

Effective and Secure Communication System for Aircraft Ad-hoc Network (AANET)

Vivek Kumar¹, Sanjay Kumar²

¹M.Tech-CSE, Uttarakhand technical University, Dehradun, India

²Assistant professor, Uttarakhand technical University, Dehradun, India

Abstract: Ad hoc network technology is play a great role in communications between aircrafts. Aircraft ad hoc networks are defined as self organizing networks where airplane works as node. Ad-hoc network is dynamic network which can be created anywhere with just two basic nodes and does not require any centralize infrastructure. Simulation study is one of key research area by providing simulation scenarios through software. Through the simulator, we can evaluate and validate of the proposed protocol and network architecture for AANET. In this paper, we proposed a development issue on the architecture simulator is based on Matlab. We propose that any available receiver would be able to trace the plane. A new protocol is proposed to meet out the challenge. System modelling technique proposed in has been taken into consideration for aircraft ad hoc network. To design the relevant model, we implement that In case Aircraft loses its basic communication with ATC it can communicate with any available network including Army network which can operate at very low and very high Altitude also. Over the sea where radars fail it can communicate with the any nearby ships sailing and also with the satellite in case there is no Ship in the range. The model developed by Matlab will be presented to validate its operation by diverse experiments.

Keywords: AANET, Ad-hoc, Manet, Vanet, Matlab

1. Introduction

Wireless ad hoc networks are classified according to their utilization, deployment, communication and mission objectives [8]. By definition, AANET is a form of MANET, and there are many common design considerations for MANET and AANET. In addition to this, AANET can also be classified as a subset of VANET, which is also a subgroup of MANET [1-2]. As an emerging research area, AANET shares common characteristics with these networks, and it also has several unique design challenges.

Taking an idea from VANET and moved by disappearing of Malaysian Airlines a new approach has been propagated. A Plane due to its altitude and speed is hard to trace during trying conditions in such a scenario it is proposed that any available receiver would be able to trace the plane. A new protocol is proposed to meet out the challenge. System modelling technique proposed in has been taken into consideration. In RF model energy and distance plays a major role. The nodes here are smart nodes or we can say they are cognitive nodes since it is a Mobile Ad-hoc network no centralized nodes are required. A very simple approach is adopted where an Aircraft sends and receives signals from ATC and also communicates with nearby Aircrafts and any in-the-range network. This helps the aircraft to stay on its course and also avoid any air collision as it has information of all the nearby networks. In case Aircraft loses their basic communications with ATC it can communicate with any available network including Army network which can operate at very low and very high Altitude also. Over the sea where radars fail it can communicate with the any nearby ships sailing and also with the satellite in case there is no Ship in the range. All in all a very robust system has been proposed where loss of communication is near impossible [11].

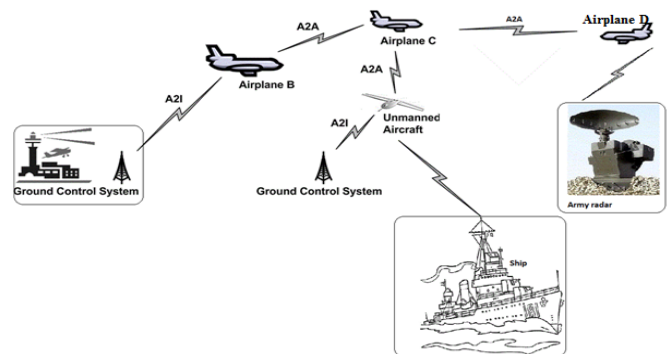


Figure 1: AANET scenarios showing the Aircraft communication

Software Design

In this section, we describe the software architecture that is software providing an artificial re-creation of aircraft flight and various aspects of the flight environment [4-5]. When a corresponding event occurs, event is notified to our display software. And, new software is used to create simulation scenarios by providing user interface.

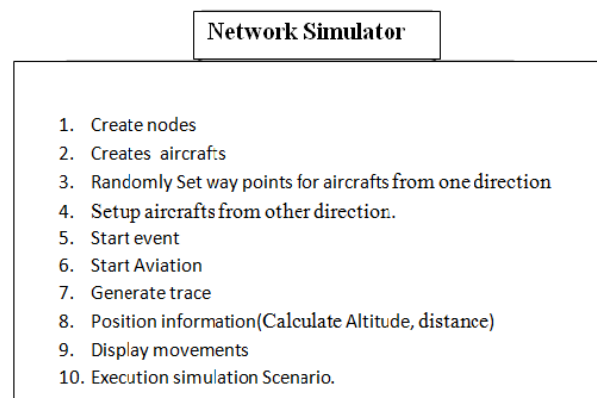


Figure 2: Software architecture and the order of interaction

2. Design for New Simulator

2.1 Problem Definition

Even above current simulators contains simulation models for MANET and VANET, AANET model is not provided by them yet. Thus, if we want to evaluate the performance of proposed scheme, it is required to extend current simulator or develop a new simulator, respectively. Our approach is the former because of low cost for development as well as many documents[6]. For development, we basically choose Matlab because it is very flexible architecture and scalable for many scenarios. Moreover, since Matlab also provides mechanism to specify node positions and mobility, it is easy to create diverse model for many aircrafts. The details for important components are discussed in the following subsections. Figure.2 illustrates our simulator framework based on Matlab and relationship between new components. New modules supply the flight-related information to the main network protocol stack simulation.

2.2 Framework

Proposed idea frame work is completely design in MATLAB.

2.2.1 MATLAB

Matlab stands for Matrix Lab provided by Math Works Inc. USA. The core of Matlab is Mathematica (once a very popular Mathematical software) Now let's see what Matlab is and what all it has [9]. It helps us in

- Math and computation.
- Algorithm development.
- Data acquisition.
- Modelling, simulation, and prototyping.
- Data analysis, exploration, and visualization.
- Scientific and engineering graphics
- Application development, including graphical user interface building All these are achieved by various tools available in Matlab.

2.3 MATLAB Desktop Tools and Development Environment

This is the set of tools and facilities that help you use MATLAB functions and files. Many of these tools are graphical user interfaces .It includes the MATLAB desktop and Command Window, a command history, an editor and debugger, a code analyzer and other reports, and browsers for viewing help, the workspace, files, and the search path.

(i)The MATLAB Mathematical Function Library

This is a vast collection of computational algorithms ranging from elementary functions, like sum, sine, cosine, and complex arithmetic, to more sophisticated functions like matrix inverse, matrix eigen values, Bessel functions, and fast Fourier transforms (FFT, DFT).

(ii)The MATLAB Language

This is a high level matrix/array language with control flow statements, functions, data structures, input/output, and object- oriented programming features. It allows both "programming in the small" to rapidly create quick and dirty throw-away programs, and "programming in the large" to create large and complex application programs. We get .m files which are open source.

(iii)Graphics

MATLAB has extensive facilities for displaying vector sand matrices as graphs, as well as an notating and printing these graphs. It includes high-level functions for two-dimensional and three dimensional data visualization, image processing, animation, and presentation graphics. It also includes low-level function s that allows you to fully customize the appearance of graphics as well as to build complete graphical user interfaces on your MATLAB applications.

(iv)MATLAB External Interfaces

This is a library that allows you to write C and FORTRAN programs that interact with MATLAB. It includes facilities for calling routines from MATLAB (dynamic linking), calling MATLAB as a computational engine, and for reading and writing MAT-files.

Who is MATLAB Useful for proposed methodology? It is my big concern for tachometric coordinates and exponential relationship between proposed energy signal Vs conventional energy signal. Matlab is easily handle tachometric coordinates and exponential function by simple mathematic for localization and energy conservation

For localization we plot XY axis and put up the value of X and Y in this axis by Matlab coordinates mathematic code and also all other function like standby battery, node authentication, and energy distribution are plotted in GIU interface. A graphical user interface (GUI) is a graphical display that contains devices, or components, that enable a user to perform interactive tasks. To perform these tasks, the user of the GUI does not have to create a script or type commands at the command line. Often, the user does not have to know the details of the task at hand[10]. The GUI contains

- An axes component
- A pop-up menu listing three data sets that correspond to MATLAB functions: peaks, membrane, and sinc
- A static text component to label the pop-up menu
- Three buttons that provide different kinds of plots: surface, mesh, and Contour

Each component, and the GUI itself, is associated with one or more user-written routines known as callbacks. The execution of each callback is triggered by a particular user action such as a button push, mouse click, selection of a menu item, or the cursor passing over a component. You, as the creator of the GUI, provide these callbacks.

3. Implementation of Interface

The Matlab software provides an artificial re-creation of aircraft flight and various aspects of the flight environment. Under the architecture, a user can place multiple aircrafts at anywhere. And then, the position of this aircraft is converted to corresponding position on software. After configuration for waypoint of aircraft and speed is done, actual movement is achieved on the Matlab in a way automatic aviation [4]. The position information of aircraft on Matlab is traced and then converted to corresponding format for simulator. As a result, realistic mobility model is achieved by using the actual model for aircraft and environment.

For the topology configuration, we simulate on Matlab. The main function of this component is to perform the followings such as creating the flight plans and recording or monitoring a flight. In Figure 2, we make simple interface for software such as Connect, Create Node, Start Simulation, Stop Simulation, and Create Mobility Model. The details are as followings.

Create Node: makes node in software.

Connect: connects crafts via ad-hoc network.

Start and stop simulation: indicates to start aviation.

Create Mobility File: makes the corresponding mobility file where default is set to Matlab.

Setup: aircrafts from one direction and other direction.

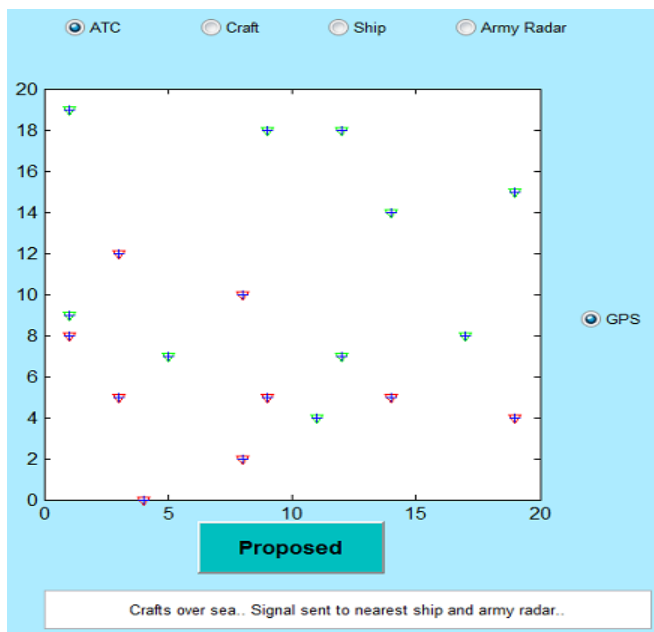


Figure 3: Software Interface

After this job is completed, a message is displayed and position information is consecutively display without regard to movement in Figure 3. Set up waypoint of each aircraft. In Figure 4, user interface is developed through Matlab. After deciding the final waypoint, the simulation scenario is completely established. As you can see in Figure 4, both altitude and distance are automatically computed. In Figure 3, a user can create a new aircraft on the software, related information to the altitude and distance is determined. A new

position of the aircraft is set by locating a point in software and all nodes indicate the number of aircraft [4].

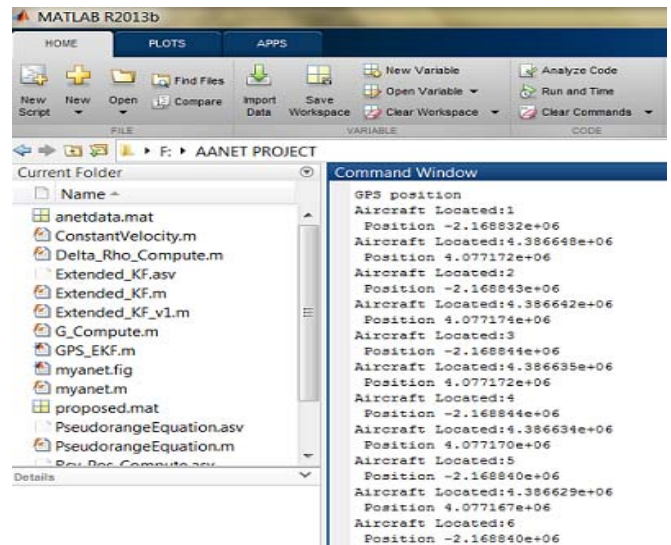


Figure 4: Receiving data from simulator

In parallel with recording the position of each aircraft, this information is passed back to software by display the position information. To display the position, passed raw position is converted to new location on the software. Finally, recorded position information is converted to corresponding format which is required in each simulator. To create new file, a user can select the type of simulator and start above procedure. As a result, a new mobility file is created.

4. Simulation Setup

Initialize required variables

For $I \leftarrow 1$ to 10

Setup aircrafts from one direction

End for

For $i \leftarrow 11:20$

Setup aircrafts from other direction

End for

Begin:

Step1. if protocol matches

Step2. for $i \leftarrow 1$ to .20

Step3. Calculate Altitude of the plane

% for simulation random value is taken

$alt \leftarrow \text{round}(50 * \text{rand}(1));$

Step4. Calculate distance

% for simulation random value is taken

$distance \leftarrow \text{round}(100 * \text{rand}(1));$

Step5. $reqenergy \leftarrow 0.5 * \text{rand}(1);$ % energy required

Step6. $reqbw \leftarrow 3 * (\text{rand}(1));$ % bandwidth required

Step7. Repeat steps 3 to 5 for second plane

Step8. $\partial d \leftarrow \text{abs}(b1.distance - b2.distance)$ %distance between two planes

Step9. $\partial h \leftarrow \text{abs}(b1.height - b2.height)$ %height between two planes

Step10. $\partial b1.bw \leftarrow b1.bw - reqbw$ % update bandwidth

Step11. if alt is greater than 30

```

Step12. if  $\Delta d$  is greater than 20
Step13. if  $\Delta h$  is greater than 100
Step14. Communicate with nearby air craft
Step15. Store log
Step16. else
Step17. Warning1  $\leftarrow$  'Diff in Height of Crafts too less..'
Step18. endif
Step19. else
Step20. Warning2  $\leftarrow$  'Crafts too close..'
Step21. update log
Step22. endif
Step23. else
Step24. Crafts over sea..send signal to nearest ship and army radar..'
Step25. Store log
Step26. endif
Step27. endfor
Step28. for  $i \leftarrow 1$  to 20
Step29.  $\Delta bal\_en \leftarrow bal\_en + b(i).energy$ ;
Step30.  $\Delta bal\_bw \leftarrow bal\_bw + b(i).bw$ ;
Step31. endfor
Step32. endif

```

5. Conclusion and Further Works

The primary objective of this paper is to understand in-depth and analyze the problem of communication in wireless sensor networks. Communication is one of the most challenging design issues for multi-Crafts systems. In which, the AANET promises applications that can significantly benefit next generation air transportation systems. Our security analysis focused on information assets that could impact airplane operation, airplane maintenance and air traffic control and provided AANET design considerations are also investigated as adaptability, scalability, latency, and bandwidth. For the further works, a new routing protocol mentioned in discussion section will be studied and developed. Also, other issues for realistic mobility model such as avoiding crash remains.

Thus this airborne internet technology has a wide range of utilities in the field of aviation services like aircraft monitoring and air traffic management, weather information etc., and also provides an opportunity for the passengers to access the internet at very high altitudes that is, in the aeroplanes and other conventional services. This new technology has already begun creating splashes in the industry. With the advent of Airborne Internet the remote sections of the world may get into main frame development. However, the technology still has to undergo testing of potential network performance. Facility to increase the antennas to control the traffic needs to be provided. Economic feasibility of the project also needs a review. Thus it is a further new trend in this mobile world which is establishing the connectivity by building network in the air.

Acknowledgement

I would like to thank **Mr. Sanjay Kumar** for taking the effort to act as my guide and for code review and for their

valuable comments, and also for providing every facility and help whenever I approached them with my problems.

References

- [1] Airborne Networking, Wikipedia, http://en.wikipedia.org/wiki/Wireless_ad-hoc_network.
- [2] Airborne Ad Hoc Networks, <http://www.csse.monash.edu.au/~carlo/adhoc.html>.
- [3] K. I. Kim and K. C. Park, "Design of movement scenarios for aircraft ad hoc networks", Proceedings of International Conference on Advanced Software Engineering & Its Applications (2012) November, 28-30, Jeju, Korea.
- [4] Ki-Il Kim, "An Architecture to Generate Realistic Mobility Trace through Verified Flight Simulator", International Journal of Software Engineering and Its Applications Vol. 7, No. 2, March, 2013.
- [5] Ki-Il Kim, "Automated Generation of Movement Trace for Aircraft Ad Hoc Networks", INNOV 2012: The First International Conference on Communications, Computation, Networks and Technologies.
- [6] Ki-Il Kim and SeUng Hyeon, "Development of Simulator for Aircraft Ad Hoc Networks", 2011 IEEE.
- [7] IETF Mobile Ad Hoc Working Group Charter.
- [8] Matlab, <http://www.mathworks.in/help/aerotbx/flight-simulator-interfaces.html>.
- [9] Matlab, <http://www.mathworks.in/help/aeroblks/flight-simulator-interfaces.html>.
- [10] Vivek Kumar¹, Arti Rana², Sanjay Kumar³, "Aircraft Ad-hoc Network (AANET)", International Journal of Advanced Research in Computer and Communication Engineering, Vol. 3, Issue 5, May 2014.

Author Profile



Vivek Kumar has received his degree in bachelor of technology in Information Technology from Uttarakhand Technical University, Dehradun in (2008-2012). At present he is pursuing Master of Technology in Computer Science & Engineering from Uttarakhand Technical University in (2012-2014).