1122.76	1266.73
50 NODES	1125.73	1271.32

Analysis of Throughput: From the above figure it is analyzed that Topology controlled IOLSR has higher Throughput as compared to OLSR.

End-to-End Delay

End-to-End delay is the time required to traverse from the source node to the destination node located in a network. The end-to-end delay is measured in second. The delay assesses the ability of the routing protocols in terms of use- efficiency of the network resources. Figure 5.3 shows the End-to-End Delay various protocols networks network with OLSR and IOLSR routing protocol.

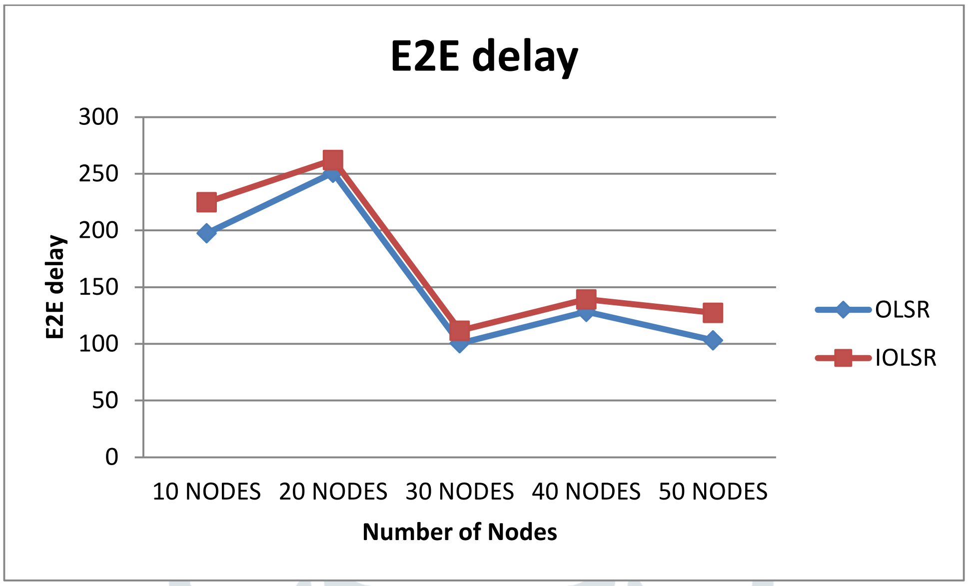


Figure: 5.3 End to End Delay Results

Table 5.4 End-to-End Delay

NODES	OLSR	IOLSR
10 NODES	197.421	224.799
20 NODES	250.917	262.23
30 NODES	100.528	111.572
40 NODES	128.288	139.284
50 NODES	103.201	127.334

Analysis of End-to-End Delay :- From the above figure it is analyzed that End-to-End Delay in IOLSR is more as compared to OLSR.

Residual Energy

Total amount of energy used by the Nodes during the Communication or simulation for example node having 100 percent energy and after complete simulation 40 percent energy remaining so we can say that the Residual energy of the node is 60 percent.

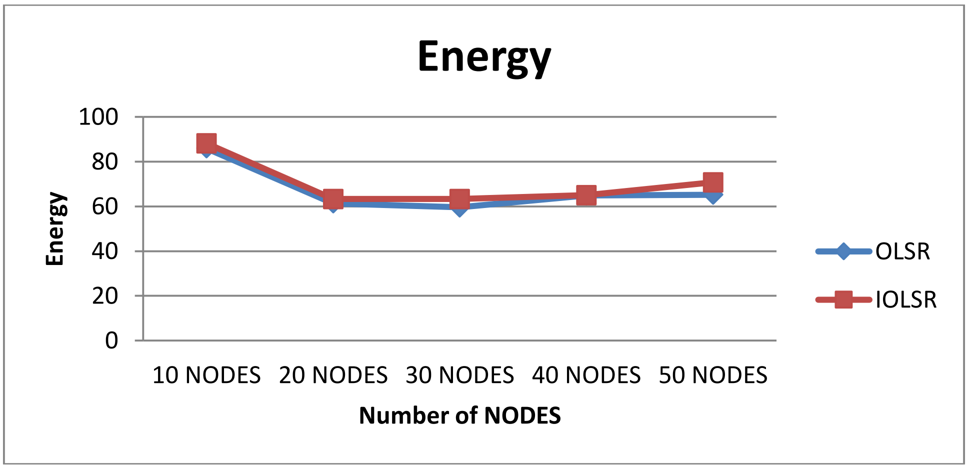


Figure 5.4 Residual Energy

Table 5.4 Residual Energy

NODES	OLSR	IOLSR
10 NODES	85.98829	88.247862
20 NODES	61.349369	63.323032
30 NODES	59.596203	63.350485
40 NODES	64.967306	65.063963
50 NODES	65.235799	70.725945

Figure 5.4 shows the Residual Energy various protocols networks network with AODV routing protocol.

Normalized Routing Load

Normalized Routing Load the number of routing packets transmitted per data packet delivered at the destination. Each hop -wise transmission of a routing packet is counted as one transmission.

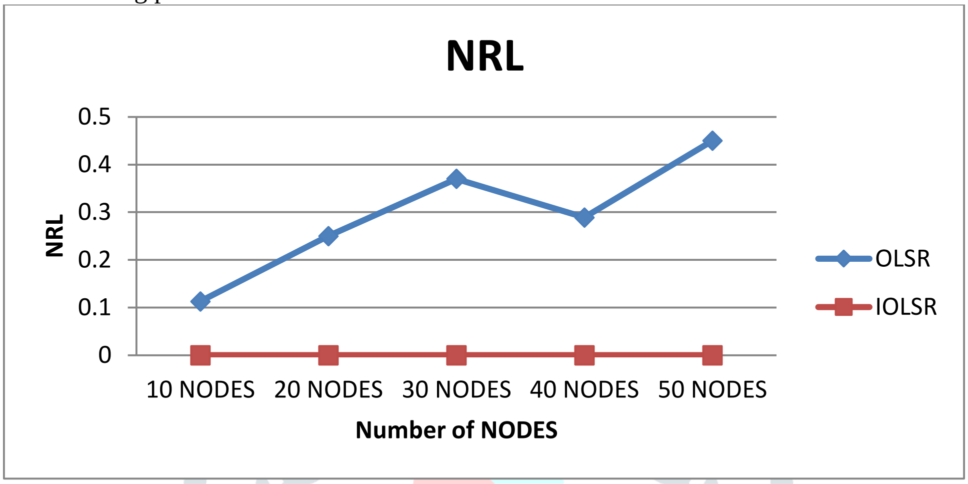


Figure 5.5 Normalized Routing Load

Table 5.5 Normalized Routing Load

NODES	OLSR	IOLSR
10 NODES	0.113	0
20 NODES	0.25	0
30 NODES	0.37	0
40 NODES	0.289	0
50 NODES	0.45	0

6. CONCLUSION

Conserving energy in MANET is challenging due to its mobility, changing topology, and mainly due to trade- off between keeping nodes in power-save mode and maintain efficient & effective communication. The key issue treated in this master's thesis project has been the improvement of parameters in Mobile Ad-Hoc Networks using the Network Simulator. It is concluded in terms of PDR, IOLSR protocol shows average of 26.35% improvement as compared to OLSR. In terms of Throughput, IOLSR protocol shows average of 2% improvement as compared to OLSR. In terms of Residual Energy, IOLSR protocol shows average of 22.83% improvement as compared to OLSR. In terms of Delay, IOLSR protocol shows average of 8.76% more delay as compared to OLSR. By the results and their analysis, it can be concluded that with the topology control the network performances are improved greatly as compared to network without topology control. The algorithm preserves capacity and connectivity of network, decreases latency, and also provides significant energy conservation.

REFERENCES

[1] "Defense Advanced Research Projects Agency (DARPA) Home Page," http://www.darpa.mil.

[2] J. Jubin and J.D. Tarnow, "The DARPA Packet Radio Network Protocols", *Proceedings of the IEEE 75,* pp. 21–32, January 1987.

[3] T. Rappaport, "Wireless Communications: Principles & Practice", *Prentice Hall*, Englewood Cliffs, 1996.

[4] P. M. Shankar, "Introduction to Wireless Systems", *John Willey & Sons INC,*2002.

[5] Y. Wang and Li. Fan, "Vehicular ad hoc networks In Guide to Wireless Ad Hoc Networks", *Springer*, Berlin, Germany, 2009.

[6] Paolo Santi, "Topology control in Wireless Ad Hoc and Sensor Networks", *Instituto di Informatica e Telematica*, ACM

Computing Surveys, pp. 164–194, Vol. 37, No. 2, June 2005.
[7] Zhuochaun, H. Chien-Chung, S. Sathapornphat, S. and Jaikacoc, “Topology control for Ad hoc Networks with directional antennas”, *Computer Communications Networks*, 2002.
[8] Atsushi Yoshinari, Hiroki Nishiyama, Nei Kato, and Dan Keun Sung, "Dynamic Topology Update Mechanism in Local Tree-based Reliable Topology (LTRT) based MANETs," *IEEE International Conference on Communications (ICC 2012)*, pp.1-6,Ottawa, Canada, Jun. 2012.
[9] T.Hu,“Topology Controlfor Multi hop Packet Radio Networks”, *IEEE Trans. on Communication*, pp.1474-1481, Vol.41, No. 10, 1993.
[10] N. Li, J.Hou and LuiSha “Design and Analysis of an MST-based Topology Control Algorithm”, IEEE Infocom’03.
[11] S.S. Dalu, M.K.Naskar and C.K. Sarkar, “Implementation of a Topology Control Algorithm for Mobile Ad hoc Networks Using Pursue Mobility Model”, *Journal of Applied Computer Science*, pp.14-20, Vol. 2 *no.2*, Suceava, 2008.
[12] S.Venkates anand C.David Young, “A Distributed Topology Control Algorithm for MANETS”, *International Journal of Computer Applications*,pp.1-7, Vol. 9, No.9, November 2010.
[13] Quansheng Guan, F.Richard Yu, Shengming Jiangand VictorC. M.Lung, “Topology Control in Mobile Ad hoc Networks With Cooperative Communications”, pp.2-7, *IEEE Wireless communications*, 2012,
[14]X. Jia, D. Li, “Qos topology control in adhoc wireless networks”, *in Proc. IEEE INFOCOM*, pp. 1264– 1272, 2004.
[15] Zhuochaun, Chien-Chung, S.Sathapornphat, S. and Jaikacoc,“Topology Control for Ad hoc Networks with directional antennas”, *Proceedings of the 11th International Conference on Computer Communications Networks*, pp.14-16, October.
[16] Jie Wu and Fei Dai, “Mobility-Sensitive Topology Control in Mobile Ad Hoc Networks” *IEEE Transactions on Parallel & Distributed Systems*, vol. 17, No.6, pp.522-535,June 2006.
[17] P.Senthil kumar, M. Baskar and K. Saravanan, “A Study on Mobile AD-HOC Network (MANETS)” *Journal of Management and Science*, pp. 16-22, Vol. 1, No.1, Sep. 2011.
[18]M. Shahaya Sheela, A. Sivanantha Raja and V.R. Sarma Dhulipala “Parametric Analysis of Mobile Ad-Hoc Network Environment” *International Journal of Computer Applications*, pp. 33-36, Vol. 9, No.9, November 2010.
[19] Hemanth Narra, Yufei Cheng, Egemen K. Cetinkaya, Justin P.Rohrer and James P.G. Sterbenz “Detination-Sequenced Distance Vector (DSDV) Routing Protocol Implementation in NS-3”, March 2011.
[20] Naigende Duncan and Btulega Tonny Eddie“An Energy-Efficient Dynamic Source Routing Protocol for Mobile Ad Hoc Networks” *International Journal of Computing and ICT Research*, pp. 23-32,Vol.6, Issue 2, December 2012.
[21] Meenakshi, Vinod Kumar Mishra and Kuber Singh, “Simulation & Performance Analysis of Proactive, Reactive & Hybrid Routing Protocols in MANET” *IJARCSSE*Vol. 2, Issue7, July2012.
[22] S.S.Manvi, M. S.Kakkasageri and C. V. Maha purush, “Performance Analysis of AODV, DSR, and Swarm Intelligence Routing Protocols In Vehicular Ad hoc Network Environment”, *International conference on future Computer and Communication*, pp. 21-25, April. 2009.
[23] Hiroki Nishiyama, Thuan Ngo, Nirwan Ansari, and Nei Kato, “On Minimizing the Impact of Mobility on Topology Control in Mobile Ad Hoc Networks,” *IEEE Transactions on Wireless Communications*,pp.1158-1166,vol.11, no. 3, Mar. 2012.
[24] Tan, H. X. Tan and W. K. S. Seah, “Dynamic Topology Control to Reduce Interference in MANETs,” *Institute for Infocomm Research Technical Report: NET-2004-AHN-GENERAL-0027*, Nov 2004.
[25] Y. Zhang and W. Lee, “Intrusion detection in wireless ad-hoc networks,” *in Proceedings of the 6th ACM Annual International Conference on Mobile Computing and Networking (MobiCom ’00)*, Boston, Massachusetts, USA: ACM Press, pp. 275–283, 2000.
[26] S. Marti, T. J. Giuli, K. Lai, and M. Baker, “Mitigating routing misbehavior in mobile ad hoc networks,” in Proceedings of Mobile Computing and Networking (MobiCom ’00)), 2000, pp. 255–265.
[27] Y.C. Hu, A. Perrig, and D. B. Johnson, “Ariadne: A secure on-demand routing protocol for ad hoc networks,” *in Proceedings of the 8th Annual International Conference on Mobile Computing and Networking (MobiCom ’02*), Atlanta, USA, September 2002.
[28] M. G. Zapata and N. Asokan, “Securing ad hoc routing protocols,” *in Proceedings of ACM Workshop on Wireless Security (WiSe ’02)*, Atlanta, USA: ACM Press, pp. 1–10, September 2002,
[29] C. Perkins, E. Royer, “Ad-hoc on-demand distance vector routing,” *Proc of. 2nd IEEE Workshop. Mobile Computing Systems and Applications (WMCSA 00)*, 90–100, 1999.
[30] Suchi smita Rout, Ashok Kumar Turuk and Bibhudatta Sahoo, “Energy Aware Routing Protocol in MANET using Power Efficient Topology Control Method”, *International Journal of Computer Applications (0975 – 8887)*, Vol. 43, No.5, pp.33-42.April 2012.
[31] Janusz Romanik, Adam KraĞniewski, Edward Golan, “RESA-OLSR: RESources-Aware OLSR-based routing mechanism for mobile ad-hoc networks”, Military Communications and Information Systems (ICMCIS) june 2016.
[32] Sandeep Kumar Gupta, Neelu Kumari “New Performance Analysis of AODV, DSDV and OLSR Routing Protocol for MANET”, International Conference on Computing for Sustainable Global Development (INDIACom), October 2016.