Performance Analysis of AODV, DSR and OLSR Routing Protocols in WSN

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ABSTRACT
Real implementation of routing protocol of WSNs is a time consuming process and expensive due to simulation evaluation. This paper presents an organized performance study of three routing protocols, Ad hoc On Demand Distance Vector (AODV), Dynamic Source Routing (DSR), and Optimized Link State Routing (OLSR) protocols for WSNs. The performance study of WSNs routing protocols is analysed by equating important metrics like end-to-end delay, throughput, total packets dropped, in the network under the similar random waypoint mobility model. Result shows that both AODV and DSR protocols have better performance than OLSR routing protocol.

Keywords
WSN, AODV, DSR, OLSR.

1. INTRODUCTION
WSN is a group of nodes ordered into a accommodating network. Every node contain [6] processing capability like one or more microcontrollers, DSP chips and CPU, may contain multiple types of [21] memory i.e. program, flash memories and data, have a RF transceiver usually with a [7] single Omni-directional antenna, have [14] a power source e.g. solar cells and batteries, and accommodate various sensors and actuators [1].Nodes communicate wirelessly and often self-organized after being deployed in an ad hoc network.

Recently, [16]wireless sensor networks are ready to be deployed at an accelerated space. It is unreasonable to expect that in 10-15 [17] years the world will be covered with wireless sensor networks with access to them via the Internet. This can be considered [12] as the Internet becoming a physical network. Dramatically changed in the [8] previous work due to reason that most past distributed systems research [3]has assumed that the systems are wired, have unlimited power, are [15]not real-time, have user interfaces such as screens and mice, have a fixed set [13] of resources, treat each node in the system very important and are location independent. On the other hand in wsn the systems are [9]wireless, are real-time, [18]utilize sensors and actuators as [5]interfaces, have scarce power, dynamically changing sets of resources, utilize sensors and actuators as interfaces, aggregate behaviour [2] is important and location [11]is critical. Many wireless sensor networks also utilize minimal capacity [22] devices which places a [10] further strain on the ability to use past solutions.

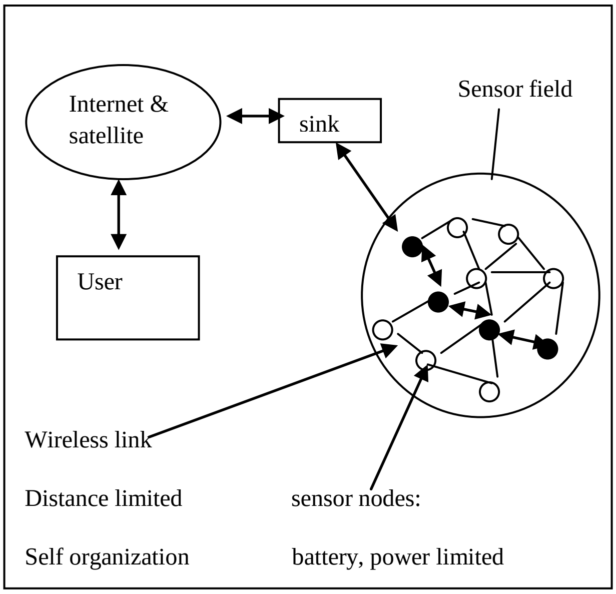

Fig.1 Architecture of WSNs

WSN [19]Application are classified as: rapid deployment [4] self-organization [20], fault tolerance [23]

- Intruder detection
- Battlefield Surveillance
- Target tracking
- Forces monitoring
- Health care
- Environmental monitoring

2. LITERATURE SURVEY
Itu Snigdh et al.,concluded that DSR performs the best where more number of nodes to be deployed. It is accepted that AODV is adopted as the default protocol for wireless application, on the contradictory that DSR obtain minimum delay, hop counts, average carried load per node and a lesser delay in comparison [19].

Xiaoyan Hong et al.,included the survey of routing protocols that address scalability. The routing protocols included in the survey fall into three categories: flat routing protocols, hierarchical routing approaches, and GPS augmented geographical routing schemes [20].

M. Palaniammal et al., provided overview of various Mobile ad-hoc routing protocols by presenting their advantages and disadvantages of the proactive and reactive protocols then makes their comparative analysis of their advantages and disadvantages. The main aim of this paper is improve the advantages and disadvantages of these protocols [21].

P. Jacquet et al., an optimized link state routing protocol (OLSR), for mobile wireless networks is discussed. The protocol is based on the link state algorithm and it is proactive (or table-driven) in nature. It employs periodic exchange of messages to maintain topology information of the network at each node. OLSR is an optimization over a pure link state protocol as it compacts the size of information sent in the messages, and furthermore, reduces the number of retransmissions to flood these messages in entire network [22].

J. Billington et al., focused on two well know algorithms: The performances of AODV and OLSR are analyzed and compared**.** The AODV protocol can be used in resource critical environments. But the OLSR protocol is more efficient in networks with high density and highly random traffic. The scalability of these protocols is quite good and their performance depend a lot from the network environment [23].

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.

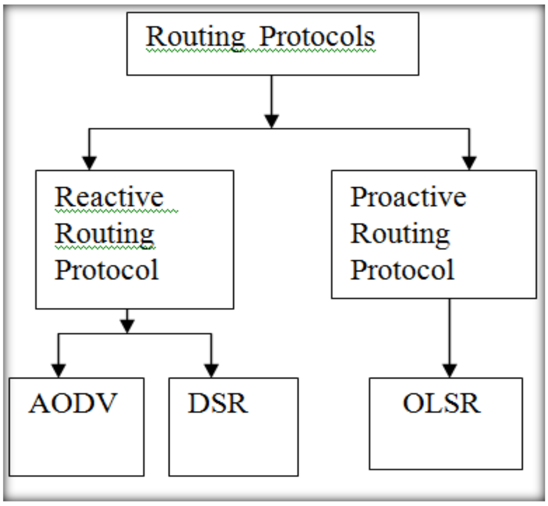

Fig.2 Types of Routing Protocols

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 [21] flooding a 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] [6] [11] is another distance vector routing algorithm, a combination of both DSR [4] and DSDV [8]. It shares DSR's on-demand features hence find paths whenever it is required by a same route discovery process. AODV uses conventional routing tables; one entry per destination node unicast route reply message which is opposite to DSR that keeps multiple route cache entries for every destination. 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. AODV utilizes a broadcast route discovery algorithm and then the unicast route reply massage.

3.1.2 Dynamic source routing (DSR)

The Dynamic[4] 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[19] all routes it knows are stored. It reduces overhead of route maintaining by maintaining[21] routes only for those nodes who needs to communicate. Major advantage of DSR is that no periodic routing packets are required. There are two main [9]operations in DSR

- route discovery
- route maintenance

Every node keeps a route cache. Source node when transmit a packet, firstly it examines its 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. In this routing protocol every node broadcasts [21] 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 [22] link state information for either building a topology or the entire network [10].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 routing is wastage of network bandwidth as flooding causes high battery consumption so to overcome this problem (MPRS) Multipoint Relays is designed [8].

MPRs are those elected nodes that are leading to broadcast messages during its flooding process. This technique essentially scales down the message overhead as compared to a classical method. This protocol is particularly suitable for [23] large and dense networks. MPRs act as intermediate routers in route discovery procedures. Disadvantage of OLSR routing protocol need more time for re-discovering a broken links. OLSR has three functions: packet forwarding, neighbor sensing and topology discovery.

Table1.Comparison between Three Routing Protocols

Parameters	AODV	DSR	OLSR
Routing Type	On-demand	On-demand	Proactive
Routing Overhead	Higher	High	Higher
Control Overheads	Low	Low	Controlled by flooding of the control Traffic
End-to-end Delay	Performance decreases	Better than DSDV	Wider delay distribution
Route Maintaining	Route Table	Route Cache	Routing table
Protocol Type	Distance Vector	Link State	Link State

4. 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 2).

Table 2. 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
ssData Rate	2Mbps

5. 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 called proactive or table driven protocols attempt to maintain consistent up-to-date routing information from each node to every other node in the network; each node maintains tables to store routing information.

This analysis the performance of three routing protocol based on different parameters i.e. Throughput, End -to-End Delay and Packet Delivery ratio. Detail description of each graph has been mentioned in next section.

5.1. Throughput

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.

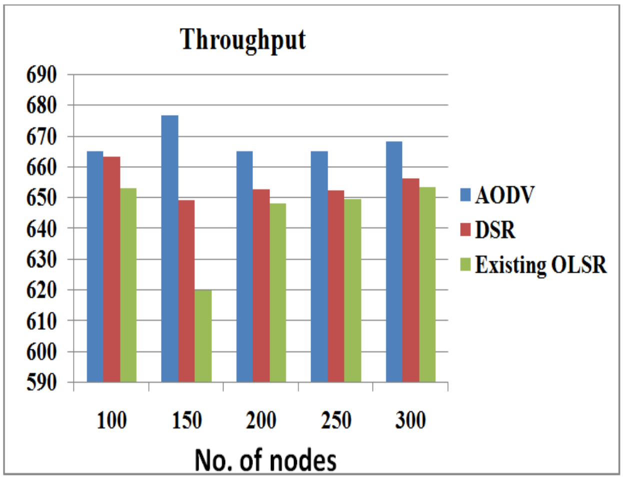

Fig.3 Total end to end Throughput

Fig.3 depicts that OLSR has lowest throughput in comparison with a DSR and AODV. 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 and Green line represents a OLSR routing protocol. Decline in the performance indicates that OLSR cannot cope with excess generated in the network. Therefore, it is observed that AODV has lowest throughput in comparison with all the other two protocols considered. Since in OLSR only the first arriving request packet (RREAQ) is answered there for it leads to less no of replies (RREPs).

5.2. 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.

$$d_{end-end} = N[d_{trans} + d_{prop} + d_{proc} + d_{queue}]$$

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)

Note: we have neglected queuing delays.

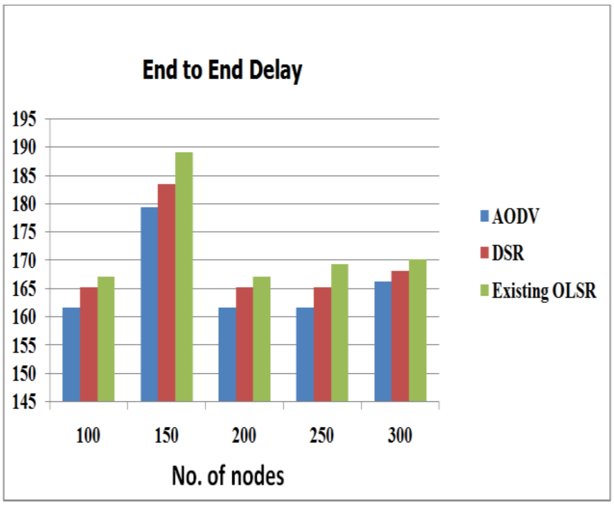

Fig.4 End to End Delay of Nodes

Fig.4 depicts that best average end-to-end delay is exhibited by DSR and AODV 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 and Green line represents a OLSR routing protocol. It is easily observe that OLSR is the worst protocol in terms of delay due to increase in the number of broken routes and the extra transmission of control messages used by AODV. It can also noted that the best average End-to-End delay for DSR protocol is less than both AODV and OLSR.

5.3. Packet Delivery Ratio

The ratio of packets that are successfully delivered to a destination compared to the number of packets that have been sent out by the sender.

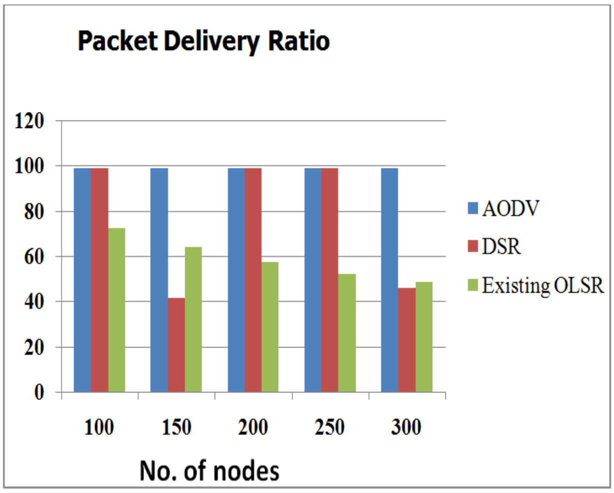

Fig.5 Packet delivery ratio

Fig.5 depicts that Packet delivery ratio of AODV is better than DSR and 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 and Green line represents a OLSR routing protocol. It can explain the markedly decline of OLSR beyond 200 nodes this decline in the performance indicates that OLSR cannot cope with excess generated traffic in the network. The second remarks about the good performance of AODV is due because the AODV protocol all known routers caches so probability of choosing route is less. 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, which leads to improve the performance of AODV protocol, especially when the number of nodes increase.

Table 3. Performance Analysis of routing protocols

Parameters	AODV	DSR	OLSR
Throughput	High	Medium	Low
End-to-End Delay	Medium	Low	High
Packet Delivery Ratio	High	Medium	Low

6. CONCLUSION

In this paper, comparison of AODV, DSR, and OLSR protocols has been considered. The results show that OLSR attained Higher delay and routing overhead than both AODV and DSR protocols. Also, AODV protocol is quicker to discover the route than DSR protocol. On the other hand, DSR dropped fewer packets and produced less total loads than AODV protocol. In the future work, use the obtained results from studying of different routing protocols and algorithms to implement reliable networked control systems.

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