COMSTAC
Commercial Space Transportation Advisory Committee

LAUNCH OPERATIONS AND SUPPORT WORKING GROUP

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Launch Operations and Support Working Group (LOSWG) Report

A Team Effort

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COMSTAC

LOSWG Report

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EXECUTIVE SUMMARY

Goals

The primary goals of the Commercial Space Transportation Advisory Committee (COMSTAC) are to evaluate economic, technological and institutional developments relating to the U.S. commercial space transportation industry and to make recommendations to the Administrator of the Federal Aviation Administration (FAA) on issues and approaches for Federal Policies and programs regarding the industry. COMSTAC provides a forum for the discussion of problems involving the relationship between industry activities and government requirements.

This report is a product of the Launch Operations and Support Working Group (LOSWG), one of four working groups that provide information, reports and recommendations to the full COMSTAC committee for adoption.

The LOSWG charter states - *"identify key space launch & landing sites and range operations, and support issues (including infrastructure) affecting the competitiveness of the U.S. commercial space transportation industry; investigate approaches to modernize and improve the efficiency of launch facilities, equipment and services; and provide appropriate recommendations to COMSTAC".*

An LOSWG review during October through December 1999 resulted in the identification of over 30 relevant issues related to "Spaceports". The issues were linked to 3 main categories - Spaceports (policy and regulation), Operations (processing, launch and landing), and Cost and Financing (competition and allocation). Three subgroups were charted to address these categories. This report identifies and examines several of the highest priority issues and offers specific recommendations. In addition, several issues were deferred requiring extensive follow-on activities and are not addressed in this report.

Background

COMSTAC was established in 1985 to provide information, advice and recommendations to the FAA Administrator within the Department of Transportation (DOT) on matters relating to the U.S. commercial space transportation industry. COMSTAC membership is made up of senior executives from the U.S. commercial space transportation industry including entrepreneurial firms as well as large aerospace companies; the satellite industry; space-related state government officials; and representatives from space advocacy organizations. Industry issues are primarily addressed through working groups, which provide information, reports and recommendations to the full committee for adoption. The four COMSTAC working groups are: 1.) Launch Operations and Support 2.) Technology and Innovation 3.) Risk Management and 4.) Reusable Launch Vehicle (RLV) Development.

The LOSWG is charged with working jointly with the other chartered COMSTAC working groups on areas of related responsibility. The LOSWG and RLVWG have many common members and have collaborated to insure that the efforts of the two working groups are in concert.

The RLVWG is charged to develop industry advice to the FAA on issues relating to licensing and regulation of RLVs. An RLV Working Group report, *FINAL REPORT ON RLV LICENSING APPROACHES*, dated April 29, 1999, presents a general RLV industry position on the RLV regulatory regime. The reports' executive summary states:

In order to develop and operate Reusable Launch Vehicles profitably, a regulatory environment is required which provides sufficient flexibility to accommodate the numerous vehicle concepts. Although a broad expanse of subjects has been covered in responding to initial suggestions and guidance provided by FAA/AST, much work remains on the part of government and industry to define an overall regulatory process. This process must encompass the diverse needs of developers and operators of the new reusable transportation infrastructure while ensuring the public safety.

Joint meetings and reviews have been conducted during the preparation of this report, resulting in the consideration of a wide range of comments and concerns. In general, this report has resolved all significant issues to the satisfaction of both groups.

Issues and Recommendations

In support of the LOSWG goals of identifying key issues affecting U.S. commercial space competitiveness, each LOSWG subgroup (Spaceports, Operations, and Cost & Financing) has examined issues that fall into their respective categories and offered recommendations. These issue statements and recommendations are presented below. Not presented in the executive summary, is the accompanying discussion for each issue and any deferred issues developed by the subgroups. The complete subgroup reports are found in chapters 1-3 of this report.

SPACEPORTS

The absence of a widely accepted or legally based definition of the term "spaceport" has become problematic when seeking recognition of the entity in regulatory, policy, and capital market venues. Setting down an acceptable definition of the term "spaceport" became a key task of the Spaceport Subgroup.

Issues and Recommendations

Issue 1. There does not exist a succinct, widely accepted definition of the term "spaceport". The term is being used in many areas of government and industry to

describe an entity for which there is not a universal understanding or acceptance of what it means, includes, or does not include.

Recommendation 1. The word "spaceport" and other aerospace terms relating to spaceports thereof and to place, area, or distance be defined as follows:

> "Spaceport" signifies facilities directly related and essential to servicing spacecraft, enabling spacecraft to take off or land, and transferring passengers or space cargo to or from spacecraft, but only if the facilities must be located at, in close proximity to, or in the direct logistical support path of the launch or reentry site to perform these functions. The term "spaceport" also includes other functionally related and subordinate facilities, such as launch control centers, repair shops, maintenance or overhaul facilities, and spacecraft assembly and storage facilities that must be located at, adjacent to, or in the direct logistical support path of the launch or reentry site.

Terms defined by 49 U.S.C.A. § 70102 and other documentation include:

"Spacecraft" means any contrivance now known or hereafter invented, used or designated for navigation of, or flight in, outer space, in Earth orbit in outer space, or in a sub-orbital trajectory. The term "spacecraft" includes launch and reentry vehicles defined by statute as: a vehicle built to operate in, or place a payload (space cargo) in, outer space and a sub-orbital rocket; and a vehicle designed to return from Earth orbit or outer space to Earth, or a reusable launch vehicle designed to return from Earth orbit or outer space to Earth, substantially intact, respectively.

"Space cargo" denotes satellites, scientific experiments, and other property transported into or from space.

"Launch site" means the location on Earth from which a launch takes place and necessary facilities. The launch site may be physically separated from the spaceport, in the air, on water, or on land, but linked to the spaceport control centers, depending upon licensed spacecraft operating requirements.

"Reentry site means the location on Earth to which a reentry vehicle is intended to return.

"Launch" means to place or try to place a launch vehicle or reentry vehicle and any payload (space cargo) from Earth in a sub-orbital trajectory, in Earth orbit in outer space, or otherwise in outer space.

"Reenter and reentry" means to return or attempt to return, purposefully, a reentry vehicle and its payload (space cargo), if any, from Earth orbit or from outer space to Earth.

Issue 2. A fragmented approach to assuring space access flight safety currently exists for the evolving space operations industry. Each national launch range has an evolutionary based flight safety system that is traditionally defense and science oriented, employs a large and costly infrastructure, funded by USAF and NASA, and is not available to all potential spaceport customers and launch providers.

Recommendation 2. A high-level federal entity (such as DOT) should be empowered and funded to develop a "National Space Access System" strategy. This strategy should be in concert with the FAA/AST integrated Space and Air Traffic Management System (SATMS). The strategy needs to encompass the various federal departments and agencies now providing space access flight safety functions. The space access enterprise should then be integrated into the resulting "Space Access Management System " consistent with the NAS CONOPS.

Issue 3. The Federal Government, in a recent report, recommends that the States and the private sector assume a greater role in funding and managing the launch ranges. This could foster "competition" with new commercial spaceports.

Recommendation 3. The federal government should work with the States and private industry to better define shared use facilities for which clear space access costs can be derived with the government and the space industry as users of ground infrastructure. Facilities would still be "shared use," but be licensed as part of the Spaceport for non-Government use. This will allow the States and private entities to provide for Spaceport customers, making the Spaceport the only access to those facilities/services for non-Government use. Each Spaceport would establish a lease/use agreement with its host agency for the specified facilities/services.

Issue 4. Access to federal flight safety systems for commercial use by non-federal Spaceports is a growing concern. The increasing frequency of commercial launches and development of new Spaceports not co-resident with Government launch ranges places a serious burden on the ability to conduct flight safety functions at the new Spaceports.

Recommendation 4. The U.S. Government, Spaceports, or both need to make the necessary investment to provide the required range safety support capability. This investment can be in additional fixed equipment/personnel at each Spaceport site, or in mobile equipment and funding for deployable launch support teams

Issue 5. Spaceport licensing is unduly constrained by the current FAA process. Licensing approval that links the development of a spaceport with a specific launch vehicle inhibits the ability of the public and private sectors from proceeding in a cost efficient manner.

Recommendation 5: Spaceports should be approved without regard to the type of launch vehicle. The regulatory authority would base its approval on the site providing services within the agreed definition of a spaceport and include basic safety including clear zones in the immediate vicinity of the site. This would ensure its presence does not present a threat to public safety. Launch vehicle licensing approval would then complete the package.

Operations

This chapter builds on the definition of terms and the high-level description of the elements composing a spaceport that is provided in the Spaceport chapter. A general discussion of spaceport operational models follows. The ultimate goal is to identify issues, obstacles, and solutions for bridging between today's launch models, and that of a generic end state, specifically related to FAA interactions.

Issues and Recommendations

It is assumed that spaceports will evolve as a subset of a space transportation industry that is supported and regulated by a structure similar to that which is currently in place for the aviation industry.

Issue 1: Consolidation of KSC/ CCAFS/VAFB space launch functions may help the current Federally owned and operated space launch range situation by capitalizing on existing synergy's, and benefit commercial operations.

Recommendation 1: The U.S. Government should evaluate the benefits of consolidation with respect to KSC/CCAFS/VAFB and implement viable changes. These Federal spaceports should identify the items to be consolidated with input from and consultation with all parties involved, including the commercial sector, industry, NASA, the Air Force and the FAA.

Issue 2: A "Range Safety" function is mandated for all launch providers from federal and commercial "spaceports". Some "Range Safety" responsibilities will be transitioning in the future to support the shared use of the Eastern and Western Ranges and Kennedy Space Center. As such, there will be commercial and federal launch sites which share range safety resources increasingly. Should the Air Force retain current "range safety" responsibilities (herein referred to spaceport safety)? How should future Spaceport Safety be handled and who should be responsible?

Recommendation 2: Spaceport Safety responsibilities for space launches should be transitioned to a "National Space Access System". The DOT/FAA should provide this function for all locations and commercial launches. The FAA and Air Force should establish spaceport safety standards for both commercial and federal launches. Commercial spaceport safety should be the responsibility of the spaceport operator as regulated/administrated by federal (FAA), state and local agencies (similar to an airport).

Issue 3: High flight rates and the intersection of domestic and international air/space will impact ground/flight safety significantly. The current "Range Reconfiguration" process does not accommodate the expected high flight rates of new RLVs, nor the "bunching" that is often seen today with DOD, civil and commercial operations. Spaceports of the future must handle expected higher flight rates for launch vehicles.

Recommendation 3: Develop an integrated domestic/international flight system which will address heavy aerospace traffic issues, abort scenarios for future vehicles, and other pertinent issues as they relate to flight and ground safety. A system for

handling high flight rates must be developed to insure safety (population, environment, other vehicles in flight, etc.). Higher flight rates for EELV/RLVs should be accommodated by the ranges where they are subject to the "Range Safety" process. The Range reconfiguration process should be improved with available technology and procedures so that it is no longer an impediment to projected flight rates at ER and WR or other spaceports dependent upon these assets.

Issue 4: Launch vehicle safety requirements impact spaceport operations and safety.

Recommendation 4: Launch vehicle safety requirements that affect licensed spaceports operation and safety should be addressed as part of the current Launch operators license or launch-specific license process or possible future certification regime.

Issue 5: Commonality /standardization of spaceport Infrastructure, international standardization, and standardized payload processing will impact spaceport operations.

Recommendation 5A: Spaceport operators should take the lead in addressing standardization in partnership with spaceport providers, the FAA and the vehicle operators. Initiate an effort to identify spaceport facilities and services that merit commonality/standardization, especially with regards to items required by the regulatory regime.

Recommendation 5B: Evaluation of International standardization for spaceports should be included in the FAA CONOPS process. Standardization not related to safety should be pursued by the industry where practicable.

Recommendation 5C: The issue of whether standardized payload processing is offered should be a business decision between the launch service provider and their payload customer's. Spaceports would respond to resulting support from users.

Issue 6: Spaceports are in the development stage without the benefit of a "role" model, and are heavily influenced by geography and existing infrastructure, if any. Areas to be considered includes the concept of the facilities, management and infrastructure associated with the launch/takeoff, tracking, control and recovery of space vehicles.

Recommendation 6: A joint-use, military / commercial / international airport is an excellent starting point for characterizing future spaceports. Three major areas that help describe such an airport are facilities, services, and governing regulation. A joint-use spaceport should be closely modeled after a joint-use airport.

Cost and Financing

Issues and Recommendations

There appears to be a consensus in both industry and the government that the status quo in space launch operations is not acceptable. It is clear that the government will continue to maintain some control over space launch operations via continued ownership of the Cape and Vandenberg, but it would like to have industry pay more than it currently does for maintenance and modernization of the Air Force owned infrastructure. In other words, the Air Force recognizes that commercial space launch now dominates the U.S. market, and its desire is to require industry to pick up an equitable share of the operations cost. The Air Force has increasingly started outsourcing its infrastructure work, which may increase efficiency and permit increased reimbursement for commercial work.

Ten years ago, there was a balance between the volume of launches, the control over the operational infrastructure of those launches, and the funding to maintain that infrastructure. That balance was possible because the Air Force dominated the three elements of volume, control and funding. Today the Air Force has irreversibly lost its leadership in the volume of launches, but strongly desires to keep operational control. Immediate action clearly needs to be taken by both industry and the government.

Issue 1: The Air Force aggregating for the collection of costs for the space launch infrastructure is not conducive to developing a comprehensive cost model that can be used to transition from a government dominated launch basis to a largely commercial basis.

Recommendation 1: Abolish the current five government cost/management categories of *base ownership; supporting infrastructure; space launch operations facilities and systems; range facilities and systems; and safety responsibilities and operations* and replace them with three new cost centers called *spaceport (host); launch services (tenant/user), and range/communications (worldwide range and tracking support).* This will better align actual space launch operations activities for transition to competitive operation and even ownership by industry.

Issue 2: Legislation currently prevents the Air Force from charging industry a pro-rata share of the fixed costs of the space launch infrastructure. It also prevents the Air Force from asking for funding to directly subsidize those same industry-associated fixed costs. Consequently, the infrastructure is chronically under funded and in need of a major capital infusion because commercial launches now dominate the mission model.

Recommendation 2: Congress should enact legislation permitting the charging of a proportionate allocation of launch costs to the using party and give industry management/ownership responsibilities in proportion to its share of the mission model. In addition, a mechanism should be established to ensure that these "pass

through" costs are based on those that would be in effect if market principles had been applied.

Issue 3: Despite the significant contributions of the RSA program, the federal government has underfunded maintenance of the space launch infrastructure for the last 30 years. Consequently, the infrastructure is in need of a major capital infusion to remain competitive with foreign launch service providers and to increase the throughput required to meet forecasted U.S. launch requirements. As industry assumes a significant operational responsibility for the space launch infrastructure, it may have to invest significant resources for modernization. Consequently, future commercial launches will, in effect, be taxed to pay for previous U.S. government launches. In addition, there is no independent comprehensive document that identifies what needs to be modernized and at what specific cost.

Recommendation 3: The Government should fund an independent assessment by a neutral non-government entity to determine specifically what needs to be modernized and at what cost to satisfy evolving space launch infrastructure needs. The federal government should then provide a one-time increase in funding to modernize the infrastructure prior to industry assuming a significant operational role.

Issue 4: Industry is concerned that, if it agrees to fund space infrastructure modernization, this will have an adverse impact on its ability to attract launch customers and on its Internal Rate of Return. There is no comprehensive and publicly available data to validate or reject these concerns.

Recommendation 4: Industry should fund an independent review by a neutral non-government entity on the impact to industry's bottom line if it assumes a greater proportion of the space launch infrastructure financial burden.

Issue 5: It is vital to the economic and national security interests of the U.S. that we maintain a robust and, if possible, dominant space launch capability. As management of the space launch infrastructure transitions to industry, selected incentives may be needed to spur technological and financial investment in this field. Tax-exempt status for facility development bonds would significantly benefit spaceport development by allowing state and local bonding authorities to issue tax-exempt bonds for spaceport financing. Commercial spaceports would need to meet the general public use requirement imposed by Treasury Department regulations in order to qualify as an exempt facility.

Recommendation 5: The Congress and the Administration should develop a comprehensive set of incentives to spur investment and innovations in space launch operations and infrastructure. These incentives would be designed to "jump start" the transition from a government space launch industry to one that is oriented toward a purely commercial enterprise. These incentives could include loan guarantees, tax incentives, insurance indemnification, and forward purchase contracts for launch services. Specifically, it is recommended that legislation like the Spaceport Investment Act be immediately adopted to allow spaceports to be treated like airports under the exempt facility bond rules

Issue 6: The recent OSTP/NSC Interagency report on "The Future Management and Use of the U.S. Space Launch Bases and Ranges" recommends that the Air Force "maximize use of nonfederal funding sources". However, there is no balanced recommendation to transfer a proportionate share of the responsibility for oversight/ownership to "nonfederal" entities.

Recommendation 6: There should be a direct relationship between the level and source of financing provided for the space launch infrastructure and the size of the voice permitted in space launch operations.

Issue 7: The CSLA Amendment of 1988 intended to "provide a mechanism in which domestic launch activities can change from a public activity, which it traditionally has been, to a wholly private endeavor". In addition, OMB Circular A-76 states: "In the process of governing, the Government should not compete with its citizens. The competitive enterprise system, characterized by individual freedom and initiative, is the primary source of national economic strength. In recognition of this principle, it has been and continues to be the general policy of the Government to rely on commercial sources to support the products and services the Government needs." Despite recent increased emphasis by the Air Force on contracting out certain launch functions, the Air Force and NASA still own the launch bases, determines what is to be contracted out, and oversees the contract operations.

Recommendation 7: The U.S. Government should not compete with private industry in those tasks, including spaceport ownership and operation, which industry is capable of performing in a responsive and economically viable manner. A mechanism should be established to ensure that commercial spaceports do not have to compete with government spaceports for space launch business on an unfair cost/price basis. The Government should develop a plan that, as soon as possible but no later than in five years, allocates a certain percentage of U.S. Government launches to take place from non-U.S. Government owned spaceports. Finally, the Government should develop a 10-year plan that, beginning in 5 years, transitions U.S. Government-owned spaceports to private ownership

CHAPTER 1: SPACEPORTS, POLICY AND REGULATION

Introduction

The Spaceport Subgroup of the LOSWG focused upon policy and regulatory issues surrounding commercial and shared-use "spaceports" as they continue to evolve. The concept and term "spaceport" has grown from the federal launch and test ranges where the U.S. space program was born and nourished. Until the early 1990's, commercial space access operations were conducted only on federal launch sites. Increased commercial space applications, increased demand for launches for commercial purposes and optimistic forecasts for the commercial space launch industry, fueled the development of additional commercial launch sites.

In 1997, the FAA began licensing (Commercial) Launch Sites as well as (Commercial) Launch Operators. There are currently four land-based launch sites licensed by the FAA and several additional sites with license applications pending. Three of the currently licensed sites are on or adjacent to federal launch ranges. Only one of the sites with license applications submitted is associated with a federal launch range. Policy and regulations affecting licensed launch sites are still evolving with roots deep in the policies, regulations and procedures of the federal launch ranges. The majority of the policy and regulation focuses upon public safety concerns, property protection, and financial responsibility relative to space access. With the development of RLVs, the concept of re-entry and landing sites have been incorporated into regulation.

The absence of a widely accepted or legally based definition of the term "spaceport" has become problematic when seeking recognition of the entity in regulatory, policy, and capital market venues. Setting down an acceptable definition of the term "spaceport" became a primary focus the Spaceport Subgroup. Other issues including tax treatment, licensing, access to federal assets for commercial use, ownership of "spaceport assets, public versus private role in "spaceport" development, access to federal flight safety systems by non-federal "spaceports", and licensed versus unlicensed operations at federal launch sites are addressed.

Spaceport Definition

The terms "launch site" and "re-entry/landing sites" still do not encompass all of the notions ascribed by the space access enterprise to what has become commonly known as a "spaceport." A universal understanding of the term "spaceport" is necessary to avoid misunderstandings and improper treatment of related issues. Spaceport development is evolutionary and what is relevant today may not be relevant in a decade. Thus, the definition should allow for the continued evolution and development of the "spaceport" concept, providing the distinction necessary so disassociated elements cannot cloud the intent of the purpose and use of the entity. The definition should acknowledge and include an understanding of the spaceport legislation being considered by federal legislative committees. The definition should

not discriminate between military and civil, but should accommodate either or shared-use locations.

Space Access Flight Safety

The national ranges are under pressure from several sources. Federal budget allocation through DOD and NASA, capacity, mission conflicts, increased commercial use, aging systems, many choices for upgrades, emergence of RLVs, and a growing number of spaceports requiring flight safety support are a few of the pressures.

In response to these pressures, the government has conducted a number of studies and hosted many forums for discussion of the launch range issues. Industry has also weighed in with their studies. These studies and forums produced great dialog and exchange of ideas and certainly a better understanding of the problems. There has been some budget attention by the DOD and NASA to address some of the more critical issues. Both DOD and NASA have developed conditional plans for addressing the growing national flight safety issues at their respective ranges. Most of the plans require funding that is not currently programmed.

Range upgrades are not happening quickly enough to address the growing demand for support services. Several related factors will exacerbate this situation: commercial launches have been delayed; RLV operations will impose increased requirements on the system ; new and developing spaceports, coastal and inland, require attention and support; and not all existing spaceports are getting equal attention. The approach to addressing the flight safety system continues to be a concern for the U.S. competitiveness in the space access market.

The requirements of developing and maintaining a recognized and accepted space launch flight safety system are larger than the individual federal launch ranges. What is needed is an overarching federal entity with budget authority (and funds) that would be responsible for space access public safety and would set standards for flight safety systems hardware, software, processes, and personnel. RLV manufacturers are justly concerned regarding the imposition of a "flight safety system" which includes a flight "destruct" system. Such a system is clearly unsuitable for a manned flight vehicle.

The space access entity would also develop and operate non-vehicle safety systems, approve vehicles and vehicle safety system interfaces, and coordinate users and nodes on the system. Spaceports would become nodes on this space access safety system. Figure 1 depicts a model for the recommended "National Space Access System".

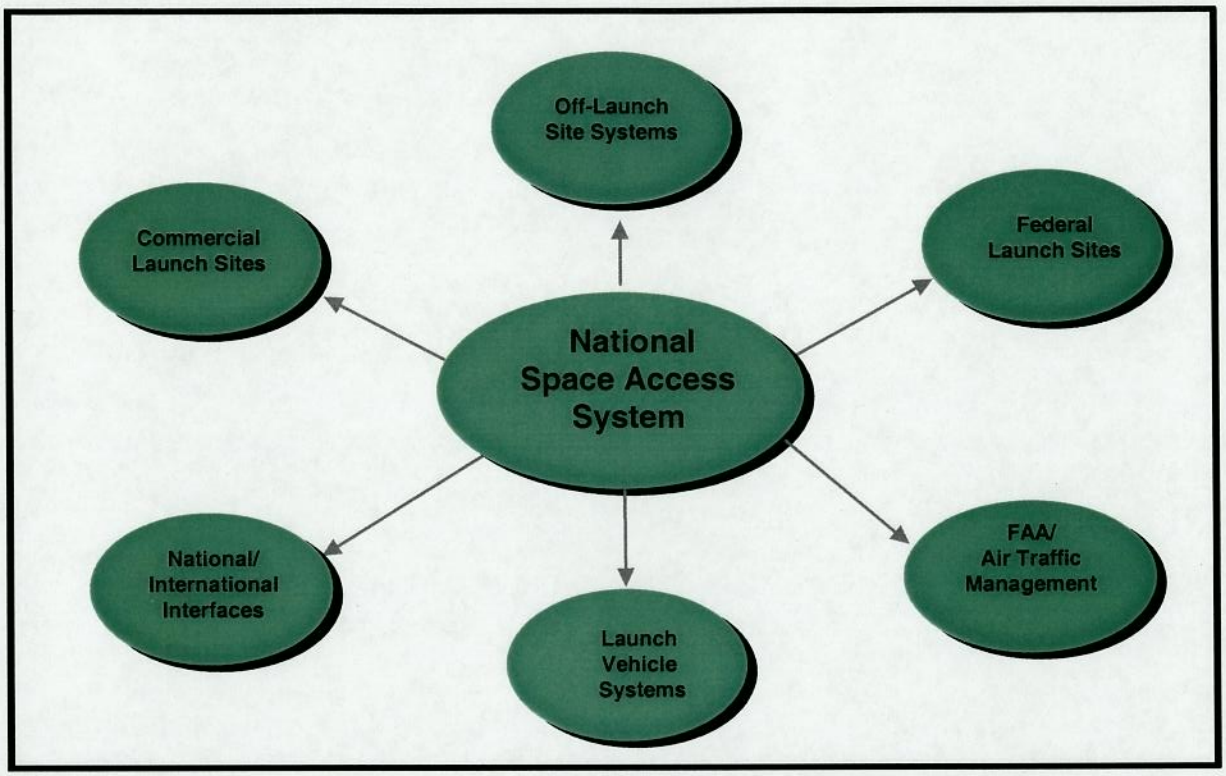

Figure 1. "Proposed National Access System"

The concept suggested in this report was developed independently from the work sponsored by the FAA in the Concept of Operations for Commercial Space Transportation in the National Airspace System, version 1.1 (CST CONOPS). The focus of the concept presented herein is upon the launch vehicle flight safety assurance and monitoring function historically provided by the federal launch ranges. The term assigned for those safety functions in this document is the "National Space Access System." The concept for the "National Space Access System" defined in the figure below is compatible with and complementary to the CST CONOPS and the FAA's 'Space and Air Traffic Management System" (SATMS) concepts.

FAA Licensed versus Unlicensed Launch Operations at Federal Spaceports.

This paradox accrues from the fact that commercial launches have historically been conducted from Government facilities. But now we have entities other than the Federal Government (State Governments and private sector entities) who have made substantial investment in creating and operating commercial Spaceports. Meanwhile, the Government continues to invest in federal launch infrastructure (e.g. EELV - a commercial vehicle) developed to joint USG/industry specifications that it deems necessary to serve the national interest. The Government intends to offer the federal launch/range infrastructure to some commercial launch operators for non-federal uses. This will compete directly with new commercial Spaceports and create an anomaly of having licensed launches (vehicles) from unlicensed sites (federal spaceports).

The Federal Government, in the recently released Report of the Interagency Working Group on Future Management and use of U.S. Space Launch Bases and Ranges, recommends that the States and the private sector assume a greater role in funding and managing the launch ranges. This presents "competition" to the potential new commercial spaceports by funding facilities that take customers away from the commercial spaceports. For States and the private sector make the desired investment, a potential for ROI must be accommodated. The States may recapture some of the investment in terms of economic development, but the private sector investment will demand a ROI, which may be in the form of reduced costs for access to space.

A better definition is required of what the Government will allow the States and private entities to provide to Spaceport customers, and then make the Spaceport the only access to those facilities/services for non-Government use. Each Spaceport must then establish a lease/use agreement with its host agency for the specified facilities/services. Facilities would still be "shared use," but for non-Government use, be licensed as part of the Spaceport.

Commercial Access to Federal Assets

Current law "encourages" the federal government to make certain space launch facilities and services available to the private sector and State governments when those facilities and services are "excess or otherwise not needed for public (federal) use."

How should the federal government equitably make U.S. government launch property available to the private sector and State governments? This is a difficult question to address and even more difficult for the government to do.

The dilemma is that the federal government cannot act like a business and a business cannot act like the federal government. At the heart of the issue is managing use (ownership, lease, temporary use) of assets that were developed by public tax dollars for government purposes for other than federal use. There are government concerns and mandates regarding "excess", schedule availability, competition with domestic sources, price setting and "fair market value", and equal opportunity for access.

As spaceports continue to evolve and develop, a classification paradigm similar to airports appears to be emerging; non-federal (civil or private), federal government, and shared use. The non-federal and federal spaceport treatment is trivial except that non-federal spaceports require access to flight safety systems only available through federal agencies.

Shared use spaceport management is not working well in its current state at the three national launch sites. The federal government is trying to live the by law to encourage, facilitate, promote commercial space launches, and facilitate State and private sector involvement in building, expanding, modernizing, and operating space launch infrastructure. However, It has found itself competing with State and private

sector investment, building facilities at government expense for the use by individual commercial entities, challenged with providing equal access opportunity to all comers, and inconsistent cost allocation to users.

This issue has been addressed in resolving similar concerns at shared-use airports. A model that provides precedent at shared-use airports is that the federal government manages those activities and facilities that are sole government use and everything else is managed by a non-government operator (e.g., GOCO, privatized, commercial). Access and use of facilities and services by non-federal users (regardless of the owner/provider) is effected solely by the non-federal operating entity, typically an airport authority.

Access to federal flight safety systems by Non-federal Spaceports is an issue of immediate concern with respect to access to federal assets for commercial use. The increasing frequency of commercial launches and development of new Spaceports not co-resident with Government launch ranges places a serious burden on the ability to conduct flight safety functions at the Spaceports.

Alaska has developed the first Spaceport that is not co-resident with a Government launch range. To support the influx of RLV's, it is likely that several more Spaceports will develop independent of Government facilities. At this time, there is no mechanism to certify non-Government personnel and equipment for use in flight safety operations. To date, Government personnel and mobile equipment have supported operations at Alaska. However, any increased pace of commercial operations (at Government and non-Government associated Spaceports) will severely tax the Government's ability to provide support. Mobile range equipment is often required for downrange tracking and telemetry following launch from a site with fixed equipment.

An investment is needed (by the Government or the Spaceports) to provide additional range safety support capability. This investment can be in additional fixed equipment/personnel at each Spaceport site, or in mobile equipment and funding for deployable launch support teams. To address the flight safety issue at new spaceports, a near-term solution could be for a federal government entity to develop and provide mobile range support, to be shared by the federal and non-federal spaceports. The labor and equipment would be "leased" to users for mission support at rates established by existing law and policy – no differently than use of fixed assets and personnel at a federal spaceport. In the longer term, an acceptable on-board tracking (e.g., GPS) and global data delivery systems might provide a more economical solution for federal and non-federal spaceport users.

Spaceport Licensing Process

What does a Spaceport need to operate safely? This is the primary question any governing body should ask. The governing body should require a spaceport and its operators to meet a safety envelope to protect people and property within a determined radius of the spaceport. Downrange safety should not be an element of approval.

Downrange responsibility should rest with the launch vehicle owner/operator. The governing authority would independently oversee the viability of a launch vehicle owner/operator being able to launch and recover their vehicle in a safe manner from a selected site. The spaceport's responsibility is to provide a site capable of safely launching and or recovering the vehicle.

Spaceports are expensive to develop. States and/or the private sector will only build a spaceport when an economically viable space vehicle is developed and produced. In addition, the site must provide a valued added component to one or more launch vehicles.

Spaceport development tied to a particular launch vehicle presents a unique situation for states and local development agencies. Funding is often tied to the specifics of a project. If a governing authority requires a launch vehicle be a part the spaceport licensing, then funding will often be tied to both the spaceport and the launch vehicle. Should the launch vehicle development be halted, then the project often dies regardless of the potential for the spaceport to serve a different vehicle in the future. This makes state programs a haphazard process that will actually slow future spaceport development rather than keeping pace with technology.

In reality, a spaceport's viability is directly tied to the type of vehicle that is proposed to launch from the site. For example, under current technology, an EELV would not be able to safely launch from an inland spaceport because the launch vehicle owner/operator could not guarantee the downrange safety. When the RLV vehicles prove their technologies they can guarantee the downrange safety. A spaceport should have the capability of pursuing a spaceport designation concurrently with these developments but not be tied directly to them.

A state will only build a spaceport where it is economically feasible and safe to operate at least one launch vehicle. States need the opportunity to follow a path independently of launch vehicles to ensure that local land use and basic infrastructure needs can be addressed in a timely manner.

SPACEPORT ISSUES AND RECOMMENDATIONS

Issue 1. There does not exist a succinct, widely accepted definition of the term "spaceport". The term is being used in many areas of government and industry to describe an entity for which there is not a universal understanding or acceptance of what it means, includes, or does not include.

Recommendation 1. The word "spaceport" and other aerospace terms relating to spaceports thereof and to place, area, or distance be defined as follows:

> "Spaceport" signifies facilities directly related and essential to servicing spacecraft, enabling spacecraft to take off or land, and transferring passengers or space cargo to or from spacecraft, but only if the facilities must be located at, in close proximity to, or in the direct logistical support path of

the launch or reentry site to perform these functions. The term "spaceport" also includes other functionally related and subordinate facilities, such as launch control centers, repair shops, maintenance or overhaul facilities, and spacecraft assembly and storage facilities that must be located at, adjacent to, or in the direct logistical support path of the launch or reentry site.

Terms defined by 49 U.S.C.A. § 70102 and other documentation include:

"Spacecraft" means any contrivance now known or hereafter invented, used or designated for navigation of, or flight in, outer space, in Earth orbit in outer space, or in a sub-orbital trajectory. The term "spacecraft" includes launch and reentry vehicles defined by statute as: a vehicle built to operate in, or place a payload (space cargo) in, outer space and a sub-orbital rocket; and a vehicle designed to return from Earth orbit or outer space to Earth, or a reusable launch vehicle designed to return from Earth orbit or outer space to Earth, substantially intact, respectively.

"Space cargo" denotes satellites, scientific experiments, and other property transported into or from space.

"Launch site" means the location on Earth from which a launch takes place and necessary facilities. The launch site may be physically separated from the spaceport, in the air, on water, or on land, but linked to the spaceport control centers, depending upon licensed spacecraft operating requirements.

"Reentry site" means the location on Earth to which a reentry vehicle is intended to return.

"Launch" means to place or try to place a launch vehicle or reentry vehicle and any payload (space cargo) from Earth in a sub-orbital trajectory, in Earth orbit in outer space, or otherwise in outer space.

"Reenter and reentry" means to return or attempt to return, purposefully, a reentry vehicle and its payload (space cargo), if any, from Earth orbit or from outer space to Earth.

Issue 2. A fragmented approach to assuring space access flight safety currently exists for the evolving space operations industry. Each national launch range has an evolutionary based flight safety system that is traditionally defense and science oriented, employs a large and costly infrastructure, funded by USAF and NASA, and is not available to all potential spaceport customers and launch providers.

Recommendation 2. A high-level federal entity (such as DOT) should be empowered and funded to develop a "National Space Access System" strategy. This strategy should be in concert with the FAA/AST integrated Space and Air Traffic Management System (SATMS). The strategy needs to encompass the various federal departments and agencies now providing space access flight safety functions. The space access enterprise should then be integrated into the resulting "Space Access Management System " consistent with the NAS CONOPS.

Issue 3. The Federal Government, in a recent report, recommends that the States and the private sector assume a greater role in funding and managing the launch ranges. This could foster "competition" with new commercial spaceports.

Recommendation 3. The federal government should work with the States and private industry to better define shared use facilities for which clear space access costs can be derived with the government and the space industry as users of ground infrastructure. Facilities would still be "shared use," but be licensed as part of the Spaceport for non-Government use. This will allow the States and private entities to provide for Spaceport customers, making the Spaceport the only access to those facilities/services for non-Government use. Each Spaceport would establish a lease/use agreement with its host agency for the specified facilities/services.

Issue 4. Access to federal flight safety systems for commercial use by non-federal Spaceports is a growing concern. The increasing frequency of commercial launches and development of new Spaceports not co-resident with Government launch ranges places a serious burden on the ability to conduct flight safety functions at the new Spaceports.

Recommendation 4. The U.S. Government, Spaceports, or both need to make the necessary investment to provide the required range safety support capability. This investment can be in additional fixed equipment/personnel at each Spaceport site, or in mobile equipment and funding for deployable launch support teams

Issue 5. Spaceport licensing is unduly constrained by the current FAA process. Licensing approval that links the development of a spaceport with a specific launch vehicle inhibits the ability of the public and private sectors from proceeding in a cost efficient manner.

Recommendation 5: Spaceports should be approved without regard to the type of launch vehicle. The regulatory authority would base its approval on the site providing services within the agreed definition of a spaceport and include basic safety including clear zones in the immediate vicinity of the site. This would ensure its presence does not present a threat to public safety. Launch vehicle licensing approval would then complete the package.

CHAPTER 2: OPERATIONS - PROCESSING, LAUNCH AND LANDING

INTRODUCTION

This chapter addresses issues relating to Federal Aviation Administration (FAA) interactions with all parties involved in future spaceport operations, including launch, landing, ground and flight operations processes. It is intended to complement the Chapter 1, addressing spaceport policy and regulation, and Chapter 3, addressing Cost and Finance.

This chapter builds on the definition of terms and the high-level description of the elements composing a spaceport that is provided in the Spaceport chapter. A general discussion of spaceport operational models follows. The ultimate goal is to identify issues, obstacles, and solutions for bridging between today's launch models, and that of a generic end state, as is specifically related to FAA interactions. It is assumed that spaceports will evolve as a subset of a space transportation industry that is supported and regulated by a structure similar to that which is currently in place for the aviation industry. This structure will obviously include an interface with the Air Traffic Management system, as described in the FAA's "CONCEPT OF OPERATIONS for Commercial Space Transportation in the National Airspace System."

This chapter was not constrained to current forecasts of commercial and government growth in the launch industry, but focused on issues and recommendations that can be used in the near term and long term. The discussion approach made no attempt to limit or restrict future launch site development, irrespective of what is currently under development or what may be possible in the near and far term.

Discussion of the future state of Reusable Launch Vehicles (RLVs) and Expendable Launch Vehicles (ELVs) was also necessary in order to frame the concepts presented. For example, it is possible that the present-day licensing regime for ELVs and initial RLVs could segue into a certification regime for RLVs. In between will likely be a period of RLV Launch licensing evolving from current ELV licensing. This evolved regulatory regime in turn will impact the evolution of spaceport facilities and services through the implementation of RLV interface safety compliance standards. Industry standards could evolve along the lines of the Air Transport Association for airlines and manufacturers of commercial aircraft for commercial development and operation.

The term "spaceport" (defined in Chapter 1), and for the purpose of this discussion includes the concept of the facilities, management and infrastructure associated with the launch/takeoff, tracking, control and recovery of space vehicles. Therefore the term spaceport provides a 'label' which the industry can use as with seaports or airports.

SPACEPORT DESCRIPTION AND DISCUSSION

A spaceport is where cargo or people embark and disembark in a mode of transportation that goes beyond the earth's atmosphere, much like an airport where

passengers or cargo embark and disembark in air travel. A spaceport should also be considered as a place to change modes of transportation, such as from ground to air, automobile to rail, rail to ocean going. It is also a center for commerce. Generically described, a spaceport is comprised of operational elements, services, and supporting infrastructure necessary for safe launch vehicle operations.

The Vision Spaceport initiative, a NASA/industry/academia partnership, has produced a detailed catalog of spaceport functions required for both existing and future space transportation system architectures. Drawing on the collective experience of engineers and managers in both commercial and government space launch operations, the partnership is now producing an operations cost model that relates key vehicle, cargo, operations, and business aspects of a space transportation architecture to its expected operational cost and cycle time. More information can be found at www.VisionSpaceport.org.

This report will focus on a high level description for the purpose of discussion of the issues. The following is provided to develop the entire framework that encompasses a complete spaceport.

Launch Operator's facilities and systems

Launch Operator's facilities and systems are those considered to be directly associated with the launch operator's operation, essentially with the operator's launch system. Although some facilities could be provided as "common use" among launch providers at a given spaceport, others would be specific to a given operator. Table 1 lists facilities associated specifically with launch operators.

Launch vehicle processing • Maintenance • assembly facilities	Launch complexes • launch pad • access structure • propellant loading equipment
Payload processing facilities	Landing/runway complexes
Operator Specific Operations Control Centers (ground, launch, flight)	Vehicle system support shops
Ground support equipment shops	Transportation (air/land/sea)
Engineering and administrative buildings	Crew operations facilities (ground and flight)

Table 1. Launch Operator's Facilities and Systems

Services & Support Functions

On any spaceport, there exist a variety of support functions and services that could either be contracted out, performed commercially, or be the sole responsibility of local, state or federal regulatory bodies. Table 2 is intended to provide a notion of those functions and services. Note that at the top of the list are safety operations. It is intended that safety functions are of prime concern, however, how safety functions

are carried out is not discussed here. Discussion regarding functions such as the current range operations is dealt with in the issues section of this report.

National aerospace control system • Air Traffic Management • Space Traffic Management • Mission Support Planning and Scheduling • Flight/Mission Safety Operations	Telemetry receivers and processing systems • Radar systems and other metric tracking assets • Optical tracking, video and photographic assets
Surveillance assets • Airspace • sea • land	Communications systems: • voice • video • data
Emergency Services • Fire department • Medical	Facilities Support • civil engineering • maintenance
Customs & Immigration	Weather measurement and prediction services
Mail service	Security

Table 2. Service & Support Functions Infrastructure

As with any seaport or airport, any spaceport will require an infrastructure to support day-to-day operations. Although there is nothing exciting listed in Table 3, the intent is to characterize the needs of a spaceport. As with any requirement of a spaceport, the driving force behind anything listed below will be the launch vehicle and payloads operating from the spaceport. As difficult as forecasting the future requirements for launch vehicles are, pre-planned expansion of initial facilities is vital to the long-term viability of the spaceport. Note that space-based systems could also support spaceport operations.

Utilities • gas • water • sewage • waste • telecommunications • electrical power	Propellant • production • storage • distribution
Motor pool	Telemetry, tracking, and control (TT&C) • Ground based systems • Space based systems
Roadways/parking facilities	Railway
Seaport	
Common use Operations Control Centers	Warehousing/storage

Table 3. Spaceport Infrastructure

Management of Assets and Control of Functions

Incorporating the management of assets and control of functions into the framework of a space transportation model has been worked from a variety of perspectives. This section will present new approaches to management of assets and control of

functions, however, for the purpose of providing perspective, references from previous reports are utilized.

U.S. GOVERNMENT REPORT

The OSTP/NSA interagency report "The Future Management and Use of the U.S. Space Launch Bases and Ranges" discusses four separate management options:

1. Public-private partnership
2. Commercial operation
3. National, state, or regional spaceport authority operation
4. Full federal funded operation.

The Interagency report also illustrates the possible shift of responsibilities as shown in Figure 2. This projects the responsibilities as they *could* exist up through 2006.

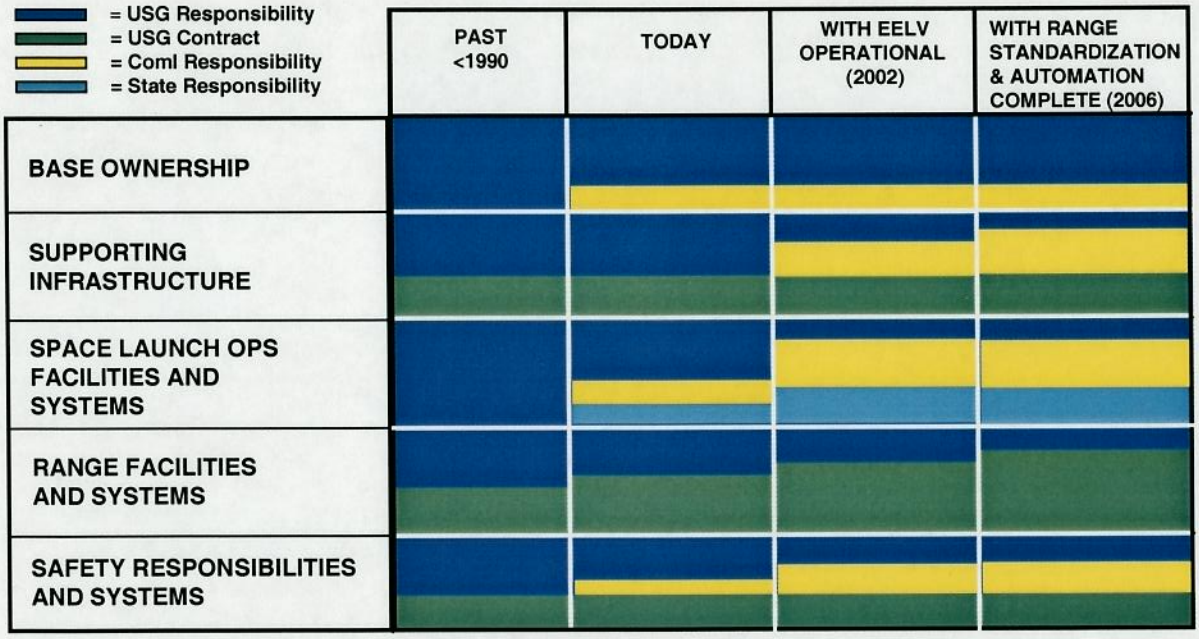

Figure 2. Current and Planned Division of Responsibilities

INDUSTRY REPORT

Boeing recently presented a concept discussing "U.S. Space Launch Range Restructuring" and a Proposed Future Conceptual Model, shown in Figure 3. This figure represents only part of a larger model which is being championed by the Commercial Space Industry Leaders (CSIL) conference. This process should be closely followed and the results carefully reviewed for application to this report's recommendations. This Figure illustrates a relationship between the FAA, the DoD, commercial spaceport and launch service providers that could exist in the future.

The intent of this model is to present an organizational structure that would provide relief to the Air Force from the financial burden of supporting commercial launches –

something the military was never intended to do. Over the years, however, this is exactly what has occurred. Although the Commercial Space Launch Act Amendments of 1988 enabled commercial launches from government facilities, the process of reimbursing the Air Force for range support does not allow the Air Force to be fully reimbursed.

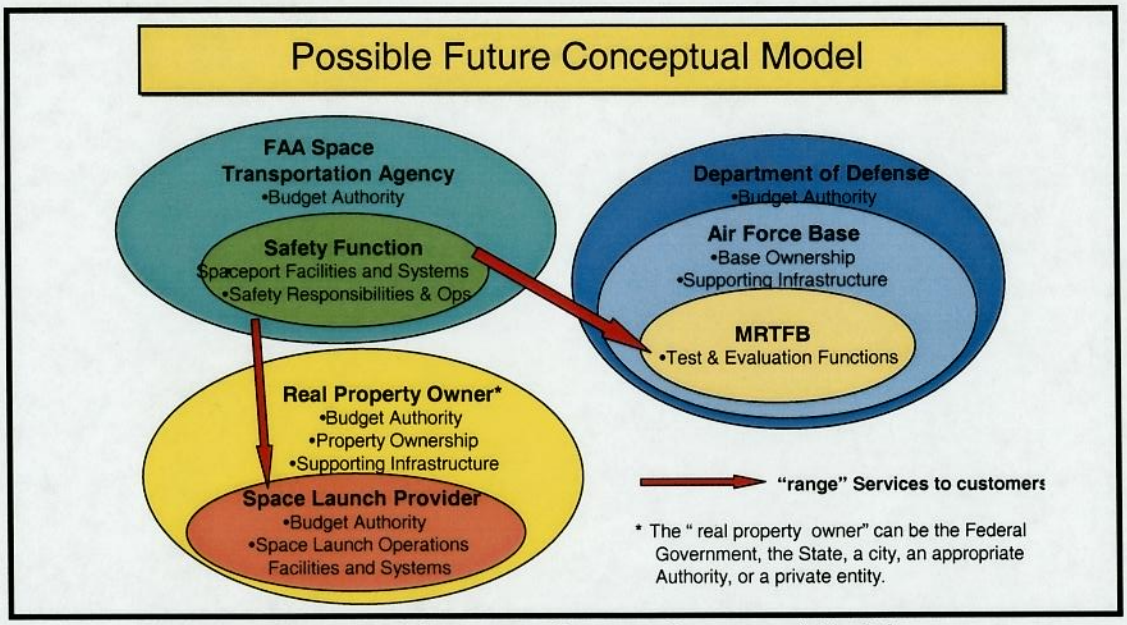

Figure 3. A Spaceport Support Conceptual Model

With the advent of EELV's and RLV's, all DOD space launches will be provided by a commercial entity. This model assumes that the DOD would obtain "range safety" or spaceport safety support for the MRTFB activities at the ER/WR. Commercial space launches would also receive safety support from the Federal Space Transportation Agency.

This model illustrates how the federal government, through the FAA or "Federal Space Transportation Agency" could be the 'single point of contact' for the range safety function in the future. The FAA could provide safety regulation standards to be implemented at commercial and military spaceports. Military spaceports may or may not utilize federal services, however, even spaceports under military control should utilize standardized safety processes, procedures and requirements. Additionally, safety would be standardized, but financial responsibility would be placed at the appropriate level – locally with the spaceport and launch service operator. Control over the spaceport would be local, yet federally regulated.

Moving from the hypothetical future spaceport design and operation can benefit from current "aviation role models" evaluation. This had lead to the review of a joint use airport model as a reference baseline, discussed in the following section.

JOINT-USE INTERNATIONAL AIRPORT MODEL AS BASELINE FOR A JOINT-USE SPACEPORT

Introduction:

As space launch operations have progressed and become more commonplace in recent years, a greater proportion of total launches are commercial. We are also seeing a move toward commercial "spaceport" development and operations. This has resulted in a greater reliance on the commercial/private sector to provide launch operations and support.

In the near-term, spaceport management and ownership could take one or more forms ranging from government owned and operated (DoD or NASA), commercial (operated by state or local governments or authorities), privately operated facilities, to a joint-use commercial/civil – military facility. The term "joint-use" more accurately reflects use of a military airfield by commercial airlines. The term "commercial spaceport" means any spaceport as defined in this section, regardless of ownership, that is organized and operated primarily as a transportation node and meets the general public use requirements of the Federal Department of Transportation.

The term "shared-use" (a commercial airport being used by commercial, civil and military users) more accurately describes the future spaceport model. For the purposes of this study "joint-use" will be used interchangeably with "shared-use". Currently the vast majority of space launches in the United States take place from Federal Government owned and operated launch facilities (currently referred to as ranges), either DOD or NASA. Today, most commercial spaceports exist contiguous with government ranges and share many of the same facilities and services. One exception is the Kodiak Launch Complex on Kodiak Island, Alaska; operated by the Alaska Aerospace Development Corporation - an Alaskan State agency within the Department of Commerce and Economic Development.

Although commercial launches in the U.S. are outpacing Government launches, there will remain a requirement for government launches, be they ELV or RLV. This may have the effect of spaceports beginning to look and operate more and more like today's joint-use airports. As there are and will be customers from outside the United States launching their payloads from U.S. spaceports, the aspects of an international airport were also reviewed.

A joint-use, military / commercial / international airport is an excellent starting point for characterizing future spaceports. The facilities, services, regulatory regime and resulting operations, with a combination of RLVs, ELVs and aircraft appear to have an almost direct parallel to existing joint-use airports operating in the U.S. today. At KSC, Cape Canaveral, and Vandenberg, aircraft operate from runways and provide logistics support as part of the "complete spaceport". The joint-use international airport model was chosen in this example to define the required services and facilities. It also offers the most rigorous regulatory environment that currently exists. National based spaceports are a subset of this larger or broader reaching international system.

The following is a top-level snapshot that considers a current and successfully operated joint-use international airport, Albuquerque, New Mexico's Sunport, and describes facilities, services and regulatory regimes that allow, or affect, the airport's operation. This description is provided as an example of one of the many possible models that can be used in developing a generic joint-use spaceport model.

A Joint-use International Airport Model:

A joint-use international airport is a carefully orchestrated blend of disparate needs that require the interweaving of many common and unique functions, management approaches and regulations. Balancing the requirements of multiple "masters", operators, tenants and support organizations demands an understanding of the individual needs of the tenants management structure, as well as their interrelationship. Using Figure 4 as a guide, there are three major areas that help define or describe such an airport:

1) Facilities,
2) Services,
3) Governing Regulation.

Within each of these three areas there are various entities that are governed by certain general and specific rules and regulations. Included are federal (DOD, NASA), state and local, commercial/civil (airlines, business and general aviation) operators, users and tenants, each having facilities they own, operate and maintain, and/or services they provide.

Facilities:

In a commercial/civil airport there are many facilities vital to airport operations. These facilities are owned and operated by the "major partners" in the airport: the federal government (FAA for air traffic control facilities), state and/or local airport authorities (the airport itself), and operators, users and tenants. Add in a contiguous military operation for a joint-use airport and the complexity of airport operations increase dramatically. Unique defense requirements of secure and separate facilities for its assets – aircraft and real property, drive the cost and complexity. Figure 4 lists the major and most common of these facilities and the responsible group (own, operate and maintain) to support operations.

Services:

Many different types of services are provided by controlling agencies (Figure 4) such as the:

- FAA providing air traffic control and other flight services,
- fixed base operator (FBO) or airport operator providing general services to the users of the airport,
- operators/users/tenants providing specialized services or services unique to their particular operation, and

- military user providing a duplicate of all the other services required for national defense.

Provider	Facilities	Services	Regulation
Government – Federal FAA	Air Traffic Control Aids to Navigation (NAVAIDS) Related Communications	ATC Safety of Flight Flight Planning Weather	National Requirements: FAA, EPA, OSHA International Requirements: ICAO, Customs, Immigration
Government – State, City, Authority as FBO	Maintenance Runways, Taxiways, Aprons, Ramps Fuel storage Terminal facilities Internal communications	Fuel/fueling (contracted out) In-terminal Food services, (contracted out) Security Parking Other Concession (s)	State/city level: FAA, EPA, OSHA
Commercial-civil Operators/Users/Tenants	Maintenance (operator specific) Ground Support Equipment Internal communications Food Service (flight kitchens) Unique cargo facilities	In-flight food services Ground support Internal communication Safety Fuel/fueling	Internal/operator procedures and policies
Military	Base Support Facilities (Squadron, Wing Ops, Base Ops, training. Etc.) Maintenance (including hangars) Military Specific aprons, ramps, etc. Secure areas Weather	Flight Planning Security Fuel Ground Support Safety Internal communications Food	DoD/Military Branch Specific (based on FARs)

Figure 4: Joint-Use Airport Model

Regulation:

Regulations, and adherence to them, are a crucial and integral part of the operation of an airport, and in the future – spaceports. Operations of, and operators flying from, joint-use airports of today are governed by multiple regulations and regulatory agencies ranging from:

- International agencies,
- National (federal agencies and departments),
- Local (states and cities),
- Internal airline regulations
- Military department regulations.

An operator flying from an international airport has a requirement to satisfy not only regulations set forth by the U.S. FAA but must also satisfy the regulations for international travel. International flights have International Civil Aviation Organization (ICAO) oversight and approvals. Airport operators must comply with the regulations set forth by these agencies applicable to airports in addition to environmental (EPA) and worker health and safety (OSHA) regulations on both the federal and state levels. Various city or airport authority regulations may also come into play depending upon the airports' individual circumstances.

Airline operators, in addition to following the requirements of the FAA and ICAO , must operate following internally generated procedures that are allowed under their FAA Operating Certificate. The DOD, and the several military departments, developed their own set of operating regulations that are generally based upon FAA regulations. They are also required to follow ICAO regulations when performing international operations. Figure 4 again lists some of the major regulatory agencies that affect airport operations.

Interrelationships:

Figure 5 depicts, at a very top level, some of the interrelationships among the various agencies, operators, users and tenants of a modern joint-use international airport.

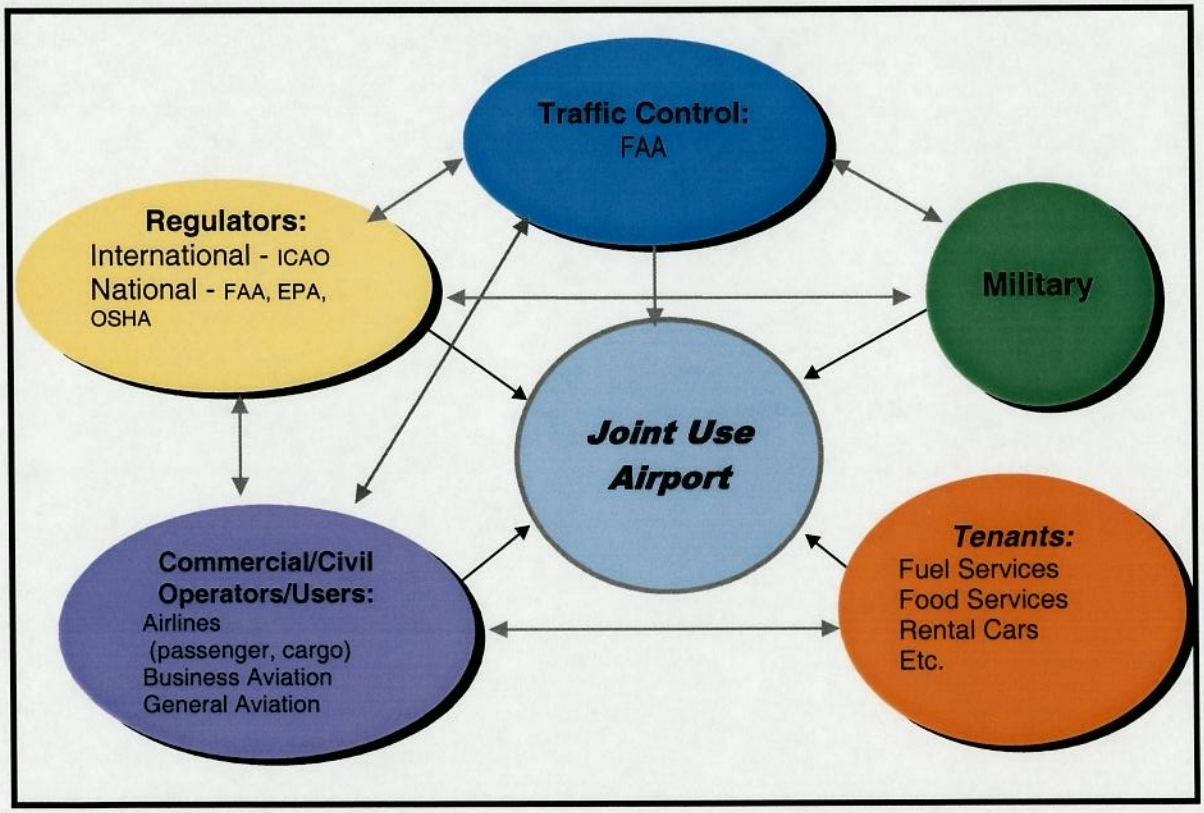

Figure 5. Joint-use Airport Interrelationships

Albuquerque International Sunport.

The Albuquerque International Sunport (ABQ) in Albuquerque, New Mexico, provides an excellent example of a joint-use airport that can be used as a baseline for developing a working model for a joint-use spaceport. ABQ is contiguous with Kirtland AFB. Military aircraft, commercial airlines (passenger and cargo) and civil and business aviation share the major airport facilities. Figure 6 outlines which agency is responsible for payment of fees and charges related to the operation of the airport.

Provider	Facilities	Responsibility
Government – Federal FAA	Air Traffic Control Aids to Navigation (NAVAIDS) Related Communications	FAA owned and maintained, close coordination with airport operator Same as above FAA owned as above
Government – State, City, Authority as Airport Operator, (or " Airport Authority")	Maintenance Runways, Taxiways, Aprons, Ramps Fuel storage Terminal facilities Internal communications	For airport owned equipment and facilities Same as above Could be arrangement between users and provider, possible airport owned and user managed Airport operator, user fees Airport operator
Commercial-civil Operators/Users/Tenants	Maintenance (operator specific) Ground Support Equipment Internal communications Food Service (flight kitchens) Unique cargo facilities Fuel storage, distribution	Airline operator Airline/operator Airline/operator Tenants, pay percentage of gross as fee to airport operator Airline/operator/other Contracted
Military	Base Support Facilities (Squadron, Wing Ops, Base Ops, training. Etc.) Maintenance (including hangars) Military Specific aprons, ramps, etc. Secure areas Weather	DoD/Military Branch

Figure 6. Joint-Use Airport Model Responsibility

The Kirtland AFB (KAFB) budget is provided through appropriated funds identified for operations and maintenance within the Air Force's portion of the annual Presidential Budget as submitted to and approved by the U.S. Congress. However, the Air Force pays an annual fee, by joint agreement, to the City of Albuquerque for its use of the runways and taxiways not on KAFB property. The Air Force also provides crash-rescue services for all airport users per this agreement. The Air Force crash-rescue personnel are trained and certified by the Air Force and the FAA. The City of Houston, Texas has concluded a more current agreement with the U.S. Government that should be researched for any detailed follow-on work in this area.

ABQ is "owned and operated" by the City of Albuquerque and the following briefly describes how the City, the FAA, the airlines, and the various tenants (including concessionaires) work together to fund the airport operations. The major airlines operating from ABQ as tenants have signed a ten-year agreement with the City and the airport operator. This long-term agreement covers major cost allocation items that include terminal rent, aircraft landing fees and the like.

A standard practice at major commercial airports is to create an Airport/Airline Affairs Committee. This Committee is chartered with determining the operating cost structure for the airport and is chaired by a representative of the airline/operator that pays the major share of all rents and charges at the airport. The other major Committee members are corporate level cost personnel from the other airlines/operators. These representatives are drawn from airline facilities or finance sections within their respective corporate headquarters. Prior to being selected to the Committee, they are required to work with several different airports to gain a

broader perspective. Airline/operator station managers are not members of this Committee. They are in charge of the day-to-day airline operations (aircraft turnaround, passenger/baggage/cargo handling, maintenance, ticketing, etc.). Airline/operator station managers may stand in for their corporate representatives from time to time, but they generally do not participate in the corporate level discussions within the Committee. Normally the station managers do not have the tools, time or experience to engage in meaningful discussions on the issues relating to the airport cost structure.

The various fees and charges assigned by the Committee to the airlines, operators, and tenants (including the concessionaires), and paid to the airport, are required to remain at the airport and cannot be included in the general City (or state if a state run airport) revenues. This is a requirement of the FAA revenue diversion rule that is described in detail in FAA Policy and Procedures Concerning the Use of Airport Revenues, dated 16 Feb 99, as codified in 49 U.S.C. Sec 47107(b), Airport and Airway Improvement Act of 1982 (AAIA).

This type of operating arrangement for determining fee structure could be adapted to apply to a joint-use, or strictly commercial, spaceport. It serves as an excellent baseline model.

JOINT-USE INTERNATIONAL AIRPORT/SPACEPORT MODEL:

Developing a joint-use spaceport model for the future becomes a matter of determining which, any or all, of the factors described above for an airport would apply to a spaceport, and what are the differences or added facilities, capabilities, services and regulations to complete the model. Figure 7 highlights the major differences to turn an airport into a spaceport (changes shown in red). The majority of the additions come in the area of facilities. This is understandable, especially if the desired spaceport has all the capabilities of an airport in order to be a multi-modal transportation center.

Figure 7 provides general facility categories that are needed for a spaceport. It does not attempt to define or describe vehicle specific facilities. The regulatory regime is still being developed and remains mostly undefined. The FAA is currently working with industry and other agencies of the federal government to establish a regulatory environment that covers increasing commercial space operations, space operators and spaceport development and operations.

There is an existing set of standards for safe handling and storage of hazardous cryogens, gases and propellants set forth in the National Fire Protection Act (NFPA). The Compressed Gases Association (CGA) and NASA also have well-defined procedures and processes for the safe handling and storage of any aerospace cryogen. The Department of Transportation (DOT) regulates the distribution of propellants, oxidizers, cryogens and gases.

This description uses one particular joint-use airport currently in operation as an example. There are many ways to assign responsibilities for facilities and services,

and the above example should not be construed to be the only solution, it is but one of many possible spaceport models.

Provider	Facilities	Services	Regulation
Government – Federal FAA	Air Traffic Control Aids to Navigation (NAVAIDS) Related Communications Aerospace Traffic Control Space-based NAVAIDS and Comm	ATC Safety of Flight Flight Planning Weather – Space Weather Orbit De-confliction NAS Integration	National Requirements FAA, EPA, OSHA International Requirements: ICAO, Customs, Immigration TBD for Space Operations
Government – State, City, Authority as FBO	Maintenance Runways, Taxiways, Aprons, Ramps Fuel depot/production Terminal facilities Internal communications Launch/Landing areas: pads, mounts, runway Propellants: including gases Common payload processing facilities	Fuel/fueling Food services(in-terminal) Security Parking Other Concession * Fueling and gases	State/city level: EPA OSHA, FAA, DOT
Commercial-civil Operators/Users/Tenants	Maintenance (operator specific) Ground Support Equipment Internal communications Food Service (flight kitchens) Unique cargo facilities Unique vehicle handling equipment Payload processing facilities	In-flight food services Ground support Internal communication Safety Payload loading On-Orbit/In space monitoring and control * Fuel production/ storage/ fueling/ gases	Internal/operator procedures and policies FAA License FAA Operating Certificate
Military	Base Support Facilities (Squadron, Wing Ops, Base Ops, training. Etc.) Maintenance (including hangars) Military Specific aprons, ramps, etc. Secure areas Weather Military specific as above for spaceport	Flight Planning Security Fuel Ground Support Safety Internal communications Food	DoD/Military Branch Specific (based on FARs)

(* denotes facility or service could be provided under other provider description)

Figure 7. Sample Joint-Use Airport/Spaceport Model

CONCEPTUAL MODEL INTERFACE ISSUES

The OSTP report addresses interface issues, from a DOD perspective, involving the FAA. Figure 8, taken from the OSTP report, presents the increasing uncertainty, with respect to management structures, of spaceports in the future. As we are in the infancy of commercial space operation, the ability of the government to enable spaceport development and launch vehicle operation are similar to that of the early days of aircraft operation. This is certainly an area that requires further exploration.

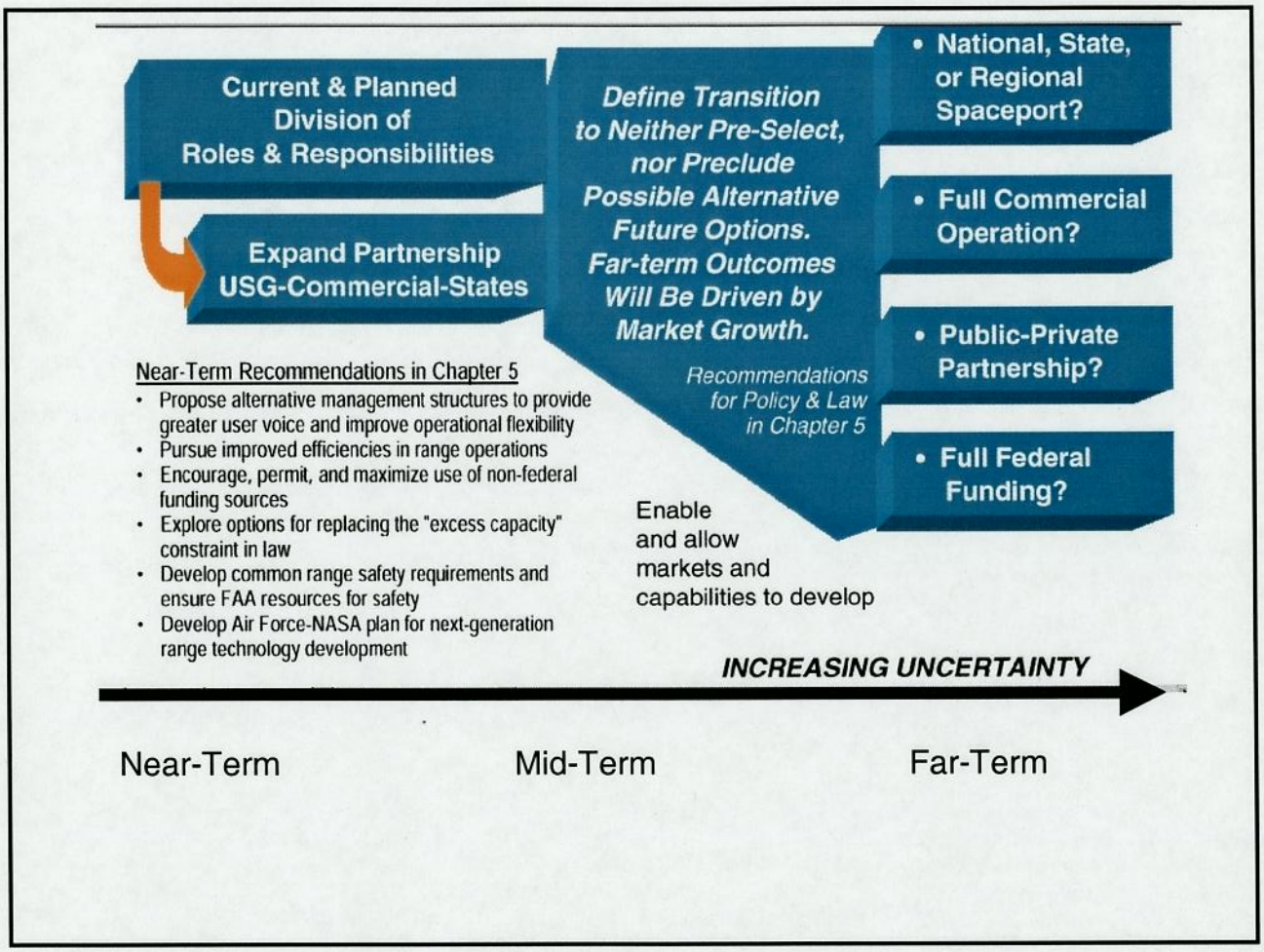

Figure 8. Recommended National Strategy

OPERATIONS ISSUES & RECOMMENDATIONS

A variety of issues exist for bridging existing space operations and the future end-state spaceport operations. The goal here is to provide recommendations to the FAA such that regulations can be developed for safe and economic operation of current and future Spaceport facilities across the United States. International regulation has historically developed around FAA policy, and as such, international considerations are also provided.

In addition, the objective is to identify issues affecting the competitiveness of the U.S. commercial space transportation industry; and to investigate approaches to modernize and improve the efficiency of launch facilities, equipment and services.

Issue 1: Consolidation of KSC/ CCAFS/VAFB space launch functions may help the current Federally owned and operated space launch range situation by capitalizing on existing synergy's, and benefit commercial operations.

Discussion : It may be feasible to consolidate KSC, CCAFS & VAFB by linking some existing assets (e.g., combining KSC computers with ROCC computers, thereby making real-time parallel operations achievable). This would increase capacity for through put. The previous discussion of a joint-use spaceport is pertinent to the discussion of consolidating KSC/ CCAFS/VAFB, whereas facilities, services, regulation, and infrastructure could be shared between both commercial and federal customers. This partnership would maximize usage of assets in a more economical manner, as opposed to having two sets of assets - one federal and one commercial.

Recommendation 1: The U.S. Government should evaluate the benefits of consolidation with respect to KSC/CCAFS/VAFB and implement viable changes. Federal spaceports should identify the items to be consolidated with input from and consultation with all parties involved, including the commercial sector, industry, NASA, the Air Force and the FAA.

Issue 2: A "Range Safety" function is mandated for all launch providers at federal and commercial "spaceports". Some "Range Safety" responsibilities will be transitioning in the future to support the shared use of the Eastern and Western Ranges and Kennedy Space Center. As such, there will be commercial and federal launch sites which share range safety resources increasingly. Should the Air Force retain current "range safety" responsibilities (herein referred to spaceport safety)? How should future Spaceport Safety be handled and who should be responsible?

Discussion : At present, the Air Force is providing support to commercial safety requirements at the national spaceports on an "excess capacity" basis. This limits the Air Force's ability to respond to commercial exigencies. Development of common safety requirements for these federal spaceports would facilitate launch operations of future commercial launch operators. In addition, skilled personnel are needed to administer and enforce safety standards. The end goal: the development of effective safety programs that are synergistic with commercial operations. These programs will span hardware, software, processes and vehicle design.

Unless an operator is flying from an Air Force run spaceport, the Air Force should not be required to retain safety responsibilities; this should reside with the FAA. This should be characterized by setting the safety standards and perhaps local operation of functions currently associated with the range safety function. Safety standards should be established through the current RLV and ELV licensing and possible future certification processes. This may mean that an "evolved range process" would be utilized by the FAA and could develop into an arrangement as described in Figure 3, A Range Support Conceptual Model. The spaceport safety function should be integral to the future Air Traffic Management System and the current RLV/ELV licensing and future certification systems. The key is to have an integrated regulatory architecture that covers all phases of launch processing, launch control and recovery.

The joint use spaceport model is applicable to addressing safety requirements for federal and commercial launches. At a joint-use airport, like Albuquerque's, as mentioned previously, military and civilian aircraft fly into and out of the same airport, adhering to a common set of safety requirements. Similarly, a set of common safety requirements could be developed for joint-use spaceports, allowing for more efficient federal and commercial operations at a given site

Recommendation 2: Spaceport Safety responsibilities for space launches should be transitioned to a "National Space Access System". The DOT/FAA should provide this function for all locations and commercial launches. The FAA and Air Force should establish spaceport safety standards for both commercial and federal launches. Commercial spaceport safety should be the responsibility of the spaceport operator as regulated/administrated by federal (FAA), state and local agencies (similar to an airport).

Issue 3: High flight rates and the intersection of domestic and international air/space will impact ground/flight safety significantly. The current "Range Reconfiguration" process does not accommodate the expected high flight rates of new RLVs, nor the "bunching" that is often seen today with DOD, civil and commercial operations. Spaceports of the future must handle expected higher flight rates for launch vehicles.

Discussion : Currently, high flight rates are considered to be 20-30 flights per year for a given launch vehicle; in the future this may exceed 100 flights per vehicle in a given year. Presently, launch/takeoff capabilities at existing spaceports would not support such a high flight rate. New reusable and expendable systems are being designed with an emphasis on operability, safety and automation (where appropriate) some of which will require considerably less support from the ER/WR.

A major limitation to flight rate today (other than launch vehicle capability) is the current function of Range "turnaround time". Simply put, the existing philosophy of Range Operations does not lend itself to the expected RLV high flight rates. The process is highly manpower intensive. Control and monitoring of individual flights should not require a complete reconfiguration of the Range system for each flight. Development of a system similar to the NAS for aircraft would be highly desirable to meet the needs of high flight rates.

Although significant efforts to upgrade the Range's are now underway, it is uncertain how much more capable the new system will be over the current system. The Range may be the most limiting function and barrier to efficient launch operation as it is central in the launch approval process.

Currently the Ranges are limited to serial launch operations and restricted by instrumentation turn-around times that include:

48 hour turn-around for the optics tracking system,
4 + hours restriction for telemetry IG,
2 + hours to re-configure the communications system.

Potential solutions might include combining radar and telemetry at the launch heads and reconfiguring for parallel range safety operations. Parallel range safety computer operations may be feasible by making KSC, ER and WR mirror images and interchangeable or adding hardware and software at ER and WR ROCC's.

Additionally, the use of a "space-based" tracking system (e.g., GPS) for range safety may have the capability of eliminating all the down-range stations and the need for a new command destruct system. Such a system is in the planning stage, having the potential of providing substantial cost savings. The space-based system could be used for guidance and worldwide tracking of an orbital or sub-orbital vehicle and fit spaceport or airport models.

RLV launch and mission management/control systems will need an interface with global air traffic management (ATM) systems. In addition, communication protocols and procedures with ATM systems need definition. Finally, a means to independently verify and validate human and electronic interfaces among the spaceport, RLV/ELV systems and ATM systems needs to be established. The FAA should be central to the development and implementation of a new system.

Recommendation 3: Develop an integrated domestic/international flight system which will address heavy aerospace traffic issues, abort scenarios for future vehicles, and other pertinent issues as they relate to flight and ground safety. A system for handling high flight rates must be developed to insure safety (population, environment, other vehicles in flight, etc.). Higher flight rates for EELV/RLVs should be accommodated by the ranges where they are subject to the "Range Safety" process. The Range reconfiguration process should be improved with available technology and procedures so that it is no longer an impediment to projected flight rates at ER and WR or other spaceports dependent upon these assets.

Issue 4: Launch vehicle safety requirements impact spaceport operations and safety.

Discussion: The Commercial Space Launch Act of 1984, authorizes the Secretary of Transportation to oversee, license and regulate commercial launch activities and the operation of launch sites as carried out by U.S. citizens or within the United States. The Commercial Space Act of 1998 revised the definition of launch to include activities "involved in the preparation of a launch vehicle or payload for launch, when those activities take place at a launch site in the United States." The FAA will

regulate vehicle processing under current RLV and ELV licensing or future certification.

Currently, the launch operator must have an FAA launch-specific license or a launch operator license. Launch and reentry of a vehicle are addressed under the launch operator's license. Once this license has been obtained, the "range requirement", or spaceport safety requirement(s) must satisfied in addition to the license. Therefor, spaceport safety infrastructure will impact the operation of the launch vehicle, and vice-versa.

"For the licensed operation of a launch site (spaceport), the FAA/AST evaluates an applicant's proposal on an individual basis. The FAA/AST issues a launch site/ spaceport license when it determines that an applicant's proposal will not jeopardize public health and safety, safety of property, U.S. national security or foreign policy interests, or international obligations of the United States."

Vehicle processing and the licensing, certification of maintenance and flight crews using established, standardized procedures and maintenance manuals developed by the launch system manufacturer are interactive with spaceport operation. These areas of discussion are best tackled by the RLV working group

Recommendation 4: Launch vehicle safety requirements that affect licensed spaceports operation and safety should be addressed as part of the current Launch operators license or launch-specific license process or possible future certification regime.

Issue 5: Commonality /standardization of spaceport Infrastructure, international standardization, and standardized payload processing will impact spaceport operations.

Discussion 5a: Infrastructure requirements such as electrical power, fiber optic communication and data lines, roadways and runways that are common use require this perspective. In addition, providing common infrastructure, as is feasible, and considering utilization of a joint-use spaceport model, would allow commercial and federal customers to spread cost of operation over a broader customer base. Launch site providers will need to forecast potential launch site operator requirements such that infrastructure capacity will support operators without being near maximum capability – a difficult task in this current environment of many new RLV concepts being proposed by several companies. When designing infrastructure, growth and simplified add-on capacity is a desired objective. New systems coming on line at CCAFS require major upgrades to the current power grid.

With respect to the regulation of launch and recovery operations, standardized interface data formats and flight plan reporting would enable more efficient and cost effective operation. The difficulty will be in establishing standardized formats, however, many in the industry would embrace this approach – especially if 'off the shelf' solutions were/are available and industry were implicitly involved in the standardization process.

Technology should be available to allow for the design and implementation of

standardized launch and landing data processing. Currently, work is being done within the Military Spaceplane Program for automated flight and mission planning for the space maneuver vehicle. Much of this work is based on existing off-the-shelf software and hardware (the software would be resident on desktop PCs) and is based on work done previously by both the military and commercial aircraft communities.

Discussion 5b: At present, foreign payloads are launched on U.S. launch vehicles from U.S. spaceports. It is conceivable that foreign operator's could launch from a U.S. spaceport. There is little international standardization in the space launch business today other than the ISO 9000 effort. Launch vehicle regulatory standards will also serve to synthesize requirements and validate RLV/spaceport operations interfaces that meet required performance and safety objectives and could provide a benefit with common infrastructure architecture.

Discussion 5c: The concept of standardized payload interfaces has more impact on economic operation of the launch vehicle and payload than on regulation of operation. Whereas safety processes or requirements could be standardized, there are many technical solutions to the payload to vehicle interface and standardization will be driven by economics rather than regulation. Payload processing facilities will be regulated by existing civil engineering standards and codes, OSHA, and EPA which are more applicable to payload facilities at a spaceport.

Recommendation 5a: Spaceport operators should take the lead in addressing standardization in partnership with spaceport providers, the FAA and the vehicle operators. Initiate an effort to identify spaceport facilities and services that merit commonality/standardization, especially with regards to items required by the regulatory regime.

Recommendation 5b: Evaluation of International standardization for spaceports should be included in the FAA CONOPS process. Standardization not related to safety should be pursued by the industry where practicable.

Recommendation 5c: The issue of whether standardized payload processing is offered should be a business decision between the launch service provider and their payload customer's. Spaceports would respond to resulting support from users.

Issue 6: Spaceports are in the development stage without the benefit of a "role" model, and are heavily influenced by geography and existing infrastructure, if any. Areas to be considered includes the concept of the facilities, management and infrastructure associated with the launch/takeoff, tracking, control and recovery of space vehicles.

Recommendation 6: A joint-use, military / commercial / international airport is an excellent starting point for characterizing future spaceports. Three major areas that help describe such an airport are facilities, services, and governing regulation. A joint-use spaceport should be closely modeled after a joint-use airport.

DEFERRED OPERATIONS ISSUES

The following issues were not addressed by the operations working group. These issues are candidates for follow on activity.

Follow on Issue 1: In an age where foreign launch customers will be flying from US spaceports, measures must be taken to protect the intellectual property of the US Government and US industry.

If the US spaceports are going to attract international launch customers, Department of Commerce regulations should facilitate the approval process while ensuring that a firewall for technologies is in place. It may be necessary to define limitations that, while protecting US interests, do not put US launch sites and launch providers at a competitive disadvantage. This is the current state of affairs with ELVs. A fresh look at how a true commercially run spaceport would be operated in an international community using the airport-based model should provide a baseline or starting point. This should be a follow-on topic to this report.

Follow on Issue 2: Spaceports must address population encroachment as this affects the interaction of launch vehicle operation and risk to population. Many airports suffer from population encroachment. As new businesses were attracted to the airports, the surrounding areas grew.
As there will only continue to be less open space in the future, city planners and spaceport planners should provide or establish inviolate buffer zones. Spaceport planners will need to establish approach and departure corridors as with military bases and commercial airports. The spaceport planners will also need to establish 'blast zones' – initially larger, perhaps reduced over time as launch vehicles evolve based upon established safety criteria.

This issue is a candidate for further discussion in the working group to determine how future spaceport layouts interact with surrounding area.

Follow on Issue 3: The risk to population value (E_c) currently used may or may not still be viable; the standard should be revisited given the substantial change in population density in the U.S. The E_c issue, or risk to population, is based on analysis of the state of affairs during the 50's (reference to GW study presented 10-99). Since population density has increased steadily and will continue to do so, current E_c requirements may not be reasonable. Although risk to population should be minimized to the greatest extent possible, it may no longer be possible to maintain the current standard.

This issue is currently being dealt with in the RLV working group. However, it should be jointly studied further as it has a direct bearing on spaceport layout and location.

OPERATIONS CONCLUSIONS

In the discussion of a Joint-Use Airport as a baseline for a Joint-Use Spaceport, Figure 5 (Joint-use Airport Interrelationships) depicts a possible inter-relationship that could be applied to future management of spaceports.

There exists many similarities between airports and spaceports and the similarities with respect to regulation are many, however, the nature of space transportation will drive many unique requirements onto spaceport standards. As such, the approach for airport regulation is applicable so long as it accounts for the unique vehicles and the demands they place on the local environment. The overwhelming need for safety standardization supports the development of FAA regulation and industry standards for compliance.

CHAPTER 3: COST AND FINANCING, COMPETITION AND ALLOCATION

Introduction

In order for the U.S. to have a "strong commercial satellite and space launch industry", that industry must be technologically and economically competitive. The Cost and Finance Subgroup identified those issues that must be addressed to ensure that the U.S. space launch industry stays economically viable.

Description of Issues: In 1989, the first purely commercial space launch occurred in the United States on a Delta launch vehicle from Cape Canaveral. Since that time, both the government and commercial industry have grappled with the proper way to allocate costs and set prices in a mixed environment of government ownership and commercial services. Although the current division of responsibility between the government and industry has worked adequately for space launch in the past, it is clear that the current model will not sustain the U.S. in the future. In a recent OSTP study, it appears that the U.S. government expects industry to increase its investment in the space launch infrastructure without a concomitant increase in industry's role in controlling that same infrastructure.

If the current model has worked well in the past, why change? Projections are that the current process will not be able to meet the launch requirements of the US. For example, a recent study by the Department of Defense concluded that "forecasted commercial missions could exceed Eastern Range launch capacity in FY00 and FY02, although the Eastern Range launch capacity may be strained in the entire FY00-FY03 period". In addition to the future capacity problem, if the trends in cost and procedural impediments at US ranges are not reversed, it will not be economically feasible to conduct launch operations no matter what the capacity.

This chapter will identify the major cost and financing issues that need to be resolved, recommend solutions where possible, and outline issues that should be addressed by future working groups.

Assumptions: The policy issues surrounding spaceport and launch ownership and operation are of paramount concern in defining the cost and financing issues. In some cases the Cost and Financing recommendations are relatively insensitive to such issues as RLV development/operation and in other areas they are very sensitive. In order to bound the problem, the Subgroup made the following assumptions.

1. The mission model projections are accurate (+/- 10%) for the next 5 years. Beyond the 5-year horizon, the mission model could clearly be impacted upward if there is a dramatic drop in launch prices resulting from the operation of RLVs.
2. The number of launch service providers will remain relatively constant for the next 5 years. While there may well be some shakeout in the number of new launch companies, at some point after 5 years, the number of economically viable launch service providers may increase significantly.

3. New expendable launch vehicles will replace older systems on an evolutionary basis.
4. While there is great uncertainty as to when commercially viable RLVs will be available, they may well have a significant impact on the cost and financing of space launch. However, for the purpose of the Subgroup, they are not expected to have a significant impact on launch operations in the next five years.
5. The U.S. commercial launch industry, under significant price competition from foreign launch service providers, will continue to be competitive with foreign sites and operations;
6. User fees, whether charged by the government or by a commercial entity, will be fair and equitable.
7. The U.S. government will continue to have launch requirements that are national security driven, although they will continue to decline as a percentage of the total U.S. launch requirement.
8. Launch service providers and spaceport operators should have an opportunity to make a reasonable profit.
9. While some ELV and RLV issues for the Subgroup are the same, other RLV issues may well be unique. However, those differences should not be a significant factor during the next 5 years.
10. Launch services and vehicles will continue their general decline in prices.
11. RLV operations will generally converge with aviation operations.
12. The National Airspace System will be responsible for airspace clearance during launch, enroute, and landing for both ELVs and RLVs.

DIVISION OF RESPONSIBILITIES

Government Role

Current federal law constrains both the Air Force and industry from establishing mutually acceptable agreements for financing and oversight of space launch operations.

Commercial Space Launch Act: The CSLA, as amended, requires the Department of Defense to support the commercial launch industry, but allows U.S. industry to use space launch facilities only on an excess capacity basis. The capacity constraints typically involve personnel, facilities, and supporting infrastructure limitations. DOD is permitted to require reimbursement from a commercial user only for any direct costs associated with its usage of the excess capacity. This limitation effectively prevents DOD from requiring reimbursement from commercial users either for ongoing fixed operational costs or for modernization of commonly shared facilities. Under the CSLA (as codified in 49 USC, Title IX, section 70111), commercial

operators reimburse the government only for those direct costs that "can be associated unambiguously with a commercial launch or reentry effort and the government would not incur if there were no commercial launch or reentry effort."

Where modifications to government facilities are required to accommodate commercial activities, commercial operators are responsible for funding the improvements. As the OSTP report *The Future Management and Use of the U.S. Space Launch Bases and Ranges* states "each of the three major U.S. commercial launch service providers have funded modifications to government launch facilities to meet their commercial requirements: Lockheed Martin funded modifications to SLC-36A to accommodate the Atlas IIAS; Boeing funded modifications to SLC-17B to accommodate the Delta III; and Orbital Sciences funded modifications to Building 1555 at Vandenberg to accommodate Pegasus processing activities." Where facilities are purely used by industry, they lease the facility and pay rent based on an Army Corps of Engineers recommended fair market value of the land and facilities.

For dedicated commercial facilities, the commercial firm must pay for all operation and maintenance and investment funding associated with the facility. According to the same OSTP study one example is the construction and operation of the Astrotech payload processing facility on Vandenberg AFB. For the new EELV program, funding for the facilities and systems being constructed for the new Delta IV and Atlas V launch vehicles will be the responsibility of industry since DOD intends to purchase commercial launch services.

DOD Appropriations/Authorizations: The various permanent and annual Congressional appropriations and authorization acts prohibit the Department of Defense from carrying on activities or expending funds in support of functions not narrowly defined to be a national security responsibility. While that approach properly provides "checks and balances" to prevent DOD from expanding its mission beyond what the founding fathers envisioned, when taken in conjunction with the limitations of the CSLA, it ensures a continuing deterioration of U.S. space launch capabilities. Industry is neither required nor permitted to contribute to the modernization of U.S. space launch facilities that it uses, and DOD is legally precluded from making up the deficient funding even if it had the resources --- which it does not.

DOD Policy In addition to constraints contained in current federal law, DOD (in most cases Air Force) policy imposes impediments to commercial financing/market entry and technical operations.

1. Impediments to commercial financing market entry. There are no existing facilities (real property) on the Eastern or Western Ranges suitable for new launch vehicles. Thus any new commercial program must secure and modify existing launch property or build completely new facilities. Either of these options requires significant capital investment. However Air Force policy is to offer short-term, joint use licenses and restrict long-term leases to those programs which are, in the Wing Commander's judgment, in the

national interest. Currently EELV related programs are the only such programs (Astrotech at Vandenberg is an exception and secured a lease before current policy became effective). This policy effectively makes any real property improvements un-financeable.

2. Policy impediments to technical operations. Air Force Space Command policy mandates certain use of certain federal infrastructure elements and deny use of others. For example, use of range communications infrastructure is mandatory but limited by excess capacity.

Underfunding

There is a consensus in industry and the government that the Air Force, as custodian of the space launch infrastructure, has not provided the required funding to maintain that infrastructure at an acceptable operational level. Over the past few years there has been recognition of the degraded state of the U.S. government launch infrastructure, but much remains to be done.

Factors: The space launch infrastructure has been chronically under funded for nearly three decades. One factor is obviously the legal constraints discussed above. A second major factor was associated with the aborted decision in the 1980s to shift all space launch to the shuttle. However, a third major factor has been the inability of space programs to have a sufficiently high priority to compete successfully in the Air Force for critical resources.

Investment History: As concluded in the DOD Space Launch Facilities Pricing – Support of Commercial Expendable Launch Industry" briefing to Dr. Paul Kaminski, Feb 7, 1997 , the "base Infrastructure (is) 30-40 years old with (a) 15-100 year life expectancy…(A) need for major overhaul may be indicated." As an example, at the Eastern Range, there was virtually no facility construction investment by the Air Force from 1965 to 1997.

Supporting Infrastructure. The same briefing found the following typical problems in the funding for the supporting space launch infrastructure at CCAFS.

(1) Water distribution. The local community water system initiated a sectional replacement program following major failures. The CCAFS system was exhibiting the same kind of failures

(2) Electrical. A survey of the CCAFS electrical system estimated that it would cost $100 million to overhaul the electrical power grid.

(3) Range. Even though the Range Standardization and Automation (RSA) program planned to invest $750 million to overhaul the range equipment over 10 years, the "funding (is) slipping to right and O&M reductions (are) not expected until '05".

(4) Commercial Users. There is "(no) economic incentive for non-paying customers to economize".

Industry Role

While the government has dominated space launch in the past, that is no longer the case. There are now more commercial U.S. launches than government launches. In addition, the government does not build launch vehicles nor does it develop innovative space launch technologies. Industry does.

The government has expressed concerns during the briefing to Dr. Paul Kaminski, Feb 7, 1997 over the "growth of non-viable private launch concerns using federal property;" "National Policy adds to oversight burden at the Wings;" "considerable safety concern over unproven technology;" "protecting numerous startup companies from full market force in midst of industry consolidation;" and "little economic incentive for industry to constrain demands on infrastructure."

Industry does not believe that it is appropriate for the Air Force, which is charged with implementing "National Policy", to characterize the associated workload as an "oversight burden". Industry believes that the Air Force should not be permitted to single out U.S. space launch policy established by the President and the Congress and define it, as opposed to any other Air Force responsibility, to be a burden. Industry fully endorses the Air Force position that full market forces should determine the winners and losers. In that context, it is not clear what continued role the Air Force has to play in continuing to operate the two major spaceports.

COST AND FINANCING

There are two separate, but interrelated, financial considerations concerning space launch for both the government and industry. The first can be loosely termed "cost", that is, the dollars required to perform space launch operations, and the amount charged by one party for hardware or services provided by another. The second area is financing --- the sources of the revenues or credits that cover the costs being incurred.

COST

In previous decades, the cost for space launch was borne by the Government. It owned the payloads, the launch vehicles, and the spaceports. Today, the payloads and launch vehicles are primarily owned by industry, but the Air Force owns the spaceports. This has resulted in an imbalance in the allocation of space launch costs for spaceports since the Air Force continues to absorb the majority of the facilities costs, but industry is the predominant user.

In the last few years, this new imbalance has been addressed in many studies such as the OSTP study *The Future Management and Use of the U.S. Space Launch Bases and Ranges,* the *Range Integrated Product Team Report* and others. In many the recommendations are similar. A few common themes are as follows:

> Conduct audit of current space launch reimbursable activities.

> Establish equitable burden sharing arrangements between the government and commercial users of the ranges.

> "Carried to the final conclusion, a minimal government work force...would provide the most cost reduction and least risk to the mission.

> "It must be left to contract management to determine the contract structure for least cost and best performance.

> In FY 1998, the majority of the launches at the Eastern and Western Ranges were non-DOD. Yet the Eastern Range received only 16% and the Western Range only 21% in reimbursements for operation and maintenance, or only a total $128 million out of the total of $731 million in total obligation authority for both ranges combined. Of that amount, "the total cost to operate, maintain and sustain the ranges in FY 98 was $452 million.

> There is typically a mix of reimbursements. For example, in 1997:

a) Lockheed Martin paid all of the O&M for SLC-36B (Atlas);

b) McDonnell Douglas paid half of the O&M for SLC-17A & B under the MLVIII contract; and

c) NASA paid all O&M on SLC-2W at VAFB for Delta II

> A comparison of the fiscal year 1998 launch schedule and the dollars paid for the two major Air Force spaceports was as follows:

	Eastern Range		Western Range	
	Launch Schedule	Reimburse-ments	Launch Schedule	Reimburse-ments
T&E	19%	17%	42%	27%
National Defense	22	25	5	50
Civil	19	40	11	6
Commercial	40	14	42	15
Other	-	4	-	2

Table 4. 1998 Range Launch Schedules

> A short analysis by DOD trying to assess industry's possible "Cost-Price Sensitivity" showed the following:

> In 1997, direct charges by the Air Force to industry generated an average of $700 thousand per launch or $12 million per year. For that same period, a "full charge" policy for the commercial industry share of costs and capital use would have resulted in the following:

(1) Generation of an additional $147 million per year from commercial sector;

(2) An increase in commercial launch costs of 10-19%;
(3) $12,000 per pound to GTO increases to $13,440 to $14,280; and
(4) a 2-3% decrease in the 38% satellite-service-provider's internal rate of return.

FINANCING

Historically, virtually all financing for the space launch infrastructure has come from the federal government via direct appropriated funding. To an increasing, but still minor, extent industry provides some financing through reimbursements for incidental minor incremental costs associated with specific launches on the government spaceports. In the last few years, industry and non-federal government entities have provided some additional financing for new spaceports. There have been virtually no direct federal subsidies to foster the development of the commercial spaceport infrastructure.

The same studies referenced above that addressed space launch costs also generally addressed the financing issues as well. A summary of the consensus conclusions is as follows:

> The government should take steps to eliminate impediments associated with using alternative sources of investment for the continued maintenance and modernization of U.S. space launch bases and ranges.

> "Unrealistic terms and conditions in the Air Force real property leases undermine the ability of the commercial launch users to make financial investments and plan commercial launch activities with long-term stability.

> Authorize commercial investments in range infrastructure.

> No new government money is anticipated to buy requisite capabilities beyond currently defined RSA and I&M programs.

> Encourage and make use of non-federal funding mechanisms to help establish a sustainable basis for funding the operation, maintenance, improvement, modernization, and sustainment of the U.S. space launch bases and ranges.

> Government will continue to facilitate commercial space activities without direct federal subsidies to commercial industry, per current policy.

> Potential requirements savings are needed to cover existing internal range program shortfalls and new priorities as well as help pay for new, as yet unfounded, commercial requirements that are critical for the future. Equally important is the capability to generate commercial investment in mutual range improvements—investment that would help directly satisfy common range. requirements

> "Industry led an Architecture group of commercial range users to develop an "investment model." The simple objective was to determine the framework for an effective business case to allow the commercial marketplace to justify internal financial support for new range modernization projects.

> The ability of the commercial users to help 'pay their way' to a commercial launch services future is the right answer.

A major issue facing both industry and the government is determining a path that will facilitate more investment in the space launch infrastructure. While there is a consensus that the past level of Air Force investment has been inadequate, there have been some recent increases in government modernization funding. Industry, however, has been reluctant to invest significant amounts on the infrastructure because these funds would be used to improve facilities either on government-owned bases, or on privately owned spaceports that would have to compete for launches with government-owned and subsidized spaceports. The fundamental financing questions are: (1) how can the government attract commercial investment, and (2) how responsible is the government for providing additional financing since it consistently recommends that it control the major space launch facilities even though it is an increasingly minor player in space launch?

The only significant way that industry can provide financing is through cash investment. The government, however, can spur financing through either direct government cash or by providing incentives for industry to invest through loan guarantees; forward purchase contracts that will provide guaranteed revenue streams; insurance/indemnification; third party debt, customer advances; regulatory costs; international liabilities; and tax incentives.

One recent proposal is the Spaceport Investment Act, introduced in the U.S. Senate (106th Congress, S. 1239), which would permit the Internal Revenue Code to treat spaceports like airports under the exempt facility bond rules. Such tax-exempt status for facility development bonds would reduce the cost of capital for development and increase the desirability of the bonds in the market place. The Internal Revenue Code of 1986 allows exempt facility bonds to be issued to finance certain transportation facilities, such as airports, docks, wharves, mass commuting facilities, high-speed intercity rail facilities, and storage and training facilities directly related to these transportation facilities. Spaceports are not currently eligible for this federal tax treatment.

Tax-exempt status for facility development bonds would significantly benefit spaceport development by allowing state and local bonding authorities to issue tax-exempt bonds for spaceport financing. Commercial spaceports meet the general public use requirement imposed by Treasury Department regulations in order to qualify as an exempt facility.

COST AND FINANCING ISSUES AND RECOMMENDATIONS

There appears to be a consensus in both industry and the government that the status quo in space launch operations is not acceptable. It is clear that the government wants to continue to have total control over space launch operations via continued ownership of the Cape and Vandenberg, but it would like to have industry pay more than it currently does for maintenance and modernization of the Air Force owned infrastructure. In other words, the Air Force recognizes that commercial space launch now dominates the U.S. market, but its solution is to require industry to pick up more of the tab with no increased voice in its operation. The Air Force has increasingly started outsourcing its infrastructure work, which may increase efficiency, but it may also be a mechanism to sidestep current laws and permit increased reimbursement for commercial work.

Ten years ago, there was a balance between the volume of launches, the control over the operational infrastructure of those launches, and the funding to maintain that infrastructure. That balance was possible because the Air Force dominated the three elements of volume, control and funding. Today the Air Force has irreversibly lost its leadership in the volume of launches, but strongly desires to keep operational control. Immediate action clearly needs to be taken by both industry and the government.

Issue 1: The Air Force aggregating for the collection of costs for the space launch infrastructure is not conducive to developing a comprehensive cost model that can be used to transition from a government dominated launch basis to a largely commercial basis.

Recommendation 1: Abolish the current five government cost/management categories of *base ownership; supporting infrastructure; space launch operations facilities and systems; range facilities and systems; and safety responsibilities and operations* and replace them with three new cost centers called *spaceport (host); launch services (tenant/user), and range/communications (worldwide range and tracking support).* This will better align actual space launch operations activities for transition to competitive operation and even ownership by industry.

Issue 2: Legislation currently prevents the Air Force from charging industry a pro-rata share of the fixed costs of the space launch infrastructure. It also prevents the Air Force from asking for funding to directly subsidize those same industry-associated fixed costs. Consequently, the infrastructure is chronically under funded and in need of a major capital infusion because commercial launches now dominate the mission model.

Recommendation 2: Congress should enact legislation permitting the charging of a proportionate allocation of launch costs to the using party and give industry management/ownership responsibilities in proportion to its share of the mission model. In addition, a mechanism should be established to ensure that these "pass

through" costs are based on those that would be in effect if market principles had been applied.

Issue 3: Despite the significant contributions of the RSA program, the federal government has underfunded maintenance of the space launch infrastructure for the last 30 years. Consequently, the infrastructure is in need of a major capital infusion to remain competitive with foreign launch service providers and to increase the throughput required to meet forecasted U.S. launch requirements. As industry assumes a significant operational responsibility for the space launch infrastructure, it may have to invest significant resources for modernization. In effect, future commercial launches will, in effect, be taxed to pay for previous U.S. government launches. In addition, there is no independent comprehensive document that identifies what needs to be modernized and at what specific cost.

Recommendation 3: The Government should fund an independent assessment by a neutral non-government entity to determine specifically what needs to be modernized and at what cost to satisfy evolving space launch infrastructure needs. The federal government should then provide a one-time increase in funding to modernize the infrastructure prior to industry assuming a significant operational role.

Issue 4: Industry is concerned that, if it agrees to fund space infrastructure modernization, this will have an adverse impact on its ability to attract launch customers and on its Internal Rate of Return. There is no comprehensive and publicly available data to validate or reject these concerns.

Recommendation 4: Industry should fund an independent review by a neutral non-government entity on the impact to industry's bottom line if it assumes a greater proportion of the space launch infrastructure financial burden.

Issue 5: It is vital to the economic and national security interests of the U.S. that we maintain a robust and, if possible, dominant space launch capability. As management of the space launch infrastructure transitions to industry, selected incentives may be needed to spur technological and financial investment in this field. Tax-exempt status for facility development bonds would significantly benefit spaceport development by allowing state and local bonding authorities to issue tax-exempt bonds for spaceport financing. Commercial spaceports would need to meet the general public use requirement imposed by Treasury Department regulations in order to qualify as an exempt facility.

Recommendation 5: The Congress and the Administration should develop a comprehensive set of incentives to spur investment and innovations in space launch operations and infrastructure. These incentives would be designed to "jump start" the transition from a government space launch industry to one that is oriented toward a purely commercial enterprise. These incentives could include loan guarantees, tax incentives, insurance indemnification, and forward purchase contracts for launch services. Specifically, it is recommended that legislation like the Spaceport

Investment Act be immediately adopted to allow spaceports to be treated like airports under the exempt facility bond rules.

Issue 6: The recent OSTP/NSC Interagency report on "The Future Management and Use of the U.S. Space Launch Bases and Ranges" recommends that the Air Force "maximize use of nonfederal funding sources". However, there is no balanced recommendation to transfer a proportionate share of the responsibility for oversight/ownership to "nonfederal" entities.

Recommendation 6: There should be a direct relationship between the level and source of financing provided for the space launch infrastructure and the size of the voice permitted in space launch operations.

Issue 7: The CSLA Amendment of 1988 intended to "provide a mechanism in which domestic launch activities can change from a public activity, which it traditionally has been, to a wholly private endeavor". In addition, OMB Circular A-76, August 4, 1983 (Revised 1999) states: "In the process of governing, the Government should not compete with its citizens. The competitive enterprise system, characterized by individual freedom and initiative, is the primary source of national economic strength. In recognition of this principle, it has been and continues to be the general policy of the Government to rely on commercial sources to support the products and services the Government needs." Despite recent increased emphasis by the Air Force on contracting out certain launch functions, the Air Force still owns the launch bases, determines what is to be contracted out, and oversees the contract operations.

Recommendation 7: The U.S. Government should not compete with private industry in those tasks, including spaceport ownership and operation, which industry is capable of performing in a responsive and economically viable manner. A mechanism should be established to ensure that commercial spaceports do not have to compete with government spaceports for space launch business on an unfair cost/price basis. The Government should develop a plan that, as soon as possible but no later than in five years, allocates a certain percentage of U.S. Government launches to take place from non-U.S. Government owned spaceports. Finally, the Government should develop a 10-year plan that, beginning in 5 years, transitions U.S. Government-owned spaceports to private ownership

DEFERRED COST ISSUES

There are several issues not addressed in this working group. It is recommended that a follow-on panel address them.

Follow-on Issue 1. The space launch operations industry supports improved government incentives. Additional analysis needs to be undertaken to assess specific industry support for loan guarantees, tax incentives, insurance indemnification, etc. Industry should provide an analysis for the various incentives and provide a recommendation to the government of the most beneficial approach.

Follow-on Issue 2. Assuming that the government and industry can reach an agreement on the size of the voice that industry will have in space launch operations, additional work needs to be done to define specific cost sharing formulas and considerations.

Follow-on Issue 3. Assuming that the Government responds to Recommendations 3 and 4 above, should the LOSWG act as the industry contact point for the government study on space infrastructure capital improvement requirements?

Follow-on Issue 4. While there are many smaller players and a whole host of potential new players, today there are only two dominant space launch companies in the US. As more and more space launch operations develop, contract and oversight responsibilities are transferred to industry, should the LOSWG consider what, if any, mechanisms can be put in place by the government to ensure that costs and prices are truly set by market forces?

Follow-on Issue 5. Vehicles launched from U.S. spaceports are currently produced, in major part, and owned by U.S. commercial or U.S. government entities. The trend, however, is toward the commoditization of space launch hardware and the internationalization of industry. There are currently various proposals being considered to launch primarily foreign manufactured space vehicles from a U.S. spaceport. Should the LOSWG address the cost, price and financing issues surrounding such proposals?