Implementation of OLSR using 802.11g in UAV Communication Networks

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Summary
The UAVCN (Unmanned Aerial Vehicles Communication Networks) is an Emerging technology of adhoc networking which is useful for many military and civilian applications of wireless communication. It resembles like Flying Adhoc Network. Our research intends to study about the UAVCN proactive routing protocols and to develop the test beds to implement the OLSR routing protocol and observe the performance. To accomplish this task the experimental test bed scenarios developed and OLSR routing protocol implemented by using the Wireless LAN physical characteristics 1EEE 802.11g standard using OPNET modeler 14.5 version simulator tool. The scenarios designed with 10 and 20 node density and configured each node with video streaming application. However; in this study the network performance and features of OLSR evaluated by altering the number of nodes using same parameters. In this paper, the OLSR protocol implemented and evaluated in terms of OLSR Hello Traffic Sent, OLSR TC Traffic Sent, OLSR Routing Traffic Sent, OLSR Routing Traffic Received, Data Dropped, Network Delay, Network Load, Media Access Delay and Wireless LAN Throughput. The node density impact on the performance of OLSR routing Protocol.

Key words:
UAV's, UAVCN, Proactive Routing Protocols, OLSR, OPNET

1. Introduction

The UAVCN is tremendous technology which is used for military and civilian application such as ground target detection, tracking, rescue and search operation, disaster monitoring, Border Surveillances, Managing wildfire, wind estimation, remote sensing and monitoring. These networks node fly independently and can be operated from at a distant without human [1].It can be controlled remotely. The demand of Unmanned Aerial Vehicle has been increased in this modern age of technology. There are two types of the UAV Systems or networks i.e. one is the single UAV system and other one is the Multi- UAV system means group of small UAV's. In this globalized era UAVCN (Unmanned Arial Vehicle Communication Network) plays an important role, basically it is also called FANET, which is fundamentally a layout of the MANET or VANET. The major difference is that the MANET and VANET nodes mobility is lower as compared to the FANET or UAVCN. However the MANET and VANET nodes mobility takes place with the movement of human beings and ground vehicles. On other hand UAV nodes fly in the sky. In many scenarios UAVCN performs operation by forming swarm of UAV's to cope the application in large geographical area. The distance between nodes of the MANET and VANET is lower as compared to UAV's nodes. Where UAV's nodes have higher distance. Therefore, there are lot of issues mobility issues, scalability issues, reliability issue, battery issues or power issues and routing issues, these all parameters affect the UAVCN performance.

2. UAVCN Proactive Routing Protocols

Proactive routing protocols before sending data packet, each node update route status information that does mean it maintains routing table. However; these protocols are also known as table driven routing protocol. Although routing table helps nodes to establish routes as per predefined standard. Along with these standards, the shortest path or shortest route, forwarding delay among nodes and bandwidth size could be measured [1]. The proactive routing protocols use the link state routing protocol or distance vector routing protocol mechanism. In the manuscript [2] authors proved that in Unmanned Aerial Adhoc Networks realistic scenarios, table driven routing protocols (proactive protocols) have propensity to generate more overhead as compared to event driven routing protocols (reactive routing protocols). On the other hand, despite this problem, these routing protocols have advantages to offer quick connections among mobile nodes because routing information is available immediately and routes already managed in the routing table. However, there is minimum delay when data routed among the nodes.

2.1 OLSR

In [2-5] authors have carried out studies experimentally by using simulation method to assess the performance of optimized link state routing protocol.
In [6] authors developed the optimized link state routing algorithm that constructs routes without data packet

Manuscript received September 5, 2018
Manuscript revised September 20, 2018

transmission. In this platform each node proclaims their direct neighbor routes to update routing table. This table helps the periodic exchange information of TC packets and Hello packets among neighbors that produce the neighbor list. From this list each node chooses a MPR. The MPR nodes are responsible to produce link state information and forward packets to other Multi-Point Relays.

In [2] [5] authors compared AODV, DSR and OLSR and observed the better performance of OLSR in terms of End to End Delay in Unmanned Aerial Adhoc Networks. The Hello messages and TC messages continuous exchange update the Unmanned Aerial Vehicle the possible route to communicate with each other. Although the overhead produced by OLSR, it has ability to discover new route subsequent a route loss is lower to AODV. Ultimately, the recurring broadcast of multiple packets like (TC, Hello and MAC) among UAVs under high data rate.

2.2 DSDV

In [7] authors proposed that DSDV (Destination Sequence Distance Vector) is developed on the basis of Bellman Ford Algorithm. Usually two parameters are added in distance vector routing, sequence number that is used to avoid routing loops and another is dumping that holds an advertisement which helps for short duration of topology modification.

Furthermore, Destination Sequence Distance Vector exchanges 2 different kinds of packets. The first is full dump packets and second type is incremental update packets. The functionality of dump packets is to transmit all information of routing table and infrequent transmitted packets over network due to its capacity. On the other hand incremental update packets are carrying new updated information while full dump packets are exchanged.

In [8] the DSDV are studied in Unmanned Aerial Adhoc Network environment. In [9] the routing protocol LANMAR evaluated with DSDV. The LANMAR protocol combines two techniques one is hierarchical routing scheme and another is landmark routing scheme. Consequently, due to counting infinity problem in the network, DSDV remove the routing loops. Nevertheless, Destination Sequence Distance Vector suffers from delays to reconstruct the newest updates. However, it produces more end to end delay. Definitely every node waits for newest updates from connected neighbors to update the routing table to join any destination.

Moreover, to classify between dump packets and incremental update packets, an Unmanned Aerial vehicle ought to constantly listen to all events inside the network. For example, there may be chance of essential changes in the network. Therefore it might be possible to generate too much packet control that makes the network saturated in high workload.

2.3 TBRPF

In [10] authors discussed about TBRPF (Topology Broadcast Based on Reverse Path Forwarding) that is flavor of link state routing which provides the shortest path during communication. In [11], authors used the dijkstra algorithm with TBRPF that each node calculates the source tree on the basis of topology information which is stored and updated in topology table. The source tree has the link state routing information of every one available node. The updates like differential and periodic combination are used to broadcast the source tree. In network if there is no major changes in topology then it enables to send smaller size of Hello packets. In addition, TBRP provides the mechanism to each node to rapidly discover neighbors with bidirectional links. It also senses the link status if link breaks or asynchronous when it becomes unidirectional.

In [12] authors discussed that, TBRPF is able to provoke less overhead as contrast to OLSR in Unmanned Aerial Adhoc Networks scenarios, However, it facing the erroneous routing issues due to high mobility of UAV's. In [13] authors conducted experiments by using TBRPF protocol in Unmanned Aerial Adhoc Networks scenario. The parameter of this study is minimum hop count that provides the inconsistent results in terms of route discovery. However, this is due to wireless interface oscillation which is ignored. Therefore, in [13] the idea supports to introduce the link quality that is component of routing metric which helps in discovering route. The test bed scenarios may formulate to access the Unmanned Aerial Adhoc Networks performance.

2.4 BATMAN/ BATMAN-ADV

In [14] authors introduced BATMAN/ BATMAN-ADV (Better Approach to Mobile Adhoc Networking/ Better Approach to Mobile Adhoc Networking Advanced) which manage routing loops to support high node density and low traffic cost and low processing. This algorithm do not discover the network topology of entire network but it learn the directly connected neighbors by substituting of BATMAN control message packet that is known as OGM (Originator message). The size of OGM packets is very small. Usually, 52 byte packet size together with overhead of IP and UDP. When data forwarded, a sender node calculates the OGM packets which receives from its neighbor nodes. It chooses one neighbor node that sent packet more regular as compared to other neighbor nodes. The selected node has fresh sequence number; however, it chooses as a next hop neighbor node that connects with destination node.

In addition the improved flavor of BATMAN is BATMAN-Advanced, The improvement are made in BATMAN by creating the kernel module which perform

operation in kernel stack. Consequently, the routing information not found encapsulated among UDP. Although, it found in raw Ethernet frame. Therefore, all nodes have appropriate link when topology changes.
In [15] [16] BATMAN could be used through simulation, as well as through real word implementation. Authors [5] examined four routing protocols BATMAN, BATMAN-Adv, OPEN802.11S and OLSR using the Unmanned Aerial Adhoc Network environment, where 2 CS (Control Stations) are used for similar geographical location. However, 2 UAV's are launched in a particular zone. The objective of this investigation was to evaluate the BATMAN performance in the environment of Swarm of UAV's application. It has been studied that in the scenarios of low density network, layer 2 protocols BATMAN-Adv well then OPEN802.11S. Although, it has been observed in this study that layer 3 protocol OLSR and BATMAN performance is better in term of packet loss ratio and good put. Through this it was examined to reduce the control overhead and layer 2 generated routing oscillations.

2.5 FSR

In [17] authors have been proposed FSR (Fish State Routing). This routing mechanism is an improved version of the GSRP (Global State Routing) protocol [18]. FSR is a protocol that is based on fish version with the aim capturing the points that is close to focal view. Its objective is to decrease the routing update overhead through reducing the frequency of routing table update with respect to destination distance. It indicates that updates are quickly generated for nodes of close destinations as compared to nodes which are at far destinations. It keeps right routing information for directly connected neighbors. In small network it reduces overhead that is the strength of Fish State Routing.
Nevertheless, it suffers in high dense network due to overflow of routing table. This creates problem to produce out of date paths for nods of distant destinations. It has been noticed that it has greater drawback like, non optimal management when source node communicate with destination nodes which are out of transmission range. Hence, it never finds out the destination route after long search. So, for that DTN algorithm is solution for such type of problem to hold message when routing process takes place then transfer it when communication opportunity is available.
In [19] researchers accessed FSR in an environment of Unmanned Aerial Adhoc Network test bed that is known as UCSS (Unmanned Aerial Vehicle Communication Simulation System). The objective of this study was to examine the tees beds rather than Fish State Routing performance.

3. Research Methodology

The proposed approach or research method for the outcome of this study to implement the test beds of proactive OLSR routing protocol by using the OPNET tool 14.5 version. It has been studied by implementing the test beds using IEEE 802.11g environment. The experimental method is used to learn about the features of OLSR protocol and its functionality. The simulator which is more important in this dissertation is OPNET (Optimized Network Engineering Tools). This is known as a discrete event network simulator. It is written in C and C++ language. It was introduced by MIT in 1986. It is commercial simulator tool which is mostly used in developing network simulation. It has academic version which is free of cost that is widely used by researcher, academicians in universalities. It provides several network hardware's for example antennas and transceivers supporting adhoc network routing protocols etc. It is user friendly and it has ability to monitor and execute simultaneously the variety of scenarios that is more important feature. OPNET provides the platform to user to use graphical user interface to develop the scenarios and models the network and observe the graphs. This modeler supports to design the networks by using many network devices and protocols as per required application. This modeler could be used on both Linux and window platform. Fig: 1 shows the OPNET modeler workplace for design the scenarios.

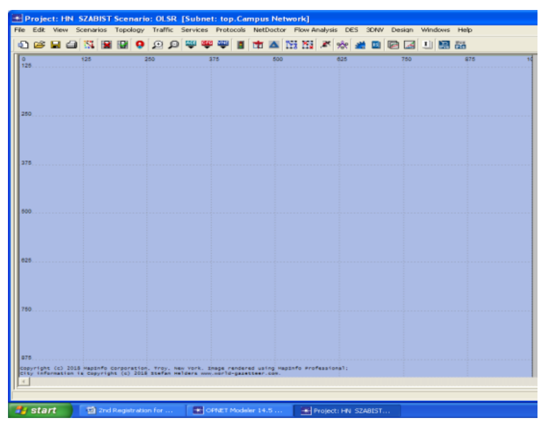

Fig. 1 OPNET Modeler 14.5 Workplace

3.1 Testbed Experimental Setup

The test bed experimental setup is designed for this part of dissertation study by using simulation tool OPNET. We have developed the scenario using 10 nodes. The routing protocol OLSR has been configured in each scenario with default setting. The Wireless LAN physical characteristics standard 802.11g has configured as default setting attributes. The main characteristics of test bed scenarios updated as shown in table 1 given below: After this experimental setup the simulation has been carried out and observed the results. After this, changed the number of nodes from 10 to 20. Again, the Wireless LAN physical characteristics standard 802.11g updated similarly and run the simulation then simulation has been carried out and observed results is recorded.

Table 1: Main Characteristics of the testbed scenarios

Scenarios Parameters	Scenario Values
Simulation tool	OPNET 14.5 Version
Adhoc Routing Protocols	OLSR
Network Scenario Size	1400x1400 meters
Number of UAV's Nodes	10 and 20
ZABIS HN-OLSR 802.11g Recoverd-DES-1	10 Nodes
ZABIST HN-OLSR 802.11g-DES-1	20 Nodes
Data Rate	54 Mbps
Application	Video Streaming
Application Description	High Browsing
Wireless LAN Phy Characteristics	IEEE 802.11g
Mobility model	Random Waypoint
Scenario Simulation Time	30 min

Table 2: Wireless LAN Parameters Values

Wireless LAN Parameters	Wireless LAN Parameters Values
Channel Setting	Auto assigned
Transmitter Power	0.005 Watt
Transmission Range	250 meters
Fragmentation Threshold	1024 bytes
Buffer Size	256000 bits

The scenarios have developed having 10, and 20 UAV's nodes for simulation according to given tabular metrics. In both scenarios 1400x1400 meters campus network has been designed. From object palette the application definition, profile definition, mobility configuration, server and mobile nodes dragged and dropped to workplace. Subsequent to the application definition the application attribute is updated by selecting video streaming consequently application definition is configured. High browsing is selected for video streaming. Later, Profile Definition is also configured by using the services of FTP and HTTP and application video streaming selected. The mobility configuration is updated by using Random Waypoint model.

The Wireless LAN physical characteristics are updated by using IEEE 802.11g than data rate selected 54 mbps, Table 2 WLAN parameters values configured as channel setting auto assigned, transmitter power assigned 0.005 watt, fragmentation threshold 1024 and buffer size 256000 bits used these all parameter updated in all mobile nodes. In configuration of run discrete simulation the run time of network nodes communication duration was configured 30 minutes and in simulation kernel preference selected as optimized. Then run the simulation. At the end of simulation, results are collected.

4. Simulation Results and Discussion

The OLSR results are observed in the following graphs and parameters are discussed.

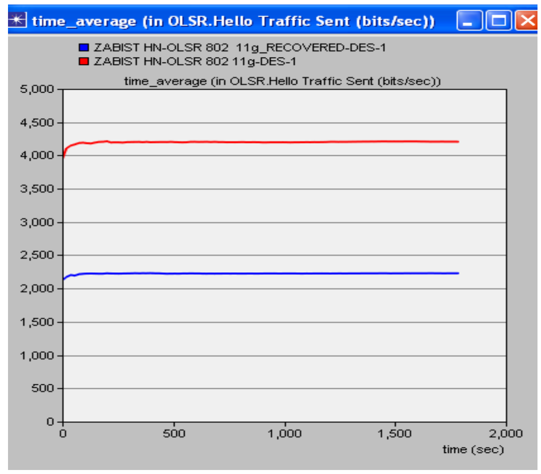

Fig. 2 OLSR Hello Traffic Sent bps

In the above Fig: 2. it has been observed that in WLAN 802.11g environment for OLSR Hello Traffic Sent 41 kbps when we used 20 nodes in scenario. On other hand, in WLAN 802.11g environment OLSR Hello Traffic Sent 22 kbps when we used 10 nodes in test bed scenario. The OLSR sent more messages in the dense network environment. 20 nodes send more Hello messages as compared to 10 nodes, in the environment of 802.11g Wireless LAN physical characteristics.

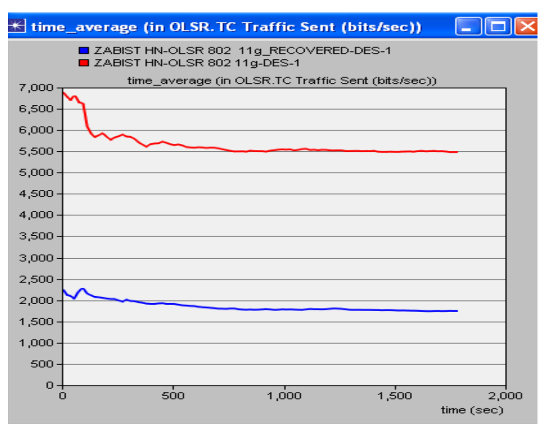

Fig. 3 OLSR TC Traffic Sent bps

In the above Fig: 3. it has been observed that in WLAN 802.11g environment for OLSR TC Traffic Sent is 5.6 kbps when we used 20 nodes in test bed scenario. On other hand in WLAN 802.11g environment OLSR TC Traffic Sent is 23 kbps when we used 10 nodes in test bed scenario. The OLSR Sent TC Traffic more in the dense network environment. Consequently, it has been evaluated that when we are using 20 nodes by using OLSR routing protocol it sent TC Traffic more. As compared to 10 nodes in case of 802.11g Wireless LAN physical characteristics environment

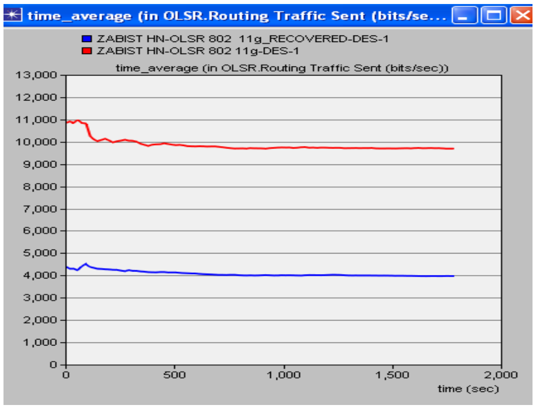

Fig. 4 OLSR Routing Traffic Sent bps

In the above Fig: 4. it has been observed that in WLAN 802.11g environment for OLSR Routing Traffic Sent 10 kbps when we used 20 nodes in test bed scenario. On other hand, in WLAN 802.11g environment OLSR Routing Traffic Sent 4.4 kbps when we used 10 nodes in tested scenario. The OLSR Sent Routing Traffic more in the dense network environment. Consequently, it has been evaluated that when we are using 20 nodes by using OLSR routing protocol it sent Routing Traffic more. As compared to 10 nodes in case of 802.11g Wireless LAN physical characteristics environment

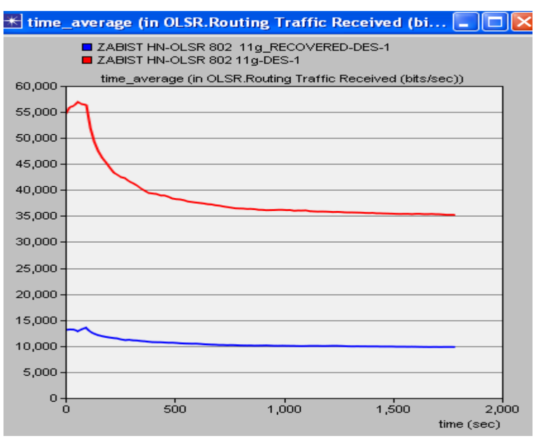

Fig. 5 OLSR Routing Traffic Received bps

In the above Fig: 5. it has been observed that in WLAN 802.11g environment for OLSR Routing Traffic Received is 45 kbps when we used 20 nodes in test bed scenario. On other hand, in WLAN 802.11g environment OLSR Routing Traffic Received is 14 kbps when we used 10 nodes in test bed scenario. The OLSR Routing Traffic Received more in the dense network environment. Consequently, it has been evaluated that when we are using 20 nodes by using OLSR routing protocol it Received Routing Traffic more. As compared to 10 nodes in case of 802.11g Wireless LAN physical characteristics environment.

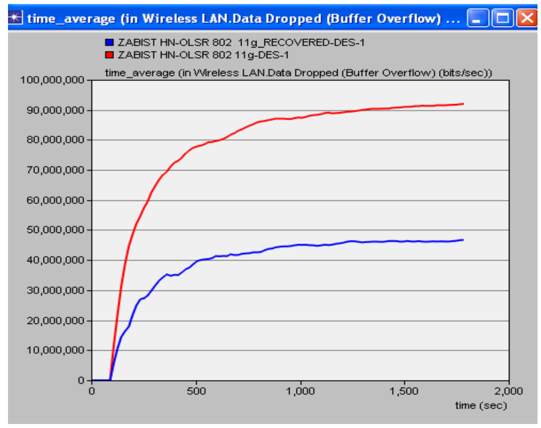

Fig. 6 Wireless LAN Data Dropped (Buffer Overflow) bps

In the above Fig: 6. it has been observed that in WLAN 802.11g environment for Wireless LAN Data Dropped (Buffer Overflow) is 91 Mbps when we used 20 nodes in test bed scenario. On other hand, in WLAN 802.11g environment Wireless LAN Data Dropped (Buffer Overflow) is 46 Mbps when we used 10 nodes in test bed scenario. The Wireless LAN Data Dropped (Buffer Overflow) is more in the dense network.

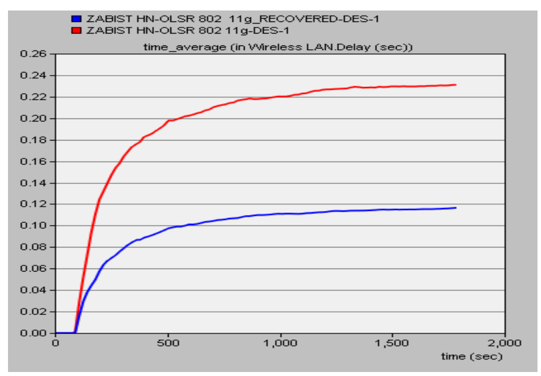

Fig. 7 Wireless LAN Delay (sec)

In the above Fig: 7. it has been observed that in WLAN 802.11g environment for Wireless LAN Delay is 0.23 (sec) when we used 20 nodes in test bed scenario. On other hand, in WLAN 802.11g environment Wireless LAN Delay is 0.11 (sec) when we used 10 nodes in test bed scenario. The Wireless LAN Delay is more in the dense network environment. Therefore, it has been evaluated that when we are using 20 nodes by using Wireless LAN, it produces more delay as compared to 10 nodes in case of 802.11g Wireless LAN physical characteristics environment.

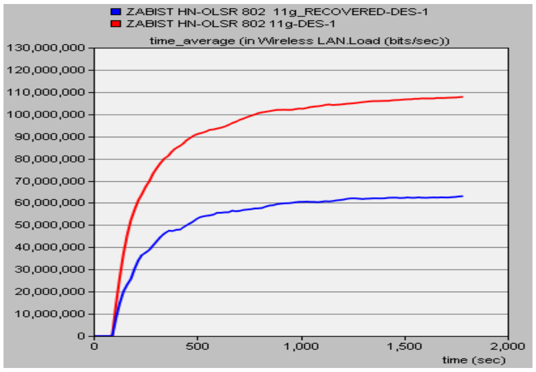

Fig. 8 Wireless LAN Load bps

In the above Fig: 8. it has been observed that in WLAN physical characteristics 802.11g environment for Wireless LAN Load is 109 Mbps when we used 20 nodes in test bed scenario. On other hand, in WLAN physical characteristics 802.11g environment WLAN Load is 62 Mbps when we used 10 nodes in test bed scenario. The Wireless LAN Load is more in the dense network environment. Therefore, it has been evaluated that when we are using 20 nodes by using WLAN it has more Load as compared to 10 nodes in case of 802.11g WLAN physical characteristics environment.

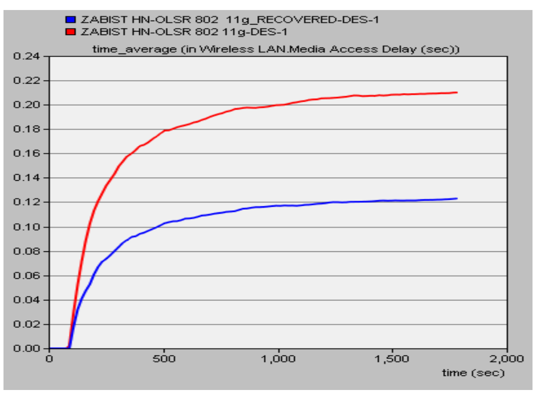

Fig. 9 Wireless LAN Media Access Delay (sec)

In the above Fig: 9. It has been observed that in WLAN physical characteristics 802.11g environment for Wireless LAN Media Access Delay is 0.21 sec when we used 20 nodes in test bed scenario. On other hand, in WLAN physical characteristics 802.11g environment Wireless LAN Media Access Delay is 0.12 sec when we used 10 nodes in tested scenario. The Wireless LAN Media Access Delay is more in the dense network.

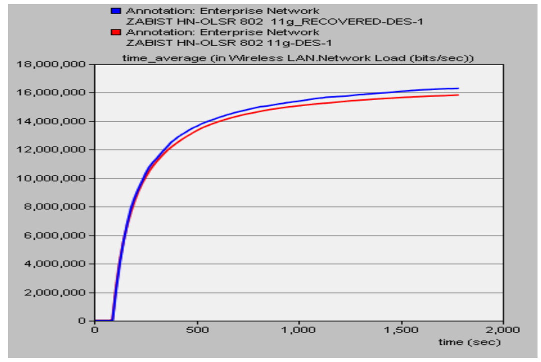

Fig. 10 Wireless LAN Network Load bps

In the above Fig: 10. It has been observed that in WLAN physical characteristics 802.11g environment for Wireless LAN Load is 109 Mbps when we used 20 nodes in test bed scenario. On other hand, in WLAN physical characteristics 802.11g environment WLAN Load is 62 Mbps when we used 10 nodes in test bed scenario. The Wireless LAN Load is more in the dense network environment. Therefore, it has been evaluated that when we are using 20 nodes by using WLAN it has more Load as compared to 10 nodes in case of 802.11g WLAN physical characteristics environment.

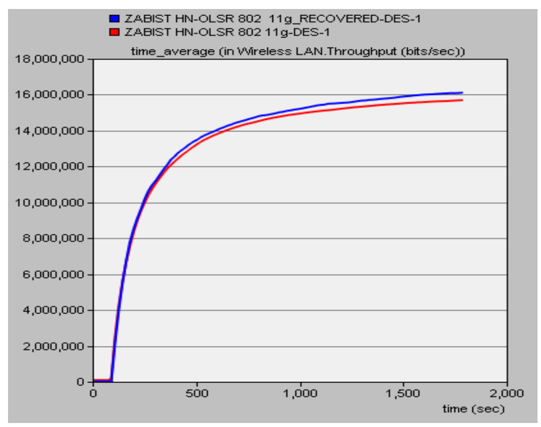

Fig. 11 Wireless LAN Throughput bps

In the above Fig: 11. It has been observed that in WLAN physical characteristics 802.11g environment for Wireless LAN Throughput is 15.5 Mbps when we used 20 nodes in test bed scenario. On other hand, in WLAN physical characteristics 802.11g environment Wireless LAN Throughput is 16 Mbps when we used 10 nodes in test bed scenario. Throughput is less in the dense network.

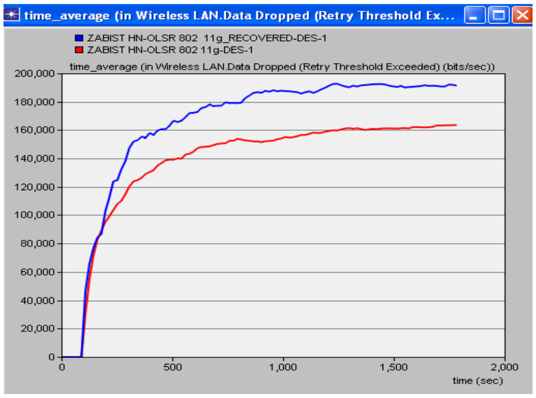

Fig. 12 Wireless LAN Data Dropped

In the above Fig: 12. It has been observed that in WLAN physical characteristics 802.11g environment for Wireless LAN Data Dropped (Retry Threshold Exceeded) is 160 Kbps when we used 20 nodes in test bed scenario. On other hand, in WLAN physical characteristics 802.11g environment Wireless LAN Data Dropped (Retry Threshold Exceeded) is 185 Kbps when we used 10 nodes in test bed scenario. The Wireless LAN Load is more in the dense network environment. Therefore, it has been evaluated that when we are using 20 nodes by using Wireless LAN, it has less Wireless LAN Data Dropped (Retry Threshold Exceeded) as compared to 10 nodes in case of 802.11g Wireless LAN physical characteristics environment.

5. Conclusion

In this research, the proactive routing protocol test bed scenarios developed in which OLSR protocol implemented in UAVCN environment. Wireless LAN Physical Characteristics 1EEE 802.11g standard is used for the experimental test bed scenarios. The scenarios are designed with 10 and 20 UAV’s node densities for the application of video streaming. However, in this study, the performance and features of OLSR are evaluated by altering node density. In order, to evaluation and implementation of OLSR, this protocol is implemented and evaluated in terms of OLSR Hello Traffic Sent, OLSR TC Traffic Sent, OLSR Routing Traffic Sent, OLSR Routing Traffic Received, Wireless LAN Data Dropped (Buffer Overflow), Wireless LAN Delay, Wireless LAN Load, Wireless LAN Media Access Delay, Wireless LAN Network Load and Wireless LAN Throughput. The node density impact on the performance of OLSR routing Protocol. It has been observed that all parameters have the greater values with respect to greater node density.

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