Space Commercialization

An AIAA Position Paper
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Preface

The American Institute of Aeronautics and Astronautics (AIAA) is a nonprofit professional society whose mission is to advance the arts, sciences, and technologies of aerospace and to nurture and promote the professionalism of those engaged in these pursuits. Its membership of over 40,000 aerospace professionals is drawn from all levels of American industry, academia, private research organizations, and government as well as from numerous nations abroad. The AIAA represents all facets of the profession, from aerospace's pioneers to today's cutting-edge researchers; from leaders in industry and government to the students who will someday take their places.

AIAA papers focus primarily on the technical considerations that underlie policy decisions concerning the U.S. civil and commercial aeronautics and space programs. These papers reflect not the provincial viewpoint of a single constituency, but a balanced perspective of the profession as a whole. AIAA members also speak for an industry which employs

nearly a million people, generates over $100 billion in gross domestic product, and produces a positive trade balance of over $25 billion.

I. Introduction

During the past few years increasing emphasis on reducing government budgets worldwide has forced the world's spacefaring nations to reassess their civil space programs. Investments in such space programs help build and maintain economic, political, and scientific and technical leadership. Aggressive action is clearly needed, therefore, to make U.S. civil space programs both more cost-effective and more pertinent to economic growth and other national objectives. Such action requires establishing close working arrangements among government, industry, and academia and, wherever possible, fostering commercial development of space technologies that can be pursued successfully with minimal financial government support. Applications employing such technologies currently include satellite communications, navigation and position location, remote sensing, data processing, automated systems, support services, and certain infrastructure elements, including space transportation.

A private-sector company will invest in a new business venture only if it believes that

(1) the expected rate of return on its investment is adequate to offset the perceived risk, and

(2) the amount of investments at risk is affordable.

This implies that

(a) the size of the market, both short-term and long-term, is judged to be sufficient,

(b) the various elements of risk (i.e., market, technology, cost, schedule, etc.) can be defined, are manageable, and are acceptable, and

(c) the resources required can be obtained at reasonable cost.

There are mutually supportive roles for government, industry, and academia in establishing the conditions necessary for industry to capitalize on government investments in technology development. In satellite communications, for example, the U.S. government's investments in academic and industrial research and in the advancement, development, and demonstration of a broad range of relevant technologies enhanced the ability of industry to develop products and services for a large, waiting market.

This paper summarizes the background and current status of commercial space activities, identifies the major problems (or barriers) faced by the U.S. in expanding and broadening these activities in the current changing global environment, and suggests actions to help resolve the problems and improve the environment for successful U.S. commercialization of space technologies. Definitions of terms used in the paper appear in the Appendix.

II. The Policy Environment

The current space policy environment has been shaped by legislation and presidential directives, beginning in 1962 with the Communication Satellite Act and continuing in 1984 with the establishment of a statutory and policy basis for developing U.S. commercial launch and remote sensing industries. Other statutes and federal policy directives govern global navigation and other civil space activities with commercial potential.

The first and foremost element of any policy aimed at commercializing space is the establishment of a cooperative relationship between government and industry. This type of relationship has proven highly effective in other countries, most notably Japan and Europe, in maximizing the returns on their investments in space science and technology.

In aviation, beginning with the formation of the National Advisory Committee for Aeronautics (NACA) in 1915, NACA and its successor, NASA, had primary responsibility for the development of new technologies applicable to aircraft performance, efficiency, and safety. As the field matured, NASA began to work on technology development in conjunction with industry rather than being the bellwether. As a result, NASA forged a new relationship with industry that depends on close, frequent interaction. User requirements have become increasingly more important in guiding NASA’s aeronautical technology development policies.

In space, NASA responded to presidential commercial space policy directives by establishing a number of mechanisms aimed at integrating government, industry, and university resources and capabilities; for example, the Centers for Commercial Development of Space (CCDSs); the 50 Space

Grant Consortia (SGC); the Small Business Innovative Research (SBIR) award program; the Technology Utilization and Technology Transfer programs; Joint Endeavor Agreements; Space System Development Agreements; and Technical Exchange Agreements. Recent NASA contracts incorporate substantial contractor participation in both financing and project management.

Other government policies aimed at strengthening cooperation with industry were established by the Federal Technology Transfer Act of 1986 and the National Competitiveness Technology Transfer Act of 1989. Successful past examples of U.S. government-industry interaction include Comsat, Sematech, and Spacehab.

III. Markets

Successful commercialization (or privatization) of space technologies cannot occur without an adequate market. The most successful past example of this tenet was satellite communications, where the confluence of supportive government policy and a large waiting market created a powerful new industry. That market continues to expand, with a number of new satellite constellations being developed for launch into low, medium-altitude, and geostationary orbits during the next ten years.

But even when a market exists, it cannot be exploited in the face of adversarial government policies, as was graphically illustrated by the rollercoaster-like ups and downs of the U.S. commercial space launch industry. Created by an act of Congress in 1984, the industry was stillborn by competition from the government-operated Space Shuttle, which charged artificially low prices for commercial payloads.

When that policy was changed in 1986 following the Challenger loss, the U.S. expendable launch services industry found itself trailing far behind Europe's Arianespace, whose much more efficient launch systems were developed with European government investments at low cost to the company.

Today the U.S. commercial launch industry is involved in a difficult catch-up game (with some government support in the form of international trade agreements), as more and more heavily subsidized launch service providers, especially from the nonmarket-economy nations, enter the global launch market. Moreover, recent technical problems with both old and new U.S. launch vehicles may exert pressure on the government to consider a change in its current supportive policy of launching government payloads only on vehicles manufactured in the United States.

The critical role government policies can play in stimulating the growth of new commercial markets is illustrated by two very different examples. Spacehab was able to design and develop a commercial laboratory to carry experiments on the Space Shuttle because NASA became an "anchor tenant," buying Spacehab facilities for research the agency would otherwise have conducted using government facilities, and also because the agency allowed Spacehab to delay payments for Shuttle flights, reducing the company's capital requirements by about $150 million.

(Note that although the government is traditionally considered as an "anchor tenant," a recent private-sector anchor tenancy agreement was consummated when Hughes guaranteed ten satellite launches plus ten options on a new

Delta-3 vehicle to be developed by McDonnell Douglas. Private-sector anchor tenancy is also common in aviation: a new commercial air transport development is undertaken only when a "launch customer" places a sufficiently large order).

The second example is the new satellite navigation and position-location industry, which was enabled by the U.S. Department of Defense's $10-billion investment in the Global Positioning System. The 24-satellite constellation was built for the DoD's own needs, but government policy allowed access to it by both civil and commercial users. The enormous demand for these capabilities then spawned a burgeoning commercial market for ground receivers and navigation or position-location services, including, among other customers, several automobile manufacturers and the world's fleet of transport and cargo aircraft.

In summary, the existence of market opportunities dominates the successful creation of viable commercial space enterprises. Governments can both help to ensure the adequacy of markets and reduce market uncertainty and resulting risk. Therefore, government policy is clearly a key factor in the U.S. industry's ability to exploit those opportunities. Hence the policy initiatives identified below are essential in any overall U.S. policy framework designed to enhance space commercialization.

IV. Technology

Acceptably low risk is the second key element in successful commercialization. Market and technical risk dominate space development. Both the investment and the time required to reduce that risk to acceptable levels often exceed the

allowable limits set by private-sector companies for obtaining a return on their investments. Hence the government historically has assumed the role of conducting long-term, high-risk research, technology advancement, and demonstration of prototype space systems.

This role is generally regarded as being in the national interest for noncommercial activities such as national defense, scientific research, or space exploration, and therefore is properly filled by the government. However, in past years the government also has performed this essential technical risk-reduction function to facilitate successful commercialization of technology, most notably in aeronautics and in satellite communications. This role has been justified on the basis that a healthy economy is in the national interest and that high-risk, long-term technology advancement and demonstration are beyond the financial capability of the private sector.

Nevertheless, the propriety of this latter government role is currently being questioned by the assertion that it is up to the private sector to reduce the risk of commercial development when the required technologies are sufficiently mature. This contention raises two key issues:

(1) how is "sufficiently mature" defined, and

(2) does the relinquishing of the risk-reduction role by the U.S. government compromise the competitiveness of U.S. companies vis-a-vis their overseas counterparts, whose governments do fulfill the technical risk-reduction function.

As noted earlier, the U.S. government does engage in technology transfer and does support research that leads to commercial developments. In response to critics who claim that technical risk reduction is really a subsidy, and also to meet budgetary constraints, NASA recently began to issue cooperative contracts that require substantial cost-sharing by industry in return for greater control over project management. Examples of these new government/industry partnerships include the X-33 and X-34 launch vehicle projects and the Discovery and New Millennium spacecraft programs.

Extending and intensifying such a policy could have serious negative consequences, however. For example, even if the X-33 program is successful in reducing technical risk, it is difficult to see how a private-sector company could invest billions of dollars to develop an operational launch vehicle, in the present policy environment, without some guarantee of enough launch business to return its investment in a reasonable time. In other words, the combined market uncertainty and level of technical risk create a commercial risk that is too great to warrant private-sector investment. Moreover, the current activities appear to be too narrowly conceived to achieve the desired goal of commercialization.

A policy framework is needed to team government and industry in a way that maximizes industry's ability to finance and develop commercially successful systems with acceptably low risk. Such a policy also must encompass long-term strategies, such as ensuring that the U.S. does not lose key technologies and personnel that are currently at risk due to the defense industry drawdown, and capitalizing on industry's superior ability to identify commercially valuable

long-term research areas that should be funded in cooperation with government laboratories.

V. Incentives

There are a number of incentives the government can use to encourage private investment in commercial space development. These include, for example, tax credits on R&D, on plant investments, or on sales of specific products or services; multi-year, streamlined procurement packages; forgiveness or delayed payments of use charges (e.g., for laboratory facilities on the ground or in orbit, launch facilities and services, data and data processing, skilled personnel, training, etc.); transfer of assets without full cost recoupment; indemnification from liability; and, of course, direct funding of relevant activities. State and local government incentives include support for commercial spaceports, which has been provided by several states.

Most such incentives involve some degree of subsidization, so it is necessary to formulate underlying principles which define in some detail the desirable or allowable extent of such subsidies, as well as the conditions under which they can be applied. The present piecemeal and unstable incentive structure, which is exacerbated by changes imposed from year to year by new Congresses and Administrations, does not encourage private-sector investment.

VI. Policy Formulation

For effective commercialization the objectives are

(1) to encourage industry investment that capitalizes on the government's investments in space-related research, technology advancement, and development, and

(2) to reduce or eliminate the barriers that deter industry investment.

These objectives can be accomplished by

(1) creating new investment opportunities (for example, availability of the Space Shuttle made Spacehab possible);

(2) creating awareness of government-developed technologies, opportunities, and policies (for example, publishing the NASA Tech Briefs),

(3) reducing perceived risk (for example, developing and launching the Advanced Communication Technology Satellite, providing anchor tenancy to Spacehab, and establishing a general policy of not competing with the private sector, thereby enabling establishment of a commercial launch service industry), and

(4) reducing private-sector financing exposure (for example, delaying payment of charges for Shuttle flights by Spacehab).

Government policy strategy aimed at encouraging commercialization should therefore include these key elements, many of which are mutually supportive and synergistic:

(1) Reducing perception of risk. To reduce market, technical, cost and other risks, the government should

(a) procure products and services from industry wherever possible,

(b) not compete with industry,

(c) extend and broaden patent and proprietary-rights protection when appropriate,

(d) enter into multi-year contracts with termination liability,

(e) participate in new enterprises as an anchor tenant, and

(f) support research, technology advancement, development, and demonstration.

(2) Increasing perceived return on investment. Policies should aim at reducing investment exposure by shifting a portion of the required investments from industry to government. These could include

(a) demonstration programs (which also reduce risk),

(b) industry access to government facilities and infrastructure,

(c) government participation in infrastructure development,

(d) tax incentives,

(e) favorable terms on leasing or selling facilities, and

(f) delayed repayment for use of facilities or for government services such as Shuttle flights.

(3) Increasing industry's awareness of opportunities. Government policy should support the broad dissemination of information on

(a) the results of technology advancement and demonstration programs (existing mechanisms whose effectiveness could be improved include publications such as NASA Tech Briefs and technical papers, the Technology Utilization and Technology Transfer programs, briefings to industry, symposia, and conferences),

(b) available technology transfer mechanisms (e.g., personnel exchanges, mechanisms for government laboratory personnel to interact with industry engineers, and cooperative agreements), and

(c) education and training opportunities such as joint research programs, technical interchange meetings, student and faculty internships and other similar exchanges.

(4) Creating new investment opportunities. Policies to stimulate private-sector investment in new space-related product or service areas should emphasize

(a) government-industry teaming; for example, the above-mentioned use of the Shuttle by Spacehab, and the

cooperative agreements recently initiated by NASA to create the basis for new commercial space launchers (X-33 and X-34) and to develop technologies for next-generation spacecraft (Discovery and New Millennium),

(b) stronger support for U.S. industry in international trade negotiations,

(c) creation of more opportunities for flying experiments in space, and

(d) streamlining the process and schedule for conducting space experiments.

Some of these policies have been implemented piecemeal (for example, current space policy does encourage government use of commercial products and services and fosters the international competitiveness of U.S. commercial launch companies). But creating an overall cooperative environment in U.S. government, industry, and academia comparable in effectiveness to that which exists in Japan and Europe will require the formulation of a comprehensive integrated policy framework incorporating all the above elements.

Such a policy framework need not entail direct government support of functions that are properly the responsibility of the private sector. Among the key issues it should address and resolve are

(1) use of excess assets, such as the long-range military missile components that are restricted by current policy solely to government use,

(2) setting constraints on the launching of U.S. commercial satellites or payloads by foreign launch service providers (which pits the market-share interests of the U.S. launch service industry against the satellite manufacturing and service industries' need to reduce launch costs through free competition), and defining a "fair" pricing structure for launches, and

(3) how the government should allocate scarce resources to industry i.e., acting as an investment banker) without picking "winners," which would be necessary to ensure proper use of public assets, but would prejudice the ability of other providers to engage in fair and open competition.

The overall goals of the government's space commercialization policy must also be clearly defined; that is, should it maximize jobs, or gross domestic product, or industry growth rate, or should there be some other metric by which to define success?

In summary, the general criteria for successful space commercialization are known, and a number of the specific elements on which to base an effective policy can be well defined. However, many of the important issues facing the successful formulation of a suitable policy framework have yet to be resolved.

Appendix: Definitions Of Terms

Anchor Tenancy: The government becomes a major customer for products and/or services offered by a commercial organization. The government's motivation is to create or stimulate a market that will provide sufficient

revenue to encourage further private-sector investment to expand the offering of those products and/or services to a broader range of customers. Anchor tenancy also reduces market uncertainty and perceived financial risk. [Note: There are instances in which a private-sector customer is the anchor tenant, but these cases are unusual]

Commercialization: The provision of products or services that involve private capital at risk to exploit the attributes of space and associated market applications.

Exposure: The maximum investment that is at risk. Exposure is the maximum negative value of the cumulative cash flow as measured over time. It is the maximum level of funding required by the business venture.

Privatization: The transfer of care, custody, and control of government assets to the private sector to perform the same or very similar functions. There are generally two situations in which privatization has economic merit: if the private sector can function more efficiently than the government and/or if private-sector operation can lead to market expansion.

Return on Investment (ROI): The rate of return (in percent) that results from an investment. In simplified terms, it is the financial return divided by the investment. More precisely, the ROI is normally a discounted return; that is, it is the discount rate that makes the discounted cash inflow equal to the discounted cash outflow associated with the investment.

Risk: the perceived variability of the return on investment or other financial performance measure.

Termination Liability: An agreement to assume a liability in the event of contract termination. This assumption of liability by the government reduces the investor's perceived risk.