# Analysing admission control for AODV and DSR routing protocol in mobile ad-hoc network

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| Article Info | ABSTRACT |
|---|---|
| | The widespread deployment of mobile ad-hoc network (MANET) in the areas of agriculture, military defence, weather forecasting and disaster control has necessitated the implementation of admission control within a network for a guaranteed quality of service (QoS). Admission control organises traffic flows to ensure the network medium is fairly shared among various nodes in the network. Various admission control algorithms have been proposed in the literature, using different metrics and parameters to achieve different admission control quality. In this work, we propose an Admission control in mobile ad-hoc network routing (ACMANR) using both bandwidth capacity and resource estimation to achieve a good QoS. Furthermore, we analyse the behaviour of two well-known routing protocols in wireless network, ad hoc on-demand distance vector (AODV) and dynamic source routing (DSR), in our proposed admission control algorithm. Simulation results obtained from our proposed admission control algorithm using OPNET show that AODV routing protocol had a better throughput while DSR produced a better delay with lower overhead in MANET. Our proposed approach also shows better performance in terms of throughput and delay when compared with the state-of-the-art admission control routing using AODV and DSR.<br><br> |

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## 1. INTRODUCTION

In recent years, MANET have received much attention due to its deployment in the areas of disaster site, battle fields, search and rescue operation. A significant feature of an ad-hoc network is the absence of backbone infrastructure or a base station to enhance its communication [1]. Therefore, for communication to be possible in an ad-hoc network, nodes communicate directly with each other without the need to go through an intermediary. Notwithstanding its numerous benefits and applications, the deployment of MANET has brought about various issues that needs to be addressed. Prominent among these are its dynamic topology, in-ability to predict the topology, non-reliability of wireless medium and constrained nodes [2]. This has therefore resulted in various reliability issues such as node failure, link failure, and breakage of route (especially during congestion) [3], [4]. The routing protocol to be deployed must therefore compensate for issues posed by the ad-hoc network to achieve network efficiency.

The function of an admission control is to decide on the type of application to be admitted into a network. This could be highly consequential in situations where there are high level of constrained resources

within the network. It does not guarantee any node resources if there are limited available bandwidth within the network, to avoid network congestion or interference. Admission control ensures that the admission of a new flow into a given resource constrained network does not violate previous rules set by the network admission flow. The rules made by a network administrator could either be qualitative or quantitative. Admission control also tends to control the allocation and usage of network resources, especially for applications requiring additional service. Therefore, admission control allows component such as bandwidth to be used only when it is available, in order to avoid constraining the network resources.

There are three different approaches to admission control; the parameter-based, the endpoint-based, and the measured-based. The parameter-based admission control function by computing the total network resources required to support a set of flows, giving a flow priori characteristic. The endpoint-based approach, on the other hand, allow users to make decision whether or not to join the network using a probe packet. Finally, the measured-based admission control totally relies on the measurement of traffic load before an admission decision can be made. In this study, we adopt the measured based admission control that use the bandwidth capacity and resource estimation to guarantee and maintain a high QoS. Furthermore, we will observe and analyse the behaviour of our proposed admission control algorithm when AODV and DSR routing protocols are introduced in MANET. Finally, we will compare our proposed approach with the state-of-the-art admission control routing using AODV and DSR to observe their throughput and delay.

As earlier stated, the main function of an admission control scheme is to ensure the admission of a new traffic flow into a network, provided it does not violate the rules that may exist within the network. According to [5], [6], for an admission control scheme to be successfully implemented, there are several requirements that must to be fulfilled [7]; these includes:

a. Robustness: the implemented admission control scheme on the network must ensure that the necessary QoS requested is provided. The network quality must also be robust towards traffic heterogeneity, heavy load, and time scale.

b. Resource utilization: the implemented admission control scheme must maximize resource utilization with respect to the QoS constraint of the admitted flow.

c. Implementation: the deployment cost of an admission control scheme must also be put into consideration. Its cost must be less than its benefit.

It is also important to note that while deploying an admission control scheme, focus should not be directed on only the gateway for QoS to be maintained in MANET. There must be adequate provision for locations that are hotspot centred, especially those locations around the MAC layer [8]. All these requirements were considered during the designing of our proposed admission control algorithm to achieve a good and guaranteed QoS in MANET.

In the literature, admission control have been implemented in MANET. The authors in [9] made use of a sender based admission control to regulate real-time UDP traffic. Makrakis [10] also proposed a QoS routing algorithm that depends on an effective admission control while the authors in [11] proposed a measured-based admission control algorithm. It is important to note that while proposing a measured-based admission control, there cannot be an accurate measurement in its design for MANET considering the unpredictable movement of mobile host [12].

## 2. RESEARCH METHOD
### 2.1. Bandwidth capacity

Bandwidth capacity is the amount of traffic that can be transmitted by a network without causing either a traffic degradation or affecting other flows transmitting within the network [13]. When the capacity of the channel is accurately determined, it ensures an easy deployment of the admission control scheme on the network to prevent network congestion within MANET [8]. Due to the fact that mobile nodes share the wireless network medium based on contention, there is a relationship between the capacity of a channel and the bandwidth of the channel. This is expressed as;

$$\Sigma^n Bi \leq c/a \qquad\qquad (1)$$

where; n=the number of nodes sharing the wireless channel

B=Bandwidth of the node i

C=Capacity of the wireless channel

$1/\alpha$=Channel utilization rate

A simulation to estimate the value of $\alpha$ was first conducted, thereafter, two algorithms were used to calculate the bandwidth on each node. OPNET was used to simulate our design and the parameters used is presented in Table 1. To address the control traffic's influence on data packet transmission, an amount of

control packet that is enough to serve 10 data sessions in MANET is produced and the mobile node density is changed in different simulations. We simulated the scenario with 10, 15, and 20 nodes sharing channel. Each node forwards data packets to a randomly selected neighbour node on an equal probability basis. Figures 1-3 show the results for the average data packet delivery ratio, average throughput on each node, and average end-to-end delay with different traffic load and node density value.

Figure 1 shows that the packet delivery ratio declines with an increase in the number of nodes and the same also applies in Figure 2. The sudden performance degradation shows that wireless network with shared channel has certain rate of utilization. Its value is determined by the access channel mechanism, number of active node and traffic pattern. Therefore, an increase in the node density results in the decrease in channel utilization (α).
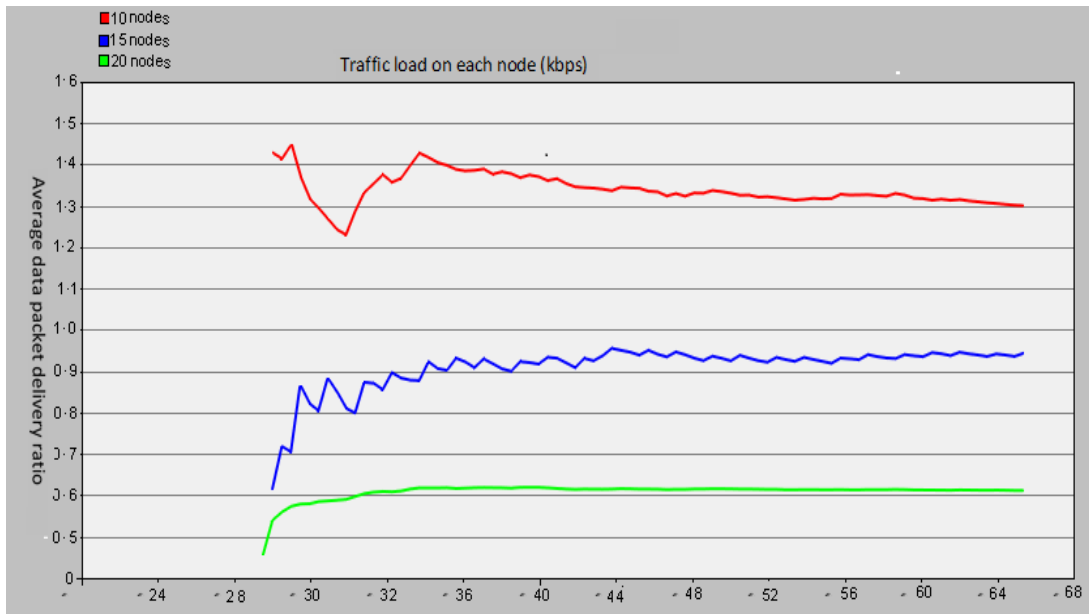


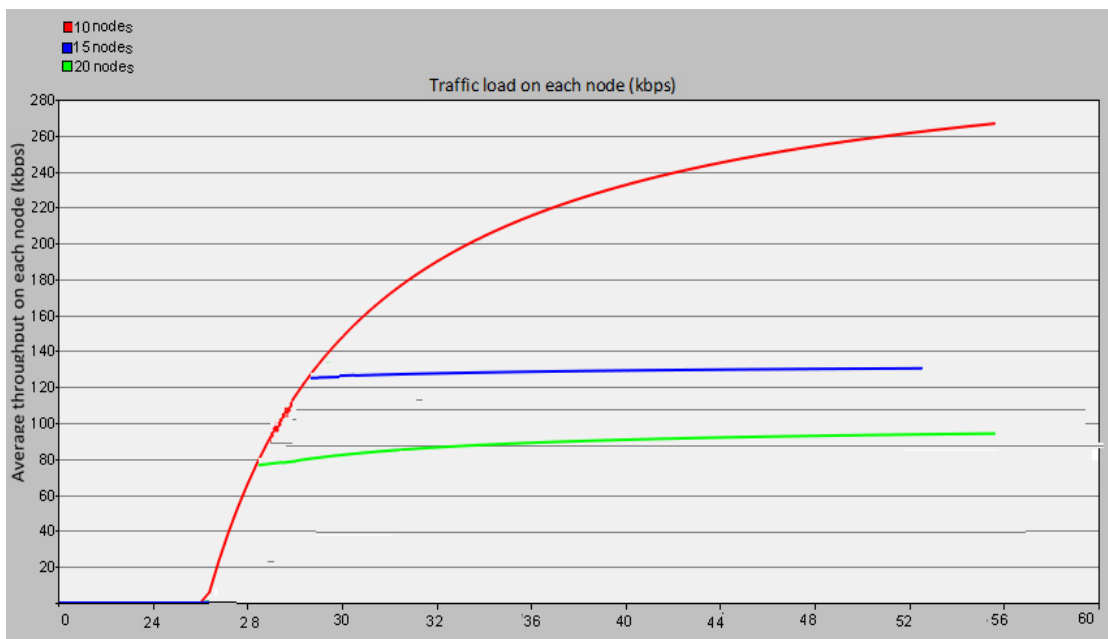Figure 1. Average packet delivery ratio vs traffic load



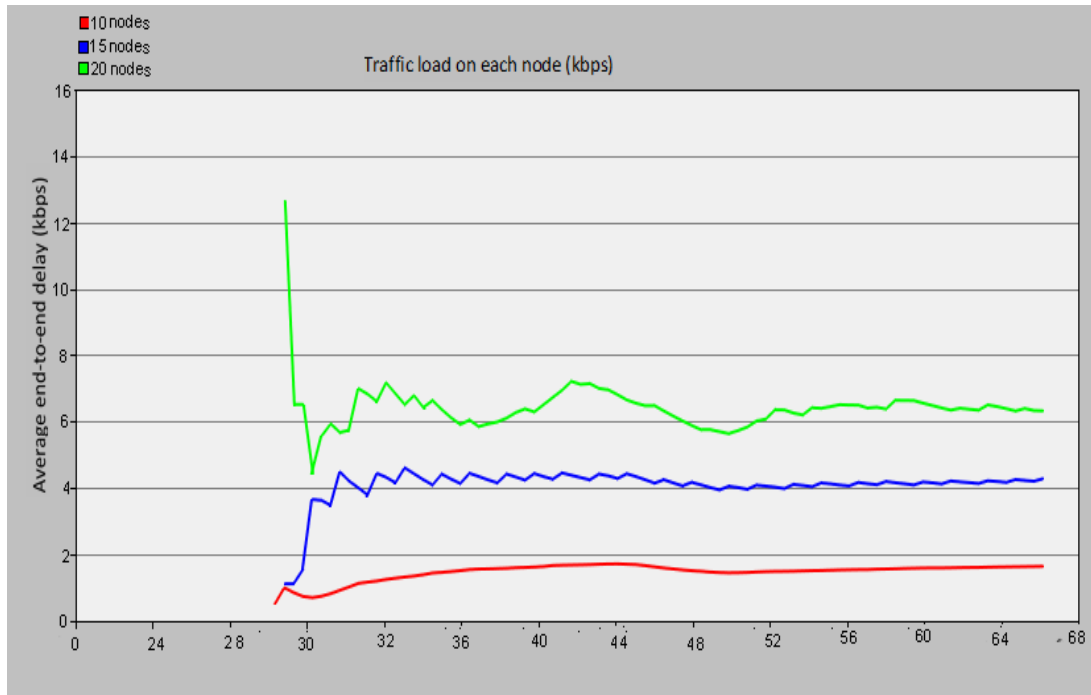Figure 2. Average throughput on each node vs traffic load

Figure 3. Average end-to-end delay vs load

Table 1. Simulation parameters

| S/N | Parameter | Value |
|---|---|---|
| 1. | Mobile nodes deployed | 50 nodes |
| 2. | Transmission Range | 250m |
| 3. | MAC Layer Protocol | IEEE 802.11 |
| 4. | Packet Size | 1024bytes |
| 5. | Buffer Length | 512byte |
| 6. | Traffic rate | 64kbps |
| 7. | Channel Capacity | 2Mbps |
| 8. | Routing Protocol | AODV/DSR |
| 9. | Topology size | 1000x1000 |
| 10. | Simulation Time | 1 hour |
| 11. | Mobility | Random Way Point |

## 2.2. Bandwidth estimation algorithm

Two possible bandwidth estimation algorithms have been investigated. The channels busyness ratio in MANET and the current loss rate. The former emulates a TCP connection by measuring the actual throughput within the network, while the latter estimates the current loss rate, thereby deriving a bandwidth estimation rate from the lost packet [8], [14], [15].

*Channel Busyness Ratio in MANET*:

As observed in Pokhrel, *et al.* [16], in a slot, we could possibly have three different kind of slots; an empty slot, successful transmission, and an occupied slot causing collision. Giving that Pi , Ps and Pc are the probabilities that the observed slot is any of the three. Similarly, let T_suc and T_col be the average time period associated with one successful transmission and one collision. These can therefore be expressed as shown in below;

$$T_{suc} = T_{rts} + T_{cts} + T_{data} + T_{ack} + 3T_{sifs} + T_{difs} \qquad (2)$$
$$T_{coi} = T_{rts} + T_{cts\ timeout} + T_{difs} = T_{rts} + T_{eifs} \qquad (3)$$

The successful probability transmission of the frame is equivalent to the packet transmission because of no hidden terminal. Therefore, the following equations can be obtained:

$$P_i = (1 - pt)^n \tag{4}$$

$$P_s = np_t(1 - pt)^{n-1} \tag{5}$$

$$P_c = (1 - pi - ps) \tag{6}$$

The definition of the channel idle ratio (Ri), channel busy ratio (Rb) and channel utilization ratio (Rs) is also as shown in:

$$R_i = {}^{p_i\sigma}\!/\!_{p_i\sigma + p_sT_{suc} + p_cT_{coi}} \tag{8}$$

$$R_b = (1 - R_i) \tag{9}$$

$$R_s = {}^{p_sT_{suc}}\!/\!_{p_i\sigma + p_sT_{suc} + p_cT_{coi}} \tag{10}$$

Where σ is the time slot length.

*Packet loss rate Estimation*:

This is the second bandwidth estimation algorithm that estimates the current loss rate while deriving a bandwidth estimation rate from the lost packet. According to [14], it is not trivial to estimate the loss rate on a given path. Savage [17] in his work developed a TCP based tool for measuring the rate of packet loss between pairs of host. Therefore, it is not necessary to convert the loss rate to determine the throughput because the loss rate can be evaluated directly.

In MANET environment, a routing protocol ensures that a source finds a path to forward traffic to its destination. For communication to occur within a network, a routing protocol must be deployed. Due to the unpredictable nature of MANET, the routing protocol deployed must be very quick to adapt to changes, especially during congestion or link failure, which may result in data loss. The aim of routing protocols in MANET is to guarantee an efficient and reliable path, therefore in this work our focus is on reactive routing protocols.

Reactive routing protocols were designed to reduce the cost of storage and bandwidth attributed to table driven protocols. Reactive routing computes its route based on demand, and are only established when it is required between the source node and the destination node. The established routes are created and maintained in two phases, namely; route discovery and route maintenance. The route discovery occurs on-demand by flooding the route request (RRQ) packets throughout the network. As soon as a route is found, the destination responds with a routereply (RREP) which contains the route information transverse by the RREQ. An example of reactive routing protocol in MANET is AODV and DSR.

AODV protocol uses both hop count and shortest path to the destination when routing packet within the network. By deploying AODV to route traffic in MANET, the sending node begin by initiating a route discovery in order to set up a route path to the destination. The AODV does this by using a RREQ and RREP message system. The RREQ, whose aim is to discover a route towards a giving destination, is broadcasted by the source node towards its immediate neighbour. When the neighbour receives the request, it broadcasts the RREQ message further to their immediate neighbours and this broadcast continues until the packet gets to its destination [18]. When the destination receives the RREQ message, it sends a RREP through the path where the route request transverse through. This reply is however sent as a unicast to the source node. The path is set-up by the RREP by updating the routing table generated at the intermediate node on the transverse path. Once a RREP is received, the source node begins the transmission of its first packet [19]-[21]. Other properties of AODV includes, hop-by-hop routing, sequence number and the use of periodic beacon. The destination sequence number is used to frequently ensure a loop free network. Therefore, AODV is often referred to as a combination of DSR and DSDV routing protocols.

The DSR routing protocol exhibit similar properties posed by the AODV by making use of source routing. DSR is an on-demand reactive protocol that does not use periodic advertisement, but only computes the route discovery when necessary, before maintaining them thereafter. Both DSR and AODV routing protocols can be deployed in MANET [22], [23].

The aim of this work is to implement our proposed admission control and tests its performance by using existing on-demand routing protocol; AODV and DSR. We observe and compare the behaviour of these two protocols using network metrics such as throughput, delay and network load.

Admission control is performed at the route discovery stage during the set-up or repair of data transmission. The sender issues a RREQ containing the bandwidth requirement [23]. Once a node receives

the RREQ requirement, it first of all calculate its own available bandwidth, thereafter, it decides to accept and forward the RREQ if the node has enough available bandwidth space. If the RREQ is beyond the capacity of a giving node, the node will deny the admission of the RREQ by discarding the request, thereby, preventing it from forwarding any form of request. For a successful RREQ, once a node receives a RREP, this means that the route has enough bandwidth and can be reserved for a new session. Subsequently, if a node in a given session fails to receive data packet for a certain period of time, or if it receives a route error (RERR), the bandwidth that has been reserved initially will be released. This same procedure will be performed if a source node refreshes the route or if it rediscovers a new route by sending a RREQ message.

## 3. SIMULATION AND RESULTS

The simulation of both AODV and DSR routing protocols with admission control in mobile ad-hoc network routing (ACMANR) is conducted in order to evaluate and observe the performance of these protocols under the bandwidth capacity and estimation algorithm. We deploy MANET and conducted two different simulations to test the two different routing protocols. In the simulation, a randomly selected node issues a RREQ packet with a bandwidth request of 64 kbps. If a route is discovered that has enough bandwidth to accommodate a bandwidth of 64 kbps, the source begins to send data through that route until the simulation terminates. Otherwise, if there is a bandwidth constrain to accommodate the 64 kbps data packet, the request will be rejected. This prevents the network channel from been over-utilized. Each node in our simulation moves freely and independently with similar speed. Random way point mobility model was also deployed in our simulation. Random way point allows a node to randomly select its destination. It therefore moves in the direction of the destination with uniformly chosen speed which is between a minimum and a maximum speed. Once its destination is reached, the node stays there for a pause time, after which it moves on thereafter. The minimum speed chosen in our simulation is 0 m/s while the maximum speed is 20 m/s. Pause time was set to 0 in order to observe the performance under high mobility.

### 3.1. Channel utilization parameter

The channel utilization for this work was carried out using OPNET simulation tool. The parameters used for the simulation are as follows.

− Throughput: This is the ratio of the total packets sent to the amount received correctly which is often measured in bits per seconds (bit/s or bps) and in some other times, data packets per time slot (p/s or pps) [24]. Determining the throughput of a network tends to help in revealing the reliability of the routing protocol used.
− End-to-end delay: This is the time taken for a packet to be transmitted across the network from the transmitter to the receiver during the simulation [25], [26]. It is the sum of the delays encountered by the packets or traffic flow at each node along the path which can be measured by the length of the path and the sojourn time at each node along the path [27]. End-to-end delay analysis is a very important element to measure network performance in MANET [28].
− Network load: This is the total amount of traffic received by the entire WLAN BSS from the higher layer of the MAC that is accepted and queued for transmission [29], [30].

### 3.2. Result and analysis

The Figure 4 shows the throughput, using the time average to compare the AODV and DSR routing protocols, under our proposed bandwidth capacity and estimation admission control algorithm. From Figure 4, it is observed that the throughput of AODV routing protocol is greater than the throughput of DSR under our proposed bandwidth capacity and estimation admission control scheme. Therefore, AODV shows a higher level of throughput compared to DSR.

Figure 5 shows the delay observed between AODV and DSR routing protocols with our proposed bandwidth capacity and estimation admission control implementation. It can be observed that the delay difference between the two protocols is not significant, however, AODV has a higher delay as compared to the DSR.

Figure 6 shows the network load observed between the AODV and DSR routing protocols with bandwidth capacity and estimation admission control implementation. It can be observed that the AODV routing protocol utilizes more of the network resources than the DSR. Therefore, AODV has a higher network load capacity usage as compared to DSR.

### 3.3. Discussion and performance evaluation

In order to demonstrate and validate the performance of our proposed protocol, ACMANR, we compared it with some admission control protocols that exists in the literature. All the admission control

protocols have been simulated using either AODV or DSR routing protocol as shown in Figure 7. Figure 7 (a) shows the throughput comparism of our admission control protocol, ACMANR, against other admission control protocols using AODV routing protocol. Results from Figure 7 (a) show that ACMANR outperforms other admission control protocols in terms of throughput and average time. ACMANR throughput performance was also compared with other existing admission control protocol using DSR routing protocol. The result obtained also shows that its throughput performance is higher than all the other admission control protocol. The delay of ACMANR was compared with other existing proposed admission control using both AODV and DSR routing protocol as seen in Figure 8 (a) and (b). Results from this comparison show that ACMANR has the least delay amongst other admission control protocols used for comparison. This however shows that ACMANR provides for better performance in terms of throughput and delay notwithstanding the routing protocol used.
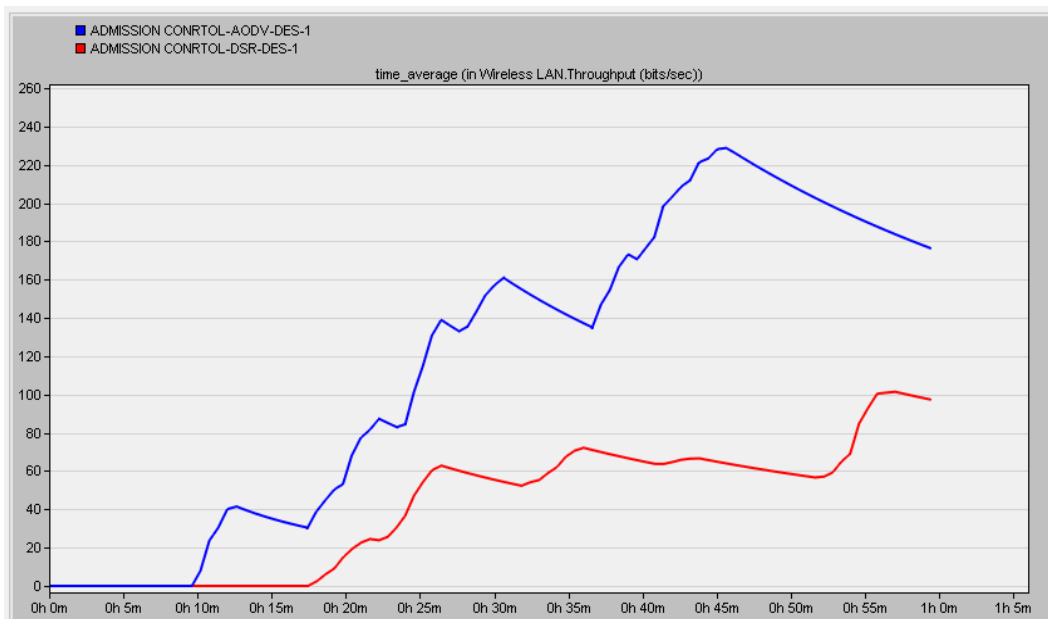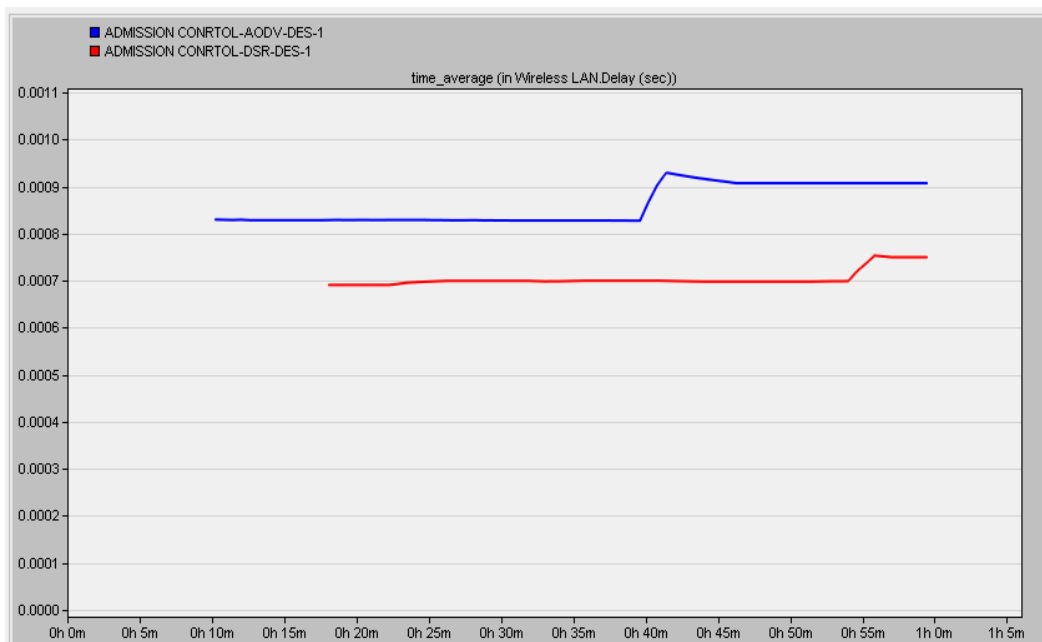


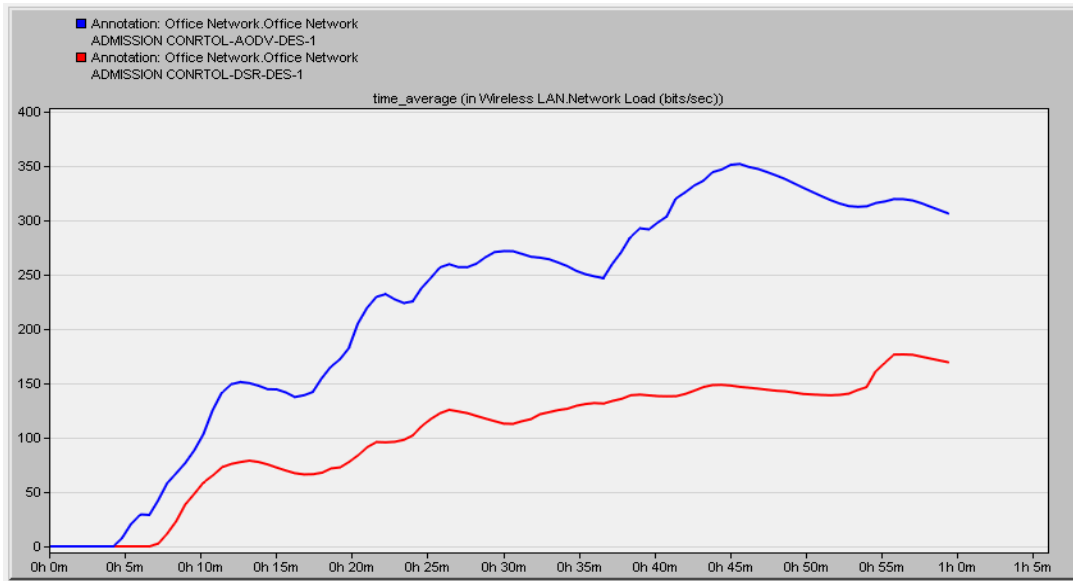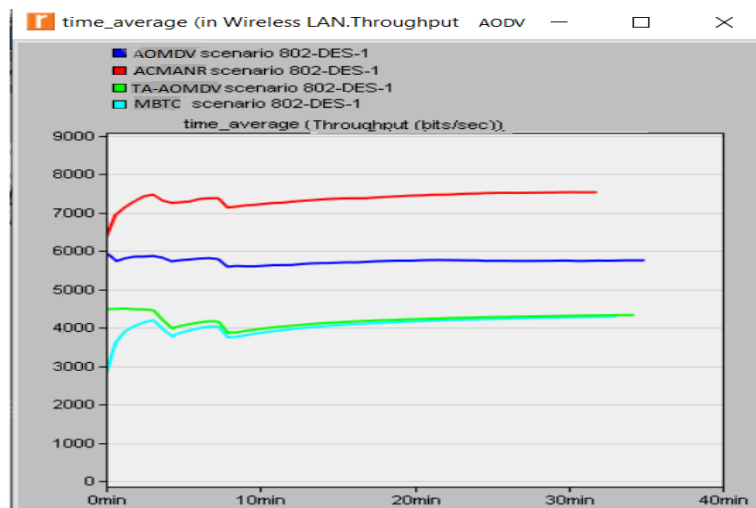Figure 4. Throughput using the time average



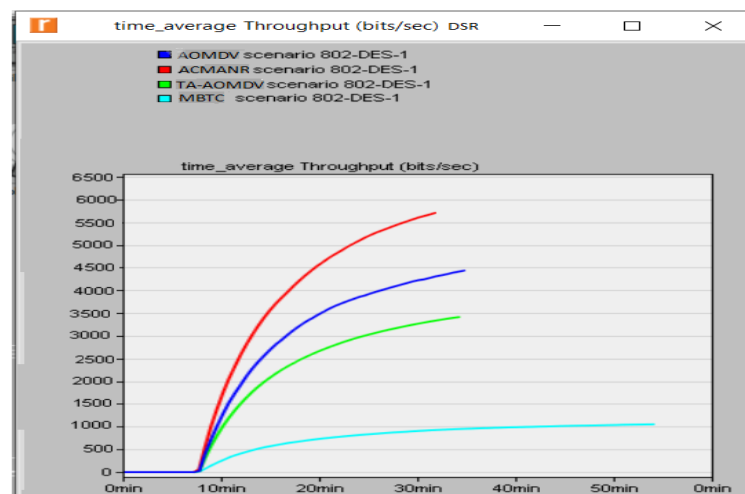Figure 5. Delay using the time average

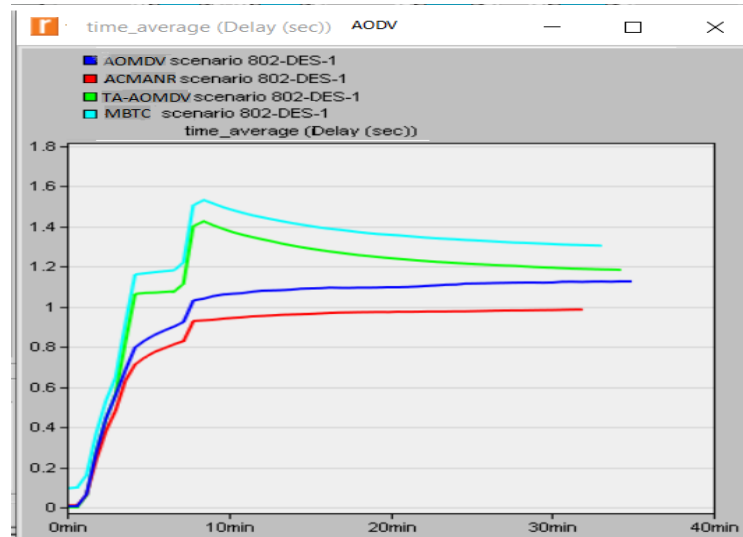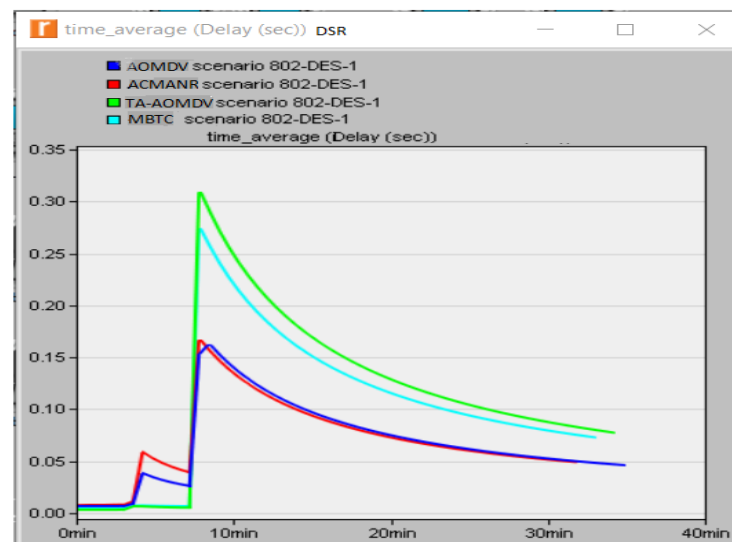Figure 6. Network load using the time average



(a)



(b)

Figure 7. Throughput comparison based on routing protocol, (a) AODV, (b) DSR

(a)



(b)

Figure 8. Delay comparison based on routing protocol, (a) AODV, (b) DSR

## 4.    CONCLUSION

This work has studied the admission control in MANET by comparing two of the most prominent MANET routing protocols available in the literature. We adopted a measured based admission control approach by proposing a bandwidth capacity and resource estimated admission control algorithm, Admission control in mobile ad-hoc network routing (ACMANR). Furthermore, we analysed and studied our proposed method against the existing on-demand routing protocols. Experimental simulation, using OPNET simulation tool, was used to evaluate our proposed method in order to compare the behaviour of AODV and DSR routing protocols under bandwidth capacity and resource estimation admission control algorithm. Results from this simulation show that the AODV had a better throughput than the DSR while the DSR had a better delay value with less network utilization. Our proposed approach was also compared with the state-of-the-art admission control. Simulation results obtained show that our proposed ACMANR technique produced a better performance in terms of throughput and delay using AODV and DSR. In future, we plan to extend our evaluation to include other routing algorithms to determine the efficiency and robustness of our proposed admission control technique.

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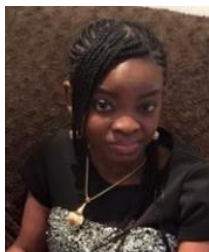
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