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ORBITAL MONITORING OF AUTOMATIC DEPENDENT SURVEILLANCE – BROADCAST (ADS-B) SIGNALS FOR IMPROVED AIR TRAFFIC SURVEILLANCE IN REMOTE AND OCEANIC AIRSPACE

Abstract

The continuing increase in commercial aviation traffic has prompted airspace authorities to take measures to increase the capacity and ensure the safety of flight in increasingly crowded airspace such as the North Atlantic region. Current radar surveillance cannot track aircraft beyond sight of land, requiring traffic over the ocean to use inefficient and imprecise procedural techniques to provide separation. These techniques require the use of standardized waypoints for ocean-crossing aircraft, lengthening their flights compared to great-circle routes with resulting increases in flight time, fuel consumption, and engine emissions. Provision of continuous surveillance in this airspace would address these issues. Such a system could also be used over land areas without existing radar coverage, for example in northern Canada and large areas of Africa, Asia, South America, and Australia.

As a potential source of continuous surveillance, orbital monitoring of Automatic Dependent Surveillance – Broadcast (ADS-B) signals is proposed and investigated. In ADS-B, currently being adopted by airspace authorities worldwide, aircraft continually transmit encoded signals containing their identity and position information, derived from onboard navigation systems. Experimental work is described which successfully demonstrated reception using a stratospheric balloon of ADS-B signals sent over the 1090 MHz Extended Squitter system. A model is developed of the signal propagation from aircraft to satellites in various orbits, including atmospheric effects. The resulting power level at the orbital altitude is used to determine the net receiver gain needed to reliably detect the signals from orbit. The effect of signal collisions is modeled and resulting design parameters determined. A model of the effect on detectability of signal collisions is developed and resulting design parameters determined. ADS-B signals are concluded to be detectable with a gain of 0-5 dB from LEO and 30 dB from GEO orbits, for aircraft populations of up to 4000 in the sensor's field of view.

The potential for a satellite system to implement ADS-B based surveillance is discussed. The greater accuracy of ADS-B based navigation over procedural separation could allow an increase in airspace traffic capacity, while improving safety and efficiency. Due to the international and intercontinental nature of the flights being monitored, the global view of the satellite sensors, and the existing international co-operation in air traffic control, any future implementation of spaceborne ADS-B sensors is expected to benefit from, and lend itself to, international co-ordination.