Broadband Communications for Aircraft in Oceanic and Other Remote Areas

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ABSTRACT

Data communication with aircraft presents unique technical challenges and these challenges are more pronounced when the aircraft are travelling over oceanic or other remote areas. When in populated areas, systems are available that can support high speed data services, one Gigabit per second (Gbps) and beyond via terrestrial ground stations. However, no such systems exist to provide airborne communications with high bandwidths among aircraft and between aircraft and the ground in more remote regions. Passengers will expect data service on the aircraft similar to what they typically experience on the ground. Multimedia activities, such as video streaming, are very bandwidth intensive and the provision of these services presents a serious technical challenge. On the ground, fibre optic cables are the method of choice for the provision of high speed data service, and in contrast, an airborne high speed data communications solution will need to be a wireless one.

Keywords: Aeronautical Oceanic Communications, Aeronautical Satellite Communications, Air to Ground (ATG) Communications, Airborne Broadband, High Speed Data Communications

INTRODUCTION

This paper will examine the problems and solutions related to providing aircraft with broadband communications services over the ocean or in remote areas. This paper is a continuation of the themes discussed in an earlier paper entitled “Future trends in spectrum management and technology choices for broadband aeronautical communications” by Stephen Curran. The earlier paper proposed a solution for broadband communications for aircraft suitable when aircraft are in range of terrestrial ground based systems, using a proposed radio communications standard referred to as Long Term Evolution (LTE)-Advanced (Curran, 2013). This technology requires ground stations which cannot be technically or cost effectively located over oceans or in remote areas of the globe. This paper will review the current literature on airborne broadband communications and examine techniques that may be suitable for the

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provision of data service on board aircraft in these more remote regions. Satellite and mesh type networks will be discussed and evaluated.

PROBLEM STATEMENT

What solutions exist to provide broadband service to aircraft over the ocean or in remote areas and what bandwidth can be provided by these solutions?

LITERATURE REVIEW

The issue of improving the bandwidth between air and ground has been addressed in several papers. Future bandwidth requirements per aircraft have been estimated to be in the region of 375 Megabits per second (Mbps) per 300 passenger aircraft (Buchter, 2012). An overhead of 25 Mbps could be added to account for aircraft telemetry and other aircraft (non-passenger) generated specific data giving an overall average bandwidth requirement of 400 Mbps per aircraft.

One proposed solution for an Airborne Communications Network (ACN) contains three main elements; photonic high capacity communications links, hybrid photonic/RF diversity networking and High Altitude Platform Stations based ACN to internet connectivity (Buchter, 2012). The proposed mesh solution uses laser ground stations to transmit information optically to balloons in the high atmosphere. From there the balloons would relay the data traffic via laser to the large aircraft.

Past implementations of airborne satellite platforms at L-band frequencies suffered from low-data rates, lack of available spectrum, and high costs. More modern satellite systems have been launched that use higher frequency parts of the spectrum band that have more available bandwidth as shown in Figure 1. These newer Ku- and Ka-band commercial satellite solutions help to eliminate the issues of the L-Band systems (Losada, 2011).

One of the main challenges that must be overcome in any airborne implementation is the fact that the antenna is on board an aircraft in motion, at speeds of up to 600 miles per hour. As the aircraft is moving dynamic re-pointing is necessary to track the satellite (Losada 2011). A Ku band antenna systems with a mechanically steered dish would have a dish diameter in the region of 0.65m, the antenna should track the satellite during movement of the aircraft at an angle speed of up to 25 degrees per second and have pointing error no more than 1 degree (Tyurin, 2007).

In 2010 Hughes demonstrated their HX satellite system that used a low profile mechanical antenna and achieved a 2 Mbps sustain data rate during test flights (Arnold, 2010). This system testing included the aircraft banking to simulate an aircraft in flight. The solution worked but the data rate of 2 Mbps is very low, compared to our target data rate of 400 Mbps.

An alternative to a mechanically tracking antenna is a phased array. A phased array is an electronically steered antenna, allowing the antenna to be physically stationary (PN Designs, 2011). A stationary antenna eliminates the mechanical tracking problems associated with a traditional satellite antenna. Research on a phased array concluded that a Ku-band

Figure 1. Satellite band plan (Maritime Telecom, 2014)
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