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Wireless War Field Communication Using UAV's

R.Gowtham
M.E Embedded system Technologies
SNS College of Engineering
Coimbatore, gowthamece34@gmail.com
Dr.P.Gnanasundari
Professor/ECE
SNS College of Engineering
Coimbatore, mail id: sundaribalakrishna@yahoo.co.in

Abstract

UAV is which an aircraft with no pilot on board is. UAVs can be remote controlled aircraft or can fly autonomously based on pre-programmed flight plans or more complex dynamic automation systems. UAVs are currently used for a number of missions, including reconnaissance and attack roles. For the purposes of this article, and to distinguish UAVs from missiles, a UAV is defined as being capable of controlled, sustained level flight and powered by a jet or reciprocating engine. In addition, a cruise missile can be considered to be a UAV, but is treated separately on the basis that the vehicle is the weapon. The acronym UAV has been expanded in some cases to UAVS (Unmanned Aircraft Vehicle System). The FAA has adopted the acronym UAS (Unmanned Aircraft System) to reflect the fact that these complex systems include ground stations and other elements besides the actual air vehicles. The war field communication system required infrastructure less networking between the mobile station and base station. However GSM, satellite and RF communication need infrastructure to establish a network, where it is not possible to install and also it will bring loss as it destroyed. So using UAV for wireless communication will be an alternative method to increase the clarity of communication, mobility and also low cost then other methods.

Keywords: wireless; UAV; network;aerial;RF;warfield

Introduction

The techniques of aircraft conceptual design have come a long way over the first century off light. The design algorithms advocated by modern textbooks are distillations of a vast body of collective engineering experience and are underpinned by a wealth of design, manufacture and flight data. However, the knowledge base that lies at their foundation, though very broad, is inevitably biased towards the aircraft categories that form the bulk of today's commercial and military fleets and the workflows of these design processes are also better suited to certain applications than to others. One of the roads less well traveled is the design of unmanned air systems and this is our main motivation here. Although Unmanned Air Vehicles (UAVs) go back almost as far as aviation itself, they only account for a fairly small proportion of the combined design effort of the aircraft industry over the past decades and this is reflected to some extent in our current ability to conduct effective UAV conceptual design studies.

Design Challenges

A. Design Metrics of UAV

The first UAV-specific challenge of conceptual design – the more limited availability of historical data – can have a significant impact on the initial steps of most current design algorithms. Tradition ally, these preliminary sizing techniques have a strong statistical bent and, inevitably, the data that they are based on is mostly related to manned aircraft. Although correction factors can go some way towards mitigating, inaccuracies can still arise. For example, it is not obvious how much weight penalty is accrued by designing an airframe to accommodate a pressurized cockpit, doors, crew escape systems, air conditioning systems, active and passive safety elements, landing gears (which some UAVs do not have), etc like design in figure 1.

Another difficulty lies in the vast design space UAV designers tend to have at their disposal. Consider, for example, the category of High Altitude Long Endurance (HALE) UAVs. The Northrop Grumman RQ-4A Global Hawk, the Aurora Flight Sciences Theses and the Scaled Composites Proteus, although designed to have similar endurance values (24-36h) and similar service ceilings (65-82,000 ft), have entirely different airframes. Conversely, if the task is to design, say, a 120-passenger,short to medium-range airliner, with a cruising speed of Mach 0.8, different airframes designed to this specification will show little variation, both in terms of external surface and internal structure(compare the leaders in this market segment, the Boeing 737-600, the Airbus 318 and the Embraer195). The reasons are manifold – one could speculate on the relative contributions of factors such as the difference in maturity of the two industries, different constraints (particularly on fuselage shapes), multiple possible launch and recovery solutions for UAVs, less stringent certification criteria for UAVs, etc. Whichever of these reasons has the greatest impact, the fact remains: the different feasible concepts in UAV design generally outnumber those the designers of manned aircraft have to consider.

B. Operational States

The reassigned UAV is the boundary object whose relationship with the reassignment task is the most evident, since it suffers state modifications explicitly associated with the task execution. The reassigned UAV may be in one of the three states presented below:

- State 1: surveillance state -the state the UAV is in when it is executing regular surveillance, searching for contacts.
- State 2: transiting state - the state the UAV is in when going from one region to another (being reassigned, following the reassignment route).
- State 3: non-steady state -the state between surveillance and transiting (or vice-versa), a state in which velocity, altitude and routes are changing.
- State 4: backup state –the state where the UAV power down or might not in the position to provide communication or no contact service yet to provide release connection and provide alternate connection.

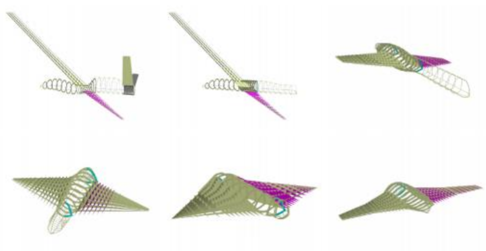

Figure 1: Design of UAV

Wireless Communication

One 'portable' wireless set issued for use by the infantry required the operator to strap an accumulator to his back and the wireless apparatus on his chest. He also needed the active assistance of two comrades: one to walk 50ft in front, and the other 50ft behind, carrying the necessary length of antenna wires. There was also work on developing wireless-guided torpedoes and even pilotless aircraft, a forward-facing development that arguably anticipated 2014's unmanned aerial vehicles (UAVs).

Table 1: RF Frequency Allocation

Name	Frequency range	Applications
Low frequency	30 to 300 kHz	Navigation, time standards
Medium frequency	300 kHz to 3 MHz	Marine/aircraft navigation, AM broadcast
High frequency (shortwave)	3 to 30 MHz	Broadcasting, mobile radio, amateur radio
Very high frequency	30 to 300 MHz	Landmobile,FM/TVbroadcast,amateurradio
Ultra-high frequency	300 MHz to 3 GHz	Cell phones, mobile radio, WLAN, personal-area networks (PANs)
Super-high frequency	3 to 30 GHz	Satellite, radar, backhaul, TV
Extremely high frequency	30 to 300 GHz	Satellite, radar, backhaul, experimental

The ultra high frequency is used for creating PAN network with the solider in the high dense or hostile environment as many as 20-100 connections can be created. Modulation techniques such as
Amplitude modulation (AM)

- Double-sideband modulation (DSB)
  - Double-sideband modulation with carrier (DSB-WC) Double-sideband suppressed-carrier transmission (DSB-SC)
  - Double-sideband reduced carrier transmission (DSB-RC)
- Single-sideband modulation (SSB, or SSB-AM)
  - SSB with carrier (SSB-WC)
  - SSB suppressed carrier modulation (SSB-SC)
- Vestigial sideband modulation (VSB, or VSB-AM)
  - Quadrature amplitude modulation (QAM)
  - Angle modulation,
  - Frequency modulation (FM)
  - Phase modulation (PM)

all the modulation techniques are considered, except frequency modulation in order to avoid local oscillator and also reducing the complexity in the frequency conversion without leading to more noise in the message signal.

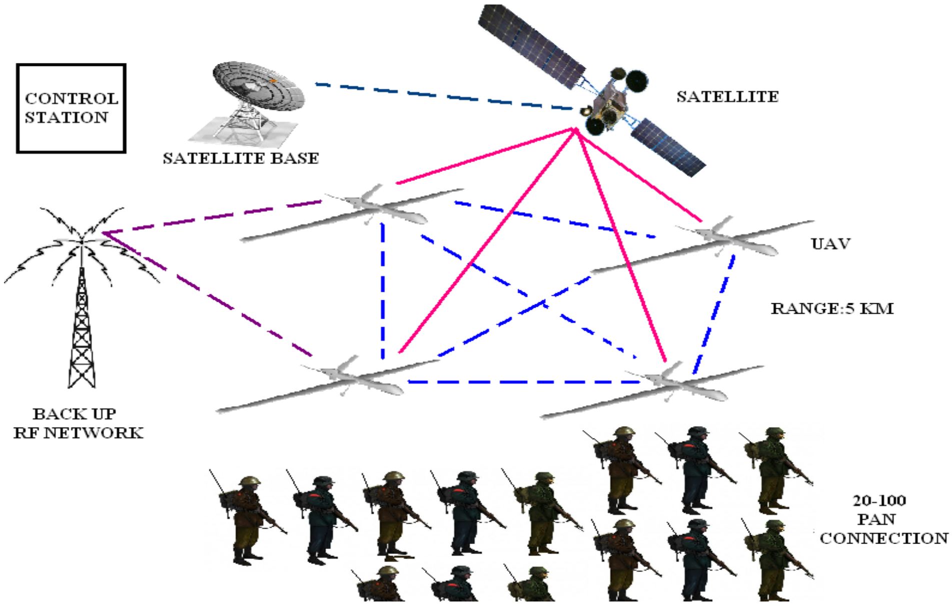

Figure 2: Network Architecture

A. Personal Area Network

A wireless personal area network (WPAN) is a personal area network — a network for interconnecting devices centered on an individual person's workspace — in which the connections are wireless. Wireless PAN is based on the standard IEEE 802.15. The two kinds of wireless technologies used for WPAN are Bluetooth and Infrared Data Association.

A WPAN could serve to interconnect all the ordinary computing and communicating devices that many people have on their desk or carry with them today; or it could serve a more specialized purpose such as allowing the surgeon and other team members to communicate during an operation.

A key concept in WPAN technology is known as "plugging in". WPAN-equipped devices can be communicated (within several meters of each other) or within a few kilometers of a central server is the control room through RF frequency. Another important feature is the ability of each device to secure out from other devices, preventing needless interference or unauthorized access to information.

The technology for WPANs is in its infancy and is undergoing rapid development. Proposed operating frequencies are around 2.4 GHz in digital modes. The objective is to facilitate seamless operation among home or business devices and systems. Every device in a WPAN will be able to plug into any other device in the same WPAN, provided they are within physical range of one another as in figure 2.

A wireless personal area network (WPAN) is a PAN carried over wireless network technologies such as:

- INSTEON
- IrDA
- Wireless USB
- Bluetooth
- Z-Wave
- ZigBee
- Body Area Network

Most commonly zigbee are used for frequency of 250MHz and the can able to work few meter apart from the UAV's.

B. Satellite Communication

Satellites support both "fixed applications" because the terminals on the ground are in fixed locations, and "mobile applications" where the terminals can be fixed, or in motion such as on a vehicle, a ship or even an airplane. Demand for both FSS and MSS is growing rapidly and the distinction between the two is becoming blurred as each is now serving the other's traditional markets. MSS can use several frequency bands, but has historically relied on L-band and S-band frequencies which facilitate terminal designs. It has happened with FSS, MSS applications are moving to higher frequencies such as Ka-band frequencies of 26.5–40 GHz as capacity demands increase. However there is privilege to the military purpose.

Satellite is an ideal primary form of connectivity in a remote location. It takes weeks, sometimes months, to get a terrestrial broadband connection installed. So, it's better to use some dynamic mobile station for a dynamic environment.

It can act as an excellent back up option in places where the quality of terrestrial access such as RF is unreliable and/or poor. Satellite back up ensures UAV's are connected to the Intranet when the primary terrestrial access is unavailable for short periods of time.

C. Signal linking and combiner

Small Aperture Terminal (VSAT) refers to a earth station linked to satellite using RF link and usually will have different diameter antennas. VSATs provide the important communication link to set up a satellite based communication network. VSATs can be used for voice, data, or video transmission and reception. The VSAT comprises of two modules viz. an outdoor unit and an indoor unit. Outdoor unit mainly housesAntenna, feed horn, RF Transceiver, LNA, Power amplifier.

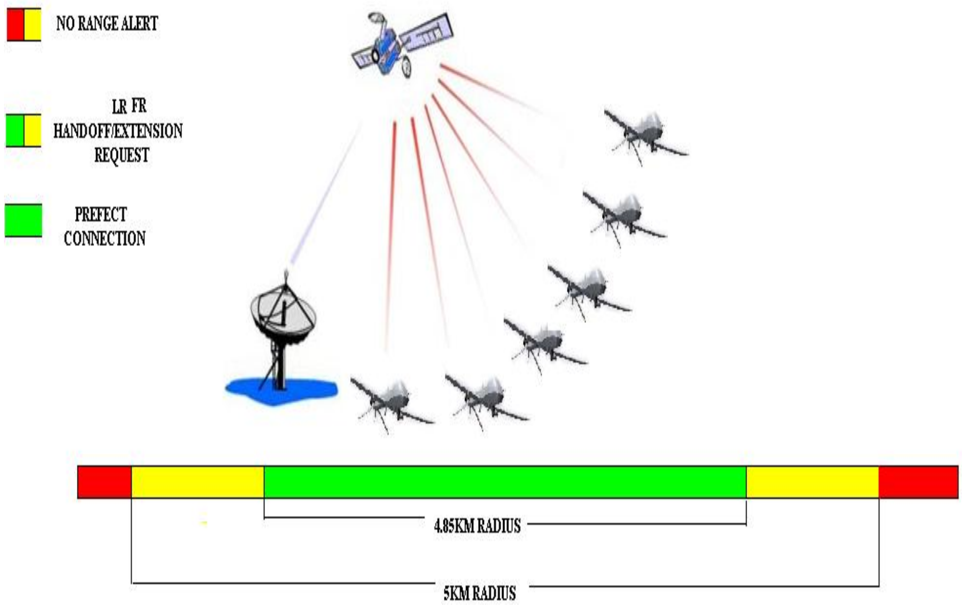

Figure 3: Handoff /Extension of UAV's

The antenna size is typically 1.8 or 2.4 meter in diameter, as in figure 3,although smaller antennas are also in use. The indoor unit functions as mux-demux, modem and interfaces with the end user equipments like PCs, LANs, Telephones or an EPABX. As in figure 4 describes typical schematic consisting various VSAT subsystems.

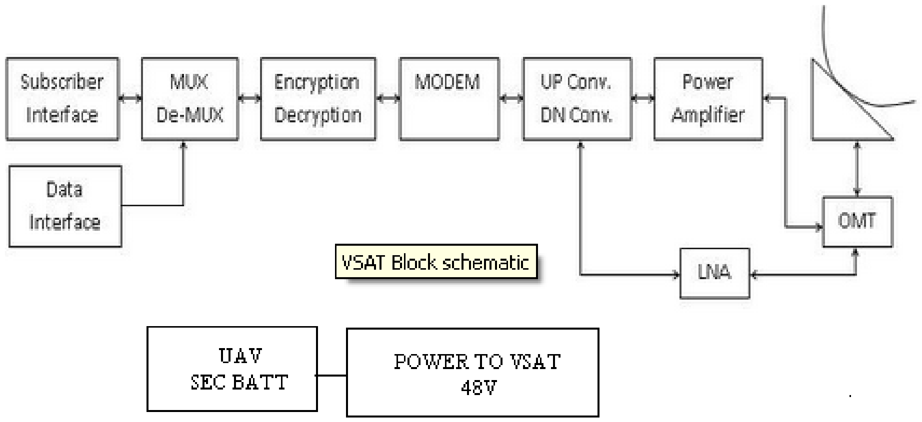

Figure 4: Outdoor Unit on UAV'S of VSAT

D. Outdoor and Indoor Modules of Vsat

The Up/Down converters convert frequencies IF to RF frequencies and vice versa. For example, Up converter converts 70MHz to 6175 MHz and Down converter converts 3950MHz to 70MHz for C band application. As in figure 4, Power Amplifier will amplify the signal before transmitting to the feed horn of the Antenna system. LNAs are designed to amplify the noise added received signal received from the satellite. It is designed such that it will amplify the signal and not the noise. Noise temperature defines LNA performance. Antenna system houses reflector, feed horn, mount and cables. VSAT antenna usually varies from 1.8 meters to 2.4 or 3.8 meters. Feed horn is mounted at focal point of the antenna below the UAV's. The feed horn guides transmitted power towards the antenna dish and will go to the medium consecutively. It also collects the received power from dish and will enter into the LNA. Feed horn is made of array of microwave passive components. The outdoor unit is connected through zigbee to the indoor unit, which is situated inside the bag of the solider.

The IDU consists of MUX/DEMUX, EDU (Encryption Decryption Unit), modem (modulator-demodulator).

MUX will interface with end user equipments viz. telephone, computers and sometime with EPABX and LAN or router, if it has to carry more information. MUX will multiplex all the channels connected with it using TDM. On receiver side DEMUX is used to de-multiplex the channels and passed on to respective end user equipments. EDU is basically the Encryption-Decryption unit which provides security by modifying the information to be transmitted.

On receiver side encryption technique will be conveyed so that the information can be retrieved back again. MODEM is basically performs modulator-demodulator functionality on transmit and receive side respectively. Modulator inserts information on intermediate frequency (IF), usually called carrier. This is done based on modulation scheme set.

QPSK scheme is used in satellite communication and Forward Error Correction is also employed in modem which enhances the BER for the same transmitter power usually used in non-FEC systems. In order to communicate between VSAT 1 and VSAT 2, modulator frequency of VSAT 1 and demodulator frequency of VSAT 2 need to be same and vice versa to complete full duplex communication channel. Based on frequency assignments as per FDMA various modem and RF frequency converters are set.

E. Zigbee Based Pan

ZigBee as a protocol does not typically change channels. Bluetooth, like some other wireless technologies, is a channel-hopping protocol and some believe that channel-hopping is required for reliability. Not so.

Due to the robust nature of O-QPSK and DSSS, 802.15.4 radios are very robust, even in a noisy RF environment. In fact, tests performed at the ZigBee Alliance with WiFi turned up to maximum on all channels, did not cause ZigBee to lose even one packet, over a series of thousands of data requests. Occasionally there were some retries, but not a single packet was dropped.

In any ZigBee device wishing to join a network must scan all channels, and be able to join any network on any channel. If the profile is a private profile, it may choose to limit the device to one or any set of the 16 available channels.

But scanning channels does take time. When forming a network, ZigBee performs two scans:

- Anenergydetectscan
- An active scan

The energy detect scan is used to determine which channels are the quietest. The active scan sends out a Beacon Request, and is used to determine what other ZigBee or 802.15.4 PAN IDs are currently in use on that channel within hearing range of the radio. By default, ZigBee chooses the channel with the fewest networks, and which is the quietest (in that order).

Only the active scan (detecting other networks) is used when joining a network. If a network is already formed, and the Beacon Response can be heard by the joining node, it is assumed that the channel is quiet enough for communication.

The scan duration is defined by 802.15.4 specification, and is an integer between 0 and 14. See Table 53—MLME-SCAN.request parameters in the 802.15.4 specification for details. Since the value is used in a formula involving super frame duration, I've converted those times to milliseconds for your convenience (see Table 2).

Table 2: Zigbee Channel Scan

Value	Scan Duration (ms)	Value	Scan Duration (ms)
0	3 1	8	3,948
1	46	9	7,880
2	77	10	15,744
3	1 38	11	31,473
4	2 61	12	62,930
5	5 07	13	125,844
6	9 98	14	251,674
7	1,981		

In the Free scale platform, both channel selection and scan duration are fully under application control. The defaults for these are properties that can be set in Bee Kit. The channels are defined by m Default Value of Channel_c in Application Conf. h, and the scan duration by gScanDuration_c in BeeStackConfiguration.h. The defaults are channel 25 and scan duration 3. Each platform will have its own way of defining the channel set and scan duration.

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