The Integration of Spacecraft into the National Airspace System

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Abstract

The recent development of the commercialized human spaceflight industry has sparked a great interest in the utilization of spacecraft for suborbital transportation as well as the growing space tourism industry. The Federal Aviation Administration has recognized the developments that have occurred in this industry and has begun looking towards developing new technology and procedures for the integration of commercial spacecraft into the national airspace system. As the frequency of spaceflight operations and the number of new spaceports continue to increase, the necessity for a system which enables aircraft and spacecraft to operate in the same airspace will become evident. This paper will identify some of the challenges of spacecraft integration into the national airspace system as well as attempt to provide viable solutions for the smooth transition to a more space-friendly airspace system.

Background

On June 21st, 2004, soon-to-be-astronaut Mike Melville piloted the first commercial spacecraft into suborbital flight over the desert of New Mexico (Scaled Composites, 2010). Four months later, Scaled Composites had completed their third commercial spaceflight to earn the Anarsi X-Prize and launch a new era of commercially available space transportation. Today, Scaled Composites is constructing the first spacecraft intended for the transport of paying passengers into suborbital spaceflight. Numerous other companies are working on their own designs for commercial space transports and the expectations are that this is the new future of transportation. As interest and industry continues to grow around the expectations of sub-orbital space transportation, the Federal Aviation Administration is working on plans to integrate these new spacecraft into the existing national airspace system.

Recent Developments

With President Obama's call for increased reliance on commercial spacecraft for transport to and from the International Space Station (ISS), a large number of companies have begun developing, constructing, and testing various spacecraft partially funded through NASA grants. Most recently, Space Exploration Technologies (SpaceX) has launched and orbited a test vehicle aboard their Falcon 9 launch system, activated a communication/navigation system onboard the ISS, and completed aerodynamic drop tests of their Dragon capsule all in preparation for the first commercial launch of an ISS resupply mission in November 2011 (FAA, 2011).

On October 10th, 2010, Virgin Galactic, the world's first "affordable" space tourism company completed its first free flight of the *Enterprise* in preparation for commercial sub-

orbital space tourism flights scheduled to take place later this year (FAA, 2011). Virgin Galactic also announced the construction of its second spacecraft, named *Voyager*. Both spacecraft are named after fictional spaceships in the popular Star Trek television series.

Other developments that took place in 2010 involved Bigelow Aerospace moving forward with development of additional space station designs for commercial use, XCOR's completion of wind tunnel testing on its Lynx re-useable spacecraft, and Masten Space System's first ever demonstration of in-flight re-ignition of their rocket engine (FAA, 2011). All of these developments indicate significant technological progress towards a viable commercial space transport system, not only for government use, but also for public transport as well as commercial and industrial use.

Spaceport/Airport Facilities

As the development and testing of new spacecraft progresses, the need for specialized spaceport facilities grows increasingly evident. Historically, the Federal Aviation Administration has only granted space launch licenses to government facilities; however, with the expected proliferation of sub-orbital space vehicles, the FAA has granted a limited number of Commercial Space Launch Licenses to various facilities throughout the US (FAA, 2005). Several of these facilities are co-located alongside federal launch facilities such as Space Florida at the Kennedy Space Center, the Mid-Atlantic Regional Spaceport at Wallops Flight Facility, and the California Spaceport at the Vandenberg AFB. Most recently, though, states, local communities, and private developers have taken initiatives to build their own spaceports and acquire licenses from the FAA. Spaceport America, located in the Mojave Desert is home to Scaled Composites and Virgin Galactic and will most likely become the first operational

commercial spaceport (Spaceport America, 2011). Florida has also recently received approval to renovate the Cecil Field airport to become the state's second licensed spaceport (Cecil Field Spaceport, 2011). Other spaceports have recently received licenses or are under development in Alaska, Oklahoma, Texas, and Alabama.

With the expansion of the commercial space tourism industry, the need for spaceport facilities will grow. Initially, the development of these spaceports should focus on serving the needs of the spacecraft they are expecting to support. For the next several years, commercial space transport for paying passengers will primarily consist of space tourism flights and will depart and return to the same point.

Sub-orbital spaceflights are eventually expected to expand into point-to-point transportation along long-haul routes around the globe. These flights will greatly shorten travel times and are expected to become economically sustainable as technologies progress. As the commercial spaceflight industry begins to develop into point-to-point transportation, the FAA needs to begin evaluating whether or not it would be feasible to integrate spacecraft into operations at our nation's airports or if communities would need to develop separate spaceports. Certainly, one would expect there to be certain restrictions on the types of spacecraft certified to utilize airport facilities, but the FAA should begin collaborating with spacecraft developers to ensure the designs and technologies are in place in order to create a smooth transition into the current system. Standardization of radio, navigation, ground support, and other equipment would be necessary to integrate spacecraft into daily airport operations.

In order to support spacecraft, current airport operators will also need to evaluate their resources to ensure they are capable to supporting spacecraft operations. For example, airport

managers would need to properly equip and train Aircraft Rescue and Fire Fighting teams to work with the hazardous chemicals and materials used to power spacecraft in the event of an accident. The FAA will need to play a pivotal role in ensuring combined use facilities are properly prepared to handle spacecraft operations.

Control

Another challenge to integrating spacecraft into our national airspace system concerns the role of the air traffic controller and who should have the equipment and authority to control spacecraft throughout the different stages of flight. The FAA has proposed the development of a Space and Air Traffic Management (SATM) system which would provide the framework for the cooperation between Air Traffic Control (ATC) and Space Traffic Control (STC) (Brown, 2011). Under this arrangement, the spacecraft would operate under standard aviation flight rules when in airspace normally controlled by Air Traffic Control. Space Traffic Controllers would then be responsible for controlling spacecraft outside of the National Airspace System when conducting sub-orbital or orbital operations (Alvarado & Curran, 2008).

According to The Telegraph, the European Space Agency is already working on the creation of a "Space Situational Awareness Programme" which could eventually become the foundation for an International Space Traffic Management system (Gray, 2010). While the primary focus of this agency will initially be to monitor orbital debris and prevent collisions with spacecraft, it is expected the same technology and agency could be adapted to provide spacecraft separation services when the need arises.

Spacecraft

Current commercial spacecraft designs are targeting one of two potential clients: (1) the commercial heavy-lift orbital customer and government contracts or (2) the space tourist. None of the current designs are being developed for extended operations within the Earth's atmosphere. If point-to-point commercial passenger operations are to be developed and operated in conjunction with aircraft, a new spacecraft will need to be designed which would be capable of operations within the atmosphere. In addition to the equipment required for space operations, these spacecraft would need to include avionics equipment which would provide navigation and communication capabilities which are compatible with the upcoming NextGen system. They will also need the appropriate air-breathing propulsion systems to enable them to safely operate in conjunction with aircraft at combined use facilities.

Airspace Integration

As reusable spacecraft become more prevalent in sub-orbital point-to-point passenger transport operations, the Federal Aviation Administration must assess the issues associated with the integration of these spacecraft into the current national airspace system. In the developmental stage which we are currently witnessing, the FAA has determined the safest method of operation is to setup a Temporary Flight Restriction near the areas in which a spacecraft launch or re-entry will be conducted (Brown, 2011). Due to the relatively low number of launches per year, and the limited number of launch facilities throughout our nation, this is a practical approach to ensuring the safety of both the spacecraft and other aircraft. However, in the future, it will become quite impractical to shut down airspace for launches and re-entries.

This is especially true in heavily congested airspace around busy international airports, which is where the most demand for these flights will exist.

According to the International Space University, one method for integrating spacecraft into the national airspace system is the creation of "Space Transition Corridors" (Alvarado & Curran, 2008). These corridors would operate in a manner similar to current Military Operations Areas (MOA) and would provide a safe area in which to conduct launch and re-entry operations away from congested airspaces. These Space Transition Corridors would be dynamic and could change size or shape depending on the spacecraft's operational characteristics (Brown, 2011). While this approach is very logical, it may prove difficult to execute in areas of busy airspace where there is already limited space such as around the Northeastern US. It would also require the spacecraft to be able to operate in a self-powered mode within the atmosphere. Current reusable spacecraft designs do not include this ability.

Conclusion

While there are many issues that still need to be resolved before a complete integration of spacecraft can be accomplished within the National Airspace System, the Federal Aviation Administration has stayed ahead of the curve and is developing policies and procedures as the technology and industry progresses. We are still in the early stages of development of commercialized suborbital spaceflight, but by establishing performance and technological requirements for spacecraft designs in these early stages, we can mitigate problems that would otherwise present a much larger challenge to correct. As we progress towards commercialized human spaceflight, we are preparing to take yet another giant leap for mankind. With the proper preparation, cooperation, and leadership, we can make sure we land on our feet.

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