Future Trends in Spectrum Management and Technology Choices for Broadband Aeronautical Communications

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ABSTRACT

The aircraft of the future will have an increased need for airborne communications among aircraft and between aircraft and the ground. Communications will include traffic such as on board passenger generated internet traffic, aircraft telemetry and information on air traffic control and weather. The likely data requirements are such that the data generated by passengers will be far greater than the aircraft generated data traffic. Passengers will expect data service on the aircraft similar to what they typically experience on the ground. Multimedia activities such 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 Communications, Aeronautical Spectrum, Air to Ground (ATG) Communications, Airborne Broadband, Long Term Evolution (LTE)

INTRODUCTION

This article will examine the problems and solutions related to providing aircraft with broadband communications services. The paper will review the current literature on broadband communications and with this research targets can be defined for future data usage on board aircraft. A brief review of current and planned methods of providing aeronautical high speed data connections will be presented. The current spectrum allocated to aeronautical communications will be defined, as will the services that use each spectrum band. The availability of extra spectrum resources or the sharing of the spectrum within these bands will be discussed. The last step will be to try and evaluate different communications technologies, how suitable technologies could accommodate aviation’s future bandwidth requirements and consider the requirements of competing stakeholders for the limited amounts of spectrum available.

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Currently aviation has a set of dedicated frequencies in which various services are allocated. For example Air to Ground and Air to Air communications occupy one particular segment of the frequency band, Radar and Air navigation services occupy a different distinct segment. Aeronautical spectrum has a significant allocation of spectrum allocated exclusively for aeronautical use. As well there are portions of the spectrum referred to as white space. White space is the name given to the various gaps and odd pieces of spectrum remaining, in addition to the dedicated spectrum that current users have been allocated. An explanation of the technology that can be used to take advantages of these white spaces and other spectrum available is also a key discussion point.

**PROBLEM STATEMENT**

Is it possible to provide broadband service to aircraft that is in the order of two orders of magnitude greater than current data systems and what spectrum and technology are required to achieve this?

**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, with a breakdown of estimated usage detailed in Table 1 (Buchter, 2012).

<table>
<thead>
<tr>
<th>Data Usage</th>
<th>Number of Users</th>
<th>Approx. Average Data Rate</th>
<th>Weighted Data Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-mail, web browsing, social networking</td>
<td>25%</td>
<td>1 Mbps</td>
<td>0.25 Mbps</td>
</tr>
<tr>
<td>Multimedia (streaming video etc.)</td>
<td>10%</td>
<td>10 Mbps</td>
<td>1 Mbps</td>
</tr>
<tr>
<td>Average per passenger</td>
<td></td>
<td>1.25 Mbps</td>
<td></td>
</tr>
<tr>
<td>Average per 300 seat aircraft</td>
<td></td>
<td>375 Mbps</td>
<td></td>
</tr>
</tbody>
</table>

375 Mbps is proposed as an average traffic load per standard wide body 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. This nominal requirement of 400 Mbps per aircraft will be used as an input data traffic assumption throughout this paper.

One proposed solution for an Airborne Communications Network (ACN) contains 3 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 solution uses laser ground stations to transmitting information optically to balloons in the high atmosphere. From here the balloons would relay the data traffic also via laser to the large aircraft.

ZTE is a Chinese communications equipment vendor and in their white paper *LTE ATG Coverage* the current Long Term Evolution data network technology for operation of Air to Ground (ATG) communications is described (ZTE, 2013). The system operates in the aeronautical band between 962 MHz and 977 MHz (just above the GSM900 cellular Downlink band of 925 to 960 MHz) and 1037 to 1057 MHz. The ZTE paper addresses and explains the key technical issues such as how to handle communications with a jet travelling up to 800 kilometres per hour at an altitude of up to 13 km.

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