Performance Analysis of OLSR Protocol using Pipelining and Multi-point Relay in WSN

Rajinder Kaur
Research Scholar
Department of ECE
Shaheed Bhagat Singh State Technical Campus, Moga Road

Amit Grover
Assistant Professor
Department of ECE
Shaheed Bhagat Singh State Technical Campus, Moga Road

ABSTRACT
Wireless Sensor network is an application based network. The design of WSN is influenced by factors like flooding, scalability, operating environment, hardware constraints, power etc. Scalability acts as a major design issue in the WSN domain. So, routing protocols should be used to continue perform well as the network grows larger or as a workload increases. This paper presents a performance analysis of three routing protocols OLSR, DSR and AODV based on various parameters like end-to-end delay, throughput and packets delivery ratio. In this Article, the limitation of OLSR routing protocol (wastage of network bandwidth) due to flooding has been overcome using Multipoint Relays and pipelining. Results show that OLSR protocol has better performance than AODV and DSR routing protocols.

Keywords
WSN, AODV, DSR, OLSR, BS

1. INTRODUCTION
Wireless sensor network (WSN) is a rising and popular topology which is applied to different applications such as the measure or check of temperature, moisture and pressure [1]. A wireless sensor network (WSN) consists of a large number [15] of small and common Devices mostly sensors, which send their data within a wireless network. The general task is that these devices [27] can perform: [6] on board data processing, communication between sensors, [20] sensing capabilities and actuation applicability. It is the combination of many [16] sensor nodes, having wireless channel to communicate [7] with each other. These sensor devices communicate either directly to the Base Station (BS) [17] or among each other. Each node requires a power source [8] which can give a node maximum life in spite of its small size. The self-organizing capability of sensor nodes provides several [10] network protocols [22]. The communication architecture of WSN consists a number of nodes these nodes send data back to sink and end users as shown in Fig1[9].

The communication protocol have five standard layers: application layer, transport layer, network layer, [13] data link layer, physical layer and three management planes: power management plane, mobility management ,task management plane [2].

WSN applications are mainly [12] classified as monitoring and tracking [18].The potential application include military sensing, air traffic control, traffic surveillance, [24] industrial and manufacturing automation, environment, health, home and other commercial areas. The design of WSN is influenced by factors like fault tolerance, scalability, operating [21] environment, hardware constraints, power etc [3] and depends [25] significantly on the application. Scalability act as a major design issue in the WSN domain [11] because it specifies the system's capability to [14] accommodate additional [26] nodes up to certain [23] threshold without restructuring the entire system [4,5]. Therefore routing protocols used for WSN should support network scalability .These protocol should continue to do well as the network grows larger or as a workload increases [19].

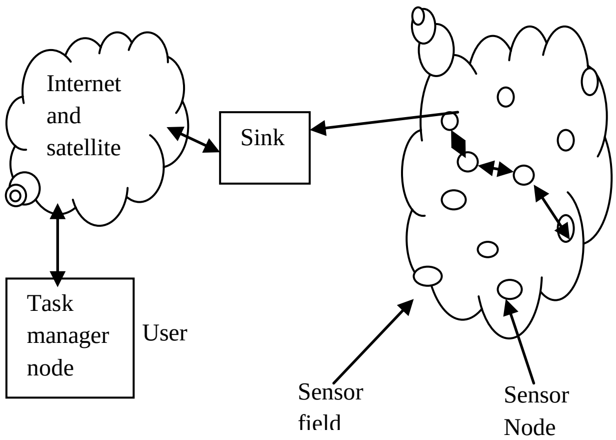


Fig.1 Communication Architecture

2. LITERATURE SURVEY
Ait Ali et al., compared and examined the performance of AODV and DSR routing protocols using default random way point mobility model. For evaluation of performance of related protocols they used ns-2 simulator with flexible pause time. After getting simulation results they determine that DSR outperformed AODV on small number of nodes with lower load and mobility in terms of delay and throughput while AODV performed efficiently than DSR on large number of nodes in terms of higher load and mobility. It is also concluded that DSR has low throughput and delay due to huge uses of caching and stale routes [24].

Chowdhury et al., evaluated the performance of AODV and DSR routing protocols using ns2 simulator having variable nodes. Simulation results determined that AODV shows very high packet delivery ratio in 40 mobile nodes, but it varies if network nodes are increases. Similarly DSR shows less end to end delay as compared to the AODV. It is concluded that AODV performs best because it delivers nearly identical result in all scenarios and DSR suits for minor scalability networks in which mobile nodes move at moderate speed [25].

Yassine et al., introduced a comparative analysis between various routing protocols and their impact on the performance of WSN. The performance analysis of routing protocols is estimated by providing simulation results based on end to end delay (EED), packet delivery ratio, and throughput. This simulation is implemented in NS2 by varying number of nodes and pause time in the first and second scenario respectively [26].

Pratibha et al., explained that WSN consists of number of small size nodes, inexpensive and battery powered sensor nodes. To perform routing in these networks, number of routing protocols has been implemented. In this paper, Random Waypoint model has been used to evaluate the performance of the routing protocols and Opnet tool is used for simulation purpose. The performance analyses of these protocols will emphasis on the influence of the size of the network and the number of nodes. The performance metrics used in this work are throughput, average end-to-end delay and network load [27].

3. CLASSIFICATION OF ROUTING PROTOCOLS

There are numerous routing protocol have been proposed for WSN [3]. It is classified into two ways Reactive Protocols and Proactive Protocols Fig.2.

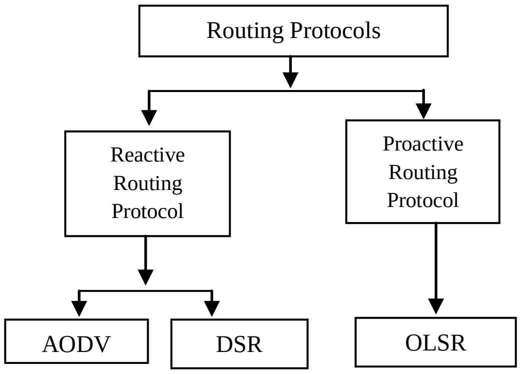


Fig.2 Types of Routing Protocols

3.1 Reactive Routing Protocols

These types of protocols [12] are called as on Demand Routing Protocols. A route discovery process is initiated by a source node throughout the network only when it want to send packet to its destination. It establishes route "on demand" by flooding a [20] network with a problem i.e. Route Request (RREQ) and Route Reply (RREP). Some reactive routing protocols are Ad hoc On-Demand Distance Vector (AODV), Dynamic Source Routing (DSR) etc.

3.1.1 Ad hoc on-demand distance vector routing(AODV)

Ad hoc On-Demand Distance Vector (AODV) [15] is based on Distance Vector routing protocols. It is also [6,8] called a reactive MANET routing protocol. Similar to DSR, AODV [4] broadcasts a route request (RREQ) to discover a route in a reactive mode. The difference is that in AODV [16], the number of hops is used in the route record, instead of a list of intermediate router addresses. This link points to the router that forwarded the request. When intermediate [7] routers receive the reply, they can also set up corresponding forward routing entries. It has other important features whenever a path [23] exists from source node to destination node, it does not append any overhead to the packets. Since, route discovery process is only started [7] when paths are not utilized and immediately removed. This method decreases [13] the impacts of state routes as well as the requirement for route maintenance for unused paths. Another important feature of AODV is its ability to present unicast, multicast and [16] broadcast communication.

3.1.2 Dynamic source routing (DSR)

The Dynamic Source Routing protocol (DSR) [9] is a reactive protocol .It is based on link-state algorithm. This type of routing protocol is specially built on a simple and efficient designed use for multi-hop wireless ad hoc networks of mobile nodes. When a node tries to send data packet to some unknown destination node, the node will flood RREQ message dynamically to all alternative nodes that are reaching to the destination node. Therefore, DSR is a reactive protocol. It uses source routing [13] which means that the source must know the complete hop sequence to the destination. Each node maintains a route cache, where all routes it knows are stored. It reduces overhead of route maintaining by maintaining routes only for those nodes who needs to communicate. There are two main operations in DSR

- route discovery
- route maintenance

Every node keeps a route cache. Source node when transmit a packet, firstly it examines its [11] route cache for a path to the destination node. If it is found, the node utilizes that one found. In case if node does not discover any right path [5] to the destination, it begins the route discovery process. In the route discovery process, the source node floods a Route Request [15] (RREQ) packet, which is broadcasted via intermediary nodes. Nodes without path to the destination add their addresses to the RREQ packet and again flood it until it reaches the destination node or an intermediary node with a right path to the destination [14] node. Then, it neglects the RREQ packet obtained. The destination node upon obtained the RREQ packet, routes a Route Reply (RREP) packet to the source node. It consists the complete path from the source node to the destination node.

3.2 Proactive Routing Protocols

Proactive routing protocols are also termed as table-driven routing protocols are used to maintain all the route information in its routing table [20]. In this routing protocol every node broadcasts its routing table to all its neighbouring nodes. If they is any change in the network topology, then all the nodes in the network will updates its routing table to maintain stable network .Example of Proactive routing protocols are Optimised Link State Routing (OLSR).

3.2.1 Optimized link state routing protocol (OLSR)

OLSR is a Proactive link state routing protocol [6]. In a link state every node in the network transmits few message i.e. "HELLO" message or some sort of information to their neighbouring nodes, this process is called flooding. After sometime, each node constructs a topology of the network in the foam of a graph. In link state routing every router communication with other routers and exchanging their link state information for either building a topology or the entire network [21].But the main problem with this flooding mechanism is that flooding causes encountering multiple copies of the same link-state information. The main limitation in link-state [22] routing is wastage of network bandwidth as flooding causes high battery consumption so to overcome this problem (MPRS) Multipoint Relays is designed [8].

4. METHODOLOGY

The main limitation of OLSR routing protocol is wastage of network bandwidth as flooding causes high battery consumption so to overcome this problem (MPRS) Multipoint Relays and pipelining is designed.

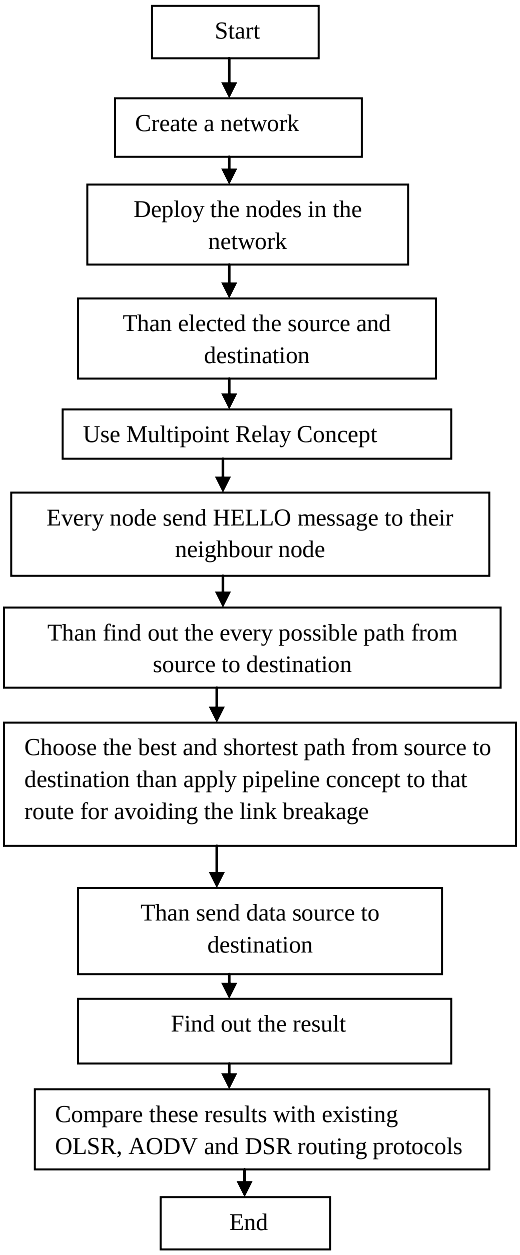
MPRs are those elected nodes that are leading to broadcast messages during its flooding process. This technique essentially scale down the message overhead as compared to a classical method. This protocol is particularly suitable for large and dense networks. It is based on dijkstra algorithm. OLSR has three functions: packet forwarding, neighbor sensing and topology discovery.

Packet forwarding is the transit of logically addressed network packets from one interface network to another using MPRS in OLSR [10]. Neighbor sensing operation allows routers to diffuse local information to the whole network. Topology discovery is used for calculate and determine the topology of entire network

OLSR uses four message types:

- Hello message,
- Topology Control (TC) message,
- Multiple Interface Declaration (MID) message, and
- Host and Network Association (HNA) message.

Pipelining is used to continuously transfer of data to all nodes in the network without any link breakage. It help to remove the problem of congestion. It increase the efficiency of OLSR protocol in dense environment.



Algorithm

Initialization
N= Network
N(n)= No of nodes in the network
M=Message
S=Source
D=Destination
R=Routing table
MPR=Multipoint Relay
P=Pipelining
N(e)=Neighbour nodes
ACK=Acknowledge

Start

- Create a N
- Deploy the N(n) in the N
- Create a R
- Decide the S and D

Now
S ⟶ Check their N(e)

Than
S send (HELLO) Message to the N(e)
S ⟶ D(HELLO)
D send ACK Message to S
D ⟶ S(HELLO+ACK)
Now they are ready to communicate
Intialize MPR+P
Now
S send their message to D by using MPR+P
Using Shortest path (dijkstra algorithm)
S ⟶ D
END

5. SIMULATION ENVIRONMENT

Using the model proposed by Verma et al.[5] the routing protocols were implemented with 2.35 Network simulator 2[13]over windows platform. The simulations were run on Intel Core i5-4210M 2.6 GHZ with Turbo Boost up to 3.2 GHZ processer with 2GB Dedicated VRAM(Table 1).

Table 1. Scenario properties

Simulation Version	NS2 -2.35
Area	1500x1500
Number of nodes	50,100,150,200,250,300
Traffic Type	CBR
Path Loss Model	Two Way ground
Routing Protocols	AODV,DSR,OLSR
Network Interface Type	Phy /Wireless Phy
Simulation Time	300s
Antenna Model	Omi-Antenna
Data Rate	2Mbps

6. PERFORMANCE ANALYSIS

In this Paper work based on three routing protocols AODV, DSR and OLSR.AODV and DSR are called reactive or on demand protocols are based on source initiated on-demand reactive routing. This type of routing creates routes only when a node requires a route to a destination. OLSR is proactive routing protocols are also termed as table-driven routing protocols are used to maintain all the route information in its routing table . In this routing protocol every node broadcasts its routing table to all its neighbouring nodes. If they is any change in the network topology, then all the nodes in the network will updates its routing table to maintain stable network

This analysis the performance of three routing protocol based on different parameters i.e. Throughput, End -to-End Delay and Packet Delivery ratio.

6.1 Throughput

Throughput is the rate of successful ratio of delivered packets at the destination over a channel.

$$Throughput = \frac{Total\ packet\ received}{time\ simulation} \quad .....(1)$$

Total number of packets received per unit time at the server is defined as throughput at the network. This can be as total packets received at the server divided by average end-to-end delay. This metric must be maximized to improve the performance.

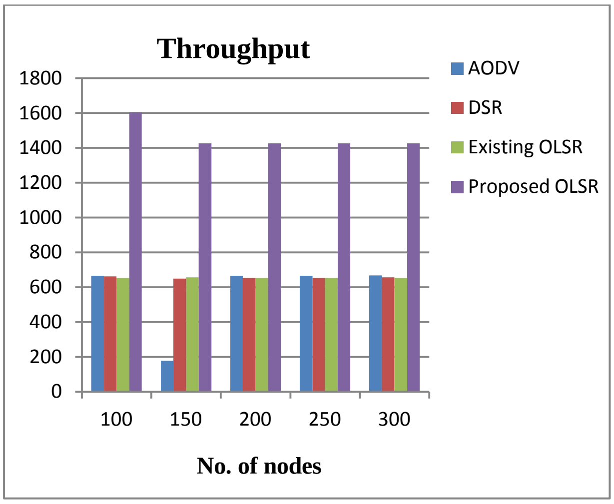


Fig.3 Total end to end Throughput

Fig.3 depicts that Proposed OLSR has highest throughput in comparison with a DSR, AODV, existing OLSR and proposed OLSR. Here X-axis represents number of nodes and Y-axis represents Throughput in bits per second. In graph Blue line represents a AODV routing protocol, Red line represents a DSR routing protocol, Green line represents a existing OLSR routing protocol and purple line represents a proposed OLSR. Rising in the performance indicates that Proposed OLSR perform better as compared to other routing protocols. Therefore, it is observed that AODV has lowest throughput in comparison with all the other protocols considered. Since in proposed OLSR Problem of flooding is remove by using MPR and Pipeline concept.

6.2 End-To-End Delay

End to end delay at the server is the average time difference between the reception of the packet at the server and the transmission of the packet from source. This metric should be minimized for enhanced performance

$$d_{end-end} = N[d_{trans} + d_{prop} + d_{proc} + d_{queue}]....(2)$$

Where

$d_{end-end}$= end-to-end delay
d_{trans}= transmission delay
d_{prop}= propagation delay
d_{proc}= processing delay
d_{queue}= Queuing delay
N= number of links (Number of routers - 1)

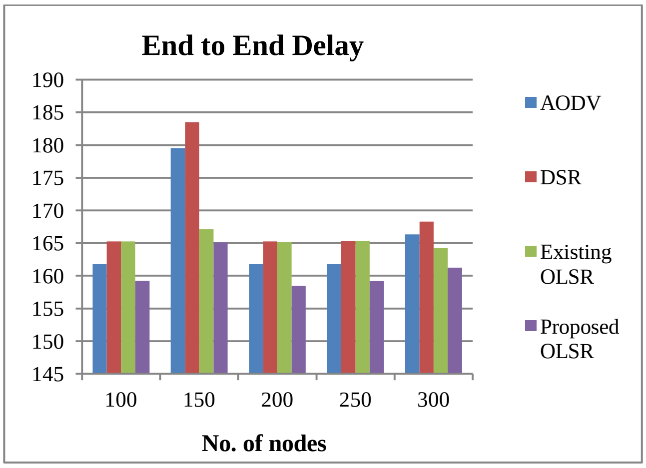


Fig.4 End to End Delay

Fig.4 depicts that best average end-to-end delay is exhibited less by existing and proposed OLSR protocols. Here X-axis represents number of nodes and Y-axis represents a Delay in sec. In graph Blue line represents a AODV routing protocol, Red line represents a DSR routing protocol, Green line represents a existing OLSR routing protocol and purple line represents a proposed OLSR. It can easily observe that DSR is the worst protocol in terms of delay due to increase in the number of broken routes and the extra transmission of control messages . It can also noted that the best Average End-to-End delay for Proposed OLSR protocol is less than other AODV , existing OLSR.

6.3 Packet Delivery Ratio

The Packet Delivery Ratio parameter shows the number of packets received at the destination while the whole transmission. This parameter can be evaluated as:

$$Packet\ Delivery\ Ratio = \left(\frac{Packet_{Received}}{Packet_{Total}}\right) * 100.....(3)$$

Packet $_{Received}$ shows the total number of packets received at the destination divided by total number of packets.

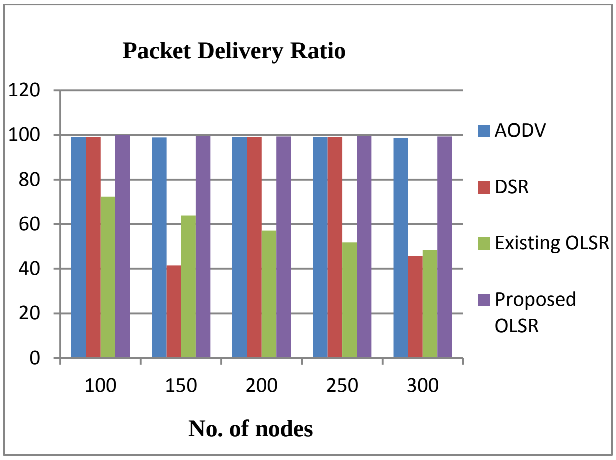


Fig.5 Packet delivery ratio

Fig.5 depicts that Packet delivery ratio of AODV and proposed OLSR is better than DSR and existing OLSR with increasing in the number of nodes. Here X-axis represents number of nodes and Y-axis represents a Packet delivery ratio. In graph Blue line represents a AODV routing protocol, Red line represents a DSR routing protocol, Green line represents a existing OLSR routing protocol and purple line represents a proposed OLSR. It can explain the markedly decline of Existing OLSR cannot cope with excess generated traffic in the network. The good performance of AODV is due to that because AODV protocol all known routers caches so probability of choosing route is less and flooding problem of proposed OLSR is remove by using MPR and Pipeline. It is very likely that during route discovery for some destination such as node D, a route for another node A is found, recorded, and latter used form the cache, this strategy will ultimately save the network bandwidth.

Table 2. Performance Analysis of routing protocols

Parameters	AODV	DSR	Proposed OLSR
Throughput	Low	Medium	Very High
End-to-End Delay	Medium	high	Very low
Packet Delivery Ratio	High	Medium	High

7. CONCLUSIONS

In this paper, comparison of AODV, DSR, existing OLSR and proposed OLSR protocols has been considered. The result shows that Proposed OLSR performs better as compare to other routing protocols. Proposed OLSR attained Lower delay and routing overhead than other AODV, DSR and existing protocols. Flooding problem of OLSR has been overcome by using Multipoint Relay and Pipelining. It increase the efficiency of OLSR in dense network.

8. REFERENCES

[1] Akyildiz Ian F, Weilian Su, Yogesh Sankarasubramaniam and Erdasurvey," Computer network38.4(2002); pp.392-422.

[2] Yick, Jennifer, Biswanath Mukherjee, and Dipak Ghosal, Wireless sensor network survey," Computer Networks-Elsevier 52.12(2008), pp.2292-2330.

[3] Al-Karaki, Jamal N, and Ahmed E. Kamal, "Routing techniques in Wireless Sensor Network: A Survey," Wireless Communication, IEEE 11.6 (2004),pp.6-28.

[4] R. Szewczyk, J. Polastre, A. Mainwaring, D. Culler, Proceedings of First European Workshop on Sensor Networks (EWSN 2004), Berlin, Germany, 2004, pp. 307–322.

[5] V. K. Verma, S. Singh, N.P. Pathak, Analysis of scalability for AODV routing protocol in wireless sensor networks.

[6] E.M. Royer and C.E. Perkins, "Multicast Operation of the Ad Hoc On-Demand Distance Vector Routing Protocol," Proc. ACM/IEEE MobiCom, pp. 207-218, Aug.1999.

[7] C. Wu, Y. Tay, and C.-K.Toh, Ad Hoc Multicast Routing Protocol Utilizing Increasing Id-Numbers (AMRIS) Functional Specification," Internet draft, Nov. 1998.

[8] X. Zhang and L. Jacob, "Multicast Zone Routing Protocol in Mobile Ad Hoc Wireless Networks," Proc. Local Computer Networks (LCN '03), Oct. 2003.

[9] C.-C. Chiang, M. Gerla, and L. Zhang, "Forwarding Group Multicast Protocol (FGMP) for Multihop Mobile Wireless Networks," ACM J. Cluster Computing, special issue on mobile computing, vol. 1, no. 2, pp. 187-196, 1998.

[10] J.J. Garcia-Luna-Aceves and E. Madruga, "The Core-Assisted Mesh Protocol," IEEE J. Selected Areas in Comm., vol. 17, no. 8, pp. 1380-1394, Aug. 1999.

[11] M. Gerla, S.J. Lee, and W. Su, "On-Demand Multicast Routing Protocol (ODMRP) for Ad Hoc Networks," Internet draft, draftiest- manet-odmrp-02.txt, 2000.

[12] Santa Barbara Elizabeth M. Royer and Chai KeongToh. "A Review of Current Routing Protocols for Adhoc Mobile Wireless Networks."IEEE Personal Communications, pages 46-55, April 1999.

[13] A. Boukerche, "Performance comparison and analysis of ad hoc routing algorithms," in Proc. of IEEE International Conference on Performance, Computing, and Communications, pp. 171-178, 2001.

[14] D. B. Johnson, D. A. Maltz, Y. C. Hu, and J. G. Jetcheva, "The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks (DSR)," Internet Engineering Task Force208(IETF) draft, Febuary2002.

[15] I. D. Aron and S. K. S. Gupta, "On the scalability of on-demand routing protocols for mobile ad hoc networks: an analytical study," in Journal of Interconnection Networks, vol. 2, no.1,pp. 5-29, 2001.

[16] C. E. Perkins, E. M. Belding-Royer, and S. R. Das, "Ad hoc On-Demand Distance Vector (AODV) Routing," Internet Engineering Task Force (IETF) draft, November 2002.

[17] Snigdh, N.Gupta, Quality of Service metrics in wireless sensor networks: a survey, J.Inst. Eng., Ser.B(2014)16.

[18] K. Sohraby, D. Minoli, T. Znati, Wireless Sensor Networks: Technology, Protocols and Applications, John Wiley &Sons,NewYork,USA,2007.

[19] L.Alazzawi, A.Elkateeb, Performance Evaluation of the WSN routing protocols scalability, J.Comput. Syst. Networks Commun. 2008(2009).

[20] V.Y. Leanna, B. Rahmat, Comparison of proactive and reactive routing protocol in mobile adhoc network based on ant-algorithm, in: International Confer-ence on Computer, Control, Informatics and its Applications,IEEE,2013,pp.153-158.

[21] P.Jacquet, P. Mühlethaler, T. Clausen, A. Laouiti, A. Qayyum, L. Viennot, Opti- mized link state routing Protocol for ad hoc networks, Multi Topic Conference Technology for the 21st Century. IEEE INMIC, 2001, pp. 62–68.

[22] T. Clausen, P. Jacquet, A. Laouiti, P. Minet, P. Muhlethaler, A. Qayyum, and L. Viennot, "Optimized Link State Routing Protocol," Internet Engineering Task Force (IETF) draft, March, 2002.

[23] A. Qayyum, L. Viennot, and A. Laouiti, "Multipoint relaying: An efficient technique for flooding in mobile wireless networks," Research Report-3898, INRIA, France,2000.

[24] Ait Ali, K.; Baala, O.; Caminada, A., "Routing Mechanisms Analysis in Wireless Sensor Networks(WSN),"in Proceedings of Ad hoc Networks Technology Conference , 2011 IEEE 73rd ,May 2011,pp.15-18.

[25] Chowdhury, S.I.; Won-Il Lee; Youn-Sang Choi; Guen-Young Kee; Jae-Young Pyun, "Performance evaluation of reactive routing protocols in Wireless Sensor Networks," in proceeding of Communications (APCC), 2011 17th Asia-Pacific Conference on ad hoc networks ,2011, pp.559,564.

[26] Yassine, Maleh, and Abdellah Ezzati. "Performance analysis of routing protocols for wireless sensor networks." Information Science and Technology (CIST), 2014 Third IEEE International Colloquium in.IEEE, 2014.

[27] Pratibha ,Dr.Prem Chand Vashist."Performance Evaluation of OLSR and DSR Routing Protocols for Wireless Sensor Networks (WSN)". International Journal of Computer Trends and Technology (IJCTT) V12(5):242-248, June 2014. ISSN:2231-2803.