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# Performance Evaluation of AODV and OLSR with Varying Number of Nodes and Fragmentation Threshold

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**Abstract:** *A Mobile Adhoc Network (MANET) is a collection of mobile devices dynamically forming a communication network without any central devices controlling it or any pre-existing network infrastructure. Frequent topology changes of MANET have generated some routing challenges. The present investigation was conducted on impact of fragmentation threshold and node size On-demand Distance Vector (AODV) Routing Protocol, a proactive routing protocol and the Optimized Link State Routing protocol (OLSR), a reactive routing protocol. Different network scenarios of sizes 5 and 20 nodes method were used under fragmentation threshold of 256 bytes and 1024 bytes, with a trajectory to give mobility to the nodes. The Transmission Control Protocol (TCP) flavor Tahoe was used as the default TCP congestion control protocol. AODV and OLSR were evaluated based on their performance, using: Throughput, Delay and Retransmission attempt. AODV has a better throughput over OLSR under the fragmentation threshold 256 bytes but OLSR has better throughput with fragmentation at 1025 bytes with node size kept constant at 5. Increase in note size from 5to 20 resulted in the AODV been better than OLSR but with fragmentation at 256 and 1024 bytes. Under the constraints defined in the simulation, the retransmission attempt in AODV displayed better performance for larger network (20 nodes) and OLSR with fragmentation threshold at 256 bytes with smaller network (5 nodes).*

**Keywords**: *Mobile Ad hoc Network (MANET), Network size, Routing protocols, Mobile and Network topology*

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## 1.0 Introduction

Mobile Ad hoc Networks (MANETs) is an autonomous system of mobile nodes which are connected by wireless links and communicating without the presence of any central administration. It is a form of network that requires no infrastructure for its maintenance and management(Kumar, 2010 and Mirza & Bakshi, 2018). MANET is also called Mesh Network. It is a highly adaptable and rapidly deployable network (Harjeet*et al.*, 2013). MANET provides mobile users with ubiquitous computing capabilities and information access, regardless of the location provided they are within the functional communication range. The system is supported by wireless communication technologies such as WiFi, ZigBee, and WiMAX (Zemrane*et al.*,2019). MANET is the new emerging technology that provide a wider scope of coverage and other benefits to users, regardless of their geographical location. The increase of cheaper, small and stronger devices boasts MANETthe fastest and highly embraced network (Ankur and Prabhakar, 2013). The mobility of nodes in MANETs is capable of enhancing the complexity of the routing protocols and the degree of connection's flexibility (Ammar*et al.*, 2012); MANET has no fixed router but all notes can serve as routers. Each node can comprehend the neighboring nodes to forward the packet because these nodes usually have only a limited transmission range. All nodes are capable of movement and can be connected dynamically in an arbitrary manner. The responsibilities of organizing and controlling the network are shared among the terminal themselves without the need of a predefined infrastructure. The ability of nodes to self-configuration and also its affordable cost of deployment makes MANET suitable for situations such as soldiers transmitting information on the battlefield, sharing of information during conferences or meetings and also during disaster rescue. In MANET, the connections between the wireless links are not fixed but depends on the channel conditions as well as the specific media access control (Kartheek and Raj, 2011).

### *1.1 Routing in MANET*

In any network setting, there is communication between different nodes, which requires the passage of control information and data packets from the source to the destination. The process of finding a path/ route to send a packet of data from a source to a destination is called routing. Routes are multi-hop in Ad hoc Networks because the propagation range (250 meters in an open field) of wireless radio is limited. Some, nodes cannot communicate directly with each other. Routing paths in Mobile Ad hoc Networks potentially contain multiple hops, and every node in Mobile Ad hoc Networks has the responsibility to act as a router (Kumar*et al.*, 2010). Fig.1 is a pictorial presentation that shows how MANETintermediate nodes take the responsibility of organizing and finding the path packets of data that are routed to the destination through the network in a hop by hop fashion. Since nodes are mobile and can move from one area to another, this characteristic leads to an issue called link failure. Link failure may occur if a neighboring node (next hop) through which a packet should take to the destination is out of the signal range of the sent node. The result is that routes are frequently broken causing extra network traffic to reconstruct the routing table. If there is a high frequency of broken links, the overhead cost of routing can dominate the traffic load causing congestion and consuming precious energy in an attempt to discover unstable pathways. Link failure is not common in wired networks because the network topologies or structures are fixed. In general, one goal of routing is to choose a suitably efficient path, where efficiency can be measured in terms of end-to-end delay, packet delivery ratio, power expended, amount of self -interference, and so on.

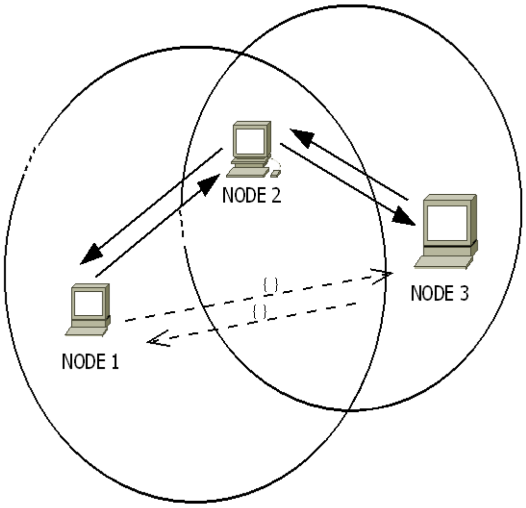

**Fig.1: Mobile ad-hoc network example, conceptual model**

A major challenge in MANET is the design of a robust and scalable routing protocol that can adapt to a wide variety of conditions that are common to any Ad hoc environment. For example, a node in an Ad hoc Network may alternate between periods during which they may be stationary with respect to each other and periods during which their topology alternate rapidly. Routing protocols in Ad hoc networks is typically categorized into three different groups, including, Table driven or Proactive, On-demand or reactive and Hybrid routing protocols.

### 1.2 Pro-Active / Table Driven Routing Protocols

Proactive protocols attempt to monitor the topology of the network in order to have route information between any source and the available destinations at all time. Each node stores and maintains routing information to every other node in the network through the maintenance of a periodic exchange routing table throughout the networks. It performs well in low mobility environments. The Destination Sequence Distance Vector (DSDV), Optimized Link State Routing (OLSR), Fish-eye State Routing (FSR) and Cluster-head Gateway Switch Routing Protocol (CGSR) routing protocol are well-known proactive routing protocols.

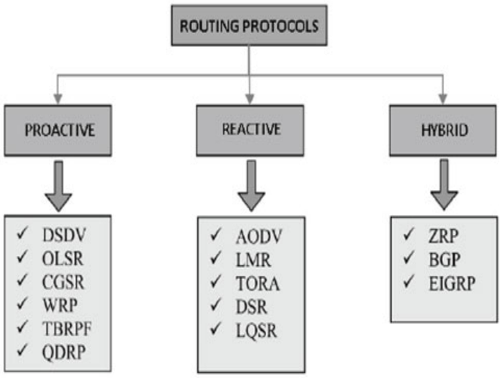

**Fig. 2: Types of routing protocol (Mirza1 and Bakshi, 2018)**

### 1.3 Reactive (On Demand) Protocols

Reactive protocols find a route only when it is needed, once the connection starts. It is also called on-demand routing protocols (Barushimana and Shahrabi, 2003). It is better suited to networks of more mobile nodes. Reactive protocol was designed to reduce overheads present in proactive protocols by maintaining information (Rakesh and Pooja, 2015). The Ad-hoc On-Demand Distance Vector (AODV) and Dynamic Source Routing (DSR), Temporally Ordered Routing Algorithm (TORA), Associativity based routing (ABR), Signal Stability-Based Adaptive Routing (SSA) and Location-Aided Routing Protocol (LAR) are representatives of On-Demand Routing Protocols.

### 1.4 Hybrid Routing Protocols

Hybrid routing protocol combines the basic properties of both reactive and proactive routing protocol. It is used to find a balance between both protocols. Proactive operations are restricted to a small domain, whereas, reactive protocols are used for locating nodes outside those domains (Royer and Chai-Keong, 1999). Zone Routing Protocol (ZRP) and Wireless Ad hoc Routing Protocol (WARP) are examples of hybrid routing protocols.

### 1.5 IEEE 802.11 MAC Protocol

The IEEE 802.11 protocol specifies both the MAC and the Physical layer specification for wireless devices. The standard includes polling-based and contention-based medium access protocols, called the Point Coordination Function (PCF) and the Distributed Coordination Function (DCF) respectively. The IEEE 802.11 DCF, the widely used access method in MANET, functions as the wireless MAC protocol. DCF protocol employs an algorithm called Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) which requires every node to perform a Carrier Sensing to determine the current state of the communication medium (idle or busy). When a node wants to send a data, it first sensed the channel to check whether the medium is free or busy. If the medium is busy, the node waits for a specific period of time known as the Back off interval and then tries to sense the medium again. Meanwhile, a slotted binary exponential back-off procedure takes place: the number of such slots is determined by a random value uniformly chosen in [0, CW-1], where CW (Contention Window) is the current window size. If the medium remains idle for a time interval equal to Distributed Inter Frame Space (DIFS), the node is allowed to transmit. The destination node replies with an acknowledgment message upon successful reception of the frame. But if the sending node does not receive an acknowledgment within a time interval, it tries to resend the frame.

Unlike in wired networks, the devices in MANET are mostly able to move from one place to another such that a consequence is a frequent topology change. This mobility characteristic leads to the failure of packets from reaching its destination. The persistent packet dropping can cause performance degradation in such a network. In view of the absence of centralized control and frequent changes of network topology, routing is a vital issue and a major challenge in MANETs. Different routing protocol has been developed over the years for the routing of packets of data from the source to the destination node. Each routing protocol has characteristics that are unique in differentiating it from others while their respective performance also differs under various network conditions. The Ad hoc On-demand Distance Vector (AODV) and the Optimized Link State Routing Protocol (OLSR) are some of the prominent MANET routing protocols. MANETs are continuously expanding in terms of traffic and services like peer-to-peer file sharing, Video streaming, HTTP browsing and FTP and Email (Mandeep and Jasbir, 2013). This traffic comes in various packet sizes and their applications are increasingly dominating the MANETs. Consequently, it is important to evaluate the performance of the MANET routing protocols with different fragmentation thresholds under FTP application traffic. Therefore, the present study is aimed at evaluating the performance of AODV and OLSR under different packet fragmentation thresholds. The performance analysis will be investigated using the routing throughput, retransmission attempt and network delay. This review further concentrates on the description of the simulation environment, methods of implementation, results in the presentation and analysis

## 2.0 Methods and Experiment

The simulation study was conducted using the Riverbed Modeler Academic Edition 17.5 PL6 (formally a proprietary of OPNET). The package offers an easy graphical interface that makes it possible to develop and run some simulation programs. It has the fastest discrete event simulation engine that is useful for finding the solution to several industrial problems. The simulation environment was set up to observe the behavior of AODV and OLSR over fragmentation threshold showed in Figs. 3 and 4. The simulation was accessed and analyzed based on two scenarios; 5 nodes and 20 nodes respectively. In the course of setting up the simulation environment, mobile nodes were located within simulation coordinates; 100m by 100m. The nodes were provided with mobility using two different defined trajectories that were arbitrarily given to all mobile nodes within the simulation environment. A trajectory defines the path a mobile node moves along during simulation. During the simulation, the mobile nodes follow the trajectory by traveling in a straight line from one defined position to the next. Mobile nodes maintain their position as final, whenever the simulation time exceeded the last specified time, in the trajectory file. The wireless server, application configuration, profile configuration and mobile workstations (nodes) are used during the design of the network. File Transfer Protocol (FTP) traffic was designed. The packet size of the FTP traffic used for the simulation is 5000 bytes. The Transmission Control Protocol flavor used for the simulation is Tahoe.

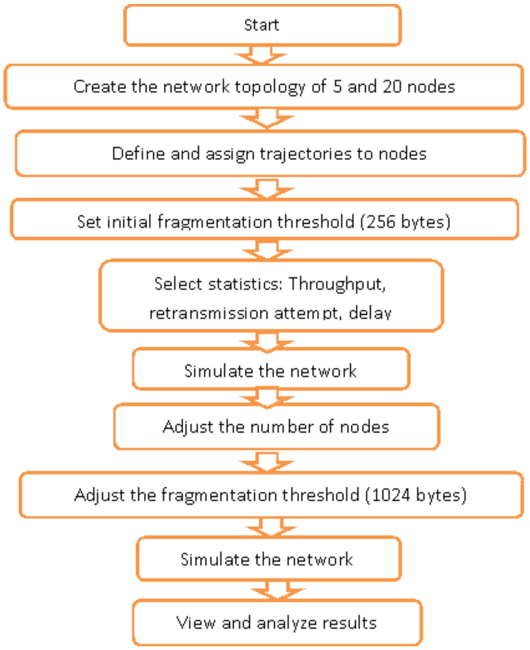

**Fig.3: Simulation Model**

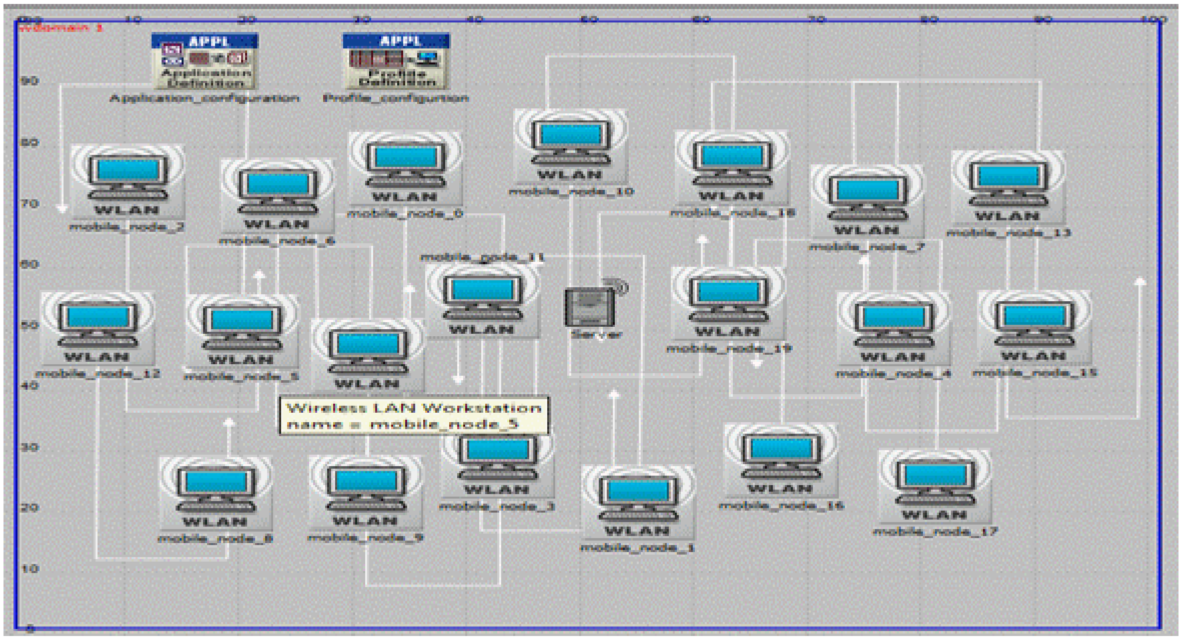

**Fig. 4: MANET network entities**

## 3.0 Results and Discussion

Results obtained from the simulation are showed and analyzed in this section, there are two types of a scenario for each number of nodes and fragmentation threshold. However, we were mainly concerned with throughput, retransmission attempt and delay based on each fragmentation threshold size and the fitness to one of the two routing protocols AODV and OLSR fit best for the MANET environment. Each scenario was considered as a separate event, although the five note scenario was first analysed.

Table1 shows the routing protocol and the fragmentation threshold sizes in a 5 nodes scenario. This node is a fixed node that acts as the traffic source. A connection has been established from each node to transfer FTP_Application of the same size over each connection. Then the size of the fragmentation threshold performed well and under the particular routing protocol.

**Table 1: Details of Fragmentation Threshold Size and Routing Protocol 0 to 5 Nodes**

| Stage | Fragmentation threshold size | Routing protocol | Number of nodes | Speed of node (M/S/) |
|---|---|---|---|---|
| **A** | 256 | AODV | 5 | 10 |
| **A** | 256 | OLSR | 5 | 10 |
| **B** | 1024 | AODV | 5 | 10 |
| **B** | 1024 | OLSR | 5 | 10 |

### *3.1 Throughput analysis*

Fig 5 presents plots for the threshold comparison in a five nodes system under 1024 Bytes fragmentations threshold. From the figure, it is evidence that the throughput performance between AODV and OLSR at approximately 5 seconds, favours the AODV more than the OLSR, which confirms that AODV has the overall best performance over

OLSR under the fragmentation threshold 256 bytes.

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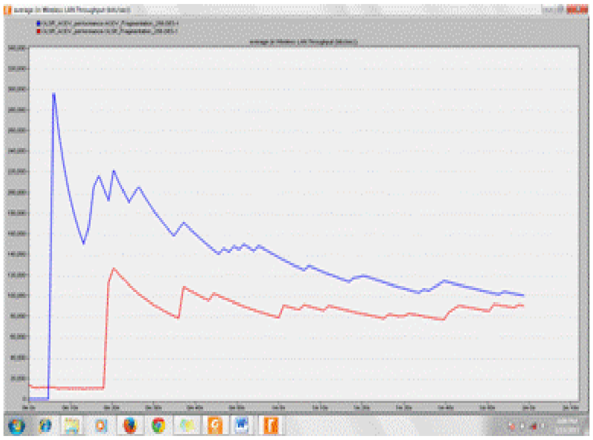

**Fig 5A: Threshold comparison in five nodes under256 bytes fragmentation threshold**

Table 2 is a pictorial repetitive of routing protocol and fragmentation threshold sizes in a twenty (20) nodes MANET scenarios. There are twenty (20) nodes and each of the node is given mobility through a trajectory. There are twenty (20) nodes working as client to establish connection with a fixed node functioning as an FTP_Application traffic source

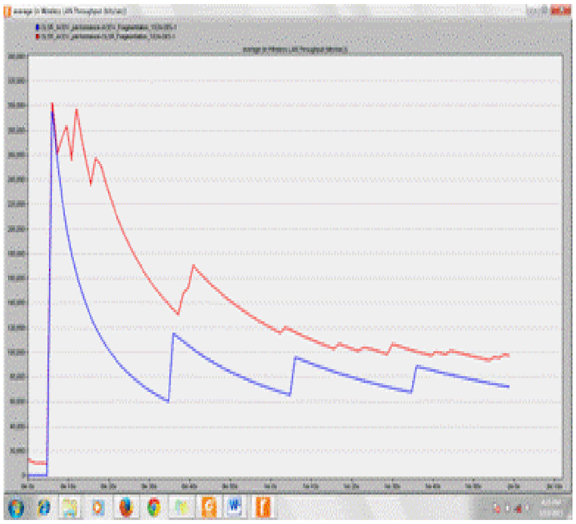

**Fig 5B: Threshold comparison in five nodes under 1024 bytes fragmentation threshold**

**Table 2: Details of fragmentation threshold size and routing protocol 0 to 5 nodes**

| Stage | Fragmentation threshold size | Routing protocol | Number of nodes | Speed of node (M/S/) |
|---|---|---|---|---|
| **A** | 256 | AODV | 20 | 10 |
| **A** | 256 | OLSR | 20 | 10 |
| **B** | 1024 | AODV | 20 | 10 |
| **B** | 1024 | OLSR | 20 | 10 |

From Figs. 6a (Threshold comparison in 20 nodes scenario, under 256 bytes fragmentation thresholds) and 6b(Threshold comparison in 20 nodes scenario, under 1024 bytes fragmentation threshold) was observed that the graph behavious changes tremendously. The throughput of the OLSR was better at approximately 17 seconds as compared to AODV. At exactly 45 seconds, the same throughput was attained but after this point, the AODV throughput increased while that ofOLSR decreased. Overall there was approximately 54% decrease in throughput in OLSR and 24% decrease in AODV with the fragmentation threshold being 256 bytes. Looking at the graph from Fig. 6B, we observed that the throughput of better but after this time, the AODV throughput increased while that of OLSR decreased. The inference from the result shows that node size and mobility condition defined in this simulation with fragmentation threshold at 1024 gives a better throughput for AODV as compared to OLSR, under the above condition

**Fig.6A: Threshold comparison in 20 nodes scenario under 256 bytes fragmentation threshold**

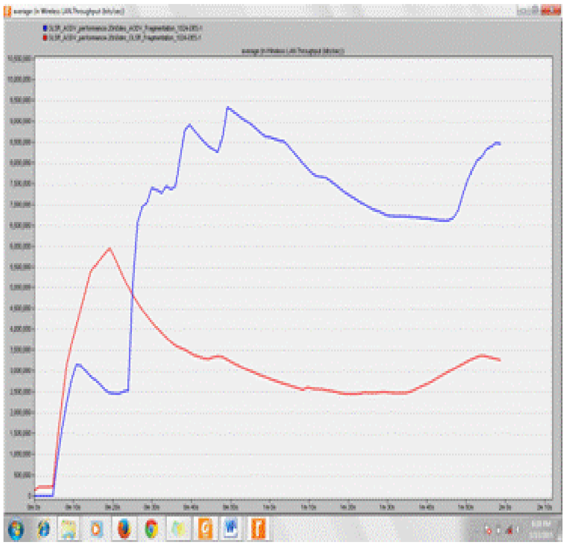

**Fig. 6B:Threshold comparison in 20 nodes under 1024 bytes fragmentation threshold**

### *3.1.1 Deductions*

It has been found that AODV has a better throughput under a small fragmentation threshold and with a small number of nodes than OLSR. Also, the higher size of fragmentation threshold gives a better throughput in OLSR than in AODV even with the small number of nodes and under the defined mobility conditions.

## *3.2 Delay analysis*

Figs. 7a to 8b showthe simulation result of 5 nodes and 20 nodes scenario under fragmentation thresholds of 256 bytes and 1024 bytes with respect to the different routing protocols AODV and OLSR. Fig. 7a reveals that at 9 seconds, the delay in AODV was high (approximately 0.026 second) but dropped virtually immediately to (approximately 0.009 second) and become stable in 25 seconds (approximately 0.004second). The delay noticed from graph in respect to OLSR was low (approximately 0.001 second) and it jump up a little to (approximately 0.003 second) at 20 seconds, this dropped a little and remain stable from 30 seconds to the end of the simulation at (approximately 0.002 second). Also, the consideration of the pattern observed in Fig. 7b suggests that the delay in AODV initially jump to (approximately 0.026 seconds) then dropped to (approximately 0.009 second) and remains stable for 25 seconds before a slight fluctuation of 0.004 seconds at certain intervals. The OLSR protocol has a delay of (approximately 0.006 second) and started a downward movement before it became stable in 40 seconds at (approximately 0.002 seconds).

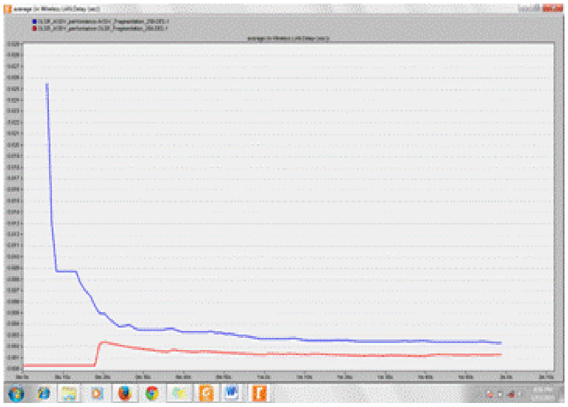

**Fig. 7a: Delay comparison of 5 nodes scenario with fragmentation threshold at 256 bytes**

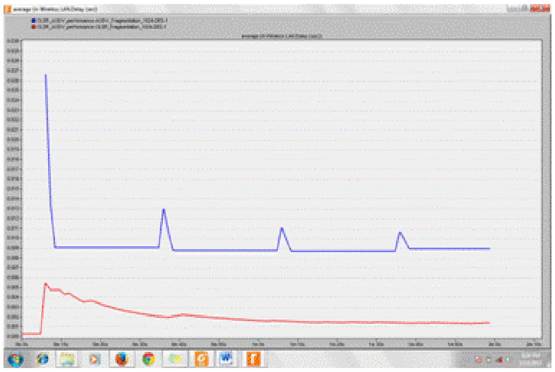

**Fig. 7b: Delay comparison of 5 nodes scenario with fragmentation threshold at 1024 bytes**

Fig.8a and Fig.8b present the results obtained for the 20 nodes scenario under a fragmentation threshold of 256 bytes and 1024 bytes with respect to the various routing protocols, namely, AODV and OLSR. Fig. 8a reveals that there was an increase in the delay for both protocols but when at 48 seconds the two routing protocols attain the same value (approximately 14 seconds), then the OLSR increased gradually till it gets to 1minute 45 seconds before it remains stable at (approximately 19 seconds).

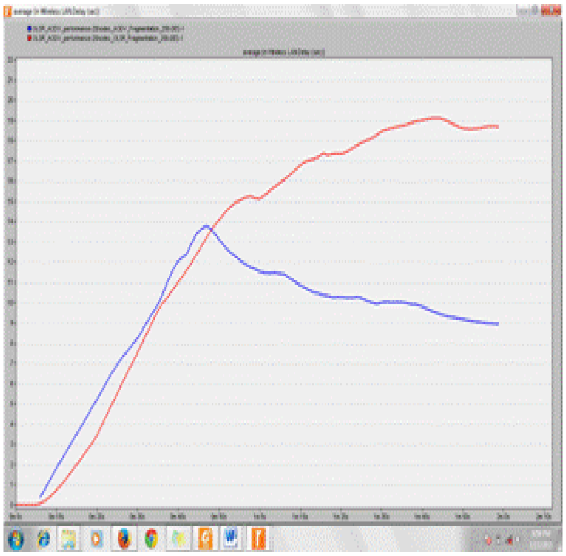

**Fig. 8a: Delay Comparison of 20 Nodes Scenario Under Fragmentation Threshold at 256 Bytes**

Fig. 8b also shows the delay value that was obtained from the simulation result. At 22 seconds the two protocols have a similar delay of (approximately 5 seconds). This delay in AODV dropped slightly and became stable in 30 seconds up to the end of the simulation. Also, the OLSR displayed a similar pattern of delay under the fragmentation threshold size at 256 bytes. The only significant change was a drop from 19 seconds to 16 seconds at 1 minute 30seconds.

### *3.2.1 Deduction*

It can be concluded from the graph result obtained from the simulation that irrespective of the fragmentation threshold size under a small number of nodes, the delay in OLSR remains small as compared to the AODV. But an increase in the number of nodes and fragmentation threshold size, the delay in AODV decreases. Also, the OLSR simulation remains the same, that is an increase in the number of nodes under different fragmentation threshold sizes indicates a similar delay.

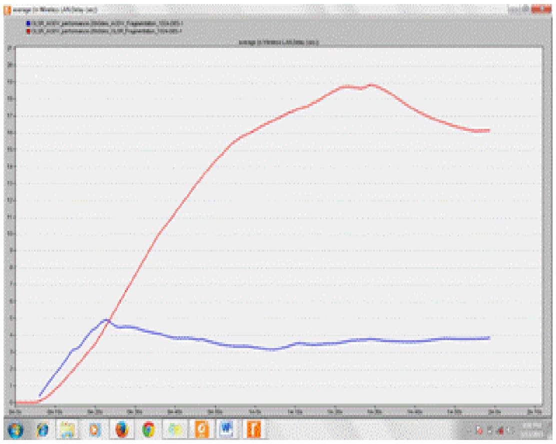

**Fig. 8b Delay Comparison in 20 Nodes Scenario Under Fragmentation Threshold of 1024 Bytes**

## *3.3 Retransmission attempt analysis*

Figs 9a to 10b are plots showing results obtained from the simulation of 5 nodes and 20 nodes scenario under fragmentation thresholds of 256 and 1024 bytes with respect to the various routing protocols AODV and OLSR. Fig. 9a, which represents the result of the simulation of 5 nodes under a fragmentation threshold of 256 bytes shows that at the start of the simulation the transmission attempt for OLSR was high (at 0.065 packets per seconds around 20 seconds). It is however became smoother before fluctuates between 0.025 and 0.034 packets per seconds. Therefore, the retransmission attempt in OLSR was higher than that of AODV under 5 nodes, mobility constraint and fragmentation threshold at 256 bytes.Fig. 9b shows that OLSR attained a high retransmission attempt at 0.065 packets per seconds but dropped to 0.040 packets per seconds. However, that of AODV increased from 0.035 packets per seconds and dropped to 0.040 packets per seconds while that of AODV increased from0.035 packets per seconds to 0.45 as at 1munite 5 seconds till the duration of the simulation time.

**Fig. 9A: Transmission attempt comparison in 5 nodes scenario under fragmentation threshold of 256 bytes**

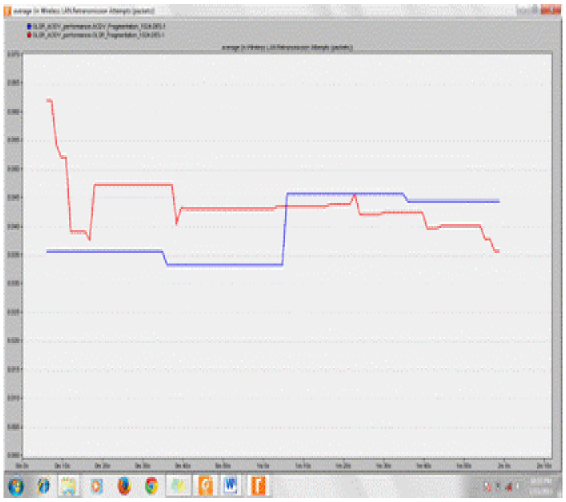

**Fig. 9B: Retransmission attempt comparison in 5 nodes scenario under fragmentation threshold of 1024 bytes**

Fig. 10a indicates that the retransmission attempt of OLSR was slightly higher than that of AODV. At 10 seconds, the transmission attempt of OLSF stood at 0.65 packets per seconds while that of AODV was stood at 0.55 packets per seconds. The retransmission attempt of OLSR however dropped slightly to approximately 0.62 packets per seconds and maintained this till the end of the stimulation. The AODV retransmission attempt was observed to decrease from 0.55 packets per seconds to 0.45 packets per seconds, which increased back to 0.51 packets per seconds. Fig. 9b shows that the retransmission attempt in OLSR is higher than the attempt in AODV under the constraints listed above. We observed that OLSR attained a height of 0.66 and retained a smooth pattern for a reasonable period of the simulation. However, AODV attained a height of 0.55 packets per seconds and dropped to 0.38 packets per seconds as at 1minute simulation time, then increased to 0.49 packets per seconds as the simulation elapse.

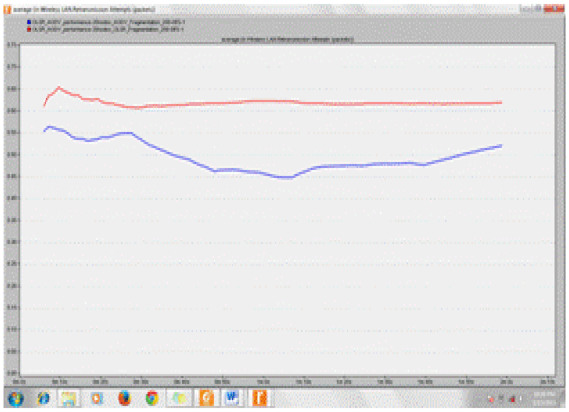

**Fig. 10A: Retransmission attempt comparison in 20 nodes scenario under fragmentation threshold of 256 bytes**

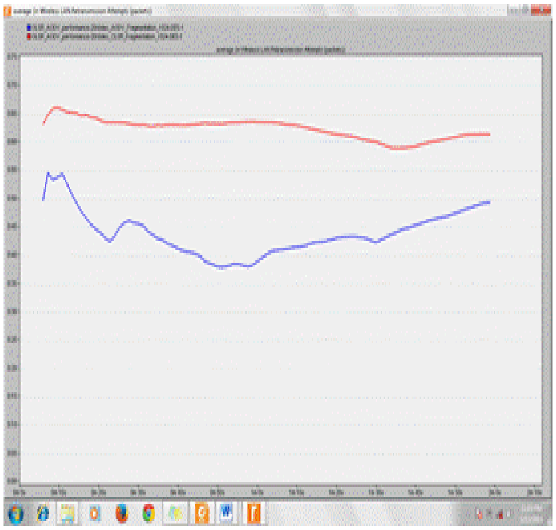

**Fig. 10B: Retransmission attempt of 20 nodes scenario under fragmentation threshold of 1024 bytes**

## 4.0 Conclusion

It is worth stating that at the 5 nodes and fragmentation threshold of 256 bytes, OLSR has the least transmission attempt than AODV, but as the fragmentation threshold increases to increasing to 1024 under the same number of nodes (5 nodes), the performance of the AODV slightly leapfrog that of OLSR. Therefore, an increase in fragmentation threshold at a constant number of nodes (20 nodes) gave OLSR a higher retransmission attempt than that of AODV.In conclusion, the fragmentation threshold affects the performance of AODV and OLSR routing protocols. AODV routing protocol in 5 nodes scenario with fragmentation threshold at 256 bytes shows a better throughput performance but OLSR better throughput with fragmentation threshold at 1024 bytes. The delay and retransmission attempt was higher in OLSR using fragmentation threshold 256 bytes and 1024 bytes. Even with the network size scaled to 20 nodes (from 5 nodes), the delay and transmission attempt remain worse in OLSR. Irrespective of the fragmentation threshold size, the AODV has shown the better performance under the mobility constraint and fragmentation threshold sizes defined in the simulation than the OLSR.

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## Conflict of Interest

The authors declared no conflict of interest