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Performance of Optimized Data Transmission Mechanism in Air Ad-Hoc Networks

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***Abstract*— An Air Ad-Hoc Network is similar to the Mobile Ad-Hoc Network (MANET) which is mostly used in data transmission of aeronautical vehicles. The Air Ad-hoc Network is a dynamic, distributed and a heterogeneous network which does not rely on the pre-existing infrastructures such as routers and access points. Instead each node forwards the data to neighbour nodes or to the destination node. Based on the transmission time, data link between the nodes, reliability of the network, distance between the nodes, bandwidth of the network, and efficient transmission of the data to the desired destiny, there exists different types of links to communicate which are disparate. The optimization of the data transmission provokes evolution of various types of routing algorithms. This paper explains about a detailed survey of data transmission mechanisms and its various types of algorithms.**

Keywords*— *Air Ad-Hoc Network, Mobile Ad-Hoc Network (MANET), Routing algorithms, efficient transmission and optimization.

I. INTRODUCTION

In order to better carry out aviation management and provide passengers with better service, there is an urgent need to develop a real-time, efficient, and reliable aviation communication system. The need is to meet the improvement of efficient aviation management, flight safety and passengers' air experience. In the exploration of the solutions of future civil aviation communication, there are problems of high cost, long delay, and limited bandwidth in the solution of space-based network according to the satellites. The reasons to improve the data transmission to an optimized to overcome the problems of the Space-Based Network and Ground-Based Network. The Space-Based Network has the problems of high cost, long delay and limited bandwidth. The Ground Based network has problems of high construction cost, limited coverage and these networks don't support communications for transoceanic flights.

The Air Ad Hoc Network and the Mobile Ad Hoc Network both are combined to give the solutions for these problems. These two networks having a common feature which is that the networks require a self-organizing node. But the Air Ad Hoc Network has its own features: - (1) It is a Heterogeneous network and different types of links. (2) Nodes move regularly and predictably, move fast. (3) Topology is highly dynamic. (4) Nodes have strong processing ability. (5) Cyberspace span and node communication radius are large.

II. AIR ADHOC NETWORKS

A. *Advanced Technologies for Networking in Avionic Applications - ANETENNA*

Fuchs et al. [1] proposed the project, Advanced Technologies for Networking in Avionic Applications (ATENAA) offers broadband communication services to the passengers. It provides facilities of In-Flight entertainment as high speed videos and internet access. It also facilitates Flight relevant information like the high resolution weather maps which are very helpful to the flight captain and crews. The project ATENAA uses the technique of Outer Optical Link (OOL) validation platform. This developed platform consists of a Fixed Terminal (FT) and a Mobile Terminal (MT) of hardware construction to provide communication. To avoid fading in the communication link, here the Packet Layer based Forward Error Correction (FEC) Scheme is used. In addition to this, the Synchronous Pseudo Random Binary Sequence (PRBS) is made possible in the transmission link. This technique allows the characterization of the optical channels by measuring the Bit Error Rates (BER).In this platform, the terminal acquisition was done by GNSS-position data, via the Omni directional RF signalling link. As a result the project provides broad band communication for commercial aviation.

B. *Aernautical Adhoc Network*

Sakhaee et al. [3] proposed the concept of Ad Hoc Networking between the aircrafts is introduced in this project to increase the data rate in transmission and to implement the

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future In-Flight Internet access in practical. This method reduces the internet traffic load on the satellite nodes and propagation delay for real-time traffic transmission by bypassing the satellite link for non-real time data. The method of providing data transmission link happens through a medium of three layered topology where as the top layer is the satellite layer, middle layer is the aircraft layer and the bottom layer is the ground layer (Earth Segment layer). Using the intra-link layers, the three layers could interact with each layer. Here the aeroplanes directly communicate with each other in the middle layer (aircraft layer). The techniques used here for the effective communication are Doppler shift, Aeronautical mobility and routing model and the Multipath Doppler Routing Algorithm. Doppler shift is used to control the packets to estimate link duration, Aeronautical mobility and routing model is used to find the mobility of the planes and to find the best route and the Multipath Doppler Routing (MUDOR) Algorithm is used to find out the reliable and stable routing path by using measurable Doppler shifts which also includes the on-demand routing scheme. The result of using Doppler Shift of packets in communication provides identification of relative stability of nodes.

C. NEWSKY

Schreckenbach et al. [2] proposed NEWSKY-A concept of networking the sky for civil aeronautical communications, is the paper which deals with the development of the Global network using Commercial-Off-The-Shelf (COTS) components on IPv6 based air-ground network. The technique used in aeronautical communication is ATM (Air Traffic Management) which includes Air Traffic Services (ATS), commercial Aeronautical Passenger Communications (APS) and the Airline communications (AOC, AAC). The ATM is mainly processed on voice data using the DSB-AM (Double Side Band-Amplitude Modulation).The techniques are performed in the VHF Digital link. The results of these techniques include enabling real air-ground integration and the System Wide Information Management (SWIM) for Collaborative Decision Making (CDM) in aircraft. It also provides opportunities for better information availability and sharing of data in the transmission link. Furthermore, the integrated network increases redundancy, availability and reliability in the network. But in this technique there is a possibility of eavesdropping, so the network safety has to be improved.

D. QoS – MUDOR

The QoS-MUDOR [6] is the Quality of Service Multipath Doppler routing algorithm based on the velocity of nodes which incorporates the QoS terms. The ultimate aim of the algorithm is to maintain the long link durations and to meet the QoS constraints. The algorithm uses a unique Hashed Data Identifier (HDI) to hold the destination address which identifies the requested data. The system mainly follows the Doppler Shift effect as a basic principle. The technique uses a unique scheme known as the *Forward Best REQuest (FORBEQ)* which forwards only the best packets into the data transmission link and discards the rest of the packets which avoids the excessive request flooding. The result of the technique is the QoS-MUDOR routing protocol. The results of the routing algorithm are the application of data sharing and focus on integrating QoS, flood minimizing by rebroadcasting 'best' packets and effectively finding the path which are stable and higher duration whilst also meeting QoS constraints. Though it meets QoS constraints it does not include the optimization of relative weights of QoS and Doppler values.

E. Aernautical Mobile Adhoc Network – ARPAM

The protocol proposed here is the Ad-hoc Routing Protocol for Aeronautical Mobile Ad hoc Networks (ARPAM) [7] and it is based on the AODV which is the multipurpose routing protocol for Air Ad Hoc Networks. The protocol uses a combination of multiple algorithms such as Data link layer selection algorithm, Distance vector protocol, Topology Dissemination Based on Reverse Path Forwarding (TBRPF) routing protocol. It also includes the combination of novel directional high bandwidth data link technology and Omni-directional VHF data links. The results of the ARPAM are providing stable and high performance behaviour for routing in aeronautical MANETs and exploitation of geo-localization information. However the simulation outputs forth complex network topologies can't be determine.

F. Airborne Internet

The Airborne internet [8] is the concept of multihop wireless mesh networking. The technique uses the Geographic routing protocol to access the geographical locations, load balancing techniques to balance the corresponding loads in the nodes in transmission link. The Airborne internet also used the Self organized Time Division Multiple Access (STDMA) to assign the time slots to the users. It follows the Direct Air to Ground (A2G) cellular network and Direct Air to Air (A2A) communication link. As a result it provides the ability to share total A2G bandwidth among all airborne users and the per-user throughput is reached close up to 90%. The use of highly directional antennas at Aircraft's flight level (35000ft) is very difficult.

G. AANET

The Aeronautical Ad Hoc Network (AANET) [10] is a novel geographical routing protocol. This protocol uses the technique of Automatic dependent surveillance- broadcast (ADS-B) system aided geographically routing protocol (A-GR) for AANETs which uses the position and velocity of aircrafts aided by airborne ADS-B system to avoid routing beaconing. The technology Cockpit Display of Traffic Information (CDTI) improves the ability of collision avoidance and situational awareness. The CBR protocol is used in the application layer to simulate aeronautical communication traffic. Thus resulting in decrease of routing

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overhead, improving the packet delivery ratio and end to end delay and also to make use of the network resources.

H. Route Stability based QoS Routing – RSQR

Route Stability based QoS Routing (RSQR) [13] protocol is an advanced version of QoS routing with throughput and delay constraints. Based on received signal strength the link stability and route stability is computed. For selecting a route extra fields are included in request or reply packets. The route recoveries required during QoS transmission is reduced. In on demand protocol the AODV is enhanced. By including some extra fields in route request/reply packets, the route stability information can be utilized to select a route with higher stability among all the feasible routes between a given source destination pair. Further, inclusion of a signal strength-based admission control enhances the performance of the routing. Thus results the performance improvement in packet delivery ratio, control overhead and average end to end delay in comparison with QoS routing protocol.

I. Optimal Routing Metric for Cognitive Radio ad hoc network – OPERA

Optimal Routing Metric for Cognitive Radio ad hoc network (OPERA) [14] algorithm is proposed which has two features (i) optimality: is combined with Dijkstra and Bellman-Ford based routing protocol (ii)Accuracy: It exploits the route diversity intermediate nodes to measure the end to end delay. A closed form expression of routing metric is analytically derived. The routing metrics for CRAHNs can be classified in two classes: a) the metrics originally proposed for multi-channel environments and then adapted to CR networks; b) the metrics specifically designed for CR networks. The routing metrics in the second class, namely, the metrics explicitly designed for CR networks, either they are not optimal, or they are not able to measure the actual path cost. A CR routing metric is defined as Optimal Primary-aware route quality (OPERA), with the objective to overcome both the issues mentioned above: un-optimality and un-accuracy. The results are measuring the actual end to end delay and to improve the benefits for adopting routing metric for cognitive radio ad hoc network.

J. Estimators

Link Quality Estimators [15] for Multi hop Mesh topology is a technique used to carry on the performance comparison between two adopted delivery ratio estimators in the mesh network and the estimators are (i) Simple Moving Average (SMA) and (ii) Exponentially Weighted Moving Average (EWMA) and Simple Un- Supervised Neuron Estimator (SUNE) which is proposed based on the neutral network paradigm. Link qualities allow the routing protocol to efficiently use the neighbours' data in the communication link. The successive and effective data transfer is based on the selection of reliably connected neighbours. Thus results reveal that performance of the estimators depend on the parameters, depend on novel techniques, and also based on neutral network paradigm like SUNE.

TABLE I. SUMMARY OF AIR ADHOC NETWORKS

S.No	Methodology	Advantages	Disadvantages
1	Multipath Doppler Routing (QoS-MUDOR)	Sufficient and efficient in a pseudo-linear highly mobile ad hoc network.	This approach focus on finding disjoint paths
2	Ad-hoc Routing Protocol for Aeronautical Mobile Ad hoc Networks (ARPM)	Proactive functions and an improved approach on the route maintenance.	It is difficult to ensure the stability of routing and end-to-end delay.
3	AeroRP, a cross-layered routing protocol for airborne telemetry applications.	AeroRP significantly outperforms, while limiting the overhead.	The protocol cannot meet the requirements of massive data transmission and real-time data communication due to network Delay & congestion
4	geographic load sharing strategy	Load sharing mechanism to approach the maximum theoretical throughput in the network.	It refers only to the distance or hops between nodes as parameters to find the shortest route.
5	OPERA- both Dijkstra and Bellman-Ford based routing protocols	Optimality has been proved rigorously, Improved Accuracy	It only gives a theoretical analysis without specific any QoS metric or analysis in specific application scenarios.
6	Automatic dependent surveillance-broadcast (ADS-B) system aided geographic routing protocol (called A-GR) for AANETs.	Decrease the routing overhead, improve the packet delivery ratio	Poor independence and complicated implementation process when the transmission data are massive.

III. CONCLUSION AND DISCUSSION

The above discussed algorithms, techniques and the protocols provide different ways for the data transmission in the Air Ad Hoc Network. Each technique is commercially utilized in the data transmission and based on the laggings and the disadvantages, the new algorithm or protocol or technique is proposed and developed to meet the needs of efficient aviation management system. In the data transmission of Air Ad Hoc Network inclusion of the reliability of the link, stability of the network and the reduction of re-routing frequency may be added into consideration in upcoming projects. In addition, protocols to improve the delivery ratio of packets in the link and to decrease the average packet, end to end transmission delay and control overhead should be designed.

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