Journal of University of Duhok, Vol.23, No.2 (Pure and Eng. Sciences), Pp 402-411, 2020 (Special Issue)
3rd international conference on recent innovations in engineering (ICRIE) Duhok, September 9-10-2020

OPTIMIZING VIDEO TRANSMISSION PERFORMANCE IN 5GHZ MANET

GHASSAN A. QASMARROGY[1]
Department of Communication and Computer Engineering, Cihan University-Erbil,
Kurdistan Region-Iraq

(Accepted for Publication: December 8, 2020)

ABSTRACT

Nowadays, one of the most important technologies is video transmission. It is used worldwide across multiple platforms such as mobile, tablets, smart watches, and many more. All these devices use the 2.4GHz and 5GHz frequency ranges of IEEE 802.11. Due to the mobility of these devices, it's very important to optimize video transmission streaming between these mobile devices with minimum delay and higher throughput. In this paper, an attempt will be made to enhance the transmission performance of video over MANET using IEEE 802.11n 5GHz frequency range supported by the new devices. The performance of two famous routing protocols, AODV and OLSR, is compared in terms of delay, throughput, and retransmission attempts.

KEYWORDS: Video Transmission; buffer size; MANET routing protocols; 5Ghz; AP beacon interval

1. INTRODUCTION

High-Quality (HQ) video transmission is being upgraded to 8K depending on the network bandwidth B.W [1]. Therefore, improving video transmission is very important with less delay for a wireless device. These devices can be fixed or moving which is called mobile ad-hoc networks (MANETs), Topology can change any time, depending on the use of wireless network interface card (WNIC) as shown in figure (1) [2].

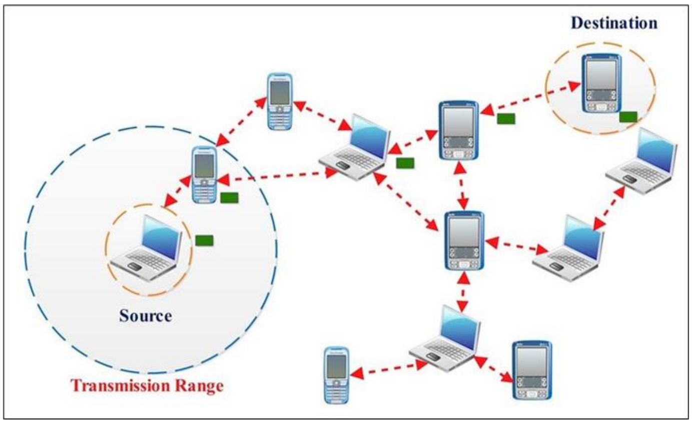


Fig. (1): MANET Changing Topology

However, a WNIC with IEEE802.11n support can use a dual-frequency range of 2.4GHz and 5GHz providing a higher B.W up to 1Gbps data rate, suitable for video with lower delays and packet drops and more throughput to ensure a reliable user experience without any problems

Ghassan.qasmarrogy@cihanuniversity.edu.iq
[1]Corresponding author: College of Engineering, Cihan University, Erbil, Kurdistan Region, Iraq.

[3]. Old IEEE802.11a, b, g can give a rate of 11Mbps to 54Mbps which is considered very inefficient for the video, causing delay, low throughput, and dropping packets [4]. Table 1 shows a standard comparison regarding the data rate of IEEE802.11 types.

Table (1): Comparison of 802.11 wireless LAN Standards [5].

IEEE Standards	Data Rate (Mbps)
802.11b 2.4 GHz	11
802.11g 2.4 GHz	54
802.11a 2.4 GHz	54
802.11n 2.4 GHz	150 - 450
802.11n 5Ghz	600

The quality of video streaming can depend on many factors such as WINC parameters and setting, for example, physical layer characteristics, data rate, transmission power, Access Point (AP) beacon interval, max receiving lifetime, buffer size, and the large packet processing [6].

Many researchers have tried to examine and analyze the video transmission in MANETs. In [7], a study was done to evaluate the video streaming application over MANET regarding two protocols, Optimized Link State Routing (OLSR) and Ad Hoc On-Demand Distance Vector (AODV). The results show a lower delay achieved by OLSR and the highest throughput by AODV. [8] examines and enhances Video Streaming in MANET by adding a new routing protocol method for increasing the video throughput over ODV with a higher packet delivery ratio than the standard AODV. In [9], a simulation with NS2 was done to analyze the effect of MAC level characteristics and parameters for video transmission over IEEE 802.11n WLAN. The study shows the parameters of WLAN MAC - level can enhance the throughput of video streaming over WLAN. The issue of QoS in MANETs for multimedia applications is addressed in [10]. To improve the QoS, the authors analyzed a combined scheme to maximize the network performance with channel modeling, threshold-based data transmission, and queuing modeling over the physical layer, which leads to an increase in network performance.

In this paper, a focus on calculating the optimal WNIC parameters for video transmission over 5GHz MANET will be done with higher B.W to support video size of HQ and more, with a comparison of two main routing protocols AODV and OLSR. To achieve this objective, an analysis will be done to measure the network throughput, end to end delay, and retransmission attempts.

The importance of this paper, is the use of mobile devices to stream camera video live with 5GHz support without any fixed infrastructure which is very helpful for tactical networks, wireless sensor networks, data networks, firefighters, the police, search and rescue teams and many more.

The rest of the paper will be structured as follows: Section II shows the background of the routing protocol. Section III shows parameter calculations of IEEE 802.11n 5GHz and video transmissions. While section IV presents the experimental results, analysis and comparison. And finally, section V provides a conclusion and direction for the future work of the paper.

Ghassan.qasmarrogy@cihanuniversity.edu.iq
[1]Corresponding author: College of Engineering, Cihan University, Erbil, Kurdistan Region, Iraq.

2. MANET ROUTING PROTOCOLS

In MANETs, all nodes need routing protocols to transfer the data from the source to the final destination through the intermediate mobile devices of MANETS. There are 3 different types of routing protocols reactive, proactive, and hybrid as shown in Figure (2) [2].

AODV and OLSR routing protocols were selected for this paper, as many researchers have shown for video transmission, they have better results compared to other protocols of their class [8].

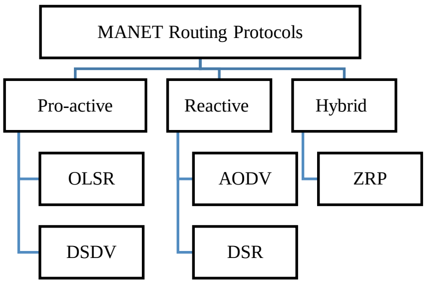


Fig. (2): Types of MANET routing protocol [2].

2.1 Ad Hoc On-Demand Distance Vector (AODV) Protocol

AODV is a proactive routing protocol. The basic function of AODV is supporting the message delivery between MANETs nodes. It initiates the routes discovery process by broadcasting a control Route Request (RREQ) messages into the network, then all intermediate nodes store the information (for a specific time) about the source, destination, and all other nodes who received the RREQ packets during transmission, this stored information will help the nodes to track a reverse connection to the source node. After receiving the RREQ message by nodes that know or have a clear path to the destination or it's the destination, they will acknowledge the source with a route reply message (RREP) through the same reversed path initiated in the beginning. This will initiate the route from the source to the final destination. If the topology changed before transmitting was finished and the route breaks, a Route Error (RERR) message will be sent to the source and a new route discovery process will start if needed. All the information of the middle nodes is gathered by the Hello packets, which are broadcasted periodically. AODV uses two techniques to keep the routes alive, sending Hello packets in the network layer, or sending ACK packets in the MAC level. Figure (3) shows the process of AODV routing protocol [2].

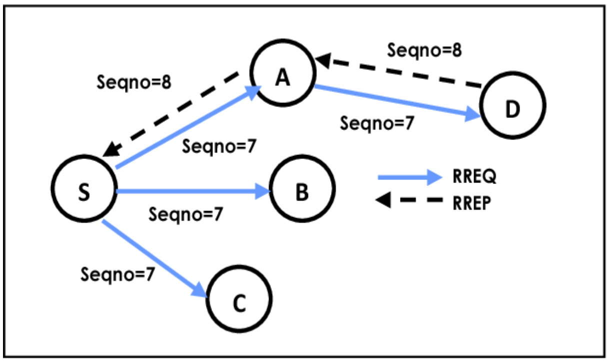


Fig. (3): The AODV Routing Protocol Process [2]

Ghassan.qasmarrogy@cihanuniversity.edu.iq
[1]Corresponding author: College of Engineering, Cihan University, Erbil, Kurdistan Region, Iraq.

2.2 Optimized Link State Routing (OLSR) Protocol

OLSR is a proactive routing protocol. It ensures that the routes are available on request, meaning that all devices have all the route information for all the devices in MANETs. The information is updated when the MANET topology changes by broadcasting all network information to all devices. It uses a Multi-Point Relays (MRP) technique, MPR's are a group of selected devices that pass through the received information from source to destination, they elected by a specific process that depends on different factors. Only the MPRs can generate the control information that is used to decide which route is the best for the next information broadcasting. By doing this they reduce gradually the information broadcasting overhead in the network and provides the shortest network route, figure (4) shows the MPR of OLSR.

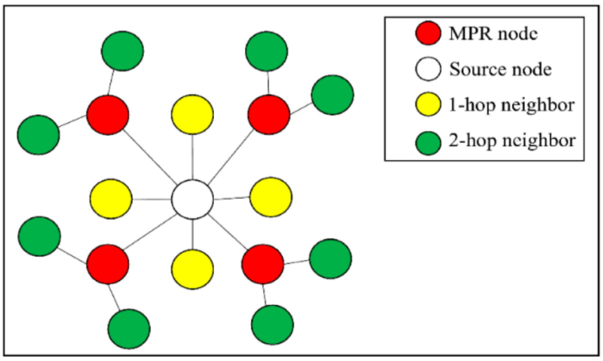


Fig. (4): The MPR Process of OLSR [11]

The broadcasted information contains Topology Control (TC and Hello messages. The first one is used by each device to broadcast their neighbor information about their MPR list. The second one helps OLSR to find all the information about all neighbor devices and the status of the link. By using all of that, OLSR can find the best routes all the time from the source to destination [11].

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

Video Characteristics and transmitting metrics depend on two factors, video formats and the WNIC parameters [5] [9]. On the other hand, the required transmission B.W for video may depend on the size of the video [12] that can be calculated using equation (1) [13].

$$Size\ of\ Video = Frame\ Rate \times Duration \times (frame\ h \times w) \times Colour\ Depth \quad (1)$$

For this paper, the following video characteristics were used based on the above equation.

Table (2): Simulation Video Characteristics

Video characteristics	Value
Duration	60 sec
Data Stream h×w	128x240
Color Depth	24 bits
Frame Rate	15

By substituting the above values to the equation (1), the video size is calculated as follows:

$$Size\ of\ Video = 128 \times 240 \times 15 \times 60 \times 24 \approx 663{,}553{,}000 bit \approx 81 MB$$

While the audio size will be neglected as it has a very small effect of the B.W [13].

The other factor that affects the transmission is the WNIC parameters, which is responsible for the connections between MANET nodes. Switching to IEEE802.11n 5GHz will give higher B.W, throughput, and lower delay [14].

Ghassan.qasmarrogy@cihanuniversity.edu.iq
[1]Corresponding author: College of Engineering, Cihan University, Erbil, Kurdistan Region, Iraq.

These WNIC parameters give different results with device movement and different transmitted data size with acceptable packet loss rate below 5% [15] and lower packet delay.

3.1 Buffer size:

Buffers are used to queue and store the received frame packets to be proceed inside the network nodes. This is done when the receiving rate is faster than the processing rate [16]. Therefore, buffer size variation can affect network performance in MANETs [17]. During network transmission, buffers are used by TCP and UDP protocols to increase the reliability of the network performance. Unlike TCP, UDP packets have a higher packet loss rate during transmission. UDP is a connectionless and unreliable protocol. UDP does not do flow control, error control or retransmission of a bad segment, which can affect the delay and reliability network buffers have a default size between 8 KB to 8096 KB [18], while the desired buffer size can depend on many factors such as node type, error rate, network topology, packet size and transmission speed.

To calculate the buffer size for UDP, B.W-delay equation is used [19].

$$\text{Bandwidth} - \text{Delay Product} = (B.W \times RTT) \quad (3)$$

Where B.W is the link capacity, round trip time (RTT) is the time from when the message is sent to when it is received. Authors in [20] proved that the buffer size must be divided by the number of flows transmitted (N) sharing a bottleneck link, which has a very small effect on the transmission throughput, Therefore, the final equation will be as follows:

$$Buffer\ Size = (B.W \times RTT) \div \sqrt{N} \quad (4)$$

Authors in [21] proved that the optimal value of N for TCP protocol is 5, while the UDP protocol has no optimal value, it does connectionless communication, Since UDP avoids the overhead associated with connections, error checks and the retransmission of missing data, it's suitable for real-time or high performance applications that don't require data verification or correction. If verification is needed, it can be performed at the application layer.

Network devices dynamically adjust the physical transmission rate/modulation used to regulate non-congestive channel losses. This rate adaptation, whereby the transmit rate may change by a factor of 50 or more (e.g. from 1Mbps to 54Mbps in 802.11a/g) [22], may induce large and rapid variations in required buffer sizes. Therefore, upgrading the channel frequency medium from 2.4GHz with 150Mbps to 5GHz with 600Mbps by a factor of 4 can also be calculated for N flows of UDP, by multiplying the N by 4.

Using equation (4) to calculate the optimal buffer size for UDP's Video transmission, with wireless medium B.W of 600 Mbps, RTT 10ms which is an optimal value when the size of the video is less than the B.W as shown in [18], and to ensure reliable delivery performance similar to TCP, N can be calculated range of (36, 144, 625, 2401) for the following equations.:

For N= 2401, $Buffer\ Size = (600 \times 1024 \times 1024 \times 0.01) \div 49 \approx 128{,}000 bits$

For N= 625, $Size = (600 \times 1024 \times 1024 \times 0.01) \div 25 \approx 256{,}000 bits$

For N= 144, $Size = (600 \times 1024 \times 1024 \times 0.01) \div 12 \approx 512{,}000 bits$

For N= 36, $Size = (600 \times 1024 \times 1024 \times 0.01) \div 6 \approx 1024{,}000 bits$

From the result above, four values for buffer size can be calculated for UTP video transmission (128,000, 256,000, 512,000, 1024,000) bits respectively.

3.2 Access Point (AP) Beacon Interval:

To synchronize MANETs, all devices broadcast a packet called a beacon, it's importantly needed to gather and synchronize all wireless network parameters. For all network devices, default is 100 milliseconds [23]. This value works fine for fixed networks, but in

Ghassan.qasmarrogy@cihanuniversity.edu.iq
[1]Corresponding author: College of Engineering, Cihan University, Erbil, Kurdistan Region, Iraq.

MANETs, it should be between 20ms to 1000ms for best performance [25]. Thus, increasing the time will increase performance and battery life. While decreasing the time can overload the B.W with beacon packets all the time and congest the network. Also, it can drain battery life faster. This option can be used if the network changes its topology continuously due to device movements. In this paper, (0.02, 0.5, 1) seconds beacon time intervals will be used.

4. Scenarios and Result

Two scenarios were calculated and simulated for this paper, the first scenario calculates the optimal buffer size from the above equations for video transmission, while the second scenario calculates the best-chosen buffer size with modification of AP Beacon interval time. The simulations were made using the OPNET simulator, AODV and OLSR routing protocols were used in both scenarios, all results were repeated 10 times for optimal average results, also no transmission was made in the first 100 seconds, which is the WHITE state of finding the best routes for data transmission, and it can affect the result [25]. The other parameters were chosen during the simulations.

Table (3): Simulation Parameters

Parameters	Value
Nodes Number	60
Date Rate	600 Mbps
Frequency Used	5GHz
Area of Simulation	1000 m2
Time of Simulation	600 sec
Date Packet Type	Video Streaming
Speed	1.4 m/s (human walking speed)
Repeated Term	600s
Mobility Model	Random Waypoint

The calculations in figures (5, 6, 7) from the first scenario show the optimal result for buffer size variation is 128,000 bits for AODV, while for OLSR 256,000 bits. In general, when the buffer size increases, the throughput also increases because larger frames will arrive and stored, but it causes a higher delay, which also affects the retransmission attempt as it increases to compensate a large amount of dropping packets, and retransmitted again, due to low mobility and higher broken routes.

OLSR shows stable performance in video transmission with buffer size variation because it's constantly broadcasting its MPR nodes to keep the routes available on request all the time. In AODV however, the routes are not available when the node needs to transmit the data, which takes more time to send the data [26].

Ghassan.qasmarrogy@cihanuniversity.edu.iq
[1]Corresponding author: College of Engineering, Cihan University, Erbil, Kurdistan Region, Iraq.

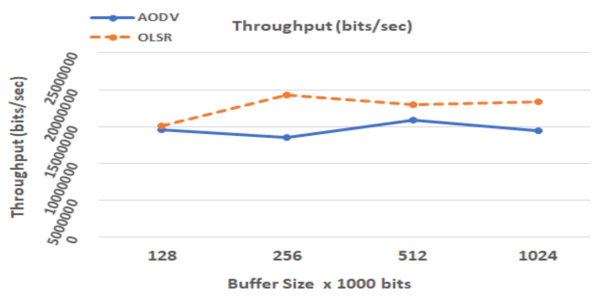


Fig. (5): Throughput (b/s) of AODV and OLSR Protocols with Buffer Size Variation

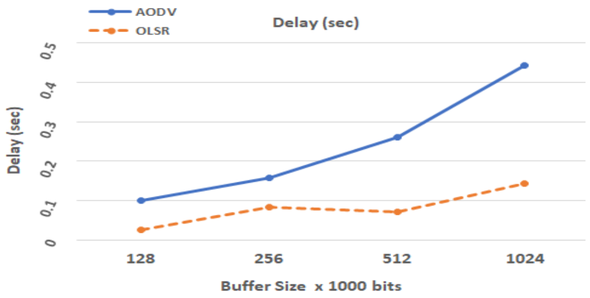


Fig. (6): Delay (s) of AODV and OLSR Protocols with Buffer Size Variation

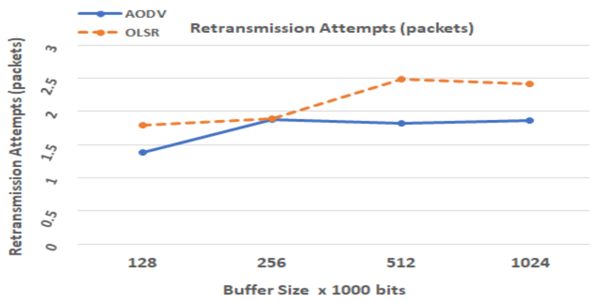


Figure 7: Retransmission Attempts (Packets) of AODV and OLSR Protocols with Buffer Size Variation

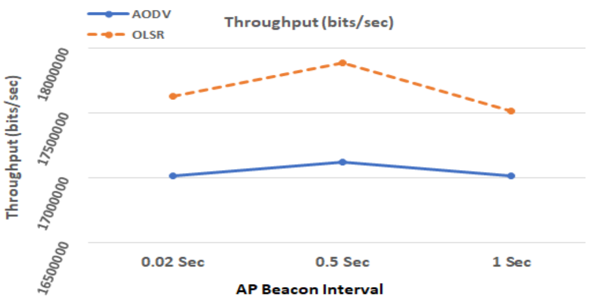
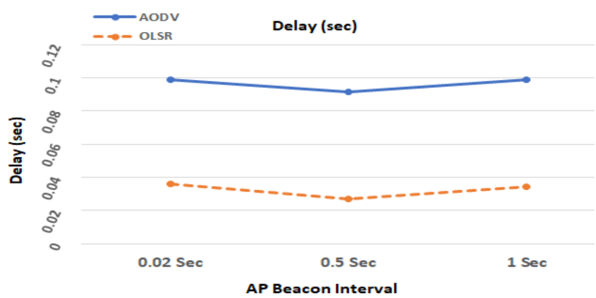
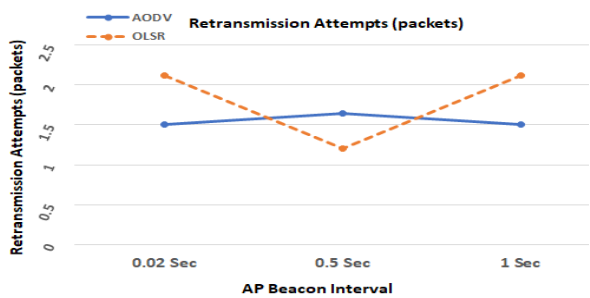


Figure 8: Throughput (b/s) of AODV and OLSR Protocols with





AP Beacon Interval

Fig. (9): Delay of AODV and OLSR Protocols with AP Beacon Interval

Fig. (10): Retransmission Attempts (Packets) of AODV and OLSR Protocols with AP Beacon Interval

The calculations in figures (8, 9, 10) from the second scenario with AP Beacon Interval variation, show the best optimal result for AP beacon interval is the 0.5s search for OLSR, while 0.02s and 1s cause poor performance, while for AODV shows stable results. The throughput increases around 0.5s due to decreasing time of finding all WNIC configurations for all devices, which makes it easier to find the best routes and send more data. But it causes more delay to process the frames in the buffer, due to the broken routes of mobility cause the device to find new routes to other nodes and new WNIC parameters. Retransmission attempts also increase for OLSR but not for AODV with increasing the AP beacon interval because it takes more time to find better routes and hence dropping more packets that require retransmitting the frames again. While decreasing the time to 0.02 Sec updates the

Ghassan.qasmarrogy@cihanuniversity.edu.iq
[1]Corresponding author: College of Engineering, Cihan University, Erbil, Kurdistan Region, Iraq.

WNIC parameters to a point very fast that it doesn't have time to connect which gives a lower performance also.

AP interval time effects OLSR more than AODV because OLSR keeps fresh routes available all the time, which makes it faster to establish a connection and send the video packets when WNICs are synchronized. Changing the AP interval time requires OLSR to broadcast new updates and find the same routes again, which causes more delay. AODV shows stable performance because it searches for new routes when it needs to.

5. CONCLUSIONS AND FUTURE WORK

video streaming is very important nowadays in wireless networks. In MANETs, a calculation and analysis were done with two major routing protocols, AODV and OLSR calculating and measuring the effects of buffer size and AP beacon interval. The study showed that a buffer size of 128,000 bits gives higher throughput and lower delay and retransmission attempts for AODV while OLSR had a very small effect. The AP beacon interval simulations showed 0.5 Sec was the optimal time for OLSR protocol, while for AODV had a very small effect.

In general, OLSR shows better performance than AODV for all scenarios in terms of throughput, delay, and retransmission attempts. Using these calculations, both AODV and OLSR were optimized for better parameters for video transmission.

For future work, we recommend using more calculations and different types of applications such as VoIP, email, and FTP. Also, more calculation values must be simulated to discover the best parameters for all types of applications.

REFERENCES

Szymanski, T. H. (2016). Supporting consumer services in a deterministic industrial internet core network. IEEE Communications Magazine, 54(6), 110-117.

Marrogy, G. A. (2013). Performance analysis of routing protocols and TCP variants under HTTP and FTP traffic in MANET's (Doctoral dissertation, Eastern Mediterranean University (EMU)-Doğu Akdeniz Üniversitesi (DAÜ)).

Agosto-Padilla, W., Loukili, A., Tsetse, A. K., Wijesinha, A. L., & Karne, R. K. (2016, November). 802.11 n wireless LAN performance for mobile devices. In 2016 IEEE/ACS 13th International Conference of Computer Systems and Applications (AICCSA) (pp. 1-6). IEEE.

Afaqui, M. S., Garcia-Villegas, E., & Lopez-Aguilera, E. (2016). IEEE 802.11 ax: Challenges and requirements for future high efficiency WiFi. IEEE Wireless Communications, 24(3), 130-137.

Narayan, S., Jayawardena, C., Wang, J., & Ma, W. (2015, January). Performance test of IEEE 802.11 ac wireless devices. In 2015 International Conference on Computer Communication and Informatics (ICCCI) (pp. 1-6). IEEE.

Kadir, E. A., Siswanto, A., & Syukur, A. (2016, May). Performance analysis of wireless LAN 802.11 n standard for e-Learning. In 2016 4th International Conference on Information and Communication Technology (ICoICT) (pp. 1-6). IEEE.

Alqaysi, H. J., & QasMarrogy, G. A. (2015). Performance Analysis of Video Streaming Application Over Manets Routing Protocols. International Journal of Research in Computer

Ghassan.qasmarrogy@cihanuniversity.edu.iq
[1]Corresponding author: College of Engineering, Cihan University, Erbil, Kurdistan Region, Iraq.

Applications and Robotics, 3, 22-28.

Rathod, N., & Dongre, N. (2017, January). MANET routing protocol performance for video streaming. In 2017 International Conference on Nascent Technologies in Engineering (ICNTE) (pp. 1-5). IEEE.

Li, M., Tan, P. H., Sun, S., & Chew, Y. H. (2016, May). QoE-aware scheduling for video streaming in 802.11 n/ac-based high user density networks. In 2016 IEEE 83rd Vehicular Technology Conference (VTC Spring) (pp. 1-5). IEEE.

Mahadevan, G. (2018). A combined scheme of video packet transmission to improve cross layer to support QoS for MANET. Alexandria engineering journal, 57(3), 1501-1508.

Kumari, N., Gupta, S. K., Choudhary, R., & Agrwal, S. L. (2016, March). New performance analysis of AODV, DSDV and OLSR routing protocol for MANET. In 2016 3rd International Conference on Computing for Sustainable Global Development (INDIACom) (pp. 33-35). IEEE.

Che, X., Ip, B., & Lin, L. (2015). A survey of current youtube video characteristics. IEEE MultiMedia, 22(2), 56-63.

Maraslis, K., Chatzimisios, P., & Boucouvalas, A. (2012, June). IEEE 802.11 aa: Improvements on video transmission over wireless LANs. In 2012 IEEE International Conference on Communications (ICC) (pp. 115-119). IEEE.

Aziz, T. A. T., Razak, M. R. A., & Ghani, N. E. A. (2017, September). The performance of different IEEE802. 11 security protocol standard on 2.4 ghz and 5GHz WLAN networks. In 2017 International Conference on Engineering Technology and Technopreneurship (ICE2T) (pp. 1-7). IEEE.

Aman, A. H. M., Hashim, A. H. A., Abdullah, A., Ramli, H. A. M., & Islam, S. (2017). Packet Loss and Packet Delivery Evaluation Using Network Simulator for Multicast Enabled Network Mobility Management. International Journal of Future Generation Communication and Networking, 10(4), 41-50.

Abdrabou, A., & Prakash, M. (2016, November). Experimental performance study of multipath TCP over heterogeneous wireless networks. In 2016 IEEE 41st Conference on Local Computer Networks (LCN) (pp. 172-175). IEEE.

Wei, D. X., Jin, C., Low, S. H., & Hegde, S. (2006). FAST TCP: motivation, architecture, algorithms, performance. IEEE/ACM transactions on Networking, 14(6), 1246-1259.

[18] Showail, A., Jamshaid, K., & Shihada, B. (2016). Buffer sizing in wireless networks: challenges, solutions, and opportunities. IEEE Communications Magazine, 54(4), 130-137.

Li, M., Tan, P. H., Sun, S., & Chew, Y. H. (2016, May). QoE-aware scheduling for video streaming in 802.11 n/ac-based high user density networks. In 2016 IEEE 83rd Vehicular Technology Conference (VTC Spring) (pp. 1-5). IEEE.

Appenzeller, G., Keslassy, I., & McKeown, N. (2004). Sizing router buffers. ACM SIGCOMM Computer Communication Review, 34(4), 281-292.

Shenoy, S. U., Kumari, S., & Shenoy, U. K. K. (2019). Comparative Analysis of TCP Variants for Video Transmission Over Multi-hop Mobile Ad Hoc Networks. In International Conference on Computer Networks and Communication Technologies (pp. 371-381). Springer, Singapore.

Ghassan.qasmarrogy@cihanuniversity.edu.iq
[1]Corresponding author: College of Engineering, Cihan University, Erbil, Kurdistan Region, Iraq.

Li, T., Leith, D., & Malone, D. (2010). Buffer sizing for 802.11-based networks. IEEE/ACM Transactions on Networking, 19(1), 156-169.

Sati, S., & Graffi, K. (2015, August). Adapting the beacon interval for opportunistic network communications. In 2015 International Conference on Advances in Computing, Communications and Informatics (ICACCI) (pp. 6-12). IEEE.

Chen, Y., Xing, Y., & Yi, W. (2016, May). Optimal beacon scheduling for low-duty-cycle sensor networks. In 2016 IEEE International Conference on Communications (ICC) (pp. 1-7). IEEE.

Erciyes, K., Dagdeviren, O., Cokuslu, D., Yilmaz, O., & Gumus, H. (2011). Modeling and simulation tools for mobile ad hoc networks. Mobile ad hoc networks: Current status and future trends, 37-70.

Qasmarrogy, G. A., & Almashhadani, Y. S. (2020). Ad Hoc On-demand Distance Vector Inherent Techniques Comparison for Detecting and Eliminating the Black Hole Attack Nodes in Mobile Ad Hoc Network. Cihan University-Erbil Scientific Journal, 4(1), 77-81.

Ghassan.qasmarrogy@cihanuniversity.edu.iq
[1]Corresponding author: College of Engineering, Cihan University, Erbil, Kurdistan Region, Iraq.