Swarm of Unmanned Aerial Vehicles Communication Using 802.11g and 802.11n

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Summary
The swarm of UAVs' (Unmanned Aerial Vehicles) is a group of aerial nodes that form the UAVCN (Unmanned Arial Vehicle Communication Networks) in the air. UAV's communication is a challenging issue but it is required, in order to implement the group of UAV's for specific military and civilian applications. In this paper, we have implemented the OLSR (Optimized Link State Routing) protocol for communication of Swarm of UAVs' by using the WLAN (Wireless LAN) 802.11g and the 802.11n environment in the ad-hoc mode for the surveillance of livestock in the desert area application. This experimental study is carried out by using tool OPNET modeler 17.5 for a reliable and self-configurable group of aerial nodes communication and OLSR performance computed in both WLAN environments.

Keywords
SWARM, UAV, UAVCN, OLSR, WLAN

1. Introduction

UAVs' communication has great importance nowadays in the world due to their infinite prospective civil and military use, for example, surveillance/ observations, inspections, search and rescue operations, agriculture monitoring, forestry assessment, aerial photography or video streaming [1-2]. Most research has been carried out about the data or information gathering with a single Unmanned Aerial Vehicle. To minimize, time of data collection a group of UAVs' play an identical role [3]. Thus, a swarm of UAVs' can perform the task rapidly instead of single UAV. Moreover, a swarm of UAV proffers robustness throughout redundant and self-organizing nature, which is impossible to achieve using one UAV. This increases the efficiency and correctness of the information by telling the 3D (three-dimensional) substances or objects, which have numerous features [4-5]. The UAVs are very small and light that can hold smaller payload due to their inadequate capabilities. The swarm of UAVs is able to overcome the complex mission [6]. The function of a swarm of UAVs' is to communicate and coordinate with each other. These nodes hardware is capable to form a network and share the information regarding the operation successfully. In [7], an architecture is proposed which support the UAVs' communication in a given set of points. In [8], an architecture proposed which help UAVs' to coordinate with each other in a target location. Nevertheless, the advantages offered by an autonomous swarm of UAV face challenges of efficient swarm formation and communication. The group of UAVs' performs the operation that offers a reliable network scenario structure for the fulfillment of the required mission of surveillance. In this paper, we have implemented swarm of UAVs' by using a wireless LAN environment through enabling routing protocol OLSR to establish communication among a group of UAVs.

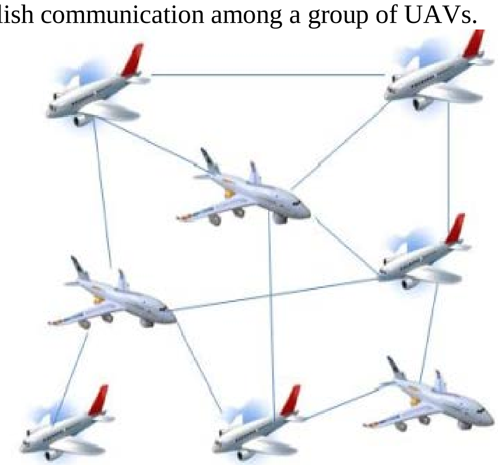

Fig. 1. Swarm of UAVs' Communication

In the Fig.1. Swarm of UAVs' Communication network shown. This has been developed for the purpose of surveillance of livestock in the desert area. For this application routing of data among UAVs' is more important to study. However, routing protocol OLSR is considered for testbed study of a swarm of UAV's using 802.11g and 802.11n environments.

2. OLSR Routing Protocol

This protocol has distinctive features as compared to other protocols. The main characteristic of OLSR, it is proactive in nature, however, it maintains an information table, thus, it is called table driven. It is an algorithm that selects the

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best or identical route by discovering numerous features such as bandwidth, a load of the link, delay, etc. These LS (link state) paths or route are more consistent, reliable and stable in finding the efficient route but are complex as compared to the hop count process. The topological data or information is updated by everyone node by broadcasting a periodic message over the network. MPR (multi-point relay) perform the operation to expedite stable flooding of the control message within the entire network. The Routes be calculated via multi-point-relays on the path to custom the route from an appropriate UAV to any destination UAV in the entire network. This protocol contains three general characteristics such as; a process of sensing neighbor, a process of flooding messages, in addition, a procedure of choosing and diffusing adequate topological messages, information or data in the entire network [9-11].

A. NS (Sensing Neighbor)

In Optimized Link State Routing, neighbor UAV associated information is collected with "HELLO messages", which are periodically sent to the entire nodes which are connected to the network [12]. HELLO, messages detect all neighbors which are connected to the node in the network and sense the modifications of interface address, Link type such as; it is symmetric, asymmetric or lost. Individually, each UAV update and keep an information set, relating to its neighbor as well as its two-hop neighbor on a periodic basis.

B. MPR (Multi- Point- Relay)

The notion of MPR is to reduce the overhead of flooding messages by decreasing RR (redundant retransmission) in a similar area of the entire network. In Multi- Point- Relay a UAV is designated via its one-hop neighbor to "retransmit" all the sent messages which it receives from connected nodes, presented that there is no message duplication and the size of TTL (time to live) message field is bigger than 1 [12]. However, to find one hop and two hop neighbor Hello Message is used to know about all neighbors. For this activity, every one UAV has an MPR selection process that designates, which node will perform the operation of MPR. The message is sent subsequently when the node received a new broadcast message and interface address of the sender's message in the MPR Selector process. A node repeatedly using the "HELLO" message through the MPR selector process to update periodically about the dynamic nature of neighbor nodes.

C. TCI (Topology Control Information)

The TCI messages are spread among nodes in the network to provide adequate link state information to permit route computation. These messages are broadcasted on the periodic basis by a node. The least conditions for the UAV is to send a stable link of its MPR Selector [12-13].

3. Materials and Method

The experimental method is used for this research study to implement the swarm of UAVs' by using the simulator tool OPNET 17.5. The testbed scenario developed by using the following table. 1. Network parameters for unmanned aerial communication networks.

Table 1 Network Parameters

Simulator	OPNET 17.5
Network Size	1100x1100 m^2
Simulation time	4000 s
SWARM of UAV's	8
Routing Protocol	OLSR
Application	Video Streaming
Mobility	Random Waypoint
WLAN Environment	802.11g & 802.11n
Channel Setting	Auto Assigned
Power of Transmitter	0.050 watt
Data rate	54 Mbps
Transmission Range	300 m
Fragmentation	1024
Buffer Size	256000

4. Simulation Results and Discussion

The simulation results carried out and described the observations. Experimentally network performance tested with respect to two different wireless LAN environment and OLSR routing behavior assessed. The following depicted figures describe the observations graphically.

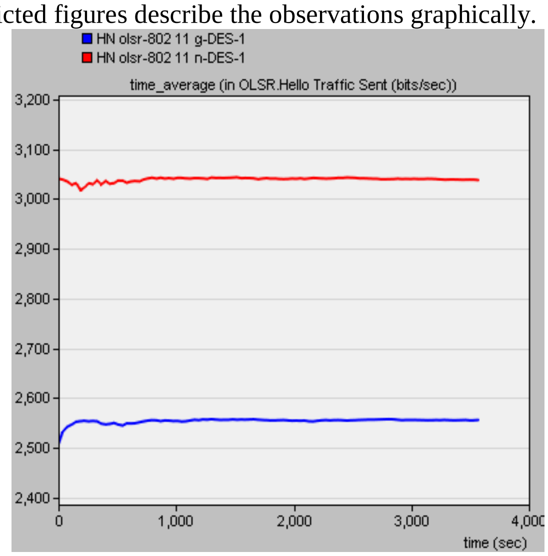

Fig. 2. OLSR Hello Traffic Sent bits/sec

In the Fig.2. The first annotation describes the Wireless LAN 802.11g platform, in which OLSR sent Hello Traffic 2560 in bps. On another hand the second annotation describes the Wireless LAN 802.11n environment, in which OLSR Hello Traffic Sent in bps is 3050

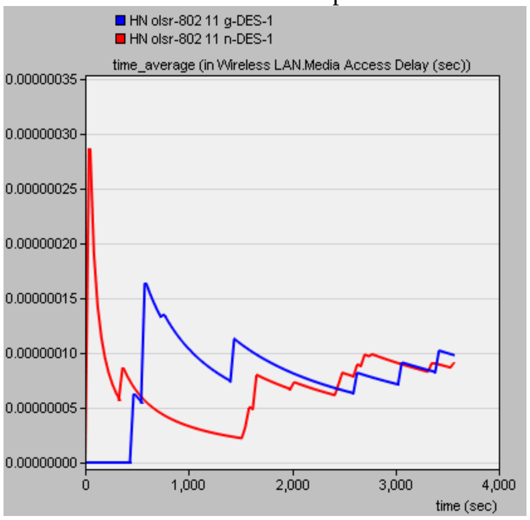

Fig. 3. Wireless LAN media access Delay in sec

In Fig: 3. first annotation describes the Wireless LAN 802.11g platform, in which WLAN Media Access Delay is 0.00000010 sec. On another hand, the second annotation describes Wireless LAN 802.11n, WLAN Media Access Delay is 0.00000009 sec.

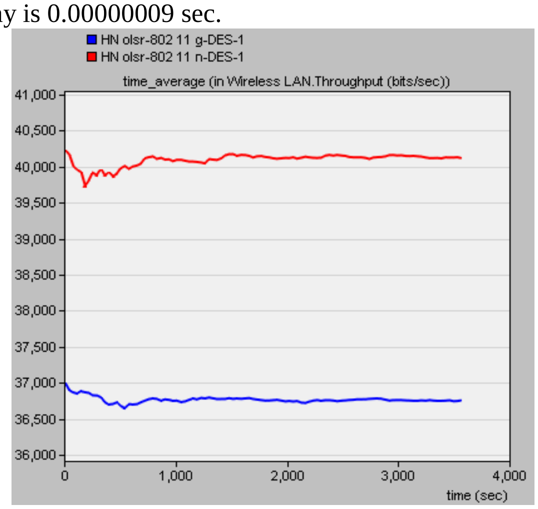

Fig. 4. WLAN Throughput bits/sec

In Fig: 4. the first annotation describes the Wireless LAN 802.11g platform, in which WLAN Throughput is 36750 bps. On another hand, the second annotation, describes Wireless LAN 802.11n environment, in this WLAN Throughput is 40100 bps.

5. Results Analysis

In the table, 2.the experimental results have been analyzed in which OLSR performance in terms of Hello traffic sent in both WLAN environment computed. Moreover, Wireless LAN media access delay and throughput calculated as under:

Table 2 OLSR routing protocol performance comparison in 802.11g and 802.11n

OLSR and WLAN Parameters	***802.11g***	***802.11n***
OLSR Hello Traffic Sent bps	2560	3050
WLAN Media Access Delay sec	0.0000001	0.00000009
WLAN Throughput bps	36750	40100

6. Conclusion

Swarm of UAVs' communication carried out by implementing the testbed scenario by using two different WLAN characteristics. In order to implement the Swarm of UAVs' for the surveillances of livestock. In this paper, we have implemented Swarm of UAVs' using the WLAN 802.11g and 802.11n environments by using tool OPNET modeler 17.5. The OLSR protocol used in this testbed scenario. Furthermore, The OLSR Hello Traffic Sent in bps. WLAN characteristics Wireless LAN media access delay and Wireless LAN Throughput parameters tested experimentally in both 802.11g and 802.11n environment. The WLAN 802.11n outperformed. The future work, the researcher can focus on the new models for a swarm of UAVs' and enable the different routing protocols to examine the performance of UAVCN and provide the results for better communication. In this area, the researcher can also explore mobility, scalability, reliability security and power issues in this emerging area. By using different simulation tools for Swarm of UAVs' and highlight the performance issues.

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