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Design and Implementation of Mobile Ad-Hoc Network Using Opnet Modeler

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***Abstract:** Mobile Ad-Hoc Network is a good illustration of a decentralized organization that does not need a foundation to function. The self-configurable and uncomplicated organizational component of this Mobile Ad-Hoc Network have made it feasible to run a wide variety of apps. As a consequence, these applications may now be used. If useful guiding standards are used, Mobile Ad-Hoc Network will develop into a robust system. During our investigation, we will attempt to determine which competent steering convention for directing hypertext transfer protocol traffic is utilized throughout the company. This will be the primary focus of our inquiry, so we must make this determination as accurately as possible. For this inquiry of the exhibition, execution measures such as latency and throughput were used. In this job reenactment research, your expectations should be based on the conventions that it chose since they had shown higher performance on every one of these fourth different viewpoints considerations. In addition to that, one way that an organization may improve the efficiency with which it operates is by picking conventions that are more suited for the business after taking into consideration the needs of the organization. AODV, DSR, and OLSR are the three routing protocols that were studied in this study to enhance the performance of ad-hoc networks via the use of OPNET Modeler version 14.5.*

***Keywords:** Opnet, AODV, DSR, OLSR, MANET, Ad-Hoc.*

1. INTRODUCTION

Lightweight devices and wireless communication are driving ad hoc networking. This has increasing extensive applicability. Ad hoc networking lets you construct a network anywhere, anytime, even without communication infrastructure. It replaced ornate or inconvenient infrastructure [1]. Ad hoc networks may boost productivity and profit in real-time

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commercial applications and huge businesses. Ad hoc networks may be classified by application. Mobile Ad hoc Networks (MANETs) are wireless networks of mobile devices without infrastructure. VANET is a mobile network made of moving cars [2,3]. Self-operating sensors control the environment in Wireless Sensor Networks (WSN).

Mobile devices may form a MANET if needed. This network can function without help from an internet infrastructure or fixed station. A MANET is a wirelessly connected network of nodes or MSs that act as routers. This describes a MANET. This is one MANET concept. These nodes and MSs constitute a communication network that may be represented by any communication graph [4,5]. However, the well-known single-hop cellular network design uses cable backbones and fixed base stations to provide wireless communication between two mobile nodes. Unlike above. In this design, a hop is the time it takes a signal to travel between base stations. This paradigm allows wireless communication between two mobile nodes. A MANET has no infrastructure, and its topology may change unexpectedly. Because MANET nodes are free to traverse the network and have limited transmitting power, they can only be accessed in their local vicinity. Figure 1 shows a MANET as a peer-to-peer, multi-hop wireless network that stores and forwards data packets. MANETs are multi-hop, peer-to-peer wireless networks [6,7].

It's called a mesh network. In a network like this, each node relays data packets between peers. Thus, data may move more quickly. It is important to remember that the link between two nodes in a network may change as other nodes move around. Always remember this. To update topological information, the local network topology change must be sent to other nodes. When the MS2 in the picture shifts its point of attachment from MS3 to MS4, the network should start utilizing this new route to send packets to it. Thus, MS2 receives the packets on time. We assume that all nodes in the example cannot be within radio range of each other since this is absurd. No routing issues will arise if all nodes are physically close and within radio range. Under these circumstances, all nodes may interact [8,9].

Ad-Hoc characteristics are represented by the ability to build a dynamic topology, changeable capacity depending on the bandwidth, and energy-efficient networking. Even with all the advantages related to MANET networking, however, there are some drawbacks related to the utilization of MANET networking represented by the limited capacity due to different routing protocol utilization, and the lack of built-in security. Ad hoc networks have an architecture that allows them to self-form, self-maintain, and self-heal. The difficulties include there being no permanent access point, having a dynamic network architecture, being in an adverse environment, and having an erratic connection. Instantaneously, an ad hoc network arises and can handle the alteration and the restricted power. Last but not least, ad hoc networks lack any reliable centralized authority. This paper aims to the examination of the performance of the existing MANET, notably with relation to web traffic, utilizing OPNET simulation to assess performance indicators like latency and throughput. Second, in planning and executing organization circumstances by fluctuation hubs number, portability for hubs with trafficable loads for assessing that conventions execution with for identifying that optimal convention on directing. Finally, such hypertext transfer protocol involves

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transmission control protocol with the application convention, focusing on trafficable with double layers apps layer and transportation layer for examining that exhibition for mobile ad hoc network steering conventions and using AD HOC ON-DEMAND DISTANCE VECTOR (AODV), Optimized Link State Routing Protocol (OLSR), and Dynamic Source Routing (DSR) directing conventions with wide space and high-level PC workstations. This perspective spurred our further exploratory tasks [10-12].

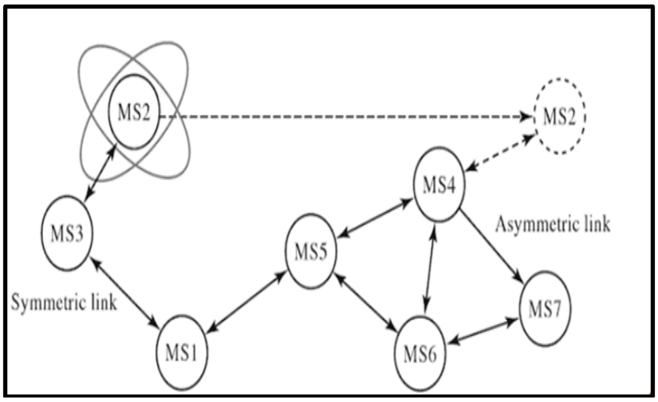

Figure 1: MANET network connection showing the symmetric and asymmetric link [11].

Related Work

Several works were proposed by researchers and networking companies to handle the problems related to the implementation of effective MANET networking. For example, researchers considered performing a routing-based MANET network performance study [13]. These protocols were DSDV, AODV, OLSR, and DSR. The system has been upgraded to include nodes with 30, 50, and 80 to assess its performance depending on several explored aspects. Based on their findings, AODV and DSR provide the best performance since they utilize less bandwidth than the routing information requires. DSDV and OLSR have the lowest performance, making them suited for smaller networks. AODV and DSR are best for large networks. AODV and DSR had the highest throughput parameter values. This study does not discuss the MANET network's application. Also, [14] used MANET to compare AODV and DSR protocols. Three scenarios with scattered nodes numbered 30, 29, and 27 were compared in a one-kilometer region. File Transfer Protocols were handled at 11 Mbps (FTP). If the node had not been infiltrated by a black hole assault, the first scene started with its default setup. Another possibility was a "black hole" assault on the second routing protocol. The fourth and most likely hypothesis was that a collaborative black hole created by hostile nodes attacked the MANET network. In all criteria, AODV outperformed DSR. AODV has 216.14 Bit/sec, whereas DSR had 72.42. DSR affected the black haul, which caused packet loss. The network was only tested for FTP-based apps; hence it has to be tested for applications with much higher loads to meet 5G application requirements. Additionally, DSDV, AODV, and DSR routing protocols were proposed for a MANET network [15]. They examined throughput, packet delivery ratio, and E-2-E delay. The network, which has thirty nodes in a 600-by-600-meter region, was built, modeled, and simulated using NS2. Based on the findings, the DSR-based technique outperforms the other two. DSDV also performs poorly. The study's drawback is that the authors didn't quantify the examined parameters'

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outcomes. Instead, they assessed the outcomes by sketching curves without considering why. Only this approach has quantified their results. The researchers considered doing a routing-based MANET network performance study [16]. DSDV, AODV, and DSR were the protocols. Performance analysis established three criteria. Spread nodes cover 800 x 800 meters. 3–40 coordinates. Based on the statistics, the AODV offers better E-2-E delay performance even at higher speeds. It also has the highest throughput, minimizing packet latency. The DSR affects delay time performance least during this period. Due to this, the DSR-based network needs considerable property upgrades. The proposed study addressed protocols with low-load applications, but to illustrate how well a protocol operates in high-load circumstances, it must be handled with considerably greater packet-based applications. Furthermore, Using the simulator NS2, the authors proposed a MANET network including DSR, AODV, and DSDV communication protocols [17]. It contains 20–100 nodes and a 1000–1000-meter dynamic area. Examined traffic was TCP. Their study found that the DSR performs best when the distribution has a small number of nodes, but as the number of nodes increases, the AODV performs best. As nodes proliferate, the DSDV performs worse. For distances between 700 and 900 meters, the DSDV delivers the most packets. DSDV has the lowest E-2-E delay, whereas AODV has the most. The method advances MANET network routing. The main shortcoming of the provided work is the tiny packet size, which must be enlarged for current purposes. Moreover, AODV and DSR routing technologies were used to create a MANET-based network [18]. Throughput, latency, access delay, and packet transmission were introduced to this network. These measures assess data transmission speed. The 50-node network was built, modeled, and simulated using OPNET. The findings showed that the AODV protocol improves throughput and latency. Packet transmission performance suffers. Thus, the AODV protocol manages MANET transmission better than the DSR protocol. AODV's 0.002-second latency may require improvement. Better. Improve the DSR's multi-hop packet transmission to boost QoS.

2. METHODOLOGY

This section will describe all the concepts related to the proposed methodology that form this paper, demonstrating the significance of the optimization of the routing protocols for Ad-hoc networks.

A. Ad-Hoc Routing protocols

Routing determines paths from source to node along which packets may be transferred from source to destination by passing via selected intermediary nodes using a routing protocol. Routing selects pathways. Routing protocols are algorithms or rules nodes must follow to successfully route. Every routing protocol stores route data. Routing metrics are the most essential stored routing data. The routing algorithm uses routing metrics to choose the best path for the user. The routing statistic might be hops, latency, bandwidth, load, or reliability. There are three different kinds of routing protocols, each of which is distinguished by the technique through which routing information is updated, these categories are classified as seen in Figure 2. [19].

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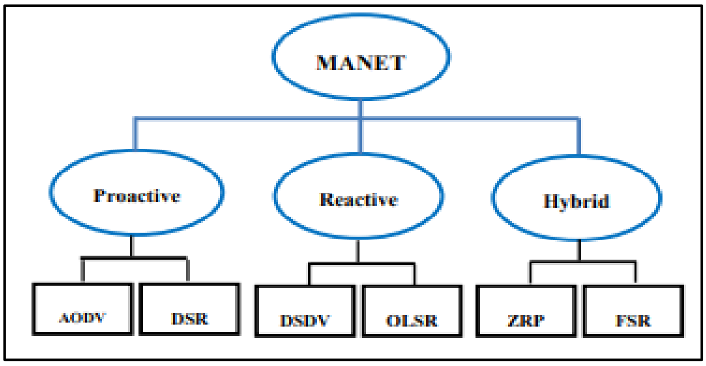

Figure 2: MANET routing protocols [20].

B. DSR Protocol

Is a simple and effective routing system designed for mobile node multi-hop wireless ad hoc networks. DSR lets the network arrange and configure itself without network architecture or administration. All of its components operate reactively. Source routing underpins it. Source routing lets a packet's sender choose its whole path [21].

Source routing frees intermediary nodes from updating their routing information to forward packets. Route Maintenance and Route Discovery comprise the protocol. DSR nodes must maintain a route cache of all self-to-destination pair connections. Nodes will use this cache to send packets. If the destination is not in the cache, route discovery involves sending a route request to locate a route. This request includes the destination, source, and special number. If a route can be obtained from the route cache, a route maintenance operation may be started, but the route is not valid. A node will only handle a route request packet if it has never done so before and the packet address is not in the route cache. A node may construct a route reply as the destination or as a node along the way [22].

Route discovery uses S1 as the source node and S7 as the destination node, as illustrated in Figure 3. In this case, S7 gets the request via two channels. Based on the route records in the incoming packet, it sends a response to the source node through the opposite way. Each hop saves the shortest route. This picture shows the route record status at each hop from source to destination. S1-S2-S4-S5-S7 is the route [22].

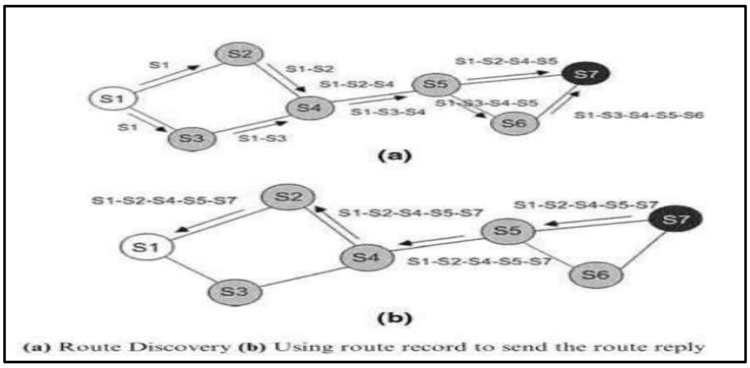

Figure 3: DSR routing protocol [22].

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C. AODV Protocol

MANET reactive protocols like AODV operate on demand. If the source node wants the packet transmitted to the specified destination node, AODV creates a route. AODV nodes maintain the routing table for one destination node per route. Node silence when no data to transmit. If the upper tier needs to request a route, a "ROUTE REQUEST" packet will be transmitted nearby. A neighbor with a suitable route will send a "ROUTE REPLY" packet. If this requirement is not satisfied, each neighbor except the originator will send the "ROUTE REQUEST" to their neighborhood and increment the hop number in the packet data. This packet also creates a reverse route entry to the originator [23].

This will continue until a route is found. This strategy includes route maintenance. If a neighbor is no longer accessible, a route's hop is invalid. AODV sends frequent "HELLO" packets to check whether its neighbors are active. Active neighbors are previously routed neighbors. The originator will delete all routes associated to a node if the node does not respond to its "HELLO" packet. Ping queries resemble HELLO packets. A "ROUTE ERROR" packet is unicast to all preceding forwarders and the station sending the packet if a connection is lost during broadcasting and layer 2 does not acknowledge. Figure 4 illustrates this protocol[24].

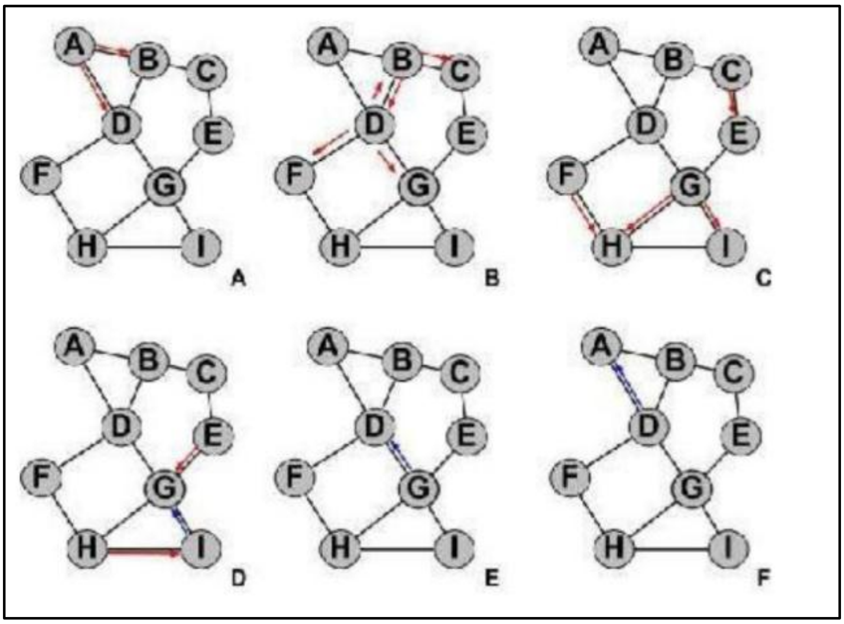

Figure 4: AODV protocol routing [24].

D. OLSR Protocol

Proactive routing technologies like OLSR are used. Each node maintains its route database, which lists all network connections. Because of this, the routes are ready for immediate deployment in any situation. OLSR is one of many link-state protocol upgrades. The topological change will flood all network nodes with topology information. Topological change causes this. MPRs decrease network overheads in the OLSR protocol. MPR aims to reduce transmissions. Lowering the frequency with which specific portions of the network

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get multiple broadcasts of the same broadcast and choosing the network route with the least distance traveled achieves this. OLSR uses Topology Control (TC), Hello, and others. Use other control messages. TC communications transmit promoted neighbor information. The MPR selection list must be included. However, Hello messages are used to determine connection status and neighboring network nodes. Reducing the Maximum Time Interval (MTI) for monthly control messages may help OLSR respond to topological changes [25]. Since it offers minimal end-to-end latency, OLSR is utilized for applications that demand the least delay. OLSR is easier to utilize than earlier procedures. Flat routing scheme. It doesn't require a central management system to route [26,27]. It also makes the protocol better for ad hoc networks by making source-destination switching more flexible. It doesn't require a reliable connection to regulate messages as they're transmitted regularly. The link isn't needed either.

E. OPNET Simulator

An optimized Network Engineering Tool (OPNET) was created to examine network performance. OPNET has four editors for system modeling. Designers, architects, students, researchers, and educators will benefit from OPNET research activities in a range of application areas. OPNET research programs examine wireless, wired, distributed, communication, TCP/IP, and Internet technologies, all of which were developed from IEEE standards [28]. The methodology followed in this paper by using the OPNET program can be seen in the flowchart seen in Figure 5.

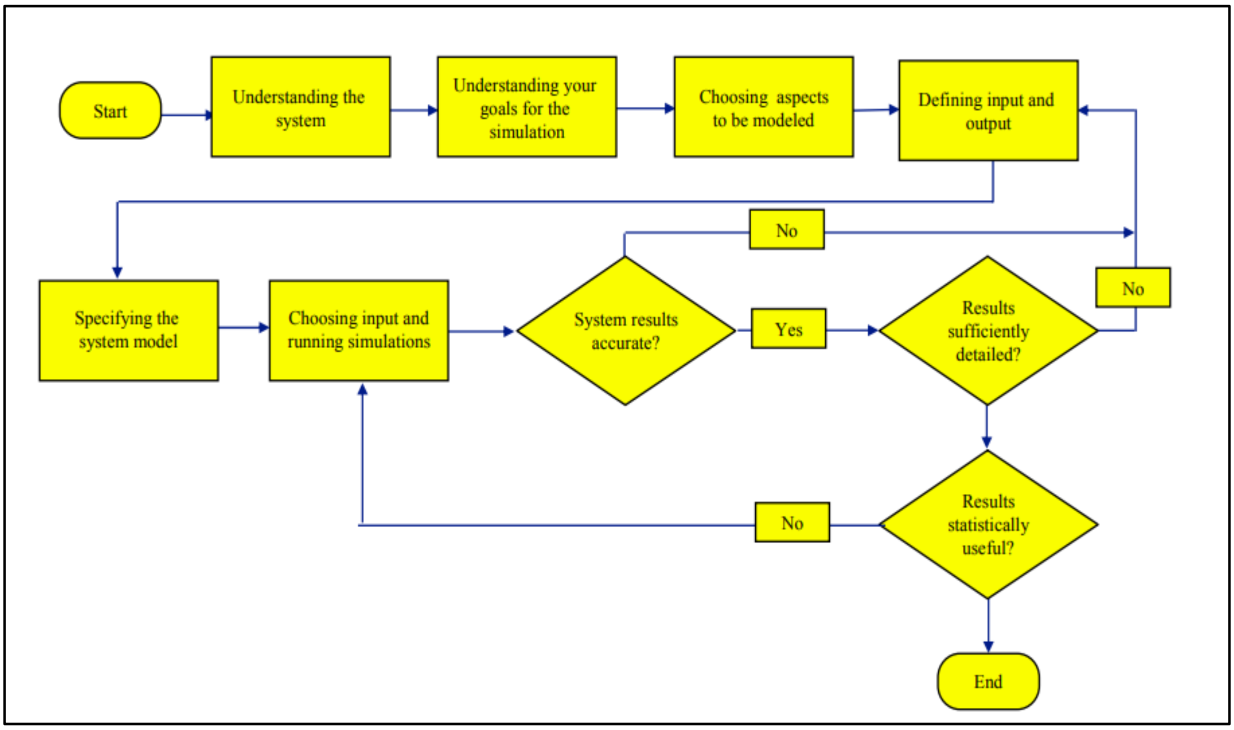

Figure 5: OPNET flowchart to show the methodology that the paper follows

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Proposed Model

This part will demonstrate the proposed model carried out by using the selected simulator, where it starts with running the OPNET modeler and create a clear starting point for the model. It will organize the present region using the predicted plan features. Application setup, Profile design, Mobility setup, Servers, and Node will be required for this product range for the project works area. The work area depiction for organization modeling is shown in Figure 6.

Figure 6: An Illustration of Organization Model Plan MANET 20 Hub Situation with Network Substances.

For the parameter setting for the workstations that are deployed within the proposed model which represent the 20 mobile nodes can be seen in Figure 7 and Figure 8 respectively.

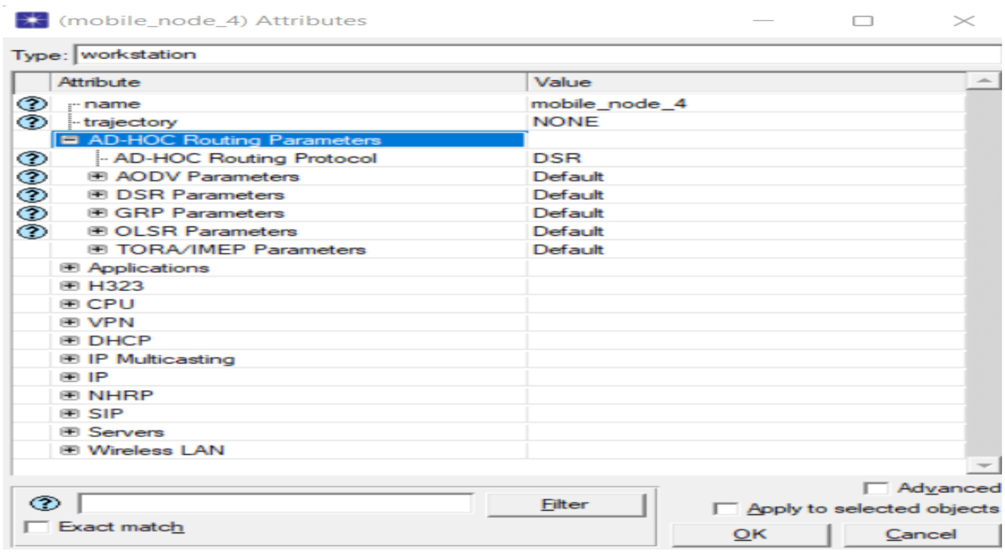

Figure 7: Parameters setting for mobile nodes (part1)

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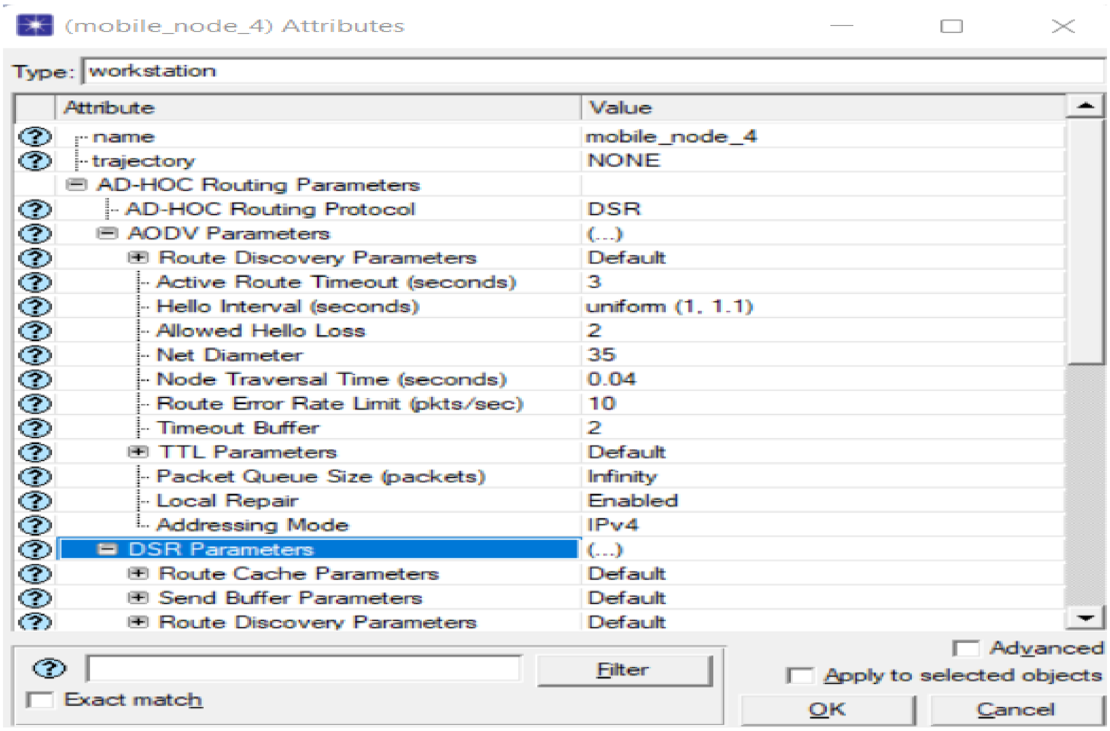

Figure 8: Parameters setting for mobile nodes (part2)

Also, the parameters of the application definition profile can be seen in Figure 9. Meanwhile, the parameters for the profile definition component can be seen in Figure 10. Finally, the parameter setting for mobility configuration can be seen in Figure 11.

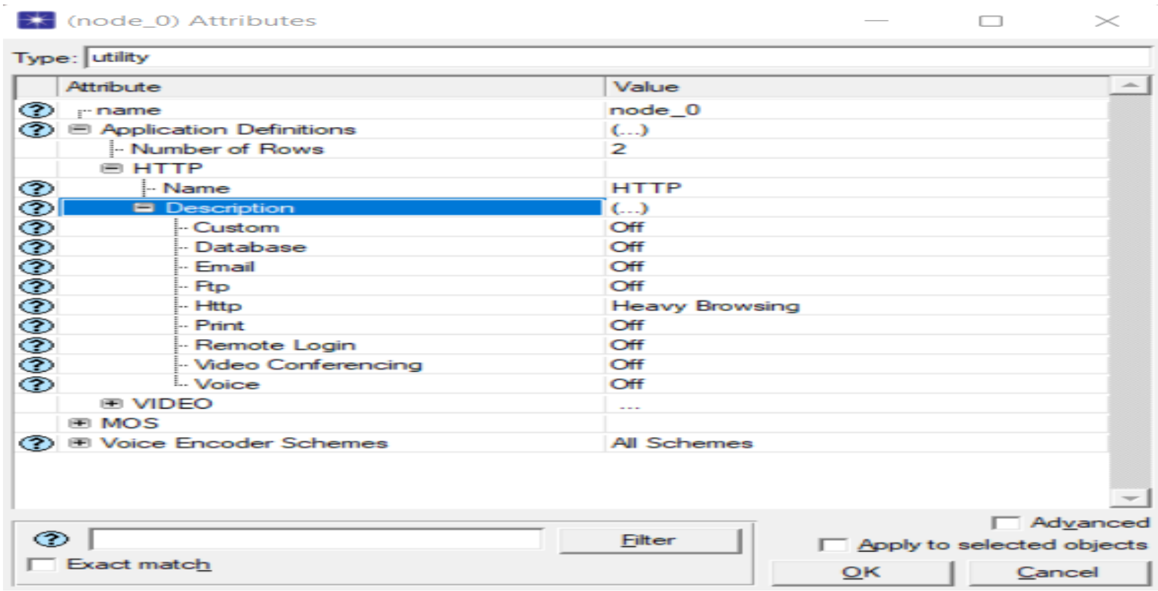

Figure 9: Parameters setting for application definition.

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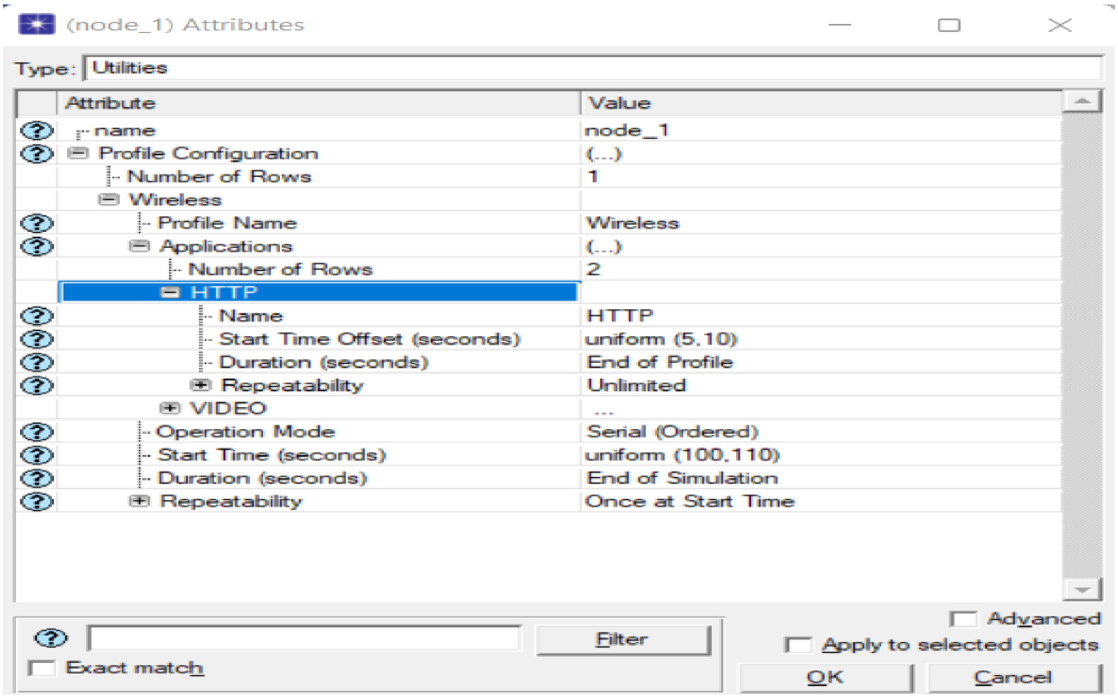

Figure 10: Parameters setting for profile definition.

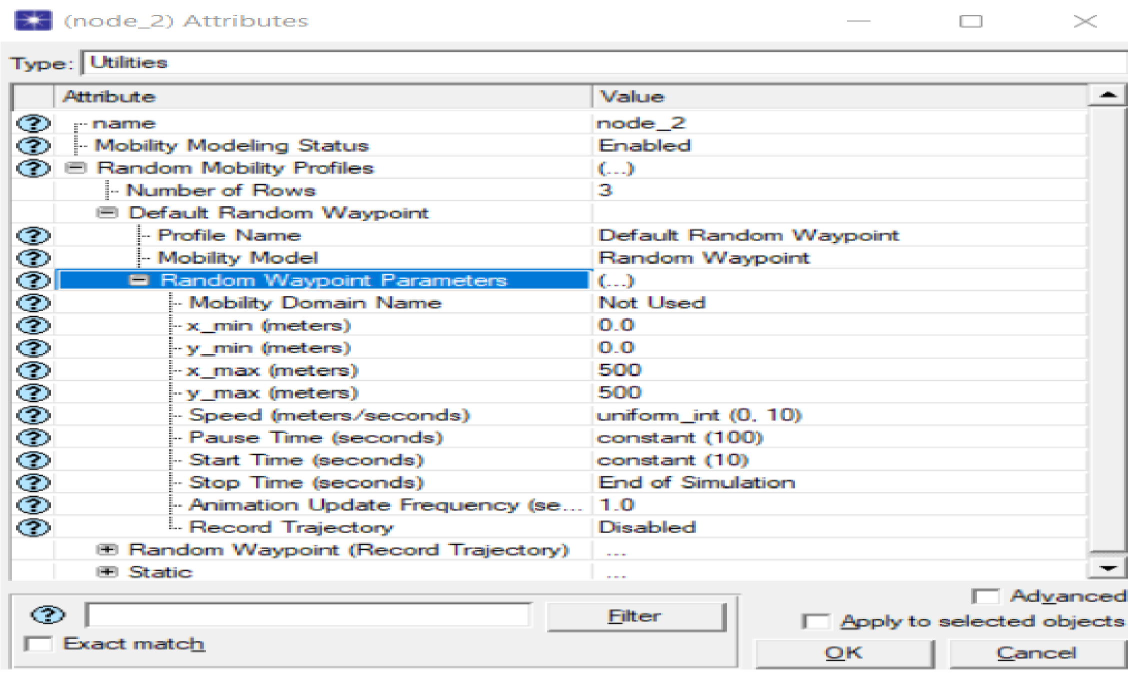

Figure 11: Parameters setting for mobility configuration.

The methodology for the proposed MANET network proposed in this work can be described as seen in the flowchart of Figure 12.

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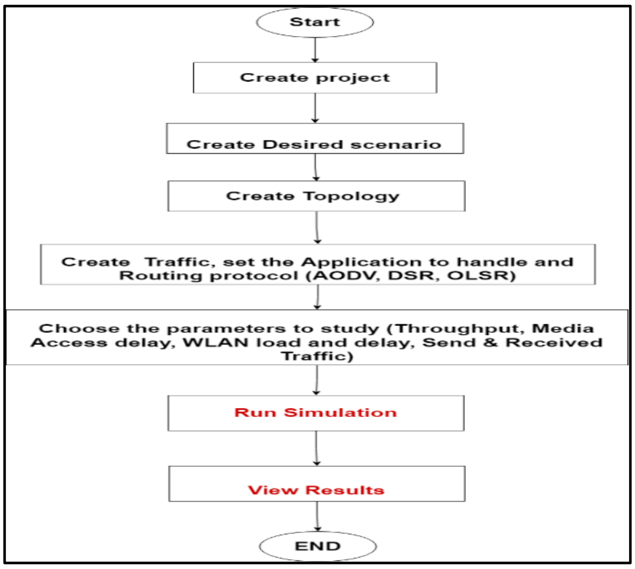

Figure 12: flowchart for the methodology of the proposed model

3. RESULTS AND DISCUSSION

This section will demonstrate the results for the proposed model using OPNET simulator and based on different factors and compare the results obtained from the three studied protocols to indicate the optimum performance criteria.

A- Results based on Response Time

In the recreation climate, two situations are grown independently within double unique profiles hypertext transmission protocol weighty burden traffic and hypertext transmission protocol burden trafficable separately, which suggests the number of HTTP demands given by clients in the organization planned will be higher in HTTP weighty burden than HTTP light burden traffic, 20 hubs are considered on every situation within steady speeding for ten meters per sec, and se seen in Figures 13 and 14, which shows object and page response times.

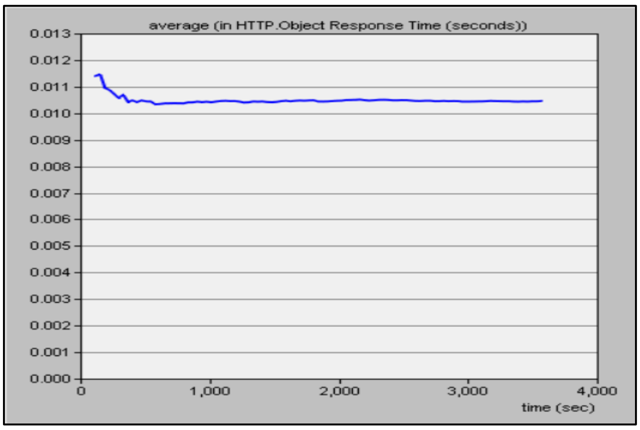

Figure 13: HTTP Object Response Time (sec).

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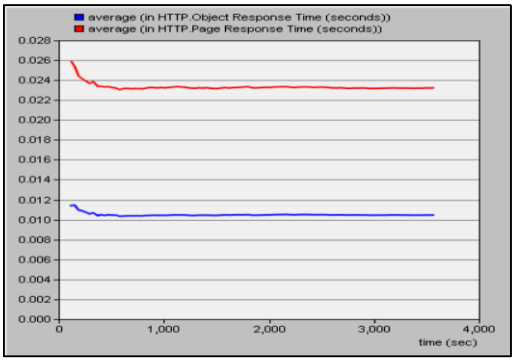

Figure 14: HTTP Object and Page Response Time (sec).

B- Result based on Traffic Send/Received

These results were studied for both cases of sending bytes and packets and as seen in Figures 15 and Figure 16. It can be noticed that the curves varied and then settled after 2000 sec. For example, the proposed system could achieve about 3500 bytes when reaching 4000 sec, which considered is a practical issue to investigate system performance.

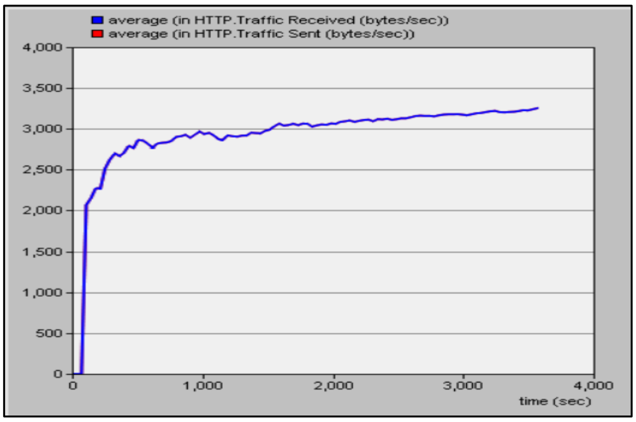

Figure 15: HTTP Traffic Sent and Received in Bytes per sec.

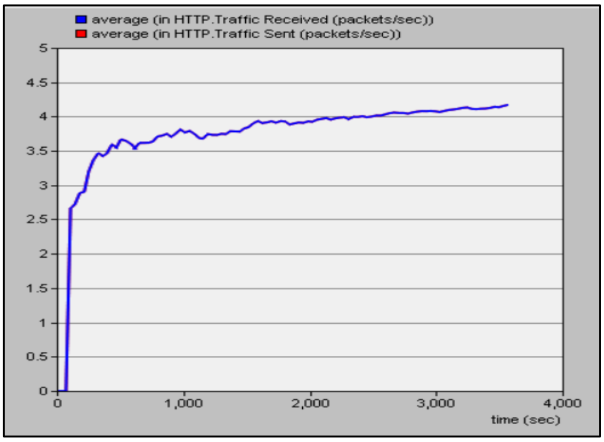

Figure 16: HTTP Traffic Sent and Received in Packets per sec.

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C- Results Based WLAN Load and Delay

As seen in Figure 17 and Figure 18 respectively, which give a stable performance over time indicating the reliability of the proposed methodology. For example, the WLAN load could reach 28,000 bps for 4000 sec.

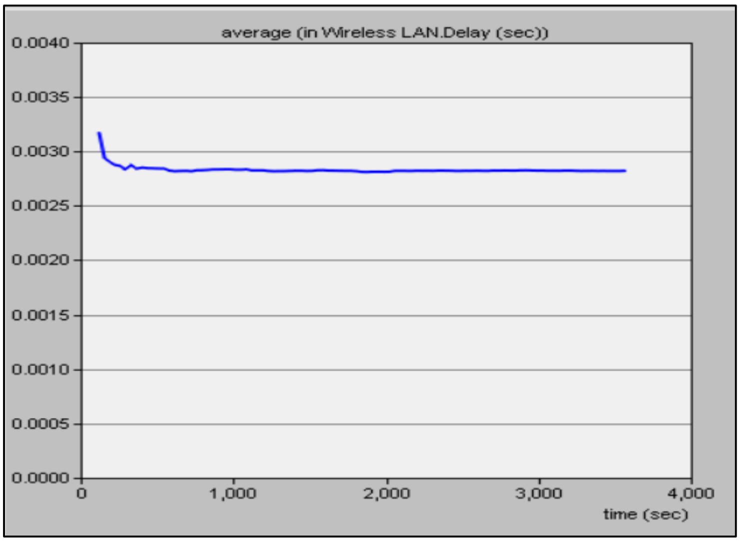

Figure 17: WLAN Delay on MANET.

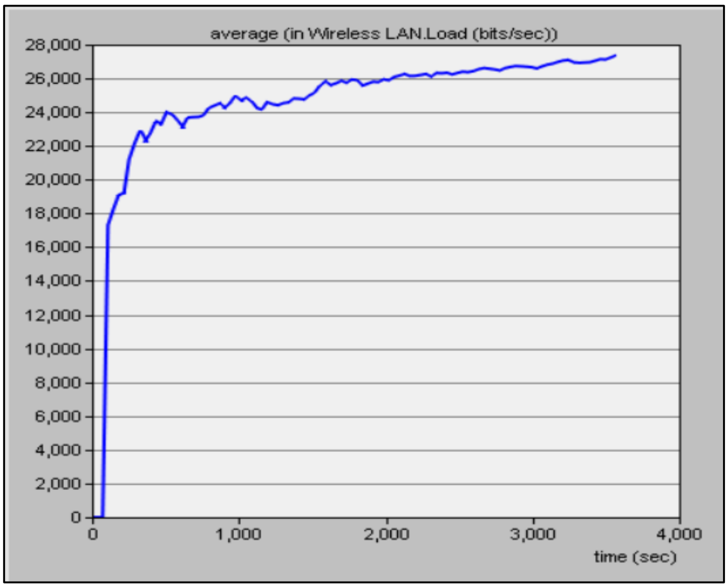

Figure 18: WLAN Load for Bits per sec in MANET.

D- Results Based on Media Access Delay

The graphs in Figure 19 demonstrate how, as the number of nodes rises, traffic production similarly rises, increasing the network's media access delay. Which indicates a reliable system performance. Note, that the data obtained represent the average from utilizing the three selected protocols mentioned earlier.

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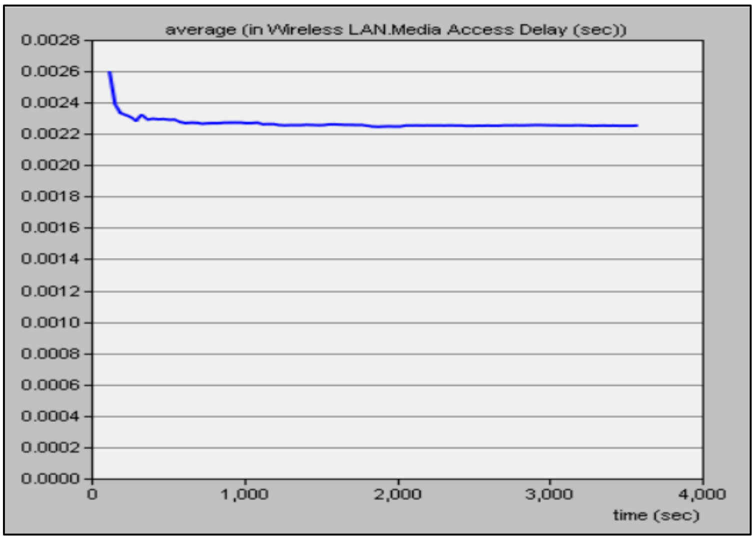

Figure 19: WLAN Media Access Delay.

E- Results Based Throughput

This represents the typical number of messages that are successfully sent across a communication link or channel. It is measured in data packets per slot or bits per second (bps). The data rate sent to network terminals is added to determine the system throughput as seen in Figure 20 and Figure 21 respectively.

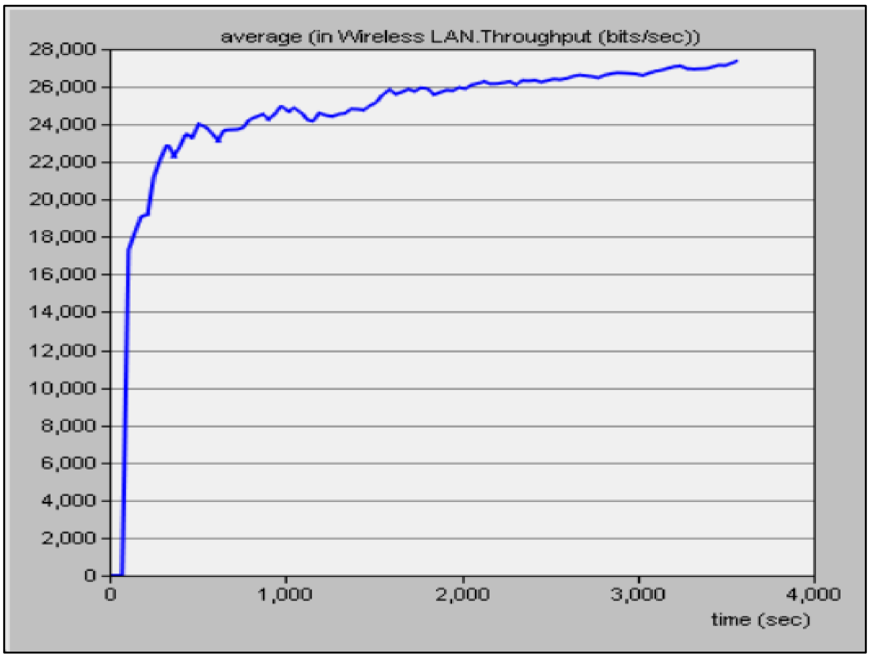

Figure 20: Overall WLAN Throughput for Bits per sec in MANET.

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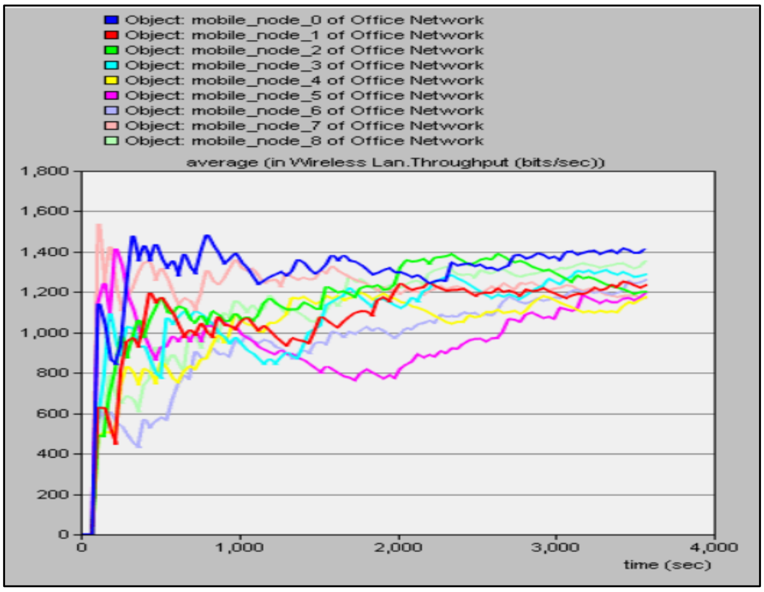

Figure 21: WLAN Throughput between Nodes for Bits per sec in MANET.

F. Results based on Protocols Comparison

In this part, results between the three protocols would be compared in terms of all the studied parameters. It can be seen that AODV gives the best overall performance, then followed by the DSR and the worst case was for the OLSR. The comparison with respect to WLAN delay for example can be illustrated in Figure 22.

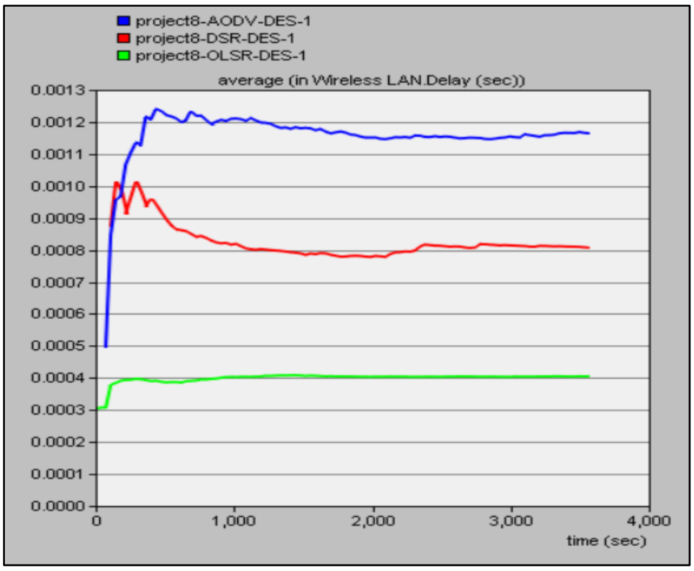

Figure 22: Comparison between Routing Protocols in WLAN Delay.

G- Results based on Comparison with Literature

This section will demonstrate a final comparison of the parameters obtained from the proposed system and the most recent previous publication and as seen in Table 1. It can be noticed that the proposed system could improve the delay by reducing it for the three utilized protocols. Also, an improvement in throughput was achieved as compared to the literature with achieving an increase of 81, 40, and 24 times the literature achieved throughput for the three utilized protocols (AODV, DSR, and OLSR) respectively.

Table 1: Performance comparison between routing protocols and our proposed work.

Parameters	Ref. [37]	Proposed Work
Wireless LAN Delay (sec) for AODV	0.015 (sec)	0.00118 (sec)
Wireless LAN Delay (sec) for DSR	0.07 (sec)	0.00081 (sec)
Wireless LAN Delay (sec) for OLSR	0.009 (sec)	0.0004 (sec)
Wireless LAN Throughput (bits/sec) for AODV	4,000 (bits/sec)	325,000 (bits/sec)
Wireless LAN Throughput (bits/sec) for DSR	2,000 (bits/sec)	80,000 (bits/sec)
Wireless LAN Throughput (bits/sec) for OLSR	9,800 (bits/sec)	230,000 (bits/sec)
PC Type	wlan_wkstn	wlan_wkstn_adv
Coverage Domain Margins	-	Wide Domain

4. CONCLUSION

This section details the results of our inquiry into the source of transmission control protocol delay. To replicate the scenarios and collect data on transmission control protocol delay, we have considered both heavy and light loads of hypertext transmission protocol traffic. Additionally, optimizing links statically route convention shown less transmission control protocol delay in the event for hypertext transmission protocol low burden than hypertext transmission protocol weighty burden yet AODV convention shown less TCP delay if there should be an occurrence of hypertext transmission protocol low burden than hypertext transmission protocol weighty burden. Due to our replication results that were gathered using our organization, we believe that showing up for organization instructions and providing that expertise for an organization could be accomplished by choosing the most appropriate conventions while taking into account the organization requirement as our results show execution minor deviation from changing the organization conditions. For future, various association conditions. different parts, for example, the effect of impedance times, multi-speed association, power limit of focuses, and different adaptability models.

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