Research Article

QoS Routing Protocols for Aeronautical Ad hoc Networks : a Survey

[1]Swapna Joshi, [2]Dr. Santosh Deshpande, [3]Dr. Ravindra Vaidya, [4]Dr. Manasi Bhate

1Research Scholar,
MES IMCC

2Director,
MES IMCC

3HOD, Dept. of MCA,
MES IMCC

4Head, T&P Cell,
MES IMCC

Article History: Received: 11 January 2021; Revised: 12 February 2021; Accepted: 27 March 2021; Published online: 23 May 2021

Abstract:: In Aeronautical ad hoc networks which is one of the family member of wireless ad hoc network and subset of MANET and VANET due to Some factors like high mobility, multi-hop communication and huge geographical area and therefore Quality of Service (QoS) routing is a critical issue. Some researchers have been done performance and comparison study to provide QoS assurances in AANET routing protocols. In current years some of QoS routing protocols with distinguishing capabilities were proposed for AANET .This paper presents a survey of some of these protocols which include a overview of all elements, evaluation parameters and recourses of QoS routing which can be affecting the performance.

Keywords: QoS ,AANET,routing protocols

Introduction:

Aeronautical ad hoc network (AANET) is highly dynamic mobile ad hoc network between aircrafts, which enables communion among ground station and air perceive information. Research study have showed that it is possible to set up a mobile ad hoc network among the aircraft thus providing a multi- hop communication link between the airliner and the ground base station. Compared with the normal ad hoc networks, the airliners in AANET move at a very high speed, typically 700km/h to 1000km/h [1]. So the multi-hop communications in AANET are extremely unbalanced due to the frequent network topology changes.

Airplanes are connected through wireless links to build a live and on-the-fly network called a Aeronautical Mobile Ad-hoc Network (AANET). The airplanes (nodes) communicate among themselves and act as both hosts and routers. Hence, maintaining appropriate Quality of Service (QoS) for AANETs is a complex task due to the dynamic behaviour of the network topology. Commonly, QoS for a network is measured in terms of the guaranteed amount of data which a network transfers from source to destination within specific time. The QoS is identified as a set of measurable pre-specified service requirements; such as delay, bandwidth, probability of packet loss, and delay variance (Jitter). The traffic types in aeronautical ad-hoc networks are quite different from other infrastructures and the use of wireless technologies in AANETs make the QoS approaches more complex.

Basically,Wireless ad hoc network is more and more utilized in the military aeronautical network communication domain, such as High Frequency Intra Task Force (HF-ITF) developed by the Office of Navy Research (ONR), its objective is quickly realizing interoperability between the navy and the air with lower cost. DARPA and Air Force Research Laboratory (AFRL) commissioned Rockwell Collins to be chargeable for the tactical focused on community technology (TTNT), to attain the speedy discovery of time touchy objectives and well timed attacking [2], [3]

Accordingly, such networks are annoying to have unique capabilities; i.e., independent architecture, allotted operation, multi-hop routing, reconfigurable topology, fluctuating hyperlink capacity, and mild weight terminals. Thus, several interesting issues can be technically involved when designing AANETs; such as security, routing, reliability, internetworking, and power consumption due to the shared nature of the high mobility ,Frequent topology change ,limited bandwidth,node density and Sparse distribution of the ground stations. Therefore, providing suitable QoS for delivery of real-time communications in AANETs is more challenging.

In this paper, we have provided the theoretical study of issues and challenges for QoS protocol in AANETs which have been found after study of previous research papers, we also presented routing protocols specially consider for AANET as it has been found that current routing protocols which are being used for MANET are not able to cope with AANETs environment.

ISSUES AND CHALLENGES FOR QOS PROTOCOL IN AANET

A. Mobility

There is a strong need for providing connectivity in aircraft, so that they can continuously communicate with other devices attached to the Internet, at any time and anywhere. However, the connectivity of the network may be frequently interrupted due to the excessive pace of aircraft [4] and sometime interrupted by weather, highly-dynamic wireless channel fluctuations as well as changing topology [5]. Hence, the network protocols of AANETs have to be more flexible The inevitable delay problems due to routing over large geographical distances and the connectivity troubles because of the frequent setup and breakup of verbal exchange hyperlinks amongst plane require extraordinarily strong answers to help excessive mobility.

B. Congestion

AANETs are intended for providing Internet access, it required all multi-hop traffic to flow through the GSs, gateway congestion may be caused at or among the aircraft near these Ground Stations. Moreover, by efficiently allocating flows, the traffic may be balanced amongst the gateways to avoid congestion as well as routing of packet in the network, the path between an aircraft and a gateway determines the service which is provided by the gateway to the aircraft. The approaches of Internet gateway allocation, routing and scheduling which minimizing the common packet delay within the network.

C. Threats

It is extremely critical to secure AANETs from every conceivable threat. Generally, the security threats to aircraft networks are internal and external ones. Internal safety threats originate from the in- cabin passenger community. On the other hand, the external security threat is caused by the security vulnerabilities of the communication links [7]. In the future, available radio spectrum will become more scarce. However, the signal transmissions in AANETs take place over A2A, A2G and A2S across airports, populated and unpopulated areas, each having different bandwidth requirements

D. Decentralized control:

The aeronautical network is set up spontaneously and all nodes may join or leave the network anytime. So there may not be any centralized control on the nodes which causes increased algorithm's overhead and complexity, as QoS state information must be disseminated efficiently.

E. Unpredictable channel:

The bit mistakes are the primary hassle which arises due to the unreliable wi-fi channels. These channels motive excessive bit blunders price and that is because of excessive interference, thermal noise, multipath fading effects, and so on. This ends in low packet delivery ratio.

F. Data Loss:

It refers when the data is loss or packet loss when the data is send from sender to receiver due to distortion.

G. Route Maintenance:

The maintenance of network state information is very difficult due to the frequent changes in the network topology and changing behaviour of the communication medium. During the data transfer process the predefined routing path may be broke so that it is become important to focus on maintenance and reconstruction of routing paths with minimal overhead and delay required.The QoS aware routing would require the reservation of resources at the intermediate nodes[8].

EVALUTION PARAMETERS FOR QOS ROUTING PROTOCOLS

As different applications have different requirements, the services required by them and the associated QoS parameters differ from application to application as per their service requirement. For example, in multimedia applications, bandwidth, delay and delay-jitter are the key QoS parameters, whereas military applications have stringent security requirement. The following is a sample of the metrics commonly used by applications to specify QoS requirement to the routing protocol.

A. Throughput –

In AANET throughput is defined as rate of how much data can be transferred from source to destination within a given timeframe over the wireless infrastructure and it is measured by how many packets arrive at destinations .Throughput generally measured in bits per second or data packets per second/per timeframe.

Throughput = Total packet received/ amount of forwarded packet over certain time interval

B. Dropped Packets –

Dropped packets are the number of packets that sent from the source node and unable to reach the destination node successfully.

Dropped packets = sent packets – received packets C.**Mean inter arrival time -**

- Mean inter-arrival time is the summation of inter-arrival times of packet divided by the number of received packets and can be computed by the following equation

av= (∑ai/n)

D. Average end to end delay-

End-to-end delay refers to the time taken for a packet to be transmitted across a network from source to destination.
The average end to end delay can be calculated by summing the times taken by all received packets divided by its total numbers.
Average E-2-E= ∑(received time-sent time)/∑(number of packets)

E. Jitter –

Jitter in ad hoc networks is the **variation in the latency on a packet flow between two nodes**, when some packets take longer to travel from one node to the other. Network congestion, timing drift and route changes may affect jitter.
The basic standard term is "packet delay variation" (PDV) which is an important quality of service (QoS) factor in evaluation of network performance.
Jitter (J)= Di+1 -Di where Di+1 is the delay of ith+1 packet and Di is the delay of ith packet.

F. Packet delivery fraction (PDF) –

Packet delivery fraction (PDF) can be measured as the ratio of the delivered packets at destination to the packets sent from the source node.
PDF= 100*(Number of received packets / Number of sent packets)

ROUTING PROTOCOLS IN AANETS:

After a lot of relevant survey of Adhoc networks,we observed that some traditional MANETs routing protocols are not effective to meet QoS implementation in AANETs due to its very high mobility of aircraft nodes and large geographical area.
So, there is a need to find out suitable routing protocols for these highly dynamic Ad-hoc networks. Here, we present some of the protocols which may be implemented in these networks.

Open Shortest Path First (OSPF):

Open Shortest Path First (OSPF) internet routing protocol which is designed based on link-state algorithm. OSPF is used to find the best path between the source and the destination router using its own Shortest Path First. OSPF is developed by Internet Engineering Task Force (IETF) which is one of the Interior Gateway Protocol (IGP), i.e, the protocol which aims at moving the packet within a large autonomous system. It is described as OSPF Version 2 in RFC 2328 (1998) for IPv4. If timer settings are reduced then there will be a decrease in packet loss during link failures. The overhead can also be reduced to meet out the problem of scalability.

Multi-Meshed Tree (MT) Protocol:

This approach is basically a combination of clustering, reactive and proactive routing schemes[9] . This protocol has been evaluated for strong connectivity amongst distinctly dynamic.This is hybrid approach of proactive Multi-Meshed Tree (MMT) and Reactive Multi-Mesh Tree (RMMT) is employed for inter-cluster routing. This protocol has outperformed other protocols in terms of success rate percentage, End-to-End packet latency, and file transfer delay.

Predictive-OLSR (P-OLSR):

This protocol makes use of GPS data available on board in aircraft which is able to track changes in highly dynamic network. For highly mobile Aircrafts Networks, geographic routing protocols can prove to be very successful as this GPS data can be obtained from airplanes. Some researchers proven that P-OLSR outperforms OLSR for frequent topology changes by the experimental and simulation results.

Reactive-Greedy-Reactive (RGR) Protocol:

Reactive-Greedy-Reactive (RGR) is a routing protocol designed for UAANETs. RGR covers both the characteristics of topology-based protocols and position-based protocols. RGR is a combination of AODV and GGF with no recovery strategy. This is a promising routing protocol for high mobility and dense scenarios. The concept of scoped flooding and mobility prediction will be used to improve the original RGR protocol [11].

AeroRP:

AeroRP is a geographic routing protocol that can be configured to run on one of three modes: ad-hoc mode, GS-location mode, and GS-topology mode. In addition, It has two parallel phases: neighbour discovery and data forwarding .This is another geographical protocol for highly dynamic networks for AANETs geographical information can be helpful for improved routing. AeroRP also is very helpful for improved accuracy, less delay and overhead, etc.

DREAM (Distance Routing Effect Algorithm for Mobility):

Here, the frequency of sharing of location information among the nodes is decided on the basis of inter-node distance and how fast the individual nodes are moving. More the nodes apart from each other, the less often position updates need to be shared. This way DREAM optimizes the rate of generation of control messages [12].

Location-Aided Routing (LAR):

It is also based on the concept of wedge zone which is referred to as the request zone as used in the DREAM.

This request zone is used to forward the route request instead of data packets[13, 14]. There are two different methods to decide if a node is in the request zone. In the first method, the sender sends a route request containing the coordinates of a rectangular area which has the request zone. A node receiving this request message will discard if it is not in the rectangle and forward if it is. In the second method, the request zone is not defined explicitly but instead, the packet is forwarded based on the distance between the sender and destinations nodes.

Optimized Link State Routing (OLSR):

OLSR is a proactive link-state protocol this routing protocol uses HELLO messages and topology control (TC) messages to discover neighbour node [14]. The HELLO messages are used to find out the neighbour nodes in direct connection (i.e. one hop). While Topology Control messages are used to build a topology information base. This protocol can be used for ad-hoc networks having bandwidth and neighbour mobility. OLSR uses the Multi-point Relay (MPR) technique to reduce control traffic overhead.

Conclusion

In this paper, we have presented a survey of QoS aware routing protocols for aeronautical mobile adhoc networks. A lot of research has been done in this field. However the different protocols discussed in the paper are very effective and useful for new researchers to identify topics for further research. The QoS routing in an ad hoc network is a challenging task due to inherent characteristics of such a network. Here, following point are covered in this paper:1) A review of the basic concepts and challenges of QoS routing in AANETs .2) evaluation metrics for qos routing protocols and 3**)** The classification of the routing protocols has been done. The protocols are selected in such a way so as to highlight many different approaches to QoS routing in AANETs, so as to explore the future areas of research. All the QoS routing protocols discussed above can further be explored in many prospective to improve their performance.

References

1. Jinhua Zhou, Lei Lei, Weikang Liu and Jiamin Tian, "A simulation analysis of nodes mobility and traffic load aware routing strategy in aeronautical ad hoc networks," *Proceedings of 2012 9th International Bhurban Conference on Applied Sciences & Technology (IBCAST)*, Islamabad, Pakistan, 2012, pp. 423-426, doi: 10.1109/IBCAST.2012.6177592.
2. H. Bobarshad, M. van der Schaar, A. H. Aghvami, R. S. Dilmaghani, and M. R. Shikh-Bahaei, ‘‘Analytical modeling for delay-sensitive video over WLAN,’’ IEEE Trans. Multimedia, vol. 14, no. 2, pp. 401–414, Apr. 2012.
3. C. Bauer and M. Zitterbart, “A survey of protocols to support IP mobility in aeronautical communications,” IEEE Communications Surveys & Tutorials, vol. 13, no. 4, pp. 642–657, Fourthquarter 2011.
4. S. Hayat, E. Yanmaz, and R. Muzaffar, “Survey on unmanned aerial vehicle networks for civil applications: A communications viewpoint,” IEEE Communications Surveys & Tutorials, vol. 18, no. 4, pp. 2624– 2661, Fourth quarter 2016
5. R. W. Kingsbury, “Mobile ad hoc networks for oceanic aircraft communications,” Master’s thesis, Massachusetts Institute of Technology, 2009.
6. N. Thanthry, M. S. Ali, and R. Pendse, “Security, Internet connectivity and aircraft data networks,” IEEE Aerospace and Electronic Systems Magazine, vol. 21, no. 11, pp. 3–7, November 2006
7. Amandeep Kaur ,Dr.Rajiv Mahajan,” Survey of QoS Based Routing Protocol for MANET’s”, International Journal of Advanced Research in Computer Science and Software Engineering, Volume 3, Issue 7, July 2013
8. Pudlewski, Scott, Nirmala Shenoy, Yamin Al-Mousa, Yin Pan, and John Fischer. "A hybrid Multi Meshed Tree routing protocol for wireless ad hoc networks", In 2008 5th IEEE International Conference on Mobile Ad Hoc and Sensor Systems, pp. 635-640, 2008.
9. Pardeep Kumar1* , Seema Verma” Routing Protocols in Airborne Ad-hoc Networks (AANETs): A Study”, International Journal of Computer Sciences and Engineering, Vol.-7, Issue-4, April 2019 E-ISSN: 2347-2693
10. Li, Yi, Marc St-Hilaire, and Thomas Kunz. "Improving routing in networks of UAVs via scoped flooding and mobility prediction", In 2012 IFIP Wireless Days, IEEE, pp. 1-6, 2012.
11. Basagni, Stefano, Imrich Chlamtac, Violet R. Syrotiuk, and Barry A. Woodward. "A distance routing effect algorithm for mobility (DREAM)", In Proceedings of the 4th annual ACM/IEEE international conference on Mobile computing and networking, pp. 76-84, 1998.
12. Ko, Young-Bae, and Nitin H. Vaidya. "Location-Aided Routing (LAR) in mobile ad hocnetwork.", Wireless networks Vol.6, Issue.4, pp. 307-321, 2000.
13. Su, William, Sung-Ju Lee, and Mario Gerla. "Mobility prediction and routing in ad hoc wireless networks", International Journal of Network Management , Vol. 11, Issue.1, pp. 3-30, 2001.

14. Clausen, Thomas, and Philippe Jacquet. "Optimized link state routing protocol (OLSR)" , No. RFC 3626, 2003.