ZANCO Journal of Pure and Applied Sciences
The official scientific journal of Salahaddin University-Erbil
https://zancojournals.su.edu.krd/index.php/JPAS

ISSN (print):2218-0230**, ISSN (online):** 2412-3986**, DOI: http://dx.doi.org/10.21271/zjpas**

RESEARCH PAPER

Improving VoIP Transmission for IEEE 802.11n 5GHz MANET

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A B S T R A C T:

In catastrophic scenarios, rescue teams need to communicate with each other without any fixed infrastructure while moving, such as search and rescue, firefighter, police, and tactical networks i.e. MANET. In these scenarios Mobile Ad hoc Networks (MANETs) can supports immediately Voice Over Internet Protocol (VoIP) service to be used, with fast deployment, low cost, and flexibility during movement. Recently the new mobile devices support the new frequency of IEEE 802.11n 5GHz that gives better performance requirements to MANET, with enhanced Quality of Service (QoS) and bandwidth (B.W). This paper will calculate and improve VoIP service in MANET that operates under IEEE 802.11n 5GHz frequency, with comparing two main routing protocols AODV and OLSR, and analyzing some QoS requirement such as end-to-end delay, throughput, and retransmission attempts using Network Simulator (NS2).

KEY WORDS: VoIP; Buffer Size; MANET Routing Protocols; IEEE802.11n 5GHz; Max Receive Lifetime.
DOI: http://dx.doi.org/10.21271/ZJPAS.33.1.17
ZJPAS (2021) , 33(1);157-162 .

1. INTRODUCTION :

In these days, the technology plays very important role in government initiatives to set up and build a new important communication through the years to support new services to the technology sectors (Mohammed, B. and Maulod, S., 2016).

Technology allows mobile devices to exchange voice messages and calls over an internet connection, it depends on different types of codec used, which converts and compress analog to a digital signal to be transmitted, and each coding gives different frame rate (bps) that affect the voice quality in MANET [Abou Haibeh, L, Hakem, N & Safia, 2017].

MANET is a group of mobile devices connected wirelessly with adapter called Wireless Network Interface Card (WNIC) while moving without any fixed infrastructure, it continuously changes its topology all the time, therefore it used by tactical networks like search and rescue, firefighter, and the police [Afaqui, MS, Garcia-Villegas, E & Lopez-Aguilera, 2016]. To transfer data in MANET, routing protocols must be applied guiding the packets from the source to the final destination [Alqaysi, H & QasMarrogy, GA 2015]. Recently WNICs works with the frequency of IEEE802.11n 5GHz, which provides larger bandwidth from the old IEEE802.11a, b, g, that gives data rate of 11Mbps up to 54Mbps that considered very inefficient for high-quality VoIP transmission [AlShahwan, F, Alshamrani, M & Amer, AA 2018]. VoIP quality in MANET can depend on many factors such as WNIC characteristics, buffer size, transmission power, data rate, max receiving lifetime, and the large

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Article History:
Received: 07/07/2020
Accepted: 10/09/2020
Published: 20/02 /2021

packet processing [Aman, AHM, Hashim, A-HA, Abdullah, A, Ramli, H & Islam, S 2017].

This paper will focus on calculating, modulating and enhancing the buffer size and max receive lifetime in IEEE 802.11n 5GHz WNIC parameters for VoIP transmission over MANET, with using Network Simulator 2 (NS2) and analyzing and comparing two famous routing protocols AODV and OLSR regarding end to end delay, throughput, and packet loss to ensure highest QoS result.

The rest of the paper will be structured as follows. Section II shows the proposed calculations of IEEE 802.11n 5GHz parameters and VoIP transmission techniques. while section III presents the experimental results, analysis, and comparison. And finally, section IV provides a conclusion and direction for the future work of the paper.

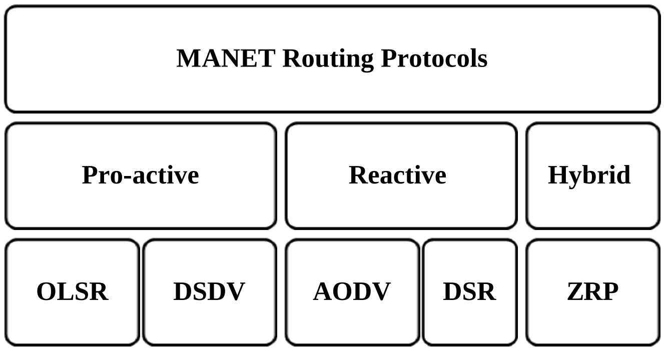
2. LITERATURE SURVEY

Many researchers tried to enhance and optimize VoIP service in MANET, in [Patel, N.K., Saxena, P., Singh, R. and Kumar, S] the reasercher tryes a novel method of signaling for broadcast voice is proposed for multi-hop broadcast voice communication in tactical Mobile Ad-hoc Network (MANET) with Time Division Multiple Access (TDMA) as underlying MAC scheme, the results show better and enhanced quality with lower delay and higher throghput. in [Antwi-Boasiako, E, Kuada, E & Boakye-Boateng, K 2016] a new approach implemented to improve the SIP voice signaling system in OLSR for MANET by modifying the routing parameters, the analysis shows an effective reducing in the delay and enhancing signaling performance. While in [Aman, AHM, Hashim, A-HA, Abdullah, A, Ramli, H & Islam, S 2017] proposed multicast protocols were used to decrease the delay of the receiver's processing, the analysis shows more accurate results using the proposed method. In (Mohammad, A.S. and Potrus, M.Y., 2016)

An analysis for TCP was done regarding the throughput during the movement of MANET wireless nodes, it shows a comparison with different types of TCP comparison, the result shows a better performance regarding the metric analyzed. In [Chandel, ST & Sharma, S 2016] an attempt was used to apply fuzzy logic for optimal routing results to transfer voice data through MANET, the result shows more accuracy, with lower delay. In [Chen, Y-H, Hu, C-C, Wu, EH-K, Chuang, S-M & Chen, G-H 2017] a comparison was made to examine the transmission of VoIP with different types of routing protocols to analyze the best protocol, the result shows that the DYMO protocol is better to be used in an ad hoc network. while, in [Erciyes, K, Dagdeviren, O, Cokuslu, D, Yilmaz, O & Gumus, H 2011] a new approach to control the congestion of the network was used during VoIP transmission, with estimating the queue size for optimal result, the analysis shows that this approach gives better performance from the existing parameters used in transmission. Finally, in [QasMarrogy, GA 2020] a new performance was done for video transmission over 5Ghz flying drones to measure the throughput, delay and transmission attempts using buffer size variation, where it was proven that the variation in buffer size can affect and enhance the transmission of video for UAV's Drones.

3. MANET IEEE 802.11N-5GHZ WNIC PARAMETERS and CALCULATIONS

To direct packets through MANET, routing protocols must be applied to find the best routes available. There are 3 types of routing



protocols namely, proactive, reactive, and hybrid as shown in Figure 1 [Ghosh, T, Tiwari, S & Sahay, J 2017]. Two routing protocols AODV, and OLSR were analyzed for this paper, as they are the best for VoIP as shown in many studies [Hassine, K & Frikha, M 2017] [Jin, C, Wei, DX & Low, SH 2006].

Figure 1: Types of MANET routing protocol [12].

Hoc On-Demand Distance Vector (AODV) is a reactive routing protocol, it uses broadcast discovery mechanism and sequence number to find the best fresh recent routes to the destination. It starts his discovery phase when a node needs to transmit data to another node, and record his routes in its routing table until the source node finishes transmitting, then the routes will be deleted, and start new path discovery again when needed. Therefore, it causes lower overhead and more delays during transmission [Hassine, K & Frikha, M 2017].

While Optimized Link State Routing (OLSR) is a proactive routing protocol, it uses a group of selected nodes called Multipoint Relays "MPR's to exchange their recent routing information between them, giving a speed to route discovery phase. OLSR broadcast hello messages and store all the fresh routes all the time on a frequent interval, with or without a request from source nodes, therefore when a node needs to transmit, a route will be available immediately. Therefore, it causes less delay and more overhead during transmission [Kumari, N, Gupta, SK, Choudhary, R & Agrwal, SL 2016].

VoIP performance can depend on two factors, the WNIC parameters, and VoIP Codec as shown in table 1.

Table (1) Bandwidth Comparison for VOIP Codecs [1].

Voice Codec	Bandwidth (Kbps)
G.711	64
G.722	64
G.723.1	6.3
G.726	32
G.728	16
G.729	8

Therefore, the required B.W and size for the VoIP codec packet can be calculated from the following equations (1) (2) (3) [Marrogy, GA 2013].:

$$\textbf{Packet size} = (\textbf{L2 header}) + (\textbf{IP/UDP/RTP header}) + (\textbf{payload voice size}) \,.(\mathbf{1})$$

$$\textbf{Packets Per Second } (\textbf{PPS}) = (\textbf{codec bit rate}) \div (\textbf{payload voice size}) \,.(\mathbf{2})$$

$$\textbf{Bandwidth} = \textbf{packet total size} * \textbf{PPS} \,.(\mathbf{3})$$

To calculate a 60 second, VoIP codec 729 will be used, and based on the above equations, B.W and size required will be the following:

$$\textbf{Total Packet Size } (\textbf{bytes}) = (\mathbf{18}\ \textbf{bytes}) + (\mathbf{40}\ \textbf{bytes}) + (\mathbf{20}\ \textbf{bytes}) = \mathbf{78}\ \textbf{bytes} * \mathbf{8bit} = \mathbf{624}\ \textbf{bits}$$

$$\textbf{Voice Payload Size} = (\mathbf{20}\ \textbf{bytes}) * \mathbf{8}\ \textbf{b} = \mathbf{160}\ \textbf{bits}$$

$$\textbf{Packets Per Second PPS} = (\mathbf{8}\ \textbf{Kb/s}) \div (\mathbf{160}\ \textbf{bits}) = \mathbf{50}\ \textbf{pps}$$

$$\textbf{B.W/Call for 1 second} = (\mathbf{624}\ \textbf{bits voice packet size}) * \mathbf{50}\ \textbf{pps} = \mathbf{31.2}\ \textbf{Kb/s}$$

Therefore for calculating 600 seconds of VoIP B.W Size

$$\textbf{B.W Call for 600 S} = \mathbf{31.2Kbps} \times \mathbf{600s} = \mathbf{18.82Mbps}$$

Where total packet size is the maximam size of the packet tranmistted, voice payload size is tha size of which carries the encoded voice data.

WNIC parameters can also affect the VoIP performance, these parameters keep the wireless connections between all network devices up to date. Therefore, using the new frequency of IEEE802.11n 5GHz will offer lower end to end delay, packet loss, with higher data throughput [Mondal, A, Misra, S & Maity, I 2018]. In MANET, these parameters gives different results with device movement and size variation, with acceptable packet loss below 5% [QasMarrogy, GA, Alqaysi, HJ & Almashhadani 2017], where more can decrease the network performance.

3.1. WNIC Parameters: Buffer Size

When a frame packet received in the destination device, it gets stored and queued in WNIC buffer until all frames reached, then the WNIC will process the fragmented packet. The variable size of the buffer can enhance the performance of MANET, while the fixed size can decrease the performance [Rautu, D, Dhaou, R & Chaput, E 2017]. The required size of the buffer can be calculated from the following equation (4):

$$\textbf{WNIC Buffer Size} = (\textbf{RTT} \times \textbf{B.W}) \div \sqrt{\textbf{N}} \ \ldots (\mathbf{4})$$

Where RTT is the round-trip time, that takes the message to send and acknowledge received from the destination. B.W is the bandwidth of the link, and N is the connection's number through transmission, where in [Savithri, V & Marimuthu, A 2017] was approved the optimal value is 5 for N. Therefore, the calculated buffer size for this paper will be

$$\textbf{Size} = (\mathbf{600} \times \mathbf{1024} \times \mathbf{1024} \times \mathbf{0.01}) \div \mathbf{25} \approx \mathbf{256,000bits}$$

To analyze optimal results for IEEE 802.11n 5GHz MANET, four cases will be calculated and simulated (128,000 - 256,000 - 512,000 - 1024,000) bits.

3.2. WNIC Parameters: Max Receive Lifetime

After storing the received frames in buffers with fragmentation technique is on, it remains there for a specific time until all packet frames received to be processed. Otherwise, if all frames weren't received during the specified interval time, the frames drop for new frames to be stored [Shenoy, SU, Kumari, S & Shenoy, UKK 2017]. Therefore, if the time variate in MANET, it can give a different result. To calculate optimal results for IEEE 802.11n 5GHz MANET, four cases will be calculated and simulated (0.1 - 0.5 - 1 - 1.5) second.

4. RESULTS AND DISCUSSION

Two scenarios were calculated and analyzed, the first scenario calculates the buffer size variations, while the second calculates the variation in Max Receive Lifetime, finally, both scenarios will compare AODV and OLSR for best results.

In this paper, a 1000 m2 with 50 moving devices (1.4 m/s human walking speed) were simulated in NS2 simulator, using a frequency of IEEE802.11n 5GHz and 600Mb/s data rate, a VoIP codec 729 sizes of 19Mb were transmitted for 10 minutes over MANET, with two routing protocols AODV and OLSR. 10 repetitions for each scenario were calculated for optimal average results, also the first 100 seconds is the white state to find fresh routes, which may affect the result, therefore no transmission and analysis was done [Singh, P, Sharma, AK & Kamal, T 2016].

The simulations of IEEE802.11n 5GHz buffer size scenario in figure 2, 3, 4 shows the best results calculated for throughput is between 128,000 and 256,000 bits, and it decreases when the buffer size increase, because when the buffer size is increased, it needs more time to process the queued frames, which cause more delay, and decrease the throughput of processed packets, also more delay can cause the incoming packets to be dropped while the queued packet get processed, which increases the retransmission attempts [Yildiz, HU, Tavli, B & Yanikomeroglu, H 2015].

AODV shows better throughput, but higher delay and retransmission attempts than OLSR. In AODV the source node with low-speed mobility obtains the routes faster while reducing the broadcasts messages to find new routes, which also decrease the requirement for memory and routes duplications, but due to the nature of

reactive protocols, it causes higher delay to find the routes and transmit the data, while OLSR remains stable during all buffer size calculations.

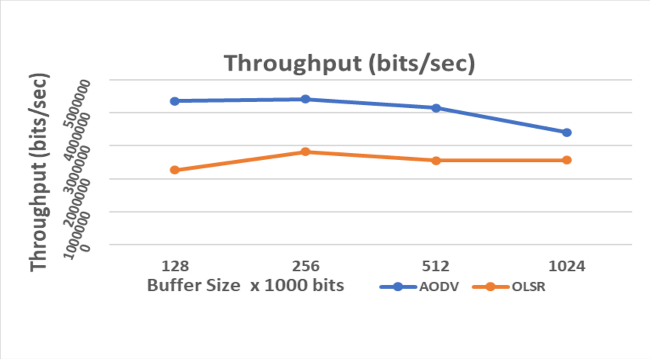


Figure 2: Throughput (b/s) of AODV and OLSR Protocols with Buffer Size Variation

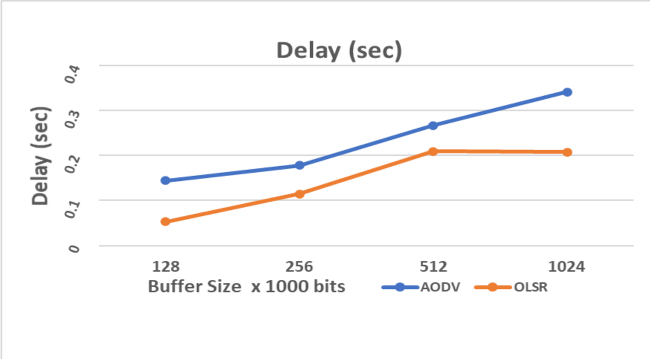


Figure 3: Delay (s) of AODV and OLSR Protocols with Buffer Size Variation

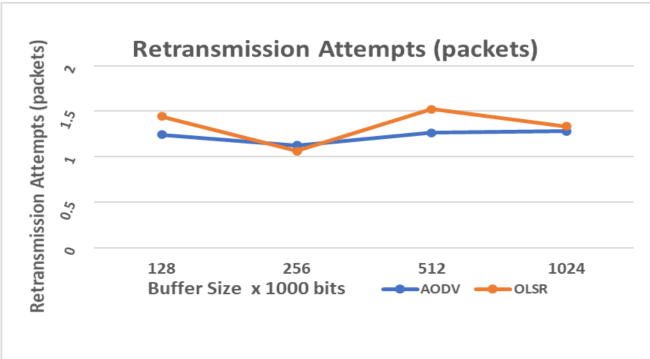


Figure 4: Retransmission Attempts (Packets) of AODV and OLSR Protocols with Buffer Size Variation

The simulations of MAX receive lifetime scenario in figure 5, 6, 7 shows the best results calculated for throughput is 0.1 second. When the time is very low, all IEEE802.11n 5GHz WNIC parameters for all nodes in MANET are synchronized faster, and routes will establish with the lowest delay as possible while increasing the time can cause the WNIC parameters to synchronize slower, thus it needs more time to find fresh better routes to destination.

When time increases AODV remains high for throughput, but it still has a higher delay and retransmission attempts than OLSR. In 0.5 second AODV enhances its performance for the lower delay and retransmission attempts, with higher throughput, which is considered an optimal parameter enhancement for the AODV routing protocol.

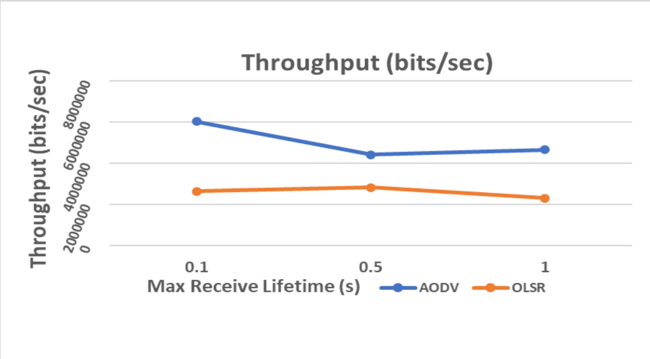


Figure 5: Throughput (b/s) of AODV and OLSR Protocols with MAX Receive Lifetime

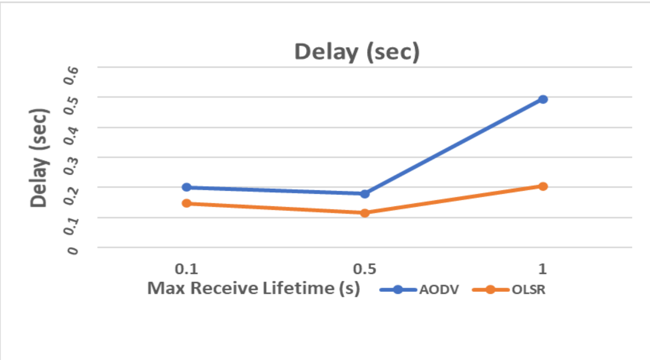


Figure 6: Delay (s) of AODV and OLSR Protocols with MAX Receive Lifetime

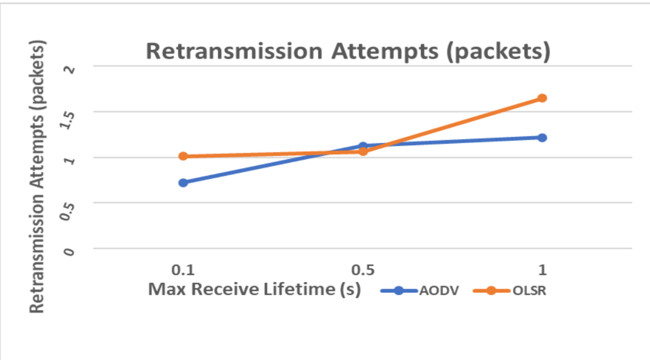


Figure 7: Retransmission Attempts (Packets) of AODV and OLSR Protocols with MAX Receive Lifetime

5. CONCLUSIONS and FUTURE WORK

Nowadays VoIP communication is essential for wireless networks especially tactical networks. In this paper, an improvement for VoIP transmission over MANET was done, by calculating the optimal IEEE802.11n 5GHz WNIC parameter's buffer size and max receive lifetime for mobile devices, with two famous routing protocols AODV and OLSR. The analysis shows the optimal result for buffer size for VoIP was 128,000 and 256,000 bits while the best max receive lifetime was 0.1 and 0.5 seconds. AODV shows better result than OLSR with throughput, but higher-end to end delay. While OLSR remains stable most of the experiment. AODV also shows enhancement when increasing the MAX receive lifetime to 0.5 with lower delay and higher throughput

For future work, a recommendation is advised to use different types of VoIP codec with more calculations, to ensure more accurate and optimal results to be found for all IEEE802.11n 5GHz WNIC parameters.

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