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A Review on Unmanned Aeronautical Ad-hoc Networks

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ABSTRACT

One of the most substantial design consequences for multi-UAV (Unmanned Air Vehicle) systems is the communication which is essential for collaboration and cooperation within the UAVs. If all Unmanned Air Vehicle (UAV) systems are directly related to an infrastructure, i.e. a ground base and a satellite, the communication between UAVs can be noticed via the infrastructure. Since, this infrastructure depending communication architecture fixes the abilities of the multi-UAV systems. Ad-hoc networking between UAVs can solve the problems producing from a fully infrastructure depending UAV networks. In this paper, Flying Ad-Hoc Networks (FANETs) are reviewed in which an ad hoc network linking the UAVs. The FANET test beds and simulators are explained first, and then the significant FANET design issues are proposed. Open research issues are also discussed about, Along with the available FANET protocols.

I. INTRODUCTION

In UAANET, UAV is projected to participate as a self-conscious node and communicates with ground base and other UAVs. Thus, these networks show different characteristics with distinctive ad hoc networks in that information becomes available through in-UAV, UAV-to –UAV and UAV-to-ground, UAV-to-ship communications and also broadcast the signal to army radar. [1] With the help of these networks, traffic between UAVs can be spread and is considered to have improved scalability as well as reliability. Based on this property, the reqirement of UAV ad hoc networks increases due to an unprecedented increase in fuel costs , environmental pollution and air traffic. [1],[2]. The routing protocol design is challenging one for UAANETs because the UAVs are associated in three dimensional structures. One plane consists some of the UAVs ; another planes have some others. They are flying at dissimilar heights. So communication is taking place at different levels. The UAV transmission range has also be considered. The routing protocol is an essential one for good communication. The routing Topology-based protocols are routing protocols where the information about the links in the network is used in order to establish and maintain routes. [3] Among these topology-based protocols, we further distinguish proactive (e.g. Destination Sequenced Distance Vector (DSDV), Optimized Link State Routing Protocol (OLSR) [4], etc.), reactive (e.g. Ad-hoc on-demand Distance Vector (AODV) [5], [6], Dynamic Source Routing (DSR) [7], etc.) and hybrid (e.g. Zone Routing Protocol (ZRP) protocols.

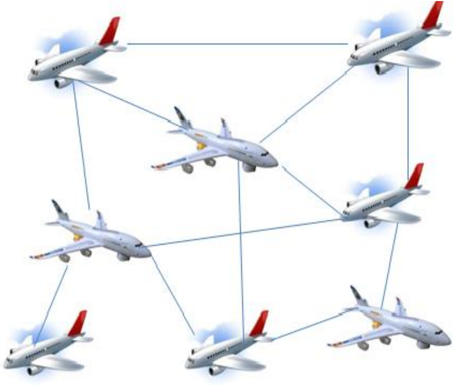

Figure 1: Unmanned Air Vehicle

II. LITERATURE REVIEW

Jean-Daniel Medjo Me Biomo.et al [1]: In this paper authors rely on simulation –based evaluation of entity mobility modals impact on routing performance. For the performance evaluation authors had taken NS2[32], NS3[33] and OPNET[34].The simulation parameters are as follows: no. of simulated nodes is 30,area length is 2000m ,area width is 4000m ,wireless transmission range is 1000m , packet size is 1024 bits, send rate of traffic is 5 pkts/s, speed is 50-6-m/s, pause time at simulation is 0s,simulation time is 1800s are used for the simulation of the routing protocols.After the simulation result authors conclude that that the upper bound for PDR for routing protocols is tend to is about 99.2% based on the result of flooding.

Yi Li, Marc St-Hilaire et al [2]: In this paper authors reports enhancing RGR routing protocol for unmanned aeronautical ad-hoc networks for the performance evaluation authors had taken OPNET modeler 16.0.[17] after the similuation result authors conclude that they reduce the protocol overhead by about 30 percent while at the same time increasing PDR by about 3.5 percent and reducing packet latency.

Stefano Rosati .et al [3]: Here in this paper authors compare two different dynamic routing for flying ad-hoc networks for the performance evaluation authors had taken OPNET for simulation results .In their work they compare two different routing algorithm for ad-hoc networks : OLSR and P-OLSR their emulation and experimental result show that P-OLSR significantly outperforms OLSR in the routing in the presence of frequent network topology changes.

Rostam Shirani et.al[4]: Here , in this paper authors outperformance the delay performance of Reactive-Greedy-Reactive Routing in Unmanned Aeronautical Ad-Hoc Networks. For the performance evaluation authors had taken OPNET Modeler 16[17].In their work they used such mobility parameters for an UAANET in a tracking mission are summarized as,in a tracking mission ,UAVs changing sapped based on a uniform distributed in the range of [17,20]m/s for low speed,[36,40]m/s for medium size, and [55.60]m/s for high speed respectively[16].They use 0 pause time and start time and stop time is 1000sec.The results illustrate that when the no. of UAVs is high enough in a searching mission to form a connected UAANET,RGR performs well but not for highly dense tracking mission or very sparsh searching missions.

Nanxiang Shi et al[5]: In this paper authors propose a Novel Cluster –Based Location Aided Routing Protocol for UAV Fleet Networks. For the performance evaluation authors had taken OPNET Modelor.In their work they used such simulation parameters are as follows. They used MANET as a network model, MAC protocol IEEE802.11, pause time 0 sec with channel capacity 2Mbps. They carry short transmission range as 500m, long transmission range as 1200m with simulation time 600 sec. After the simulation result authors conclude that the Cluster –Based Location Aided Routing Protocol for UAV Fleet Networks outperforms PSR and GRP significantly in successful delivery ratio and average end to end delay, as well as in scalability and dynamic performance, which make it more suitable to be applied in UAV Fleet Networks.

Naveen et al[6]: Here , in this paper authors surveyed the concept of Flying Ad-Hoc Network. One of the most important design problems for multi-UAV system is the communication which is bad for co-operation and collaboration between the Austin this paper , FANET is surveyed; the main design issues and challenges are also discussed. In this paper that described the most challenging task that is communication between the multi-UAVs. They also discuss the difference between FANET and other Ad-Hoc Network types in terms of mobility, node density, topology change, radio propagation model, power consumption , computational power and localization.

III. FANET Test Beds And Simulators

In this section, the existing FANET test beds and simulators are investigated to p5. FANET test beds and simulators. In this section, the existing FANET test beds and simulators are investigated to provide a quick guideline for new FANET researchers.

One of the first FANET test beds was implemented in University of Colorado [32]. It was developed and realized with IEEE 802.11b radio equipment mounted on small UAVs with Fidelity-Comtech bidirectional amplifier up to 1W output and a GPS. Dynamic Source Routing (DSR) was chosen as the network protocol, and a monitoring system was embedded into the radios for detailed performance characterization and analysis.

Berkley Aerobot Team (BEAR) [98] is another multi-UAV test bed that can support UAV-to-UAV communication. BEAR research facility features a fleet of BEAR helicopter UAVs, fixed-wing UAVs, unmanned ground robots, and a mobile ground station. Rotorcraft-based Unmanned Aerial Vehicles (RUAVs) in BEAR include 802.11 wireless network cards that can be used for FANET. Xiangyu et al. developed a new multi-UAV system based on ad hoc networking architecture [99]. The multi- UAV system successfully validated the effectiveness and feasibility of wireless ad hoc networking between UAVs. Sensing Unmanned Autonomous Aerial Vehicles (SUAAVE) project [26] aims to create and control a UAV swarm with ad hoc networking between UAVs. The project is not limited with a particular scenario, but the platform was developed based on a search-and-rescue operation.

Although the first examples of the project were planned with IEEE 802.11 protocol, SUAAVE can be used to develop new communication architectures and protocols for UAV swarms. The

UAV Research Facility (UAVRF) [100] conducts UAV related researches at Georgia Institute of Technology. The UAVRF operates different multi-UAV systems and conducts flight tests to validate research findings. Christmann et al. developed a FANET implementation with IEEE 802.11 communication hardware in UAVRF [101]. The above-mentioned multi-UAV test beds are designed to work in outdoor conditions. In order to create a more controlled environment for rapid prototyping and initial tests, there are also indoor test beds. Indoor multi-UAV test beds are designed to test UAV perfor-mances in restricted and controlled large rooms. The Aerospace Controls Laboratory at MIT utilizes a UAV test bed facility, Real-time indoor Autonomous Vehicle test Environment (RAVEN) [102]. RAVEN uses a motion capture system to enable rapid prototyping of aerobatic flight controllers for helicopters and airplanes; robust coordination algorithms for multiple helicopters; and vision- based sensing algorithms for indoor flight. General Robotics, Automation, Sensing, and Perception (GRASP) [103] is another indoor test bed developed in University of Pennsylvania. It is developed to support research on coordinated, dynamic flight of micro UAVs with broad applications to reconnaissance, surveillance, manipulation and transport.

Another way to investigate FANET designs is to simulate the developed algorithms with a realistic multi-UAV system simulator which can support ad hoc networking. Although there are many multi-UAV simulators, most of them do not model UAV-to-UAV communication links. Real time multi-UAV simulator (RMUS) [104], which is designed to work with IEEE 802.11, is one of the first multi-UAV simulators that support the direct communication links between UAVs. It is implemented as both a testing and validation mechanism for the real demonstration of multiple UAVs conducting decentralized data fusion and control [105].

A Simulator and Test bed for Micro-Aerial Vehicle Swarm Experiments (Simbeeotic) [106] is proposed as an open source simulator in Harvard University for UAV swarms that consist of up to thousands of mini or micro UAVs. It can simulate the physical movements of the UAV swarm as well as the communication architecture between UAVs. It is possible to develop algorithms and rapid prototyping with Simbeeotic. It supports both pure simulation and hardware-in-loop experimentation. Simbeeotic can cover a complete view of the UAV swarm system, including actuation, sensing, and communication.

Open research issues

Although the existing multi-UAV test beds and simulators can support a certain variety of UAVs, they enable very restricted variety of network protocols, like IEEE 802.11. On the other hand, the existing network simulators, such as OPNET [107] and ns-2 [108], can simulate different communication protocols with different parameters. However, they cannot readily model multi-UAV system specifications and mobility structures. Although there are several FANET researches simulated on OPNET, it has no built-in UAV node structure or UAV communication channel model to simulate FANETs. ns-2, which is one of the common network simulators, cannot model 3D communication, which is an important parameter for FANET design [51]. In order to simulate new FANET designs, a multi-UAV simulation tool that can simulate various UAV platforms and network protocols is needed. The FANET simulator must be able to model different UAV specifications, different multi-UAV formations, different multi-UAV mobility structures, along with different network protocols.

IV. The RGR Protocol

The RGR protocol is a new routing protocol for UAANET based on AODV and GGF. RGR is similar to AODV till a forwarding node faces a broken link. Through forwarding node, we received a data packet and trying to send it to the packet’s next hop (these nodes are also called Intermediate Nodes). In AODV, when the next hop is out of reach (broken link), we have two choices: first, if local repair is not enabled, the data packet is dropped. Second, when local repair is enabled, the FN holds the packet and broadcasts an RREQ to “repair” the broken link. Finally, it will send the data packet using the newly repaired or re-established route. In the case of RGR, when the FN faces a broken link(unreachable), it switches to the GGF mode, instead of executing local repair like in AODV. The GGF here works as follows: the FN computes its own distance to the DN beside the distance to the same DN of all its current neighbors. If there is a neighbor that is closer to the DN than the FN, the FN forwards the data packet to that neighbor. If there is no such a neighbor, the data packet is dropped altogether.

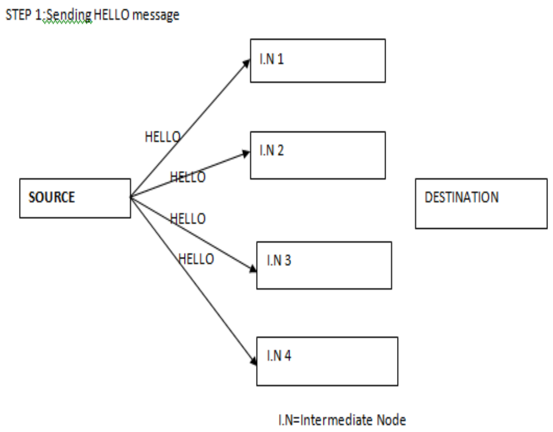

Figure2: Sending HELLO message

When the neighbor node receives the data packet, it checks for a route to the DN established by means of the reactive part of the protocol. If it does, the data packet is forwarded using that path; and if it does not, then it shifts to GGF too and so on. This strategy gives the data packet a second opportunity to be transmitted without obtaining additional overhead costs (due to new local path discovery with local repair as in AODV). In RGR, dissimilar in GGF protocol in general, the nodes location information is pickaback onto control messages from the Reactive mode in order to be propagated to other nodes in the GGF mode for distance calculation purposes. Therefore, no location service is required. A few enhancements for the original RGR were also developed, resulting in protocol variety called mpRGR, sf1mpRGR, and sf2mpRGR.

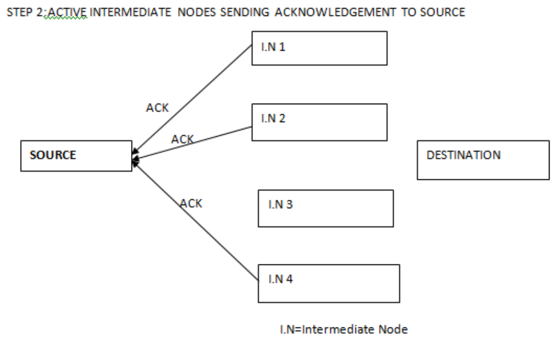

Figure 3: Sending ACK. Message

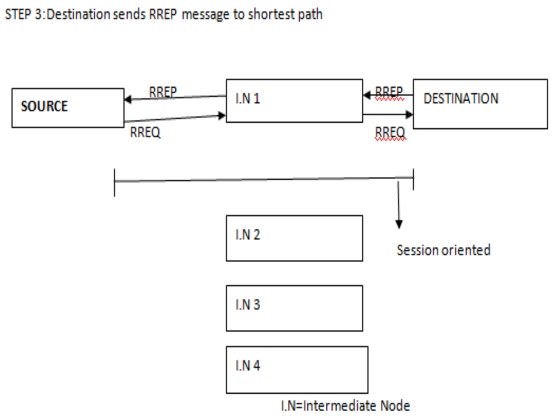

Figure 4: Destination sends RREP

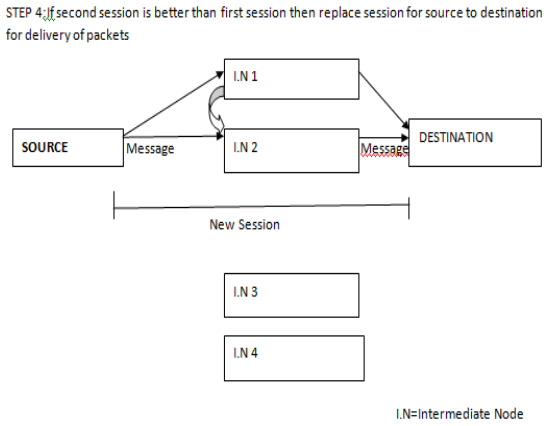

Figure 5: Replacement of sessions

CONCLUSION

Communication is the most significant design issues for multi-UAV systems. In this paper, ad hoc networks among UAVs are reviewed as a different network family i.e. Flying Ad-hoc Network (FANET). We define FANET and explain various FANET application scenarios. We also speak about the differences between FANET and other ad hoc network sorts in terms of mobility, node density, configuration change. FANET design conditions are also investigated as latency, scalability and adaptability. We extend a comprehensive survey of the recent literature on FANETs and its related challenges in a layered mechanism. furthermore, we also talk about open research issues for FANETs, with the cross-layer designs. The usable FANET test beds and simulators are also explained.

REFERENCES

[1] Jean-Daniel Medjo Me Biomo and T. Kunz, “A Survey on Geographic Routing Protocols for Mobile Ad hoc Networks,” Technical Report SCE-

11-03, Department of Systems and Computer Engineering, Carleton University, Ottawa, Canada, October 2011.

[2] Y. Li, R. Shirani, M. St-Hilaire, and T. Kunz, "Improving Routing in Networks of UAVs: Reactive-Greedy-Reactive," Wireless Communications and Mobile Computing, vol. 12, no. 18, pp. 1608-1619, December 2012. DOI: 10.1002/wcm.2333.

[3] Stefano Rosati, and V. Davies, "A Survey of Mobility Models for Ad Hoc Network Research," Wireless Communication and Mobile Computing, vol. 2, no. 5, pp. 483-502, October 2002.

[4] R. Shirani, M. St-Hilaire, T. Kunz, Y. Zhou, J. Li, and L. Lamont, "The Performance of Greedy Geographic Forwarding in Unmanned Aeronautical Ad-hoc Networks," in Proceedings of 9th Annual Conference on Communication Networks and Services Research Conference (CNSR 2011), pp. 161-166, May 2011.

[5] Nanxiang Shi, "Reactive-Greedy-Reactive in Unmanned Aeronautical Ad-hoc Networks: A Combinational Routing Mechanism," Master's Thesis, Carleton University, Canada, August 2011.

[6] Naveen, M. St-Hilaire, and T. Kunz, "Improving Routing in Networks of UAVs: Reactive-Greedy-Reactive," Wireless Communications and Mobile Computing, vol. 12, no. 18, pp. 1608-1619, December 2012. DOI: 10.1002/wcm.2333.

[7] Z. Haas and M. Pearlman, "The Performance of Query Control Schemes for the Zone Routing Protocol," ACM/IEEE Trans. Net., vol. 9, no. 4, pp. 427–38, August 2001.

[8] Y. Wan, K. Namuduri, Y. Zhou, D. He, and S. Fu, "A Smooth-Turn Mobility Model for Airborne Networks," in Proceedings of the first ACM MobiHoc workshop on Airborne Networks and Communications, ACM, pp.25-30, June 2012.

[9] T. Camp, J. Boleng, and V. Davies, "A Survey of Mobility Models for Ad Hoc Network Research," Wireless Communication and Mobile Computing, vol. 2, no. 5, pp. 483-502, October 2002.

[10] Y. Wan, K. Namuduri, Y. Zhou, and S. Fu, "A Smooth-Turn Mobility Model for Airborne Networks," IEEE Transactions on Vehicular Technology, no. 99, 2013

[11] J. Xie, Y. Wan, K. Namuduri, S. Fu, G. Peterson, and J. Raquet, "Estimation and Validation of the 3D Smooth-Turn Mobility Model for Airborne Networks," in Proceedings of Military Communications Conference (MILCOM 2013), 2013.

[12] Y. Ko and N.H. Vaidya, "Location-Aided Routing (LAR) Mobile Ad Hoc Networks," in Proceedings of ACM/IEEE Mobicom, pp. 307-321, October 1998.

[13] M. Aparna, M. Reza, P. Sahu, and S. Das, "An Efficient Approach Towards Robust Routing in MANET," in Proceedings of International Conference on Communication Systems and Network Technologies, 2012

[14] R. Thakur, S. Sharma, and S. Sahu, "Accumulating Path Information in AODV for Ad-Hoc Network," in Proceedings of International Conference on Computational Intelligence and Communication Systems, 2011

[15] Mou Zonghua and Meng Xiaojing, "A Modified AODV Routing Protocol based on Route Stability in MANET," in Proceedings of 4th IET International Conference on Wireless, Mobile & Multimedia Networks (ICWMMN2011), pp. 63-67, 2011.

[16] Zhao Qiang and Zhu Hongbo, "An Optimized AODV Protocol in Mobile Ad Hoc Network," in Proceedings of 4th International Conference on Wireless Communications, Networking and Mobile Computing (WiCOM '08), October 2008.

[17] E. Kranakis, H. Singh, and J. Urrutia, "Compass Routing on Geometric Networks," in Proceedings of 11th Canadian Conf. Computational Geometry, pp. 51–54, August 1999. Networking (MOBICOM-00), 2000.

[18] R.Suganthi "Unmanned Aerial Vehicles Classification," www.vectorsite.net/twdrn.html, [Accessed: September 2013].

[19] M. Mauve, J. Widmer and H. Hartenstein, "A Survey on Position Based Routing in Mobile Ad-hoc Networks," IEEE Network Magazine, vol. 15, no. 6, pp. 30–39, November 2001

[20] H. Frey and I. Stojmenovic, "On Delivery Guarantees of Face and Combined Greedy-Face Routing in Ad Hoc and Sensor Networks," in Proceedings of ACM MobiCom, September 2006

[21] E. Hyytia, P. Lassila, and J. Virtamo, "Spatial Node Distribution of the Random Waypoint Mobility Model with Applications," IEEE Transactions on Mobile Computing, vol. 5, no. 6, pp. 680–694, June 2006.

[22] E. Kranakis, H. Singh, and J. Urrutia, "Compass Routing on Geometric Networks," in Proceedings of the 11th Canadian Conference on Computational Geometry (CCCG'99), pp. 51–54, August 1999.

[23] B. Karp and H. T. Kung, "GPSR: Greedy Perimeter Stateless Routing for Wireless Networks," in Proceedings of the 6th ACM/IEEE Annual International Conference on Mobile Computing and

[24] Ilker Bekmezci ,S. Corson and J. Macker, "Mobile Ad hoc Networking (MANET): Routing Protocol Performance Issues and Evaluation

Considerations, RFC2501," www.ietf.org/rfc/rfc2501.txt, [Accessed: June 2013].

[25] M. Alenazi, C. Sahin, and J. Sterbenz, "Design Improvement and Implementation of 3D Gauss-Markov Mobility Model," in Proceedings of the 48th International Telemetering Conference (ITC), October 2012

[26] V. Tolety, "Load Reduction in Ad Hoc Networks Using Mobile Servers," Master's thesis, Colorado School of Mines, CO, USA, 2010

[27] "ns-2," the NS Manual, http://www.isi.edu/nsnam/ns/doc, [Accessed: August 2011].

[28] "The ns-3 Network Simulator," http://www.nsnam.org, [Accessed: July 2009].

[29] "OPNET, Application and Network Performance," http://www.opnet.com, [Accessed: August 2011].

[30] J. Ariyakhajorn, P. Wannawilai, and C. Sathitwiriyawong, "A Comparative Study of Random Waypoint and Gauss-Markov Mobility Models in the Performance Evaluation of MANET," in Proceedings of International Symposium on Communications and Information Technologies (ISCIT), October 2006.

[31] C. Perkins and P. Bhagwat, "Highly Dynamic Destination Sequenced Distance Vector Routing (DSDV) for Mobile Computers," Comp. Commun. Rev., pp. 234–44, October 1994.

[32] T. Clausen and P. Jacquet, "Optimized Link State Routing Protocol, RFC3626," http://www.ietf.org/rfc/rfc3626.txt, [Accessed: June 2013].

[33] E. Perkins, C. Belding-Royer, and S. Das, "Ad Hoc On-Demand Distance Vector (AODV) Routing, RFC3561," http://www.ietf.org/rfc/rfc3561.txt, [Accessed: May 2012].

[34] J. Johnson, Y. Hu, and D. Maltz, "The Dynamic Source Routing Protocol (DSR) for Mobile Ad Hoc Networks for IPv4, RFC4728," http://www.ietf.org/rfc/rfc4728.txt, [Accessed: July 2012].

[35] F. Kuhn, R. Wattenhofer, and A. Zollinger, "Worst-Case Optimal and Average Case Efficient Geometric Ad-Hoc Routing," in Proceedings of the 4th ACM International Symposium on Mobile Computing and Networking (MobiHoc 2003), 2003.

[36] B. Leong, S. Mitra, and B. Liskov, "Path Vector Face Routing: Geographic Routing with Local Face Information," in Proceedings of the 13th IEEE International Conference on Network Protocols (ICNP 2005), 2005.

[37] Q. Fang, J. Gao, and L. J. Guibas, "Locating and Bypassing Routing Holes in Sensor Networks," in Proceedings of IEEE INFOCOM 2004, March 2004.

[38] F. Bai and A. Helmy, "A Survey of Mobility Models in Wireless Ad-Hoc Networks," Chapter 1 in Wireless Ad-Hoc Networks, Kluwer Academic, 2006