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BLURRING THE LINES: THE OVERLAPPING INTERESTS OF HIGH ALTITUDE UNMANNED AIRCRAFT, COMMERCIAL SPACE, AND AVIATION POLICY

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ABSTRACT

The commercialization of space operations, coupled with the rapid development in unmanned aircraft systems creates a new policy dynamic between otherwise disparate industries. Existing structures do not adequately address issues of access, governance, and sovereignty across the distinct domains of air transport, space operations, and high altitude unmanned aircraft operations. Globally, aviation policy and space policy have evolved independently as distinct fields. High altitude unmanned aircraft are rapidly increasing utilization of airspace not previously occupied by civil aircraft or spacecraft, where regulation of both safety and access is sparse. Rather than consider operations in this airspace as a third category of operation, it can be seen as a bridge between air and space operations and serve as a catalyst for policy integration.

This need for integration is most apparent when considering the access issues in shared airspace. In addition to the economic issues between commercial space and commercial aviation operators, the safety hazards imposed by each upon the other must be mitigated, particularly during the launch and recovery phase when the operations are in the same altitude stratum. Dealing with these issues between commercial enterprises requires a different regulatory

framework than was appropriate when the space operations were conducted as a government function. The introduction of high altitude unmanned aircraft creates an additional regulatory demand both in the transit phases and operational phases of flight. This paper will explore the complex policy issues with regard to governance, access, and regulation needed to address this new paradigm in aviation and space.

INTRODUCTION

As space operations, once the exclusive domain of States, transition into a commercial activity, there will be a need to establish appropriate regulatory frameworks, both domestically and internationally. The United States has a well-developed program of space operations and one could assume the operational challenges of integration for commercial space activities would be straightforward. However, as there is not a clear delineation of what constitutes commercial space activity, operations like suborbital transport, stratospheric balloons, and high altitude pseudo satellites create blurry lines under existing regulatory frameworks for even the most well developed space faring nations. For those nations that are not currently space faring there is a different but no less challenging set of policy and regulatory issues that must be addressed if they are to allow commercial spaceports or otherwise allow commercial space activities that introduce operational risk within their airspace boundaries.

From a bureaucratic standpoint, the US has loosely integrated commercial space operations policy into aviation policy through the establishment of the Office of Commercial Space Transportation under the Federal Aviation Administration. While the US has a separate government agency for space, the National Aeronautics and Space Administration, NASA is a research and development agency and does not have a regulatory function. However, placing space regulation within an aviation authority is a somewhat unique construct. In most countries space law and space

regulation is separate from that of aviation. Within the United Nations structure, the International Civil Aviation Organization and the UN Office of Outer Space Affairs have maintained separate portfolios and only began formal coordination activities in 2014. The differences between the organizations and treaties of the two UN bodies go far beyond the operational jurisdiction. While ICAO was established by treaty to promote civil aviation and develop operational standards, the Outer Space Treaty seeks to ensure the peaceful use of outer space and provide a legal framework, rather than technical standards. The UN OOSA is not a copy of ICAO for space, but rather a completely different construct designed to address political issues related to space exploration and use, not to provide operational standards, as a regulated commercial industry was not envisaged at the time of its creation. Rather the body evolved from international reaction to a new technology. In 1958, in response to the launch of the first artificial satellite, Sputnik, the United Nations formed the Committee on the Peaceful Uses of Outer Space to foster international cooperation in space activities.[1] This committee led to the establishment of a small expert UN agency, UN OOSA, to support the committee activities.

As the bodies were created with distinct purposes and not to complement one another, neither the international aviation treaties nor the international space treaties define a vertical boundary between air and space. When space operations were conducted by State actors rather than regulated commercial industries, jurisdictional issues were not raised. Moving forward, the commercialization of space operations and the potential developments in human space transport, it is clear that the existing frameworks are not adequate. In addition, emerging technologies in the commercial sector are creating new types of operations that have characteristics of both an aviation operation and a space operation or may transition from one to the other. This evolution should lead to a different way of thinking about governance structures and the segregation of aviation and space policy.

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[1] *United Nations Committee on the Peaceful Uses of Outer Space: History and Overview of Activities,* United Nations Office for Outer Space Affairs, [accessed August 2015

DEMARCATION BETWEEN AIR AND SPACE

Vertical

The question of the need for a vertical demarcation line between air and space is currently a subject of considerable debate.[2] The primary argument to support a vertical demarcation is the different treatment of sovereignty in the various treaties for aviation and space. While resolving this distinction will provide clarity to the question of whether a State can deny access to the space above its geographical boundary, it will not resolve the various legal issues with regard to liability. In the Convention on Liability for Damage Caused by Space Objects, commonly referred to as the Liability Convention, the assignment of liability is to the State of launch, based on the object causing the damage, not where the damage occurs. Like other issues, the policy and governance segregation is based on the type of operation.

This is not a new question, the debate has been ongoing since the early years of national space programs. In a 1973 edition of Air University Review, Dr. Raymond J. Barrett provides an analysis of each approach under consideration and concluded, "About the only sound conclusion from a review of the various approaches to differentiating between air space and outer space is that no fully satisfactory answer is in sight. In fact, each of the approaches seems to have at least one serious defect."[3] The proposals reviewed in his analysis mirror those under consideration in the modern debate.

The absence of an agreed up line between air and space does not mean the distinction is not made. There are specific vertical criteria which must be met for a

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[2] Lai, Bhavya and Emily Nightingale, *Where is Space? And Why Does That Matter?* Science and Technology Policy Institute. Washington, DC, presented November 5, 2014.

[3] Barrett, Raymond J., *Outer Space and Air Space: The Difficulties in Definition.* Air University Review. May-June 1973. [accessed September 2015 online: http://www.airpower.maxwell.af.mil/airchronicles/aureview/1973/May-Jun/barrett.html]

mission to qualify as a space flight. The Fédération Aéronautique Internationale, the authority for aviation records, establishes the minimum altitude for an operation to be considered astronautics as 100KM.[4] However, in the 1960s, the US considered pilots of the X-15 to have achieved spaceflight and granted them astronaut status if the flight exceed 80KM (50 miles). The Ansari X-Prize to promote commercial space flight requires a spacecraft to exceed 100KM to qualify. Conversely, there are those that argue the altitude reached is less significant than the type of operation. The Federal Aviation Administration currently indicates that orbital spaceflight occurs when a spacecraft is placed on a trajectory with sufficient velocity to reach orbit.[5] The FAA approach moves the debate to one that is more operational than vertical in its distinction.

Operational

For the majority of aviation and space operators, there is no question as to whether an individual vehicle is an aircraft or a spacecraft. However, the emergence of high altitude, high endurance unmanned aircraft and aircraft designed for the purpose of launching spacecraft, vehicles are not as clearly defined. The most well known of the commercial human space transport experiments, the Virgin Galactic Spaceship uses a purpose built aircraft as a launch platform for the space vehicle. Whether the combined launch vehicle and spacecraft constitute a spacecraft is unclear. If it is a spacecraft, does it remain classified as such once the launch has occurred. Conversely, the combined unit could be regarded as an aircraft, in which case, is the spacecraft considered as a spacecraft or cargo while the launch vehicle is en route to the launch altitude? Virgin Galactic is building on their human space flight concept to develop a small satellite launcher that would launch from an aircraft at 35,000

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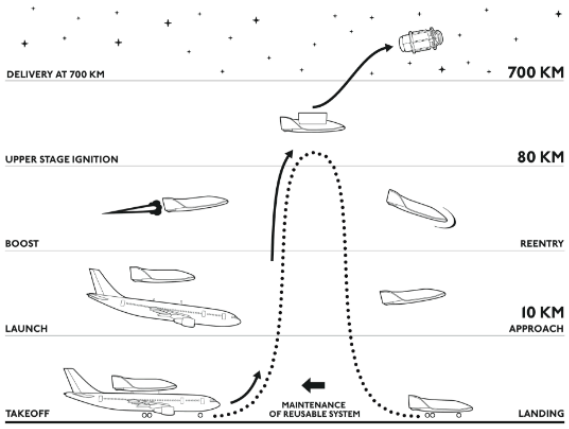
[4] FAI Astronautic Records. *100km Altitude Boundary for Astronautics.* [accessed September 2015 online: http://www.fai.org/icare-records/100km-altitude-boundary-for-astronautics]

[5] Report to the Chairman, Committee on Science, Space and Technology, House of Representatives. *Federal Aviation Administration: Commercial Space Launch Industry Developments Presents Multiple Challenges*. United States Government Accountability Office, Washington, DC. August 2015.

feet. Swiss Space Systems is in design and development of a reusable space plane for satellite launches that will be mounted on a zero-G certified A300 aircraft and launched at altitude (fig. 1). The A300 portion of the operation will be capable of utilizing traditional airports for take off and landing.[6]



Source: Swiss Space Systems

Figure 1. Parabolic Launch

In addition to the developing technologies designed to support commercial human spaceflight and satellite launches, there are developments in unmanned operations designed to access altitudes above current civil aviation and remain for long periods of time, providing satellite like communications services. These technologies are reaching operational phases. The Facebook internet project intends to deploy a high altitude network of solar powered unmanned aircraft that would remain airborne for up to 90 days to provide internet capability to underserved areas. In this way, the aircraft will perform more like a satellite network than an aircraft operation. This category of aircraft are generally referred to as High Altitude Pseudo Satellites or HAPS. The Google Loon project has been launching high altitude, high endurance balloons into the stratosphere since 2013. They are currently actively launching

[6] Swiss Space Systems. *Mission and Goals.* [accessed September 2015 online: http://www.s-3.ch/en/mission-goals]

from New Zealand, the United States, and Brazil. While balloons are commonly considered as aircraft, (technically aerostat, as it derives lift from buoyance rather than interaction with the atmosphere) the Canadian Space Agency operates stratospheric balloons as part of the Canada space program under the project name Stratos.

An effort to distinguish space flight from aviation is becoming more complex as the technologies develop. This leads to the question, is a clear distinction between air and space operations necessary to evolve an appropriate legal and policy framework as well as international governance structures? Simply put when we ask, where is space, are we asking the right question?

THREAT, HAZARD, OR USER?

For five decades, spaceflight has been primarily an engineering problem. But today, as we leave the domain of governments we introduce policy and legal problems that must be addressed. How we address these problems, how we build a policy framework is largely determined by how the new entrants, that may represent disruptive technologies, are perceived by the existing community. Each category, high altitude unmanned aircraft, suborbital space transport, or commercial space launchs conduct at least some portion of their operation in civil airspace.

If the portion of that operation that occurs in civil airspace is perceived as a threat, particularly as an economic threat to current airspace users, policy frameworks could emerge from a protectionist mindset. In this approach, preference is given to existing system users over the new entrants. If instead the new operators are viewed as hazard, then policy concepts will focus on mitigation to maintain existing levels of safety for the civil airspace operators. Finally, if the commercial space and other new operators are regarded as airspace users, there is a policy need to balance the competing interests with other system users. While this may seem to be

the obvious policy choice, the questions on how to reach this policy basis are far from simple.

Airspace Access

Equitable civil access to airspace is an underlying premise of much of US aviation regulation. However, military and other State operations are given airspace priority over commercial operations through the use of segregated special use airspace, altitude reservations, and temporary flight restrictions. NASA, as a government operator, has dedicated special use airspace at its various launch facilities that is activated when necessary to accommodate a launch or recovery activity. Currently, commercial space launches are accommodated as if they were government operations, displacing civil aviation operators during the launch window and imposing both economic and environmental costs on the aviation users. However, there is not a clear policy basis to provide government priority to commercial space users at those locations or at other identified commercial spaceports, making this a temporary mitigation to the safety risk at best.

In terms of operational access to airspace for launch and recovery activities, the transition from state operation to commercial enterprise is further clouded by the variety of operational purposes. For example, is a purely commercial launch subject to different airspace priority than a commercial launch of persons or payload under State contract? The US Federal Aviation Administration Office of Commercial Space Transportation recognizes this policy vacuum. Its 2014 Concept of Operations for Space Vehicle Operations, concludes "Since the NAS is a shared public resource managed by the Federal Aviation Administration (FAA), an approach to equitably allocating NAS resources (particularly airspace) must be developed."[7]

[7] K. Leiden, A. Fernandes, J. Rebollo, A. Churchill, K. Johnston, K. Neubecker, D. Ireland, J. Griffith, W. Patt and K. Hatton, *Space Vehicle Operations, Concept of*

With regard to the launch facilities themselves, the distinction between a state and commercial operation is equally fuzzy. For example, the Mid Atlantic Regional Space Port is owned and operated by the Virginia Commercial Space Flight Authority, an independent authority of the Commonwealth of Virginia, but physically located at NASA's Wallops Flight Facility, a federal installation.[8] Relatively infrequent launches, coupled with the FAA's ability to disapprove a launch window[9] has allowed commercial operations to persist under existing frameworks. However, as the number and frequency of launches increase, that is unlikely to be a sustainable policy.

New Challenges from 20KM to 100KM

This buffer area between aviation and space operations will not remain as commercially unused airspace even in the near term. Joseph Pelton, of the International Association for the Advancement of Space Safety identifies this area between 21 and 100 kilometers above the earth's surface as the "Protozone Area". He enumerates several near term initiatives that will see new uses for this airspace that blur the lines between aviation and space activities and projects the market size for commercial uses of the Protozone area could reach $270 billion within 20 years. In past decades, this primarily uncontrolled airspace remained largely unused for civil applications, allowing free and unrestricted access to the few experimental users. International regulation was unnecessary because the financial and technological barriers to access the airspace were self-limiting. However, Pelton

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Operations Version 1.1, Federal Aviation Administration, US Department of Transportation, Washington, DC. August 2014.

[8] Report to the Chairman, Committee on Science, Space and Technology, House of Representatives. *Federal Aviation Administration: Commercial Space Launch Industry Developments Presents Multiple Challenges*. United States Government Accountability Office, Washington, DC. August 2015.

[9] In 2013, the FAA refused a Space X request for a launch window at Cape Canaveral on the Tuesday or Wednesday before Thanksgiving due to the demands of civil aircraft in the east coast corridor. The launch was permitted and conducted on Thanksgiving day.

identifies significant numbers of near term applications that point to a clear need for safety regulation.[10]

Some experimental users, like the Google Loon Project and Facebook's Aquila plane project regard the airspace above 20KM (60,000 feet) as unregulated. While airspace above that level is generally uncontrolled that is not necessarily the same as unregulated. In the US, where the FAA generically describes Flight Level 600 as the limit of class A airspace, the agency also maintains unique separation standards for aircraft operating above FL600. Military aircraft have operated above FL600 for more than 50 years, albeit in small numbers. The most obvious differences between the military high altitude airspace users and the unmanned commercial operators are performance and endurance. Military aircraft in that stratum are generally high performance aircraft who occupy a given volume of airspace for a very short period of time. Conversely, the Facebook solar plane and the Google balloons operate at very slow speed and in patterns designed to simulate a stationary operation and remain in an area for up to 90 days. This creates a level of airspace congestion that we would not see from a similar number of traditional aircraft operations.

Each of the two early civil entrants into the Protozone area anticipate thousands of concurrently operating aircraft to achieve their coverage goals. However, they are not the sum total of the industry. Airbus Defense and Space has developed the Zephyr HAPS, which has already completed trials exceeding 330 hours of continuous flight. As this market develops and new competitors are introduced, it is unrealistic to believe that uncontrolled use of the airspace would provide the necessary safety levels. Lessons from low earth orbit and satellite collisions in an area much larger than the Protozone illustrate the flaw in assuming the current low traffic density will provide a safety buffer. Congestion in low earth orbit (fig

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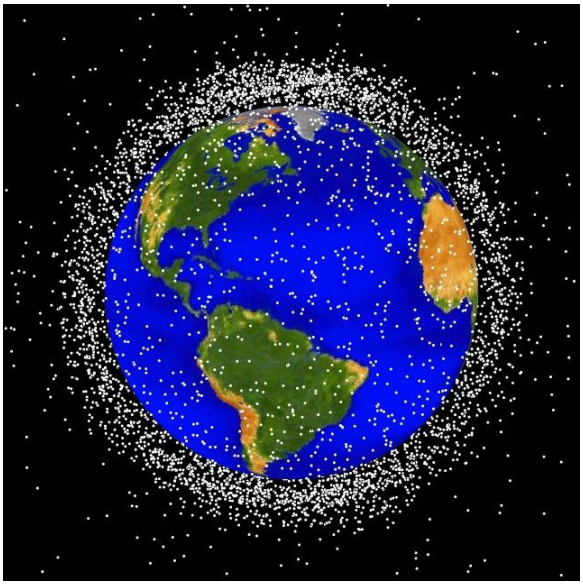
[10] Pelton, Joseph N., *A New Integrated Global Regulatory Regime for Air and Space: The Needs for Safety Standards for the "Protozone"*, presented at presented at Second Manfred Lach International Conference on Global Space Governance, May 2014

2.) has led to the development of programs to detect threats and develop avoidance maneuvers for both the International Space Station and maneuverable satellites to prevent collisions in orbit.



Source: NASA.gov

Figure 2. Space Debris and Human Spacecraft

Safety Regulation in Shared Airspace

While the cruise or orbit phases of flight may be segregated between civil aviation, High Altitude Pseudo Satellites, suborbital space flight and space orbit, in order to access their respective strata, each much transit the civil airspace layer. Launch activities pose a safety hazard to civil aviation. Conversely, civil aviation poses a hazard to launch operations. Managing interactions between the two is necessary to maintain the target level of safety. This is currently achieved through segregated, protected airspace. However, today's airspace models may not be appropriate for future launch technologies, particularly those that seek to launch from civil airports or airborne launches.

In addition to safety concerns, the current models may require the protection of much larger airspace than is necessary to accommodate modern launch technologies. This has adverse economic and environmental consequences, as

civil aviation operators would be required to utilize longer routes to avoid the airspace. The figure below (fig 3.) illustrates the protected airspace required for a Delta rocket launch from Cape Canaveral. The underlying airways, would be closed for the duration of the NOTAM period as well as sufficient time preceding the airspace closure to ensure all aircraft were clear before the scheduled activation time. Routing around the airspace is approximately 100 miles longer than the direct route through the airspace. This is a busy airspace corridor and on a routine traffic day, the operational cost imposed on commercial aviation operators for the three and a half hour airspace closure would exceed $275,000.

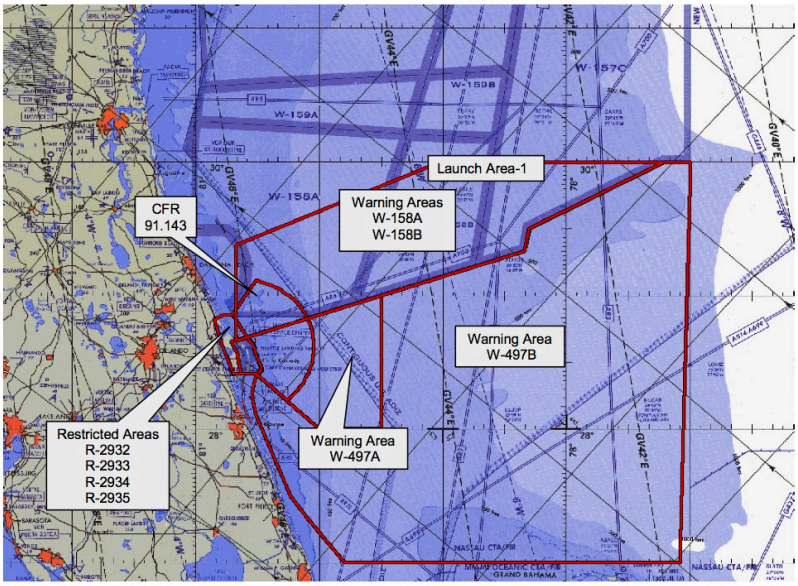


Figure 3. EXPENDABLE LAUNCHES
D7384 Delta IV GPS IIF-05
20 Feb 2014 / 6:30pm – 20 Feb 2014 / 10:00pm

In the US, there are certain regulatory constraints as a result of the 2004 Commercial Space Launch Amendments Act which precludes the FAA for issuing regulations with regard to the safety of crew and participants in commercial space flight. However, the act does not preclude the FAA from issuing regulations to protect the safety of the public and other non-participants from the hazards created by commercial space launch activities.

For countries that are not currently in the space faring community, commercial enterprises may allow for the development of space activities not possible if they required government funding. These states may lack the capacity or expertise to develop required safety regulations. This points to a need for international governance models, like the ICAO model for civil aviation, to not only support those states, but also to ensure global safety standards are developed and maintained. If launch operators are considered airspace users, the international body responsible for facilitating these safety regulations would be ICAO. If however, the launch operators are considered a hazard, the jurisdictional issues are less clear.

Legal Issues

Key policy decisions need to be made, and internationally accepted, in order for the field of space law to evolve to adequately address the emerging legal questions. These questions include those of jurisdiction, liability, and access, as well as to identify where and how the existing body of space law applies to commercial operations.

Many of the legal issues that need to be addressed have been well developed in other studies, including, "*The Need for an Integrated Regulatory Regime for Aviation and Space: ICAO for Space"*[11]. This paper is not designed to repeat the work done in previous studies, rather it is to approach the question from the point of identifying the key policy issues and operational questions that must be addressed in order for a regulatory regime to move forward. Law is developed on the foundation created by policy. Without a sound policy framework, a comprehensive an enforceable body of law is not possible. The case for the need for global regulation of commercial space activities has also been made in

[11] Jakhu, Ram, Sgobba, T., and Dempsey, P editors. *The Need for an Integrated Regulatory Regime for Aviation and Space: ICAO for Space.* Springer. New York. 2011

previous studies. But it is clear from the literature that we are far from a consensus on how this will be accomplished. In "*Regulation of Commercial Space Transport: The Astrocizing of ICAO"* [12] the author raises questions of the competency of ICAO in this field and provides compelling arguments that the addition of an ICAO Annex regarding commercial space is an overly simplistic view.

The question of sovereignty presents the key legal challenge. This issue is raised in the existing literature. *The Convention on Civil Aviation*, commonly referred to as the Chicago Convention, clearly establishes that the airspace above a state is sovereign. Conversely, *The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies,* commonly referred to as the Outer Space Treaty, specifies that no claims of sovereignty can be made. This disparate treatment of sovereignty introduces the critical question of jurisdiction for the emerging field of commercial space law.

Proposals are under consideration in the space and aviation communities for the International Civil Aviation Organization to expand its mandate to include commercial space operations. However, it is unclear whether the current structure of ICAO could adequately address the regulatory needs of this emerging industry. As the UN specialized agency for aviation, there is not currently a technical expertise in space operations. In addition, the dominance of aviation interests within the agency may not allow for adequate representation by commercial space interests. The structure of ICAO, including access to and allocation of resources, may fail to achieve the balance needed to treat commercial space operators as airspace users.

ICAO does have a developing program on remotely piloted aircraft that will be tasked with developing the requirement for the transit of unmanned aircraft through unsegregated civil airspace. It is unclear whether the work program will be

[12] Abeyratne, Runwantissa. *Regulation of Commercial Space Transport: The Astrocizing of ICAO.* Springer. New York. 2015.

expanded to include the regulation of aircraft once they are operating above controlled civil airspace. With regard to unmanned free balloons, like those used by Google, launch is governed by individual state regulation and ICAO does not currently have separation standards to provide positive separation between an aircraft and an unmanned free balloon operating in controlled airspace.

CONCLUSION

The existing division between aviation and space policy may not be suitable to address new challenges resulting from the commercialization of space operations and the technological developments in both space operations and high altitude unmanned aircraft. The development of integrated aviation and space policy approaches will help to overcome many issues, however, legal issues tied to the sovereignty question may be more difficult to overcome than those related to operational and safety regulation.

Despite the challenges presented, it is essential to address the policy issues created by the technological and commercial developments in the industry. Without a clear policy framework, legal issues, international harmonization, and governance structures cannot be properly considered. A comprehensive way forward should consider the all types of operations in civil airspace, even if only for a limited portion of the operation to be airspace users. By providing this stakeholder status we take the first step in creating a truly integrated policy framework for the various types of commercial operators competing for resources.