Abstract

Automatic Dependent Surveillance-Broadcast (ADS-B) is part of the Federal Aviation Administration’s (FAA’s) “Next Gen” air traffic control architecture. Aircraft equipped with ADS-B equipment can “see” all other ADS-B equipped aircraft on a cockpit display in relation to their own position (range, bearing, altitude, heading and airspeed). Aircraft so equipped have much improved situational awareness as pilots know where to look to meet their own “see and avoid” responsibilities. A high altitude balloon equipped with an ADS-B beacon automatically broadcasts it’s position (generally once a second) both to nearby aircraft and to the FAA air traffic control system where it can be seen “on the glass” by controllers. This has the potential to greatly facilitate effective communications with the FAA during balloon flight operations resulting in enhanced safety to the public. With appropriate connections to FAA systems, balloon flight operations personnel will also receive real-time 3D position and velocity vectors.

There are two different ADS-B systems currently in use by commercial and private aviation. The first of these is the 978 MHz Universal Access Terminal (UAT). This system is primarily used by general aviation (GA) aircraft. The second ADS-B system is the 1090 MHz Mode-S Extended Squitter (ES), primarily used by commercial aviation. Signals from either of these systems can be received by the FAA and seen by air traffic controllers at the Air Route Traffic Control Centers (ARTCCs). The 1090ES system is also in wide use in Europe and other parts of the world. 978UAT equipment has an inherent issue that must be resolved before it is a candidate for high altitude balloons. Due to the shorter length of the rigidly formatted broadcast messages, the maximum reported altitude is 100,300 ft after which the reported altitude “rolls over” and starts again at zero ft (MSL). 1090ES equipment does not have this limitation.

There was some concern regarding use of ADS-B equipment at very high altitudes. At altitudes typically flown by high altitude balloons, an ADS-B equipped balloon will be visible from a number of Ground Based Transceivers (GBTs) operated by the FAA. These GBTs subsequently send collected ADS-B signals into the air traffic control system and re-broadcast them to any aircraft in flight in range of a GBT. The concern relates to signal duplication in the air traffic control system. To evaluate this (particularly as it applies to ADS-B receivers on future low earth orbiting spacecraft) and quantify ADS-B performance at high altitude, Near Space Corporation (NSC) in Tillamook, OR flew two test flights of a dual-band (both 978UAT and 1090ES) ADS-B test system to altitudes of 95,000ft and 102,000’ in December 2013 and July 2014 respectively. In both cases, the 1090ES signal was seen “on the glass” by FAA air traffic controllers at Seattle Center for the first time ever from a platform at these altitudes. Considerable data was collected for the FAA that showed no signal duplication/confusion even though both flights were seen and reported by 18 different GBTs at some time during the flights.

Additional data was also acquired including how far away ADS-B signals of both types were received. The collected data was evaluated by FAA analysts along with data collected from the GBTs to see how well the data collected by the balloon borne systems matched that collected by the GBTs. The results showed that the balloon borne ADS-B system missed no 1090ES equipped aircraft. The results for 978UAT equipped aircraft were a little less complete, due probably to this equipment being flown on GA aircraft at lower altitudes with lower power transmitters with antennas largely mounted on the bottom of the aircraft, many with high wing configurations. The evidence from these tests do identify another potential application for high altitude balloons as a range extender for space launch ranges to more effectively see and evaluate aircraft approaching or inside of defined hazard area boundaries associated with space launch operations from beyond line of sight from terrestrial radars. This capability could be further enhanced by also carrying Automatic Information System (AIS) receivers to see and monitor ship traffic beyond line of sight of terrestrial AIS receivers.