Chapter 10

# POLICY ALTERNATIVES AND THEIR ASSESSMENT

# Contents



FIGURE

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## INTRODUCTION

This chapter brings together the background, technologies, and specific issues that are needed to formulate and analyze policy options. It establishes a range of policies that maybe considered in the light of the analysis in the earlier chapters of this report and current congressional practice and suggests a specific policy formulation. It also assesses the policy options with respect to their potential effect on existing and future programs.

Frequently, "space policy" is confused with "space program," and a review of "space policy" might be expected to provide recommendations for new projects. As understood in this assessment, space policy is the set of guidelines which establishes the goals and the institutional framework for the civilian space applications program and broadly defines its implementation. This definition of space policy includes the types of measures that are within the domain of legislative action. Specific program elements or space systems are not, strictly speaking, "policy" and are only treated to illustrate the options discussed.

## POLICY GUIDANCE: CATEGORIES AND CRITERIA

A number of general categories and criteria guide the process of formulating policy. This section summarizes some of the policies that now exist and from them develops the categories and criteria to be employed in selecting possible future policy options.

### National Aeronautics and Space Act (NAS Act)[1]

The principal guidance may be derived from the 1958 NAS Act, the existing legislative authority for the civilian space program, where there is a declaration of policy and purpose and where the functions assigned to the National Aeronautics and Space Administration (NASA) are specified. This legislation sets forth the following general categories of policy guidance:

- ***Guiding principles or philosophy.***—Such phrases as " . . . peaceful purposes for the benefit of all mankind" and " . . . a civilian agency exercising control over aeronautical and space activities sponsored by the United States, except . . . defense . . . " provide broad philosophical guidelines for the conduct of the national space program.
- ***Goals or objectives.***—The specific areas defined in the NAS Act include a very general guide to the scope of the U.S. space program, e.g., "expansion of human knowledge . . . ," "improvement of . . . aeronautical and space vehicles," "development and operation of vehicles capable of carrying instruments . . . and living organisms through space," "long-range studies of the potential benefits of . . . aeronautical and space activities," "preservation of the role of the United States as a leader . . . ," "making available to agencies . . . concerned with defense . . . discoveries (by NASA, and vice versa)," "cooperation . . . with other nations," "ground propulsion systems R& D," " . . . development of advanced automobile propulsion systems," and " . . . research . . . to alleviate and minimize the effects of disability."
- ***Organization.***–The act specified formation of a new agency, NASA, and a new coordinating body, the National Aeronautics and Space Council (which no longer exists–see ch. 3 and 9). It did not specify the internal organization of NASA, but did name the members of the Council. Several executive level positions were specified for NASA, including an Administrator, a Deputy Ad-

[1] *National Aeronautics and Space Act of 1958,* as amended, and related legislation. Public Law 85-568 (see app. i).

ministrator, and seven Associate Administrators.

- Functions.—Both the Space Council and NASA were given specific functional responsibilities. The Council was charged with: developing a comprehensive program of aeronautical and space activities; responsibility for the direction of major aeronautical and space activities; providing for cooperation between agencies; and resolving differences on aeronautical and space matters. In addition, the act specified that NASA would plan, direct and conduct aeronautical and space activities, use the scientific community, disseminate widely the knowledge it gained, and conduct R&D in specific areas.
- ***Budgets or resources.*** —An annual authorization and appropriations process was required, with no special multiyear features for longer term programs and no guidance about appropriate levels of support.

## COMSAT Act and Related Legislation

The "Communications Satellite Act of 1962" (Public Law 87-624)[2] was an innovative policy step that recognized the rapidly growing potential of space platforms for communications services as well as the need to clarify the institutional setting for providing these services. it created a new, for-profit corporation, the Communications Satellite Corporation (COMSAT), to act for the United States in establishing an international, ***commercial,*** communications satellite system. It also clearly affirmed that NASA would cooperate with COMSAT in research and development (R&D) and provide reimbursable launch and associated services.

The intent of the legislation, inter alia, was to move rapidly toward establishing such a system and to remove some of the ambiguities and uncertainties about the possible role of other firms, especially AT&T, that could have entered the international satellite communications picture. There was a clear intent to have a single global system. This was largely for technical reasons: at the time the most likely system involved large numbers of medium-altitude satellites that, as they moved in their orbits, would periodically enter and leave the fields of view of the many ground antennas sending and receiving signals through the system. The difficulties of managing multiple systems, each involving many moving satellite repeaters and the consequent high probability of overlapping and interfering signals, made a single system appear a necessity. However, experiments with synchronous-orbit platforms soon demonstrated the desirability of using high-altitude repeaters for the system, making multiple systems technically more feasible. There were also strong political reasons to favor a single multinational system dominated by the United States. In addition, the financial and managerial efficiencies of a single system were significant. Hence, the momentum for a single global system was sufficient to preserve the initial international organization that was established, INTELSAT, and more recently, to extend the concept to marine communications via a similar structure, INMARSAT.[3] Congress again acted to designate COMSAT to act as the U.S. participant in the INMARSAT system.

## Other Legislative Measures

When the NAS Act was enacted in 1958, the nature and scope of the Nation's future space activities were only dimly visible. In more recent legislation, such as in the energy field (where the technologies are better known and Congress is very familiar with the institutions), the relevant legislation has been significantly more detailed and broader in scope. While the wisdom of a detailed specification of internal agency structure and specific programs is open to considerable debate, this recent practice suggests that similar measures may properly be considered in this analysis. For example:

- ***Technology-specific goals or objectives. — In*** the energy field, Congress has mandated that certain particular technologies be developed:A electric vehicles, ocean thermal

[2] *Communications Satellite Act of 1962,* **Public Law 87-624, 87th Cong., H.R. 11040, Aug. 31, 1962.**

[3] *Communications Satellite Act of 1%2,* **Amendment:** *International Maritime Satellite Communications Act, Title V,* **Public Law 95-564, approved Nov. 1, 1978.**

[4] **Examples include:** *Solar Energy Research, Development and Demonstration Act of 1974,* **Public Law 93-473, Oct. 26, 1974;** *Geo-*

electric Conversion (OTEC) systems, photovoltaic systems, and magnetic-confinement fusion (using Tokamak devices). A comparable action in the space field might be to specify the development of a solar-electric propulsion system or a synchronous-orbit storm warning system. These examples of congressional "policy" setting come very close to being program definitions. At the beginning of this chapter, it was stated that such program definition would not be considered except as part of a larger policy framework. It must be recognized, however, that there may often be pressures to include specific technological directions in new space policy measures, and that such action is not inconsistent with the pattern set in other high-technology areas. At the very least, it is essential to consider the policy implications of mandating particular projects, including the effects on institutional structures, public-private relations, and the balance between scientific and applications programs.

- ***Tax and other incentives; loan guarantees.*** – Among the policy tools that have been used to achieve specific goals by affecting the behavior of individuals and private firms, the economic incentive has been the most typical. Such incentives have been enacted by various methods: 1 ) by adding a tax levy to discourage, or reducing a tax to encourage, specific activities; 2) through direct subsidy (e.g., food stamps); or 3) through loans and loan guarantees (to students, homebuyers, etc.). A recent example of this practice in the energy area combined all three of these incentives in the Windfall Profits/Synfuels Corp. packages

  One additional example of an economic incentive deserves further mention—i. e., a guaranteed price for delivery of a product at some future time. In some instances, where there are several potential strategies for producing a desirable product, a policy option is for the Government to guarantee to purchase a given quantity of the product at a set price, high enough to provide an attractive rate of return to the risk-taker. In such a case, the private supplier is responsible for detailed management of the project, for the technical choices that are made, and for the ultimate delivery of the product. There is limited experience with this approach, but it does appear to be applicable to Earth observations, and possibly to other space applications services.

- ***Regulatory measures.*** –Economic regulation (as contrasted with regulation to protect the public health, interest and safety) has been employed where the public interest requires a mechanism to control pricing, entry into a market, service delivery, and industry structure. A typical example is the Federal Communications Commission (FCC) operating under the Communications Act of 1934.6 In addition to carrying out its regulatory functions, FCC has recently been instrumental in allowing limited multiple entry into certain parts of the telecommunications market. h is necessary to institute some form of regulatory authority when the nature of a service makes a monopoly supplier necessary, as was originally true for the Nation's long-distance telephone system. In the early years of the system, the technology that was available required a single switched system for long-distance service. As technology advanced, at first with broad-band microwave repeater systems, and then with satellites having broad-band capabilities, the necessity for maintaining a long-distance monopoly largely disappeared. Consequently, akernative commercial systems have been allowed to compete with AT&T; many of these rely on satellites. Thus, an advancing technology that brings about changes in the market characteristics of the service system may obviate the monopolistic entity. When such a change does occur, there needs to be suffi-

*thermal Energy Research, Development, and Demonstration Act of 1974,* Public Law 93-410, Sept. 3, 1974; *Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976* Public Law 94-413, Sept. 17, 1976; and *Magnetic Fusion Energy Engineering Act of 1980,* Public Law 96-386, Oct. 7, 1980.

[5] *Crude Oil Windfall Profits Tax Act of 1979,* Public Law 96-223; approved Apr. 2, 1980 and *Energy Security Act of 1979,* Public Law 96-294, approved June 30, 1980.

[6] *Communications Act of 1934,* as amended, 48 Stat. 1064, 47 USC 609.

cient flexibility in the regulatory framework to permit both open entry and movement toward expanded competition.

- *Exemption from other /aws.*—ln many cases, the process of setting public policy requires that a balance be struck between competing constituencies, or that different incentives be offered to achieve similar objectives. When the circumstances do call for such a balance, the measures available to the lawmaker include relief from provisions of competing laws. For example, antitrust laws intended to increase competition, and thereby to provide better products and services at lower prices to the consuming public, restrict monopolistic activities of corporations. However, in some instances where the public interest seemed better served by collective action than by competition, Congress has granted statutory exemption from the antitrust laws. Examples of such exemptions include the Capper-Volstead Act of 1922, which allows agricultural cooperatives to market jointly and to set uniform prices for their products; the Norris-LaGuardia Act of 1932, which allows collective bargaining by organized labor; and the Defense Production Act of 1950, which grants a limited exemption to contractors who, at the request of the President, enter cooperative agreements related to national defense. It may be desirable to grant a similar exemption to industries that would agree to combine their resources to develop new space applications technologies.
- ***Reporting and other special requirements.***– Perhaps the most used policy requirement that has been adopted by Congress in recent times is the mandated report. One reason for these often cumbersome reporting requirements is to oblige the executive branch to attend to planning in a way that does not involve significant amounts of appropriated funds. For example, construction of a specific system such as a new strategic bomber is subject to extensive reporting and review in connection with the large annual appropriation required. A more general issue, such as the strategic posture of the United States or the tradeoffs among various new strategic weapons systems, would not necessarily be given detailed attention if a mandated report were not required. No mandate can ensure that the response will be of high quality, that attention will be paid to the issues specified, or that the deadline for the report will be met. In fact, congressional mandates have been increasingly ignored or given such cursory attention that their original intent has been negated. With the pressures of the congressional calendar making it difficult for members to oversee the tremendous volume of laws already enacted, there are many cases of missed deadlines, inadequate responses, or complete lack of attention which go without significant congressional objection. This causes the process to break down even further. Nevertheless, a mandated report, if properly followed up and if the necessary resources and time exist to complete it, can be a useful policy tool—particularly if it is part of a larger policy initiative, or if the leadership for ensuring its preparation is clearly specified.

  In addition to mandated reports, there are several other requirements that may be included to encourage greater attention to overall policy: 1 ) establishing an advisory mechanism that utilizes relevant expertise outside of the particular agency or department involved; 2) specifying project milestones or “sunset” provisions to be met before additional authority or budget is provided by Congress; 3) requiring coordination with other agencies or with specific international bodies.

## Additional Considerations

These general areas of policy development provide wide latitude for responding to the issues facing the civilian space program today, and for generating innovative approaches to emerging questions and future problems. In evaluating specific options that fall within the general types of policy, the following questions need to be considered:

- Is ***it feasible?—I*** n this assessment, the term “feasibility” will be used to imply that prospective policies are consistent with an accepted understanding of the appropriate roles of Government and the private sector, the separation of powers between Congress and the executive branch, etc.; in other words, that the option does not require a revolutionary change in current practice. The assumption is that changes that are less disruptive and evolutionary in character will have a greater likelihood of serious consideration and possible adoption than more revolutionary measures, and that the benefits of the civilian space program, however great, do not justify radical changes in American institutions and practices.

- Is it ***in the public*** interest?—The motivation for making changes to space policy is to serve the public interest and not just to promote a particular constituency or industrial sector. Hence, an additional test for acceptable policy changes would be (among other factors): does this change promise greater public benefit, in lower net costs, better services, more rapid introduction of new services, a favorable distribution of expected benefits, an improved competitive position abroad, or enhanced national security?
- ***Can it be*** implemented?–This again is largely a question of judgment in determining (on the basis of experience or other data) that a desirable policy change may or may not be capable of being implemented in the "real world, " given practical questions of timing, cost, depth and extent of previous commitments, institutional inertia, or an inability to dictate a course of action to other nations. In such judgments, there will always be room for debate. Therefore, wherever it is appropriate in the policy synthesis, questions of U.S. ability to implement a policy will be highlighted.

In summary, the foregoing discussion has focused on the major questions that should be considered in order to evaluate possible policy options. It has also identified the general classes of policy initiatives that appear to be relevant to space applications. The next section will review the major issues and problems with our current situation that prompt the search for new policies and solutions.

## SUMMARY OF ISSUES

The search for new policy options is stimulated by the belief that significant new services, and consequent public and private benefits, could result from a vigorous exploitation of current and future innovations in space. The Government may promote such new systems through policies that will, inter alia, lower barriers that may exist; provide new mechanisms for interested parties to cooperate; and, in general, encourage public and private investment in space applications commensurate with the prospective benefits to society.

In this analysis, we proceed from a basic premise—that the existing policy framework, which has served to organize the Nation's initial efforts in space, should be reviewed for possible changes in the light of current and emerging technology, as well as the more than 20 years experience in space operations that the Nation has acquired since Explorer 1. The following factors make the present a particularly appropriate time for review: the advent of the shuttle and the conditions of fiscal stringency that may lead to a reduced effort in large-scale engineering development for NASA; the appearance for the first time of significant economic competition from foreign countries; the rapid development of military space systems; and the prospect of new commercial opportunities in remote sensing and materials processing.

The flaws in our existing policy cannot be attributed to a single overriding cause. In a number of ways, it fails to provide the kind of stimulus and guidance to our national space efforts to ensure that the country's public and private resources are used in the most beneficial fashion. This shortcoming is highlighted by the fact that several foreign countries intend to develop their own space applications systems, some of which will be more advanced, and more suited for applications, than are comparable U.S. systems. The growing domestic interest in space is evident in industry initiatives and congressional hearings on space policy,[7] recently introduced legislation,[8] the growing number of voluntary space associations (see ch. 5); and efforts by individual entrepreneurs to develop private launch systems and satellites. All of these varying developments reflect the remarkable maturation of space technology over the past decade, as well as the great but unfulfilled promise that further development offers for delivering useful services, gaining international prestige, and satisfying the human spirit of adventure.

Implicit in the concerns of the constituencies mentioned above is the claim that, compared with the potential benefits to be achieved, U.S. investment in civilian space applications may be misdirected or too low. This claim raises two important questions: 1) What is the relative importance of increased public or private investment in space applications as compared with alternative investments (in defense, social programs, new plant and machinery, etc.)? 2) What are the possible benefits or returns, and to what degree can one ascertain their extent and magnitude?

These issues be will be implicit through the sections that follow; briefly, we can respond thus. First, the claim that we are investing too little in space applications does not imply that we are also investing too much in other worthwhile areas. Furthermore, opportunity costs in the public policy arena cannot be rigorously compared. The resolution of the annual conflict among alternative allocations of public resources is necessarily political, subject to all the vagaries of human judgment, prejudice, and intuition. Much depends on the overall resources available, and hence, on the state of the national economy and the Federal budget. To require that investments in space applications be explicitly compared with other alternatives is to apply a constraint that is inappropriate to public policy issues. Nevertheless, in a period of fiscal restraint and intense scrutiny of all Government expenditures, the space program can expect to have to defend its claim to a share of Federal revenues, and to justify its programs by arguing that they contribute to national goals such as defense or increased industrial productivity.

This situation is made difficult insofar as many of the societal benefits are not immediately realizable or are difficult, if not impossible, to quantify. They include such abstract notions as international prestige, national self-image, and incentives to individual achievements; a single mission or project is often not easily identified with a specific set of benefits. For example, the successful flight of a meteorological satellite does not generate public attention in the United States. However, not only do large segments of the U.S. economy depend on the accurate data such satellites provide, but other nations around the world are eager subscribers to this information and see the United States in a more positive light because of this service. It is the accumulation of many such small but significant positive effects that constitutes the sum of intangible benefits from the national space effort.

Because of the effects of space investments are derived primarily from many small, though by no means insignificant programs, it is difficult to sustain public investment at a level and scope appropriate to the potential of the consequent benefits. Partly for this reason it is important to consider public policy incentives for private sector space investments that could complement or substitute for direct public expenditures. Private investment will occur only if the benefits (usually in the form of direct profits) to the private investor are relatively assured (i.e., low risk), and are of sufficient magnitude to be attractive in comparison with other alternatives. Policy incentives must promote these conditions while ensuring that the public and national interest are also served.

[7] *United States Civilian Space Policy,* hearings before the Subcommittee on Space Science and Applications of the Committee on Science and Technology, U.S. H. R., 96th Congress, 2d sess., July 23, 24, 1980, No, 152, USGPO, Washington, 1980.

[8] For example: *The Space Industrialization Act of 1979;* hearings before the Subcommittee on Space, Science and Applications, of the Committee on Science and Technology, U.S. H. R., 96th Congress, 1st Session, on H.R. 2337, May 22,23, and June 26,27, 1979, No. 47.

[9] For example: Carl Sagan's "Planetary Society," which has an active, informed and rapidly growing membership.

The issues discussed in this chapter derive from, among other sources, a series of workshops held at OTA for the purpose of identifying the major issues or concerns facing the U.S. space program (table 1, in ch. 3) and suggesting policies that might be adopted to resolve those issues.

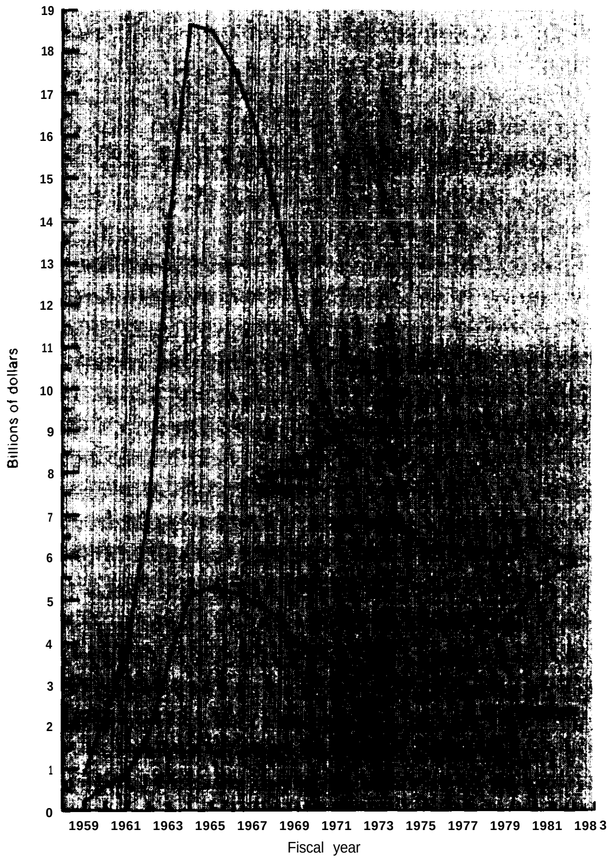
## Need for Consistent High-Level Attention to Space Policy

Current space policy does not translate easily into a set of specific goals, program areas, or mission opportunities. Hence, during periods when there is a national preoccupation with social, defense, or economic issues that bear no direct relation to the civilian space program, the process of planning and budgeting for specific missions may fall victim to lack of high-level attention and focus. Because there is no current long-term commitment to specific goals (after space shuttle development is complete), and because the most recent presidential statement on space program goals (by President Carter in 1978)[10] was vague with respect to the content and timing of future objectives (beyond "utilization of the shuttle"), annual budget and program decisions have tended to be made ad hoc. When decisions are made in the context of annual budget preparations, they unfortunately are biased by the restricted nature of the forum (primarily discussions between the agencies with space allocations in their budgets and the Office of Management and Budget), and by the tendency to look for short-term economies, to shrink or limit programs and future-year costs, to refine and improve management, and to fit the program into a budget target. While these are necessary and important management considerations, they are not suited to developing and identifying a creative program or a national commitment to long-term space program goals. For consistent, long-term policy objectives to be developed and carried out, the budget process must necessarily follow policy guidance, and not the reverse. Without such policy commitments, the annual budget process will result in mission deferrals, stretched schedules, and even cancellation of well-developed projects, adding up to a waste of scarce resources. All of these have already occurred in recent NASA budgets.

## The Executive

In the Carter administration, several major interagency reviews of space policy were carried out under the aegis of the National Security Council, and in the process a Policy Review Committee (PRC) for space was established with the Director of the Office of Science and Technology Policy (OSTP) as the chairman. The issues reviewed during this period involved principally space applications and the civilian/military interface, and led to three (classified) Presidential directives and several public statements concern-

**Figure 16.-Civilian Space Budget**




NOTE: 1959 DOD transfer = $146.6 million for appropriation, $640.6 million for constant dollars, 1961 DOD transfer = $2.7 million for appropriation, $11.0 million for constant dollars; transition quarter *(period between 1976 and 1977)* = $932.2 million for appropriation, $1,638.8 million for constant dollars.

[10] "White House Fact Sheet, U.S. Civil Space Policy, office of the White House Press Secretary, " Oct. 11, 1978.

ing: 1 ) assignment of responsibility for operational satellite Earth-sensing systems to NOAA; 2) transition to commercial operation for Landsat; and 3) general civilian space policy .11 In the Reagan administration, the PRC (Space) has been abandoned and an independent review of the Carter administration decisions and other space program questions is underway (see ch. 6 for a description of the review). One of the principal participants in this review is the Director of OSTP. In the 1976 legislation establishing OSTP, the Director is given a broad assignment that includes providing the President with analyses of major policies, plans, and programs involving science and technology. Among the priority goals delineated for science and technology is "advancing the exploration and peaceful uses of outer space."[12] OSTP can act as a focus for space policy development, provided: 1 ) the President determines that he wants OSTP to play such a role, and 2) there are enough personnel and funds available for the Office in addition to its other responsibilities for science and technology policy. Currently, OSTP'S limited budget and staff resources (approximately $1.5 million in fiscal year 1982 and 11 permanent positions) make it difficult for the Office to assume a major continuing role in evaluating space policy.

Despite the efforts of the Carter administration, two major problems with Executive direction of the space program have arisen in recent years: 1 ) ***failure to identify and commit to major new goals,*** and 2) ***failure to implement programs*** to accomplish goals already announced or identified. These problems suggest that the Executive has been ineffective in focusing its attention on the space program, because of pressure from the external environment (such as budget constraints and an emphasis on national issues that are not clearly addressed by the civilian space program) and because of internal difficulties (such as the administrative structure of NASA, and the determination to complete current large programs such as the shuttle). Better procedures are needed periodically to focus high-level attention on space program needs, procedures that will fix a continuing defined responsibility for developing space program goals and objectives, reviewing the plans to achieve the objectives, and identifying the resources that may be required. This responsibility would include periodic public presentation of the goals and objectives developed by the executive branch to Congress for debate and ratification. A forum for implementing these procedures could have a broad scope, defined in detail by Congress, or its responsibilities might be described by Congress in general terms, with its detailed structure to be determined by the executive branch.

It should be noted that, in its original form, the legislation establishing NASA also created a coordinating mechanism, the National Aeronautics and Space Council (NASC), whose responsibilities included civilian/military coordination and, more significantly, development of "a comprehensive program of aeronautical and space activities to be conducted by departments and agencies of the United States. " The Council was abolished by President Nixon in 1973 at the same time that the Science Adviser's Office was removed from the Executive Office of the President. The President's Science Advisory Committee was also abolished. This now defunct NASC is one example of an executive branch mechanism that could satisfy the needs identified above. NASC'S original functions and composition should be reviewed in the light of developments in current technology and changes in agency relationships. The scope of its responsibilities would have to be clarified: would it be limited to civilian programs only? to the **civilian/military relationship?** or extended to include both civilian and military programs, and private sector activities?

## The Legislative

Congress, insofar as it oversees and reviews executive branch agencies and programs and initiates and passes on legislation, is an essential part of the policy process. Committee hearings bring forth critical issues for public airing and debate, and staff papers, investigations and congressional

[11] Ibid.

[12] *National Science and Technology Policy, Organization and Priorities Act of 1976,* Public Law 94-282, May 11, 1976.

[13] Reorganization Plan No. 1 of 1973, 38 Federal Register 9579, Apr. 18, 1973, 87 Stat. 1089, abolished the National Aeronautics and Space Council together with its functions, and the Office of Science and Technology, efective July 1, 1973.

agency reports all contribute to the review framework. In addition, major policy initiatives frequently originate in Congress. The COMSAT Act,[14] for instance, had its origins largely in Congress, though it was well supported at the time by the president and his advisers.

Congress' watchdog role, primarily determined by the yearly budget cycle, often leaves congressional committees at a disadvantage with regard to setting policy. They can be so caught up responding to initiatives from the president, that they are unable to take the time to formulate policy or to form a long-term vision of national programs.

In addition, the present committee structure, in which several different committees have jurisdiction over different parts of the space program, makes it difficult to consider the program as a whole. In recent years, there has been no central focus in Congress for space matters. The Congressional Space Caucus recently formed in the House of Representatives may provide an informal forum for discussion of space program priorities and direction within Congress. Its formation reflects the concern of some members about the uncertain direction of the U.S. space program. Neither it nor policy studies can substitute for a broader, sustained debate on the place of the space program in the totality of national objectives, in which all the major actors are represented.

### Institutional

In developing space telecommunications, the U.S. founded new national entities and international structures that would design and procure satellites, operate the systems, and provide services to international users. These measures enabled private capital to flow into the system, resolved Government/private sector relationships, and started the commercialization process that led to a larger array of services. Many of the national and international problems confronting the united States at the time COMSAT and INTELSAT were established have analogs in the current situation in remote sensing and in other applications areas. For example, there is no clear guidance regarding the nature of commercial involvement in operational systems, whether existing or new entities should play a role, whether Government will purchase services or fly its own systems, or whether the United States will favor international competition or a cooperative framework. It should also be noted that today's circumstances have characteristics that are quite different from those encountered in the early 1960's. Then, there were no reliable vehicles to launch competitive communications satellites beyond those controlled by the United States and the Soviet Union; there were no real alternatives to cooperation. The character of the market was also very different, International communications was a well-developed business involving long-distance underwater and subsurface cables, high-frequency radio, and microwave links for short distances. Government agencies or private concerns were engaged in supplying services, so that adding a satellite repeater was a relatively straightforward step in extending and improving this existing business base. Customers were identified and demand was already established, factors which provided a solid base for the rapid development of the space segments—particularly with the better quality service that was provided.

A major issue therefore is: Are there alternative institutional frameworks that would facilitate development of desirable new space applications services and overcome barriers that exist, whether from lack of a clear national policy, underdeveloped markets, or other uncertainties? An associated issue is: Can the private and public sector roles be more clearly defined to assist in more effective and timely exploitation of space applications opportunities? A further question of importance is: Should NASA be given responsibility to operate space applications systems?

### International

Space activities (outside of short-duration vertical sounding rocket flights), unlike many other areas of national endeavor, cannot be confined to the region over a given nation's territory. Orbital flight inevitably brings the space vehicle over other nations. In the 1967 Treaty on Principles *Governing the Activities of States in the Explora-*

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[14] Op. cit., *Communications Satellite Act of 1962.*

***tion and Use of Outer Space, Including the Moon and Other Celestial Bodies,*** "outer space" was recognized as a nonappropriable area analogous to the high seas, and hence open to use by all nations. Policy regarding the well recognized international character of space activities was established in the NAS Act, where the guideline of "peaceful purposes for the benefit of all mankind" was fundamental to the U.S. program. In addition, U.S. activities were to be conducted so as to contribute materially to the following objective (among others): "Cooperation by the United States with other nations and groups of nations in work done pursuant to this Act and in the peaceful application of the results thereof."[15]

in applications, there are several national concerns that may limit our ability to obtain international agreements on the development and use of space systems. The United States has traditionally advocated open access to outer space and free commercial competition, but this position has been increasingly challenged by Communist and Third World countries which favor restrictions on space activities. In pursuing new opportunities for applying technology to space, the United States must weigh the national benefits accruing from aggressive competition against the need for, and benefits from, broader cooperation in the international arena.

The issues to be addressed include: 1) What benefits has the United States received from its cooperative programs? 2) How is the desire for cooperation to be reconciled with maintaining U.S. preeminence? 3) How should the United States respond to the growth of competitive space applications programs in Europe and japan? 4) Are there benefits to be gained by internationalizing civilian Earth observations satellite systems? How can they be realized? 5) What framework would enable systems to be established which would gather global information on topics of broad common interest, such as ozone concentrations, carbon dioxide levels, and biomass inventory?

[15] Op. cit., *National Aeronautics and Space Act of 1958.*

## POLICY SYNTHESIS

The kinds of legislative and policy options, the categories and criteria for their evaluation, and the major issues involved, have now been identified. This background enables us to outline a number of specific policy options available to Congress for more detailed consideration. **In the next section, we integrate selected options into compatible and coherent packages.** The various options are organized by the issues which suggest them.

### Need for High-Level Attention to Space Policy in the Executive Branch

The range of responses to deal with this issue is very broad. Possible actions by Congress include the following:

- Reestablish the National Aeronautics and Space Council (NASC).
- Form a Presidential or National Commission
- Establish a new department.

#### Reestablish the National Aeronautics and Space Council (NASC)

The NASC was disbanded in 1973 together with the Office of Science and Technology (OST) and the President's Science Advisory Committee (PSAC), as part of a move to reduce the size of the Executive Office and remove so-called "advocacy" groups from immediate proximity to the President.[16] OST was reestablished by legislation (as OSTP) in 1976[17] but no strong constituency emerged to press for the reestablishment of NASC at that time. The original charter for NASC in the 1958 NAS Act implied a strong need for conflict resolution and better coordination among agencies engaged in space activities. At present, the

[16] Op. Cit., Reorganization Plan No. 1 of 1973.

[17] Op. Cit., *National Science and Technology Policy, Organization and Priorities Act of 1976.*

needs for high-level coordination as well as for "a comprehensive program of aeronautical and space activities . . . ," as stated in the original NASC legislation are of critical importance.[18] A reestablished NASC might provide a suitable forum to focus attention on space program goals and objectives, problems of program coordination, competing claims of different interest groups, and a variety of other matters. Whereas the old NASC was composed of members from NASA, the Departments of Defense, Transportation, State, and the Atomic Energy Commission, membership in a new NASC should be broadened to include Agriculture, Interior, and Commerce (NOAA). The original NASC was chaired by the Vice President, who was considered a neutral arbitrator with access to the President; with the addition of observers from the Office of Management and Budget and the President's Science and Technology Adviser, a new NASC would bring together all the major Government space interests. It could serve to generate the needed commitment to specific program content, aid in preparation of annual budget proposals, and give the space program higher visibility with the President. The Council probably should have a central staff working for an Executive Secretary, although the staff could be primarily composed of detailees from the agencies involved. Only a few professionals would be needed on the staff in order to perform the basic Council tasks. However, adding the requirement of an annual report would increase staff size appreciably. Occasional reports to the public on space program goals, plans, or achievements could be part of the output of a core staff.

The Reagan Administration does not appear to favor new entities in the Executive Office, although topical committees of the Cabinet have been formed for specific policy areas. The NASA Administrator does not have Cabinet status and therefore is not represented at this level. An exception has been the appointment of vice President Bush as chairman of a committee for regulatory review, demonstrating that it is possible to have the administration accept a new entity in the Executive Office under the chairmanship of the Vice President; however, the space program does not appear to have high enough priority in the administration for this sort of treatment. Therefore, it may be difficult for Congress to establish any new mechanisms for defining and coordinating space policy, whether it is a new NASC or another option.

The existence of an NASC would enable agencies to focus their policy concerns at a high level, with the prospect of influencing critical decisions. {t would remove overall program content and strategy decisions from a strictly budget-oriented setting, as is the case today. This would greatly enhance the likelihood that long-term programs and goals can be agreed upon and effectively pursued. By having the Office of Management and Budget (OMB) represented as an observer on the Council, deliberations would have the benefit of a realistic view of the budget situation. It should be understood that the deliberations of a reconstituted NASC would not receive adequate attention from either the agencies or OMB, unless there were direct Vice Presidential interest and involvement. This would carry with it the prospect of direct contact with the President, and would make the difference between a Council with little or no power and a Council with an important role in the policy process.

Annual expenditures by the Federal Government for civilian and military space activities exceed $10 billion, all of which is "discretionary," i.e., not subject to a mandated formula or specified service. A body such as the NASC would enable these expenditures to receive the high-level review and attention appropriate to their national significance.

### Committee of the National Security Council (NSC) or a Subset of a "Cabinet Council's" Responsibilities

Because it concerns the internal management of the Executive Office, this option is not amenable to congressional action. It has been included here for the sake of completeness.

In the Carter administration, the lack of a high-level policy focus in the executive branch was recognized as a problem, and the solution was the formation of a Policy Review Committee for

[18] Op. cit., *National Aeronautics Space Act of 1958,* title II, p. 4, sec 201, d-2.

Space (PRC-Space) within the structure of the NSC. (In the Carter administration, there were various PRC'S dealing with specific national security areas). The chairman of the PRC-Space was the Director of the Office of Science and Technology Policy (OSTP). By contrast, the Reagan administration has favored routing space issues through a new "Cabinet Council" managed by White House staff, with advice from the Director of OSTP and the Special Assistant for National Security Affairs (see ch. 6).

By using the NSC structure for space policy review there is a rather strong orientation toward national security and military affairs. The civilian space program, while sometimes having a strong international impact, has traditionally been separated from specific military and national security programs. NSC is managed by a foreign-policy oriented staff with little of the necessary background in dealing with commercial or technological concerns.

While the OSTP Director is a relatively neutral figure, the stature of his office vis-a-vis the White House has varied considerably and does not compare with that of the Vice President. On the positive side, NSC has typically been a very important focal point for setting policy in recent administrations, so that issues raised in this forum usually reach the President for decision. This provides a degree of access not easily matched except by OMB and the key White House staff. Whether this situation will continue in the Reagan administration is not clear. In addition, NSC is equipped to consider issues dealing with the highly classified military and intelligence space programs, by individuals fully cleared for access to the classified aspects. This is particularly important for such common systems as the space shuttle and tracking and data relay systems, and in connection with the transfer of technology from the classified to the civilian programs.

Use of the new "Cabinet Council" method of reviewing space policy forces these issues to compete with a much larger array of other policy concerns for the very limited staff time available to support the councils. Without a dedicated staff, adequate attention is not likely to be given to understanding the issues and to the development of viable options. On the positive side, the Cabinet Council may allow for significant high-level attention to whatever proposals reach its agenda.

### Presidential or National Commission

A device that is occasionally employed to investigate a broad area of national interest is a presidential or National (implying congressional and private involvement) commission, board, committee, or council. Examples are:

- ***The Commission on Intergovernmental Relations.*** A 26-member bipartisan permanent body with State and National Government representatives, from both the legislative and executive branches, and members from the general public whose purpose is to review and recommend improvements in the Federal system.
- ***Water Resources Council. Established*** to maintain a continuing study of national water requirements. The Council reviews plans of river basin commissions, assembles these plans and submits them to Congress via the President. It also administers a program of Federal grants for water and land resource planning.
- ***Procurement Commission.*** An ad hoc group for reviewing Federal procurement policy, with public and private membership and a limited lifetime (it has completed its work). It prepared a comprehensive set of policy recommendations and procedural changes.

One possibility for space is to charter for a specified term, a "National Space Commission" with membership from the general public, State and local governments, industry (particularly aerospace and electronics firms), academia, Congress, and the executive branch—NASA, State, DOD, Interior, Commerce, and Agriculture. The Commission would be charged with reviewing and assessing the civilian space program and its benefits, and recommending long- and short-term objectives, and a time frame for their achievement. The product of the Commission would be a major report, recommending short- and long-term goals for the U.S. space program. The Commission would be publicly supported; following its report, congressional hearings could be held on its recommendations, and legislation prepared for consideration by congress.

Such a forum enables participation from a broad set of interests in developing program goals; it operates in a manner that is outside normal channels and hence would be less threatening to the annual budget preparation process; it would be public and could solicit public input as appropriate; and it would serve as an expression of broad national and bipartisan support for the civilian space program. In order to provide a specific objective for such a group, a major report should probably be specified, with annual updates for the life of the Commission.

A National Space Commission, because of its public, short-term nature, could not substitute for a means within the administration to resolve issues, develop policy proposals, review goals, and set strategy for the space program. The Commission therefore is complementary to the previous two options, although it would deal with many of the same issues. The Commission would have the advantage of being able to evaluate public response and support, and to focus that support on specific goals. It also provides a device for full discussion of congressional, executive branch, and private sector views in a constructive setting.

### Establish a New Department

This concept would place NASA in a larger Cabinet-level structure, perhaps one that incorporated a group of science and technology agencies. The principal focus for space policy would be a Cabinet officer responsible for setting space goals, as well as integrating these goals into a larger science and technology policy framework. The following choice of functions to be grouped together is largely illustrative–a considerably more detailed discussion would be required to treat this subject adequately than is appropriate to this report.[19] If, for the purposes of this assessment, we designated it the Department of Basic and Applied Sciences, it might have a Research Administration with components from the NSF, NASA, and DOE; a Space Operations Administration with responsibility for launch vehicle development and operation, manned flight, satellite integration, tracking and data acquisition; an Environment and Natural Resources Administration with land, atmosphere, and ocean activities from NASA, NOAA, DOE and possibly the U.S. Geological Survey from Interior; an Industrial Technology Administration with the National Bureau of Standards, Patent Office, and applied technology programs from NSF; and an Energy R&D Administration with the core DOE programs such as solar, conservation, fossil, nuclear, and fusion. The department could have a special projects office for interdisciplinary issues that require broad contributions such as communications and information, science and technology, or for limited-life projects such as robotics development (to assist in accelerating commercialization of this new technology). In such a department, responsibility for leadership in generating space program goals and objectives would lie with an Administrator for Space Operations, assisted by others—Research, Environment and National Resources, Energy, Industrial Technology, and Special Projects. These components would be responsible for generating programs in space science, weather and meteorology, Earth observations, space manufacturing, and telecommunications. Together, they would constitute the civilian space program. Coordination with DOD and national intelligence space programs would still be required, and for this purpose a Cabinet-level Space Council might also be desirable to resolve issues that arise, to provide a forum for program coordination and to enable consideration of other aspects, such as foreign policy considerations (which would be supplied by the Secretary of State).

This option would be extremely difficult to implement, since it would involve many congressional jurisdictions and appear to threaten existing agency constituencies. On the other hand, the Reagan administration has indicated that it plans to dismantle the Department of Energy, and this could provide the stimulus for giving serious consideration to formation of a new department by grouping together high-technology agencies, including the R&D elements from the present DOE. Many foreign countries, including Japan and most of Western Europe, have ministerial-level departments dealing with science and technology.

[19] For example, see reports of the U.S. House of Representatives Committee on Science and Technology in 1967, 1972, and 1977.

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A new, high-technology R&D department to deal with space policy issues would facilitate access to the President. It could also strengthen bargaining with OMB in the budget process, and might even (depending on the other agencies and functions that were included in the new department) result in economies in areas where common support functions can be combined (procurement, administration, facilities, personnel, etc.). It is also possible that better use of supporting laboratories would result from incorporating them into a larger departmental structure.

### LEGISLATIVE BRANCH

In the future, Congress could take a much stronger hand in formulating space policy and coordinating the different national space programs. Congress played a major role in the initial stages of the U.S. space program by drawing up the NAS Act, and Members of Congress were leaders in helping to focus national attention on space exploration. Other critical policy decisions, such as the COMSAT Act in 1962, were also initiated by Congress. Both the House and Senate formed full committees to oversee civilian space activities, while assigning responsibility for military space programs to their respective Armed Services Committees.

During the Apollo years, Congress supported major programs proposed by the executive branch and voted increasing annual budgets for NASA. However, in the late 1960's and early 1970's, NASA budgets and program proposals came under increasing attack as being too ambitious for a period when domestic social programs and the Vietnam war required ever-larger national commitments. Despite a strong core of congressional supporters, congressional critics on the Senate Appropriations Subcommittee on HUD and Independent Agencies succeeded in reducing NASA plans for major post-Apollo programs. NASA's space budget reached a low of $2,758.5 billion in 1974, down from a 1965 high of $5,137.6 billion (in current dollars; if inflation is taken into account, the differences are much greater).

In the mid -l 970's, both the House and Senate restructured their authorizing committees for space activities. In the House, responsibility for most of the civilian space program authorization and oversight shifted from several subcommittees of the Committee on Science and Technology to only one, the eight-member Subcommittee on Space Science and Applications of the Committee on Science and Technology; in the Senate the Committee on Space was disbanded and responsibility for space matters was assumed by the nine-member Subcommittee on Science, Technology, and Space of the Committee on Commerce, Science, and Technology. In addition to, the military responsibilities of the Armed Services Committees, space activities in Commerce, Interior, Agriculture, and Energy Departments are overseen by different committees.

In recent years, Congress has addressed many of the policy issues discussed in this report; in particular, it has dealt with the uses of the space shuttle, the transition to an operational remote-sensing system, international competition, and commercialization of space technology. The absence of a coherent and comprehensive national civilian policy has surfaced as a recurrent concern, and hearings on this subject were held by both Houses in 1979[20] and 1980.[21] In the Senate, S. 212, the "National Space and Aeronautics Policy Act of 1979," and S. 244 "to establish national space policy and program direction" were introduced. Both bills proposed establishing long-term programs in accord with explicit policy principles, with S. 212 specifying particular projects as well.

In the House, hearings were held in May and June 1979 on H.R. 2337, the Space industrialization Act of 1979,[22] which called for establishment of a national Space Industrialization Corporation to encourage public-private exploitation of commercial opportunities in space. In both 1979 and 1980, the House passed H.R. 2335, the Solar

[20] "U.S. Civilian Space Policy," hearings before the Subcommittee on Science, Technology, and Space of the Committee on Commerce, Science, and Transportation, U.S. Senate, Jan. 25 and 31 and Feb. 1, 1979.

[21] "United States Civilian Space Policy," hearings before the Subcommittee on Space Science and Applications of the Committee on Science and Technology, U.S. House of Representatives, July 23 and 24, 1980.

[22] "The Space industrialization Act of 1979, " hearings before the Subcommittee on Space Science and Applications of the Committee on Science and Technology, U.S. House of Representatives, May 22 and 23; June 26 and 27, 1979.

Power Satellite Research, Development, and Evaluation Program Act of 1979,23 which would have authorized $25 million for R&D on solar power satellites. In 1981, the Space Policy Act of 1981 was introduced (H. R. 371 2), and general hearings on civilian space policy were held in September.

The problems of coordinating policy and establishing long-term goals are mirrored in Congress' own activities. To a much greater extent than in the executive branch, Congress' ability to deal with these problems depends on informal and personal responses, rather than institutional or legislative changes. The problems facing sustained and broad-based congressional attention to space policy are:

- ***Not a high national or regional priority.*** — Space programs and policy have not recently been high on the national agenda as compared with questions of social, economic, and foreign policy. In addition, constituent interests force relatively few Representatives or Senators to consider space (a number of Congressmen, including former astronauts, have strong personal interests in this area and have contributed to the increased attention to space policy in recent years).
- ***Staff size and experience.*** —The change from full committee to subcommittee oversight, coupled with recent Senate staff cutbacks, may make it more difficult for Congress to deal with the many issues involved.
- ***Jurisdictional overlap and committee relations.*** –The different committees and subcommittees with responsibilities for various civilian programs create a need for coordination, if oversight of national programs and integration of national policy is to be accomplished. Relations between civilian and military programs are particularly sensitive. In previous years, Congressmen sitting on both the Space and Armed Services Committees provided informal coordination. Today, only one Senator and one Representative belong to both the space subcommittees and Armed Services Committees or Intelligence Committees.

Given strong enough leadership and sufficiently widespread perception of the importance of the issue, institutional or jurisdictional barriers to a comprehensive consideration of space policy are not insurmountable. joint hearings, multiple referrals of legislation, and ad hoc committees or additions to committees are several ways to cut across established territories.

In recent years both the House and the Senate have criticized many specific administration actions as well as the lack of an overall policy. So far, none of the proposed reforms of space policy or initiatives for major program changes have been adopted. However, the continued absence of executive leadership guarantees that Congress is more and more likely to take the initiative in setting long-range goals for exploiting the shuttle, commercializing space technologies, and meeting international competition.

[23] "Solar Power Satellite," hearings for the Subcommittee on Space Science and Applications of the Committee on Science and Technology, U.S. House of Representatives, Mar. 28, 29, and 30, 1979.

## INSTITUTIONAL CHANGES—CLARIFYING THE PUBLIC-PRIVATE SECTOR ROLES

In space applications, the services and products involve both Government and private firms and institutions. The multitude of interests and players has raised questions concerning the appropriate role of each in developing and operating applications systems. In one area, weather and atmospheric observations, the Federal Government has traditionally collected the data and made it freely available as a public service. A similar pattern has been established in oceanographic observations. In communications, Government performed much of the early research and demonstration, but industry and regulated entities have developed the platforms and supplied the services—subject to regulation by FCC and consistent with agreements under the International Telecommunication Union (ITU). In satellite Earth observations the Government has performed much of the research, developed and demonstrated the platforms and distributed the data. Private industry has supplied users with value--added services. (By contrast, aircraft surveys are normally done by private industry without Government involvement in any phase of their work.) in space manufacturing and space transportation, Government has taken the lead, but private sector involvement is growing. An important issue therefore ,is to clarify ways in which the private and public sectors might work with one another.

## Space Telecommunications

**Initially, international satellite communications were established as a Government-regulated monopoly through INTELSAT and the U.S. representative, COMSAT (see ch. 8). As the technology has advanced and new customers for it have been identified, domestic satellite** services have been established and competition for domestic services has been allowed. Maritime communications are being developed along the lines of INTELSAT, through the international maritime satellite organization (l NMARSAT), in which COMSAT is also the designated U.S. participant. INMARSAT came into existence in 1979 in recognition of the desirability of instituting a single (monopoly) system for maritime services while encouraging competition for certain other communications satellite applications.

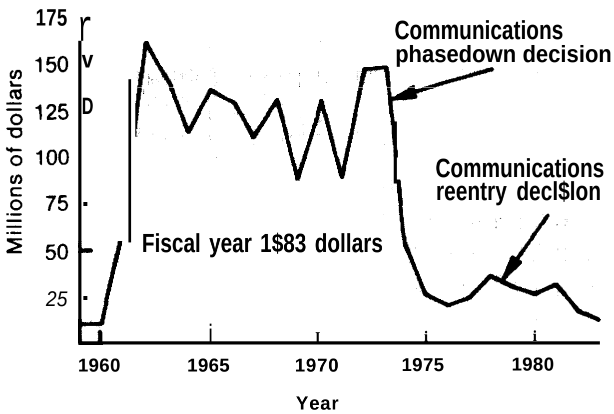
In the future, it appears that lower costs, more demand for capacity, and greater diversity of services will characterize the domestic communications industry. Direct broadcast satellites for television signals to the home are likely in the mid-l 980's. Business services are expanding, especially for data communications and specialized functions. The industrial firms that can act as suppliers are available, and the existing service markets provide an important revenue base for future new ventures. The principal areas of concern are the availability of the electromagnetic frequency spectrum in the light of competing demands for services, international control of assigned orbital positions for satellites (through ITU), and domestic regulation of technical and commercial characteristics.

Clarifying the R&D Role of Government in Space Communications.

An important policy option is to clarify and make more explicit the role of NASA in supporting R&D needs for space communications. In order to accomplish this, it may be desirable to legislate NASA's responsibilities in R&D for advanced communications satellites. The NASA program in communications was cut back for most of the decade of the 1970's (despite the general guidance of the NAS Act and COMSAT legislation) (see fig. 16), However, NASA had earlier contributed significantly to progress in space telecommunications, providing much of the technology and systems in use today. NASA could contribute to the solution of current and future problems, such as utilization of the 30/20 GHz frequency (see ch. 3). A continuing telecommunications technology program would include fundamental work at higher frequencies and demonstrations of technology and systems.

It will be very important for industry and NASA to cooperate in defining the appropriate high-risk areas for Government support and the boundary between Government and industry for development of specific systems. Industry can and should work with NASA to sponsor cooperative communications technology demonstrations. To ensure adequate consultation between NASA (as a lead agency for this work) and industry, an ***industry-Government consultative committee*** could be

**Figure 17.—NASA Funding for Communications Satellite Technology (In constant year 1983 dollars, i.e., adjusted for inflation)**




SOURCE National Aeronautics and Space Adminlstratlon specified that would consider space communications research and technology needs. On such a committee, in addition to NASA, Government would be represented by DOD, NTIA (Commerce), State, and FCC, while the industry representatives would include aerospace contractors, the common carriers, COMSAT and other space services suppliers. The deliberations of this committee could be submitted to the Congress as part of the annual budget. A committee with a similar function already exists in high-energy physics, called the High Energy Physics Advisory Panel (HEPAP). It includes all the interested parties in the field and is sponsored by the principal agency responsible, DOE. HEPAP serves to resolve the various independent views of what is needed and periodically presents an integrated plan for new facilities and research needs.

Open-ended assignment of a space communications R&D role to NASA might be difficult to sustain for several reasons: 1 ) uncertain and possibly larger budget needs would be resisted by OMB and the administration; 2) users might have little role in NASA demonstrations, with the result that unnecessary and uneconomic technologies might be pursued (i.e., there is the danger that it would become a technological “hobby shop”); and 3) NASA might create unrealistic expectations by demonstrating sophisticated new technology not ready for commercial introduction. On the other hand, remaining silent regarding the NASA role invites the type of decision that was made in the early 1970’s, when the NASA communications satellite platform and technology demonstration program were terminated. The consequences of this decision are covered in chapter 4.

By specifying that NASA should perform communications satellite R&D, including demonstration of technologies and platforms, and also specifying that there will be formal user and industry involvement in identifying the extent and nature of the program, the open-ended nature of the assignment can be modified. Such a consultative process can serve as a forum for bringing out independent views and ensuring the relevance of the NASA program. One danger of such a mechanism is that industry may press for too large a role for NASA, since their incentive is to minimize risk and to push NASA to carry out tasks that industry might otherwise be expected to do. Given NASA’s desire to maintain its budget and institutional structure, it can be expected to acquiesce. The example of the HEPAP is instructive in this regard. For it the incentives are very similar: have the Government do more, expand, press forward faster, etc. The counterbalance is the competition and rivalry among the various research groups, and the pressures of other agency demands, OMB, and eventually Congress. Within a communications committee, such pressures can be counterbalanced by competition between companies, Federal agencies, OMB and Congress. DOD’s role would bean additional factor. By including DOD in the consultative group, the technology base that is being supported for military purposes would be represented directly. Not all of the developments could be discussed, but general knowledge of classified programs could be a valuable asset in discussions of technology needs.

If in addition to acting as consultants, the industry also took a more active role in financially supporting demonstrations of new satellite systems (see Communications Issue, ch. 3), its own stake in the type and direction of work that is done would be greater. Because industry had a strong financial interest, the development work done would be more likely to reflect the genuine needs of industry. in sum, the above suggestions could lead to a role for NASA that represents a balance between technology push and demand pull.

### R&D to Support Regulatory Decisions

Regulation is always the product of balancing among the affected interests. In the balancing process, it is important that the regulatory authorities have the best possible technical information available. The ultimate decisions will reflect their grasp of the technology as well as political and economic constraints, the biases of the people involved, and the effectiveness of the various lobbying groups. The regulatory body for communications, FCC, has an R&D section and a technical staff to interpret the impact of new technology on regulations, and vice versa. But the exploding telecommunications and information technologies have created serious overloading of this staff and their limited budget. It would be unrealistic to consider space communications experiments and demonstrations to be within their capability. However, both nationally and internationally, regulations are being made that control the numbers of satellites that will be permitted (by controlling synchronous orbital slots), their power levels and signal characteristics, the frequencies used, and a variety of other technical details. Information for these decisions comes from a variety of sources–some private (like Bell Labs and COMSAT Labs) and some Government (e.g., DOD, NBS, NOAA, and NASA), but there is no lead agency for space communications R&D to support regulation. This suggests the following policy option:

*Modify NASA's legislative charter to direct the Agency to pursue communications R&D to support the needs of prospective regulatory actions, both nationally and via ITU, internationally.* internationally, the United States has much at stake in the allocation of orbital slots for satellites, the assignment of frequencies, and the technical characteristics of allowable signals and signal strengths. The United States should also be prepared to take stronger action to ensure more realistic decisions in ITU. These decisions are often driven by unwarranted fears of smaller nations, based on poor technical information, and by political objectives. Both of these aspects should be addressed, the first by better dissemination of technical information, perhaps by a traveling team of experts with equipment capable of demonstrating essential data, and the second through stronger leverage from the State Department. A high-level space policy mechanism such as the NASC could provide the proper exposure at the White House for these international political measures, and a separate subgroup for international space communications may be desirable.

Clarifying the NASA role would enable better planning of space communications research and demonstration programs by the agency and help to provide a more competent and predictable set of regulations for public and private users to deal with. By giving more attention to the preparation and technical backup for international negotiations, the United States would be in a better position to identify and defend its interests. In some cases, better technical information is likely to yield better international agreements, by removing misunderstandings about the effects of new technologies.

### Earth Observations From Space

Civilian Earth observations from space encompasses a variety of space platforms, sensors and mission objectives, ranging from weather observations made by NOAA, to ocean observations and Landsat-type systems. The technology for weather observations via satellite has developed from the limited capability of the early experimental systems to a relatively mature technology. The relationship between NASA as the R&D and launching agency, and NOAA as the operational ~ authority has also developed and matured over time. In general, this relationship now demonstrates how NOAA, as a lead agency with a clear mission to perform, can interact with an R&D agency, NASA, to stimulate and take advantage of advanced technology and adapt it to operational use (see ch. 9). The major areas of concern today are the Landsat and future oceanographic satellite programs.

For land remote sensing, the relationships between public and private interests are currently perhaps the most difficult areas to treat. The Carter administration, and now the Reagan administration as well, favored turning over this activity to private ownership and management, while the private sector, for the most pat-t, does not yet see a sufficient market to be able to respond. Caught up in the present uncertainty are the users of the data; a private industry of value--added companies that has grown up to process and interpret the raw sensed data, and the aerospace contractors capable of designing and building the satellites and other hardware. Complicating the scene are international pressures from a large number of other countries interested in using Landsat data (some with dedicated receiving stations); from a few countries planning the development of competitive systems; and from a number of countries with national concerns about the collection and use of remotely sensed data gathered about their territory.

policy options to resolve some of these issues include the following:

### FOR THE SPACE SEGMENT

***Laissez-faire or open entry.*** The Government would agree to operate space platforms through Landsat D and possibly D'. Further satellite systems would then become the responsibility of private industry. Government users would purchase data from private suppliers under commercial terms and conditions. Private suppliers would sell data to international users on a nondiscriminatory basis. Any private supplier or consortium (domestic or foreign) could purchase launch services and fly a land remote-sensing satellite. If the market did not support the service, it would terminate after Landsat D or D', except for possible DOD or foreign collection platforms.

With the current cost of launch services and satellites, there is only a very limited prospect that private sector suppliers would enter the field for the space segment. An important indicator is the nature of the current COMSAT suggestion that it assume responsibility for all operational remote-sensing systems.[24] They feel that the market is sufficiently marginal that transfer of all current operational remote sensing would (including meteorological satellites) be required, and the Government would have to commit to purchase its data from the COMSAT systems. Such marginal economics indicate very strongly that competition would not exist (beyond subsidized foreign systems) if COMSAT were allowed to proceed with its proposal. This would create a de facto monopoly, although in principle the prospect of open entry would be available. The de facto monopoly would continue until technology advanced to the point that reliable, low-cost access to space and low-cost platforms was available, thus allowing competitors to enter without the massive capital investments required today.

If the COMSAT initiative is not pursued, and other approaches are entertained through open solicitation of the industry, it is uncertain whether a single supplier (or even a consortium) would come forward to propose a data collection system without data purchase guarantees similar to those proposed by COMSAT. Thus, the likelihood is that a truly open entry policy would result in no entry.

Single designated entity. Whenever the service to be provided is such that the necessary capital investments are very large in relation to the industry base, and the technology and character of the system makes competitive suppliers either impractical or highly wasteful of resources, the conditions may warrant designating a monopoly supplier. A typical example was the designation of AT&T as the long-distance carrier for domestic telephone communications. With a monopoly supplier, however, regulatory mechanisms are required to control pricing and to insure continued service by the supplier. FCC carries out this function, as well as a variety of other important roles in communications. An important characteristic of the regulatory process must be the ability to change the monopoly situation to respond to new technological advances that modify the monopoly characteristics of the system. FCC has responded to such changes in the domestic telecommunications industry, although there has been criticism that it acted much too slowly.

On the premise that conditions may exist in land remote sensing for a monopoly supplier, ***one policy option would be to give a single private sector entity the role of developer and operator of the space segment.*** Since the revenue base for sale of the raw data does not appear adequate to support a positive return on the investment, the Government would also guarantee purchase of a minimum amount of the output, perhaps at subsidized prices, until costs and markets have developed to permit Government to decrease its role gradually. Because a monopoly position implies some regulatory control in order to protect the public interest, a new institution would probably be required to regulate prices, entry into the field, quality of services, and to control the amount and extent of Government subsidy.

The Civil Aeronautics Board (CAB) is a good example of such a regulatory agency. It originally regulated entry, controlled routes, reviewed

[24] *Civil Land Remote Sensing Systems,* joint hearings before the Subcommittee on Space Science and Applications, House Committee on Science and Technology; Subcommittee on Science, Technology, and Space of the Senate Committee on Commerce, Science, and Transportation, July 22 and 23, 1981.

fares and revenues, and provided significant direct cash subsidies to the airline operators while the airline industry built its market and its ability to sustain profitable operations. The Government also guaranteed the purchase of services, in the early days with subsidized airmail contracts to the airlines, and later with Government cargo and passenger traffic. The rationale for treating this industry in such a special way is similar to the rationale that applies to land remote sensing, viz., there is a service to be supplied which would be highly beneficial to the public, and which could eventually become an independent and profitable private enterprise given initial subsidy. Because it is normal practice in our free enterprise system for the Government to use commercial suppliers, the Government should be prepared to act in a way that ensures continuation of the services while building toward a self-sustaining capability in industry. With the passage of time and growing industry maturity, the regulatory authority can decrease and eventually cease–as is the plan for the CAB.

This suggests establishing a new entity, which for purposes of this analysis will be called the Space Development Authority (SDA). SDA would have a role for new and emerging space applications very similar to CAB in air transportation. Since there are more opportunities than simply land remote sensing, SDA could function in all applications areas. It would control entry into data collection operations, initially establishing criteria for the monopoly supplier, and later permit greater competition as the market develops. It would review pricing of services and establish a fair rate of return using guidelines derived from other, similar regulatory situations. SDA might support this rate of return by adding a direct subsidy from appropriated funds. It would review proposed satellite configurations and establish, with the aid of the user community, minimum desired performance characteristics for proposed systems. The choice of technology, specific design characteristics, and award of contracts for hardware would be the responsibility of the monopoly supplier.

An important further consideration is the responsibility for advancing technology in order to continue improving the services provided and to improve the cost v. revenue relationship for these services. Here, the analogy with civilian aviation again illustrates a Government policy option. In aviation, the Government established the National Advisory Committee on Aeronautics (NACA) and its supporting laboratory structure over 65 years ago to improve aeronautic technology in the United States. The Federal Government still continues to support advances in aeronautics through NASA. The users of this technology are the military and civilian aircraft manufacturers, and the beneficiaries are the American public. Thus, a similar technology development role by Government might be appropriate in support of SDA, and desirable in terms of long-term benefits to the public.

Thus, *the NASA role as a technology "push" agency would continue, including definition and development of new sensors, platforms and associated subsystems, and supporting technologies such as launch vehicles, on-orbit control, tracking and data recovery.* This would be very close to the current situation with respect to R&D for meteorological satellites and the previous NASA role in the communications satellite area.

Establishing a regulated monopoly in remote sensing, although less desirable than true competition, can result in high-quality services and significant public benefit (e.g., AT&T and long-distance telephone service). A key characteristic of effective regulation is that it be as little as necessary in order to protect the public interest. In addition, the boundary between regulated functions and unregulated functions needs to be flexible in order to respond to changing industry dynamics and the effects of new technology. Therefore, SDA should operate under guidelines that specify minimal regulation and responsiveness to any changes that would allow for more open competition.

Adoption of the COMSAT initiative or one similar to it from another corporation or consortium would appear to require establishing a mechanism such as SDA. If not, the control over pricing would be difficult, and quality of service would be continually open to negotiation, with little in the way of alternatives open to the Government except canceling the agreement. There are additional questions regarding responsibility for performing R&D on advanced sensors (NASA or COMSAT, or both?), distribution of data by private companies and international access to the data, that would need **to be resolved.** These are not insurmountable, but they do raise doubts about the ability to anticipate and spell out all of the conditions for a transfer to a single designated entity that would protect the interests of Government and the public. Creation of an oversight and regulatory authority **such** as SDA **would enable** these issues to be addressed as they arise and would appear to be a wise precaution to accompany a policy decision to establish a monopoly supplier.

***Government as the Operator.*** An alternative approach to the space segment, (consistent with the conclusion that a monopoly position is required, would be to retain the Government as operator instead of a regulated, private sector entity. In this alternative, procurement of the satellites, their operation and control, and the initial reception and distribution of the data stream would remain a Government function. Selection of system characteristics (sensors, orbits, number of satellites, type of coverage, and other parameters) should be done through consultation with the user community, and for this a formal structure is probably desirable. A Remote Sensing Users Group **such** as NOAA is now in the process of setting up would help ensure that users have an opportunity to participate in the planning of new systems and in the operation of existing platforms.

**In this case the operator could be either the R&D and launching agency, NASA; an agency closer to a user community such as NOAA, USDA, or Interior; or a new Government entity established for this purpose that brought together several existing roles. NOAA will be responsible** for overseeing the operation of the Landsat system after Landsat D is launched.

However, if a new agency were set up, for example, a ***Space Applications Services Administration*** (SASA) it could be responsible for defining, procuring, and operating satellites and ground stations and providing an assured flow of data from space applications systems. This agency would be independent of NASA and NOAA, but probably would include a portion of the existing space applications staff of both of these agencies. While publicly funded and hence accountable to Congress, it would collect user charges (like the recently disestablished Panama Canal Co., a former Government entity that was initially publicly funded but eventually became self-supporting). It would not conduct R&D, but would identify targets for NASA attention, and serve to channel to concerns of data users such as NOAA, USDA, and Interior in Governments; State and local governments; and private users (including private companies that process and interpret the data) to NASA. SASA would be organized to provide a valuable service at the lowest cost. SASA might assume responsibility for a variety of other space-related applications functions, such as meteorological and ocean-sensing data, storm warning, emergency communications, search and rescue identification and location, public navigation, and other noncommercial services. in this role it would be much like a private monopoly supplier, except for: 1 ) its status as a Government entity, 2) the fact that a separate regulatory entity would not be required, and 3) the periodic review of its operation that would occur through the annual budget process.

If NASA were given the role of space segment operator, the advantages would be: good integration with the present launch authority, assured technical competence, and substantial agency interest in the technology and its successful employment. On the negative side, NASA is prone to push the technology rather than its uses, and tends to continue experimentation rather than allow a system to become operational.

If it were a single established user agency, the problems would be somewhat reversed. The technical aspects become more difficult to manage and to integrate into the user's normal way of doing business; the format of satellite data is likely to conflict with previous ways of obtaining similar information, while the agency as a whole will not have much stake in the successful outcome of a satellite program that is only a small part of their total mission. On the other hand, there would be greater sensitivity to user needs and better contact with the user community (though quite likely not with all of the users in the case of multipurpose satellite systems). The satellite system would more rapidly become standardized and operational in this mode; once accomplished, new technology would probably be resisted unless "proven" and reliable.

In the case of a new Government entity created to assume responsibility for satellite applications systems, many of the above characteristics would be favorably modified, but other problems would be increased.

NASA would undoubtedly promote its mission by looking for, and attempting to satisfy demand for, new applications services. This would depend in part on obtaining support from NASA for technology development. By operating meteorological systems and Landsat, NASA might begin with a sufficient base to provide a critical mass for continuing operations.

#### GROUND SEGMENT

There are three areas to consider: 1 ) operation and control of the space segment; 2) reception and processing of returned data; and 3) distribution and interpretative processing of returned data. For the space segment it appears that use of NASA facilities on a reimbursable basis would be a sensible beginning. Independent control centers would be established as the business increased.

To receive and distribute satellite-derived information, current technology requires an array of unique and expensive equipment to convert raw returned data to images or other coherent forms. Since many users, such as agricultural analysts, require quick distribution of recently acquired data, there is a need for high throughput for the processing center and redundant equipment to allow for breakdowns or other system problems. Thus, for this segment, the potential exists for having a regulated monopoly supplier. This could quite logically be the same entity that was responsible for the space segment, in order to ensure compatibility of equipment and processing capacity as satellite designs and instruments change.

For the interpretive processing of returned data, on the other hand, an embryonic industry is already established, and continued open entry seems appropriate. Access to the initial processed data stream should remain open to all customers but at a realistic fee schedule, reviewed and approved by SDA. In order to protect the initial position of the monopoly supplier, it would probably be necessary to restrict competitive entry into the field of reception and initial processing of the satellite data stream.

As far as the space segment is concerned, a U.S. monopoly supplier appears to be necessary, at least for the foreseeable future. Competition is likely to be provided by one or more international systems capable of supplying similar data. (A more detailed discussion of international aspects, and policy options that respond to the growing capabilities of other nations, is found later in this chapter.)

The ground segment is as important to the total effectiveness of a remote-sensing system as the space platforms. The point is that providing adequate capacity for data handling and processing, compatible equipment, and common data formats should receive the same careful attention as the more glamorous and visible spacecraft. For this reason, it is important that the processing system be at least as responsive to user needs as to the R&D agency. If NASA were to assume responsibility for an operational remote-sensing system, there would need to be a stronger involvement by the users in determining the characteristics of the data processing system than is presently the case.

### Space Transportation

Throughout this analysis the implied assumption has been that launch vehicles and their supporting systems such as launch complexes, tracking, and control facilities would continue to be available through customary channels. However, space transportation systems themselves may also be considered subject to possible new policy initiatives as defined in the beginning of this chapter.

For the most part, launching payloads into space has been sufficiently costly and complex that Government sponsorship has been required to develop and operate all but the most limited systems. As the cost and importance of payloads, civilian and military, have increased, it has also become particularly important to ensure that there is a high degree of reliability and a low probability of catastrophic failure. These concerns reach a peak when manned vehicles are involved; only the two space superpowers, the United States and the U. S. S. R., have devoted the resources and effort to carry out such operations.

In considering policy options for space transportation, therefore, it is useful to distinguish between the type and scale of operations involved, e.g., manned systems; large, unmanned systems to synchronous, interplanetary or low-Earth trajectories; small, low-altitude unmanned systems.

### MANNED SYSTEMS

The presence of man in space has captured the imagination of people throughout the world, and has given national space efforts some of their most memorable moments. When astronauts are involved, there is always the possibility of a catastrophic failure leading to death or injury; such a disaster can have widespread effects on public opinion and hence on the future of the space program. The fire in the Apollo 204 capsule in 1967, which killed three astronauts, though it occurred on the ground, caused a lengthy delay in the Apollo flight schedule. The death of Soviet cosmonauts on reentry in 2 separate incidents in 1967 and 1971 had similar consequences. The result is that great care is given to the safety, reliability and resistance to single-point failures of manned systems. This also includes launch vehicles, which go through special procedures in order to make them "mandated. " These special procedures are reflected in increased costs and in a sizeable support establishment for manned flight, both of which have been sufficiently large that only government has had the resources to conduct manned space operations. Only the United States and the Soviet Union have been willing to make the investments required to engage in manned flight, and this has resulted in a form of symbolic East-West competition, centered around such space endeavors, that rarely applies to the popular perceptions of unmanned space activities.

The development of the space shuttle has given the United States a launch vehicle that is simultaneously a manned system and a form of transportation for manned and unmanned payloads. The presence of man has focused public attention on its operations; it is viewed as another step in the continuing East-West competition in space, Recently there has been considerable discussion about the possibility of private ownership and operation of the shuttle system. For a number of reasons, this does not appear to be a likely prospect for the near term. One reason is the special political significance of manned spaceflight, as mentioned above. Although the frequency of operations envisioned for the shuttle—about one launch every 10 days–will result in the public devoting less attention to individual shuttle launches, and accepting man in space as relatively routine, it still appears likely that the loss of astronauts in space would be a major blow to national prestige. Given the cost of maintaining adequate launch, recovery, and refurbishment crews and facilities for the shuttle system, continued Government control and overall management seems likely.

A second factor is that, although each shuttle orbiter is projected to have a lifetime of about 100 launches, there will be a continuing **need** for system modifications and rework that are part of the standard experience associated with any new and complex system such as the shuttle. For these changes and continuing engineering support of the system, the resources of the Federal Government are likely to be needed—as well as the expertise of the major NASA Centers, Johnson (JSC) and Marshall (MSFC).

Third, the shuttle is planned to be the "delivery truck" for most low-altitude payloads, whether manned or unmanned, including national security as well as civilian or commercial payloads. The contributions of space systems to national security are significant and appear to be increasing; so it is not likely that the Government will wish to forego control over, and assurance of the availability of, adequate transportation to orbit. Direct Government operation of the shuttle and technical support for the shuttle system **would be needed in order to provide the necessary assurances to national security authorities.**

Fourth, there is the question of liability. The shuttle, in its launch configuration, represents a very high and concentrated amount of energy which, if it were to crash in a populated area, could have widespread detrimental economic consequences. **Other forms of system failure** could also be very costly from the standpoint of liability. Government is the institution most capable of handling such contingencies; although private insurance may be available to private shuttle operators, it would be another cost factor that would tend to limit private sector operation of the shuttle system.

There is currently a proposal by an investment group[25] for private-sector purchase of an additional shuttle orbiter. The proposal calls for this orbiter to join the Government fleet of shuttle systems, in return for which the consortium providing the funds would act as the sole shuttle payload marketing agents. The needs for continued Government control outlined above would not prevent such an arrangement, nor other innovative mixes of public and private investment. Such proposals should be viewed on their merits. It does not seem profitable to attempt to construct policies in advance that would adequately **foresee all of the nuances of** such proposed arrangements.

### LARGE UNMANNED SYSTEMS

**The transportation systems for a wide variety of sizeable unmanned payloads either to low- or high-Earth orbit or on trajectories beyond Earth orbit comprise the bulk of space launch vehicles for all nations and have been** the source of greatest interest by nations that wish to enter the space business. As the basic technology that is needed for such launch vehicles is now quite widespread, the early near-monopoly by the United States and the Soviet Union is rapidly breaking down. The Japanese, the Europeans, the People's Republic of China, and India have all demonstrated their abilities to develop launchers, and other nations **could produce launchers if they decided to make such a commitment.**

For reasons described earlier, the United States has chosen to develop a manned system to launch large unmanned payloads. In the interim, work toward improvement of unmanned expendable launch vehicles has been minimal and there has been no new unmanned launch vehicle development. For a number of reasons, the cost of shuttle launches will be higher, and their availability less frequent, than was originally anticipated. All current U.S. expendable have also risen sharply in price, in large part because of the decision to develop the shuttle and phase out the use of ELVs. This appears to leave several "windows" in the potential marketplace for such systems. The major gaps are in the area of low-cost, relatively uncomplicated launches to low-Earth orbit and low-cost synchronous orbit emplacement of modest-sized payloads. It is to the second of these that the Japanese and European developments seem particularly well suited. In the United States, private investors are sponsoring work toward the former "win dow"[26] Low-cost space transportation, however, cannot attract much of a market if it does not provide reasonably high reliability, because the cost of payloads continues to be high. Hence, the willingness of a customer to entrust launch of a $30 million to $50 million communications satellite to a low-cost launcher will depend more on launcher reliability than on a small difference in launch cost.

Given the trend in alternative unmanned systems the United ***States could consider, as an option, developing a complementary, simple, reliable, and low-cost expendable booster that would serve to test the state-of-the-art in such systems and would act as a companion to the shuttle.*** Such a development could be carried out after a broadly based competition for the best ideas that would contribute to the dual objectives of low cost and adequate reliability. Such a program would be far more amenable to private operation, under appropriate safeguards, than would the shuttle. The launch vehicle options for the U.S. and international users would be expanded, and the U.S. would keep a valuable part of future space transportation alive and developing through this mechanism. "Competition" with

[25] Craig Covault, "Firm Sets Down-Payment for Buy of Space Shuttle," Aviation *Week and Space Technology,* Jan. 18, 1982.

[26] See Statement of David Hannah in "Future Space programs: 1981, " hearings before the Subcommittee on Space Science and Applications of the Committee on Science and Technology, Sept. 21, 22, and 23, 1981.

*Photo credit: RCA Corp.*

**RCA Saturn launch aboard a Delta launcher**

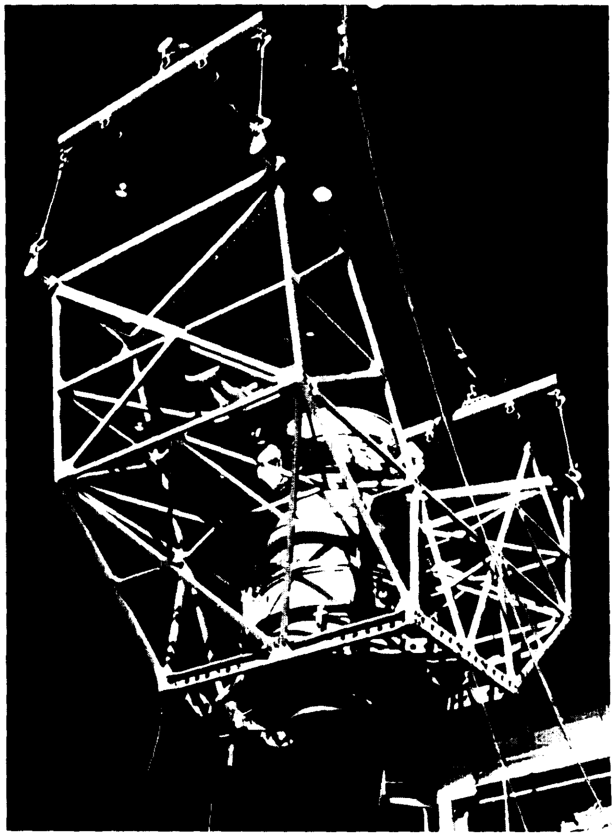


*Photo credit: McDonald-Douglas Corp.*

**Payload Assist Module for use in boosting shuttle payloads to higher orbits**

the shuttle would be allowed, recognizing that the shuttle need not be used for all such launches.

### SMALL UNMANNED SYSTEMS

**There is a family of small sounding rockets and derivative systems that provide invaluable access to space for scientists with small-scale research payloads.** These may be extended in capability for modest cost, and it would appear that open entry into this field should be permitted. However, here, as in the case of private launchers for low-Earth orbit, there is no policy in place for regulating such launches. Nor is it clear which Federal agency or agencies will be responsible for generating and enforcing the necessary regulations. In order to support industry's efforts to develop and launch its own vehicles it will be essen***tial to designate a lead agency to coordinate these efforts.***

## Applications R&D—Strengthening the NASA Role

As pointed out earlier, existing space policy identifies NASA as a performer of R&D for space systems, while remaining silent on operational responsibilities for the agency. The original NAS legislation says nothing about specific applications, and beyond maintaining U.S. leadership in space science and technology, there are few indicators of the pace of programs that might be generated. Thus, when the Nixon administration decided that the communications R&D programs of NASA were unnecessary and terminated the

Applications Technology Satellite (ATS) series, there was little basis for challenging that decision.

NASA does not lack the internal staff support for a more vigorous role in space applications. Such support could range from fundamental research to demonstration of sensors and integrated systems. However, there are other important internal claimants on NASA's resources, particularly the manned programs (shuttle, Spacelab) and space science programs (including planetary exploration). Consequently, the annual budget request for NASA is a compromise among the various opportunities for new starts (if any), the demands of each of the major agency programs for continuing baseline support, and the costs of prior-year commitments. The relative priority accorded space applications R&D may vary considerably in this setting, depending on NASA's management attitudes, the effectiveness of the internal advocates for applications R&D, and the urgency asociated with the applications areas involved.

The policy responses to these situations involve relatively minor adjustments to the existing framework, but despite their limited nature, they may be significant over time in generating additional attention to space applications needs.

The first deals with NASA's assigned responsibilities for space applications. One option is that space policy legislation recognize explicitly the continuing need for a program of fundamental research and demonstration activities in support of space applications. This would include advancement of technology in areas where the ultimate user is in the private sector as well as in Government. The rationale for such a posture is very similar to the argument used for Government funding of basic research and demonstration in fields such as aeronautics. Specifically, Government support may be appropriate when the risk is high, many of the benefits are nonappropriable, the time for potential benefits to accrue is long, and there are extensive potential public benefits. As such technology becomes suitable for incorporation in an operational system, the future operators should become responsible for the planning and engineering to utilize the new technology. judgments on where the boundary between Government support and private or user support lies must be made on a case-by-case basis, for each technology is different in regard to its operational adaptability and use. This issue, i.e., what it is appropriate for NASA to support, will therefore continue to be raised in the context of the annual budget preparations. The effect of a policy statement clarifying the existence of a NASA role will still result in debate on the extent to which that role requires, for example, a demonstration of a new technology on a satellite platform. Such demonstrations may be specifically allowed in the policy, but they would not be required. There will continue to be a need for considered judgment, discussion, and debate on such questions. This suggests a second policy initiative.

One of the important aspects of any space application is the user community. This community may be small and poorly defined for a newly identified or emerging application, or it may be very large and amorphous as in the the case of users of satellite weather data. Whatever its stage of development, it should always be possible to seek out and identify users and to have representatives become involved in a review of the NASA program in their area of interest (see ch. 9 for a discussion). Approval of particular applications demonstration systems could then be made with the aid of informed advice from the community affected by this work. ***NASA could be required by legislation to convene and support such user advisory groups and to include their reports as part of the justifications for the applications efforts proposed by the Agency.*** NASA has had such groups, but their role has been primarily internal to NASA. What is suggested here is a requirement that such groups report publicly to the Congress as well as to OMB. It should be noted that such user advisory groups would include other Federal Government agencies and State and local governments, as well as private members.

One additional policy option may be considered. In order to highlight the stature and importance of NASA's applications R&D efforts within the agency, and their prominence in dealings with OMB, it may be desirable to legislate an organizational change within NASA. Specifically, ***the applications programs could be made the responsibility of a Deputy Administrator of Applications, who would be in parallel with a Deputy Administrator of Operations and would have overall responsibility for planning, coordinating and implementing space applications research, as well as selected satellite demonstrations.*** This individual would support user advisory groups and—given the appropriate policy changes—could be responsible for operational systems within NASA's purview.

NASA's role in support of space applications R&D will continue to be uncertain, and funding levels will remain unpredictable, without more specific assignment of responsibility. NASA must take care to solicit and respond to the views of potential systems users; however, in cases where prospective users fail to recognize the potential of a new technology, or resist its introduction, NASA may need to promote the new technology actively.

### International Aspects

**part of the existing space** policy of the United States is that activities in space will be conducted "for the benefit of all man kind," and one of the objectives of the U.S. space program is "Cooperation . . . with other nations and groups of the nations in work done . . . and in peaceful application of the results thereof." In international law, outer space is recognized as a nonappropriable area, analogous to the high seas, that is open to use by any state. From its very beginning, the space program has been directed toward foreign policy concerns and has recognized the inherently global nature of much that is done in space. This is particularly true for many space applications areas. Satellite systems that receive or transmit information have the capacity to serve a wide range of international users and to provide data about any part of the globe. Other systems, such as those for materials processing in space, depend upon the uniqueness of the space environment (e.g. microgravity) and are not inherently global in nature; nevertheless, since they would take place in space, outside the territory of any State, they would be affected by international laws and regulations. They have attracted the interest of several users other than the United States.

In the international arena, two major forces are at work—competition and cooperation (see ch. 7). In the early years of the development and evolution of space technology, the virtual monopoly on space technology of the two major powers made it both desirable and necessary for other nations to cooperate in order to gain access to space for scientific and applications purposes. As the technical sophistication of other nations has increased, some have developed an independent capability for designing and constructing satellites and launchers.

Though the United States as a matter of national policy has favored international competition as a device for improving goods and services and lowering their costs, there are circumstances under which this policy is modified, e.g., when a regulated monopoly supplier, such as INTELSAT, is established as described in earlier sections. Participants are required to plan national and regional satellite communications systems so as not to damage INTELSAT'S technical and financial integrity. The U.S. approach to international competition has been subject to additional constraints. For example, national security considerations would force the United States to restrict entry of foreign steel at the point where U.S. industrial capacity was being threatened. U.S. industry is also protected, in principle, against predatory pricing, "dumping," and other noncompetitive practices, in space, the U.S. policy toward satellite and satellite subsystem development, provision of services via space systems, and development of space launching capability has tended to favor, respectively, open competition, single systems, and nonproliferation of launch capability.

U.S. policy must recognize the competitive capabilities that already exist overseas, and the plans of several nations to initiate and continue the development of competitive systems. Where conditions warrant (such as when there are limited markets or problems with signal interference from competitive systems), U.S. policy may favor limiting competition by fostering a single global system, In other circumstances, such as meteorological observations, the united States has cooperated with other nations in the use of satellites for data collection, and the coordination of separately funded national systems. The exchange of information permits all participants to derive benefits that exceed the returns from a solely national system and at much less cost for each individual participant.

### Telecommunications Services

In telecommunications, the United States supported single cooperative global systems for specific services and helped to establish INTELSAT and later INMARSAT. The U.S. position is based on the fact that economies of scale, the size of the international market, and the requirement for compatible reception and transmission of signals favor a highly integrated network with a single management structure. The situation becomes more complex, however, for proposed direct broadcast satellite (DBS) systems, in which the satellite distributes signals directly to individual receivers. The technical and political feasibility of such a system was demonstrated almost a decade ago with the United States- India experimental program (SITE) for providing educational television materials to remote villages using one of the U.S. ATS series. Such systems, which have been proposed by a number of U.S. and European entities, may threaten the existing structure of terrestrial broadcast stations and cable television distribution, and hence have been approached with great caution by the United States and foreign regulatory and communications authorities.

Direct broadcasting raises both domestic and international concerns about regulation of program content and competition with local programs. One of the principal worries is the transmission of signals beyond national boundaries, either because of unintentional “spillover” or intentional beaming of signals across international borders. These concerns have been debated at the U.N. and other international bodies for many years, without agreement on regulations for DBS systems. The United States has opposed restrictions on the international flow of information including those proposed for DBS. Severe limitations on spillover could create serious problems for the satellite system designer, for the shaping of ground patterns for signals broadcast from satellites is not a mature technology. Restrictions on transmitting across borders could affect the economic prospects for proposed DBS networks, especially in Europe.

For direct broadcast systems, many of these political and economic concerns are reflected in discussions of technical requirements, limitations on orbital spacing for geosynchronous satellites, and the allocation of frequencies. The major forum has been the International Telecommunications Union (ITU) and its periodic global and regional Administrative Radio Conferences. As in many other international bodies, the majority of the participating countries are not highly developed technologically, and this fact often makes it difficult to gain acceptance for new space services. It is also often the case that the technology associated with such services is ahead of the other necessary infrastructure to make use of the system, particularly trained technical and managerial personnel. Often, the resolution of ostensibly technical issues revolves around political conflicts between developed and less developed countries, Soviet bloc and Western states, and other such divisions. in such situations, the international regulatory process may require considerable clarification and debate about the industry structure, the sociological impacts, economics, and other key features of new service.

All nations, especially in the third world, share legitimate concerns about the availability of adequate electromagnetic spectrum for current and future services and, as pointed out earlier, information content and use of the spectrum for DBS systems. The space applications policy options that are to be considered should reflect these concerns, as well as U.S. public interest as a leading user and producer of telecommunications technology. The options tend to fall into two general categories, aggressive competition and broadened cooperation.

#### AGGRESSIVE COMPETITION

Many of the possible initiatives have been pioneered in this area by the long-standing practices that the united States has followed in helping to organize and extend the role of INTELSAT. Aggressive competition by the United States in this growing marketplace has been tempered by the necessity of gaining broad acceptance of and adherence to the INTELSAT agreements, and by the fact that, until now, the United States has been the sole supplier of most of INTELSAT'S hardware and managerial expertise. Political forces have necessitated more sharing of procurements and technology than might be the case in a highly competitive environment. Future developments under the broad umbrellas of INTELSAT and INMARSAT can be expected to be similarly constrained; competition for I NTELSAT contracts is likely to be more intense than in the past. However, there are new services that do not fall under these umbrellas and are being pursued by U.S. suppliers. These services involve purchases of ground or space hardware that are needed for a foreign system, via a solicitation that is open to any qualified supplier.

One principal area of concern has been the difference between U.S. practice–which calls for the rigorous application of antitrust provisions to any U.S. firms intending to bid—and that of our overseas competitors, where there is often a high degree of collaboration among Government and various industry suppliers. Hence, if we were to adopt a policy of "aggressive competition" in this area, it would imply that ***U.S. policy on antitrust restrictions and restrictions on other forms of information exchange for space communications would be relaxed in order to encourage joint ventures by industry the better to exploit the U.S. technology base.*** This plan could be accomplished by encouraging industry to take advantage of a procedure already available in the Justice Department Antitrust Division to render prompt advisory opinions in response to industry requests to work together on such projects. This would have the effect of strengthening the U.S. position vis-a-vis our overseas competitors.

Another possibility is expanded collaboration with overseas firms. One issue that results from such collaboration is: How to guard against the possibility that technology transfer between the United States and foreign partners may enable them to become more competitive on subsequent contracts? U.S. suppliers have a great deal of technological know-how as a result of a broad set of space and telecommunications developments, both publicly and privately funded, over the past 20 to 40 years. Other nations have highly skilled scientists and engineers similarly engaged, although generally not with the same level of space systems experience. For specific technologies, e.g., reliable, long-life, high-power traveling wave tubes, U.S. suppliers may find that they can benefit from technology that exists overseas. [n other areas, such as total systems design, the reverse may be true. In some cases, cooperative ventures with overseas firms may be desirable for political reasons; for instance, in negotiating the contracts for the recent sale of equipment and services to Arabsat, a communications satellite consortium consisting of a number of Middle Eastern countries, Ford Aerospace could not be the prime contractor because of its position on the "Arab blacklist" for having dealt with Israel. Ford then became a subcontractor (although receiving a majority of the value of the contract) to a French firm, Aerospatiale, which took the lead in negotiations.

For a number of reasons, U.S. policy has favored limited duplicative launch vehicle developments, but this policy has not been strongly pursued. Both technology transfer from the United States, as in the case of the sale of Thor-Delta technology to Japan, and indigenous developments such as the European Ariane vehicle, have resulted in the imminent availability of capable, yet relatively low-cost foreign launch vehicles for applications payloads that are competitive with United States and Soviet systems. Thus, we are at the threshold of a period in which "aggressive competition' will probably be practiced by others, whether or not the U.S. policy favors such a posture.

### BROADENED COOPERATION

The growth in foreign technical capabilities, their aspirations for a greater market share for their industry, and their desire to have more independent control over development and deployment of space systems for their own use have changed the space applications outlook. The existence of an independent launch capability is particularly significant in this regard, because it

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permits a great deal of flexibility in placing competitive national or regional systems into orbit and in providing a variety of specialized services.

In the communications realm there would appear to be little prospect of a near-term threat to INTELSAT'S long-distance and overseas markets from independent launch of satellites for general purpose communications because of the size and sophistication of the INTELSAT system and its expected ability to keep pace with technology. For INTELSAT and also for INMARSAT, it appears that no U.S. policy change is needed. With regard to a foreign nation's internal communications systems, current U.S. policy recognizes that this is an internal question for the specific nation, and—given that it constitutes no violation of other international agreements—would launch or otherwise support such a system in accord with established principles regarding foreign cooperation.

A possible future problem for INTELSAT may come from the proliferation of regional systems such as Arabsat, Nordsat, and others. A policy of "broadened cooperation" would entail a strong U.S. effort to bring such systems under a cooperative umbrella. The basis for this policy would be both economic and technical. Economically, it would be advantageous to use the larger-scale requirements already embodied in INTELSAT to provide additional service extensions for those nations able to use the large-capacity ground stations currently needed for system compatibility. For nations with limited internal communications infrastructure, satellite systems designed to operate with smaller and much less costly ground stations are attractive. The technology for these systems has been demonstrated and several such systems are planned or in operation, and U.S. policy might be to help extend this type of service to a much wider number of potential users. The mechanism for this could be a separate subdivision within INTELSAT (for specialized services) or a new cooperative international/ enterprise. In both cases, the basic objective would be to provide multiple small users access to high-quality communications services that are more compatible with a limited local infrastructure, and with a limited ability to invest in ground station capacity. The system would be optimized for low-capacity ground stations and would make maximum use of the spectrum through multiple spot beams, "on-call" service, and other techniques appropriate for low-volume users. **In principle, any nation should be able to obtain satellite communications that are matched to its particular stage of development, economic needs, and the density of local communications infrastructure.**

By providing leadership in identifying the specialized needs of smaller nations and translating these into technical specifications for communications services, the United States can accelerate the process whereby space communications can be readily provided to all nations. By bringing these multiple small users together, the aggregated market should be capable of supporting appropriate satellites. This would tend to reduce or eliminate the need for ad hoc groups of nations to organize independent regional systems. Consequently, greater technical compatibility would be ensured, and there would be greater likelihood of continuing technological advances to improve and broaden the services provided. The proposed entity would be analogous to a local telephone system, connected through a switching system to a larger network, but providing individual lines to many small subscribers at the local level.

### Land Remote Sensing

**Remote sensing from space has inherent international ramifications because the vantage point provided by the orbiting space platform provides broad synoptic coverage that is not limited to national boundaries. In contrast to the international cooperation that is essential for a successful global communications system, remote sensing does not require direct cooperation to be successfully pursued—although cooperation** in providing "ground truth" information is very useful, and foreign ground stations collect data that would otherwise be unavailable. The fact that cooperation is not essential has allowed Earth remote sensing to develop without a clear, international framework that would deal with such questions as rights to data, maximum resolution limits, technical characteristics of the sensors and platforms, data format, orbits and repetition rates, and a host of other policy and operational questions.

In approaching the international aspects of remote sensing, the United States has been guided by several principles: 1) overflight of a nation by an orbiting satellite should not be prohibited, assuming other treaty obligations are fulfilled; 2) the civilian remote-sensing program should not give rise to negative reactions that might constrain military and intelligence uses of space platforms; 3) cooperation with other nations is encouraged; and 4) data collected are to be made available to any interested party on a nondiscriminatory basis, for a fee. The early flights of the Landsat series of satellites resulted from unilateral decisions of the United States; international aspects were incorporated largely as byproducts of the effort to generate users and develop a better understanding of user requirements. Consistent with the principles listed above, the data have been been made available widely on a nondiscriminatory basis, Earth stations have been sold to enable other nations to collect data directly, and careful choice of resolution limits and sensor performance characteristics has caused many of the early concerns about Landsat as a spy in the sky to dissipate. in the interim, the United States officially revealed its military reconnaissance satellite program—confirming what most observers already believed–so that, at least publicly, the role of Landsat and its follow-on systems could be more clearly addressed in the international arena.

The United States clearly had a significant lead in civilian remote sensing—almost a decade ahead of Soviet and emerging European and Japanese systems. With the passage of time and the lack of a clear U.S. commitment to maintaining an operational Landsat, the development of competitive systems such as the French SPOT was a logical consequence. Some policy options available to the United States before the French decided to proceed with SPOT may now be foreclosed by its existence; they will at least be significantly modified. In general, the policy options fall into three categories: aggressive competition, laissez faire, and expanded cooperation.

### AGGRESSIVE COMPETITION

It may be assumed that U.S. technology, including what is available from national security systems, would permit significant improvements in ground resolution, and that multispectral sensing could be provided at adequate resolutions and at appropriate wave lengths, on a timely basis, for international as well as national use. Therefore, it is likely that anything other nations may choose to provide via an Earth-sensing system, could be matched or improved upon by the United States if there were adequate budget support and commitment. It should be kept in mind that any U.S. system will have to compete with SPOT and its derivatives, whose products are not likely to be priced to reflect their true cost. Political considerations of national prestige and advancement of high-technology enterprises may transcend questions of cost recovery. In short, aggressive competition is not likely to cause systems like SPOT to be discontinued, although it may make such investments less profitable.

The implications of aggressive competition appear to favor a continued role for Government as the operator of the space segment, but with a clear commitment to operational status for the system. This commitment would assure continuity of data, adequate processing capacity to insure timely availability of data to international as well as national users, and an active R&D program to support system improvements.

Pricing of products would be competitive with alternative systems. The premise would be that the overall global and national benefits, particularly the nonmonetary ones, would justify the subsidy to this system. Examples of the latter include the goodwill that would accrue to the United States from use of data forewarning crop failures, severe storms, or other hazards; post-disaster monitoring; monitoring the global biomass inventory; monitoring the status of the ozone layer and other worldwide environmental phenomena.

### LAISSEZ FAIRE

As an alternative, the united States could also turn over responsibility for operational systems, if any, to the private sector and buy the data it needs from whatever source was most appropriate—including foreign systems. Government users might be able to obtain appropriately screened data from classified systems, but the principal sources of remotely sensed data would be commercial suppliers. The market would determine pricing and availability, and Government would be precluded from direct competition with the private sector. This posture would not foreclose a continuing R&D role for NASA, but would require that any operational system be developed in the private sector. Satellites that serve to demonstrate a sensor or system could be Government funded or might be jointly supported. Pricing of products would be set by the private supplier, perhaps with Government participation. Because it can be expected that foreign systems will be subsidized, a private U.S. operator may have difficulty competing unless the Federal Government provides equivalent support. if industry did not see an adequate market for remotely sensed products and did not purchase a satellite, there would be no operational U.S. system, and U.S. users would have to seek other means of obtaining their data.

### BROADENED COOPERATION

Alternatively, the United States could seek to extend the arena of formal cooperative arrangements to include ocean and land remote sensing. Under such broadened cooperation, the pattern established under INTELSAT would be adapted to the remote-sensing field, For example, it should be possible to define a single management authority that would assume responsibility for global operational systems, establish technical specifications, procure satellites, and operate the satellites and the initial data reception and processing facilities.

In order to make such a new international entity possible, participating nations would be expected to forego launch and operation of national systems for civilian purposes. This would not preclude national R&D on sensors or platforms; but such systems could not substitute for commitments to the global consortium. Successful R&D could be integrated into the global system under a negotiated arrangement. Basically, the United States would be proposing to join together with other nations in launching and operating a common set of data collection platforms, with revenue to be obtained from the sale of raw or processed data. The returned data stream from the common operational platforms would be encoded so that only consortium members would have direct access to the data. Others would be able to purchase data from the central organization at established prices. The rationale for this approach is based on the following.

- Market. -the current limited and uncertain market for these data makes competitive systems redundant, and is not adequate to support a commercial operator.
- Interest.—There is broad international interest in such systems.
- *Competition.* –It is too late for the United States successfully to preempt foreign competition by offering greater or more favorable access to future Landsat data.
- *Cooperation.—* By joining together, large and small nations can participate in the benefits from a common global system with less fear of exploitation by particular nations or private firms.
- *Global systems.* –This approach would facilitate global monitoring systems for critical environmental factors such as forest inventory, biomass, carbon dioxide and ozone concentrations, which could be operated as joint projects by the consortium.
- *Economies of scale.*–Economies of scale could be achieved by common use of Earth facilities and data processing facilities to serve multiple customers, and lower cost satellites. These advantages are similar to those that INTELSAT enjoys in its multiple-satellite purchases.

The initial startup period for the consortium could be handled in a way very similar to the INTELSAT model, with interim agreements in force for a fixed period during which the detailed operating practices would be negotiated. Some of the current practices that are followed in the communications area could be expected to carry over to the global satellite consortium, including procedures for procuring operational satellites, contracting for launch services, and establishing satellite control facilities. The ground processing of data is sufficiently complex and sensitive (particularly control of decoding) that the initial stages should probably be a consortium responsibility, rather than being handled by individual governments, with subsequent interpretation made by other entities, either government or private sector. For the purposes of this assessment, such a consortium will be called "Globesat."

The differences between communications and remote sensing need additional comment. Communications *requires* active cooperation, remote sensing does not. Any alternatives to a global cooperative entity such as INTELSAT still require agreement and compatibility between separate states. The alternative to Globesat, however, is completely independent national collection platforms. Communications involves a shared benefit between the linked points, while the sensed data from an observation satellite are primarily of value to the controlling authority or to entities who use the data for specific purposes.

Privately owned international communications have, for the most part, minimal national security implications. Conversely, increasing resolution for satellite observations leads inevitably to national sensitivities regarding the detection of military installations, troop or equipment deployment, and other sensitive information. Globesat would provide a forum for reaching common agreement on system specifications and could serve to alleviate sensitivities on the part of participating nations regarding the nature of civilian remote-sensing data that would be available regarding their country. Using encoded data streams would allow selective processing so that it would be possible to limit access to high-resolution data from a particular nation if that nation required imposition of such limitations. It can be expected that most nations would avail themselves of this privilege, charging a fee for foreign or private sector access to high-resolution data. Alternatively, it could be Globesat policy that a nation could restrict access to high-resolution data for a fixed maximum period of time, say 6 or 12 months. This would reduce sensitivity about military movements and would enable national interests to have the first opportunity to use the data. As pointed out earlier, U.S. policy has been to gain acceptance of "open skies" and "open data" policies; restrictive actions carried out under Globesat might appear to undermine these positions. However, the basic concern of U.S. policy, that is, the principle that there shall be open access via satellite systems to co//ect such data, is not infringed by the Globesat practices suggested above. It is simply the civilian use that is being controlled, if specified by a participating country, and this use would reflect legitimate economic interests that the United States also shares. Thus, it appears that Globesat could operate in a fashion that is both consistent with longstanding principles of U.S. policy and yet respect the valid concerns of other participating nations.

Is it possible for Globesat to function under the auspices of the United Nations? There are organizations, such as the World Health Organization (WHO) and World Meteorological Organization (WMO), that have successfully overcome some of the inhibiting characteristics of such broad sponsorship. However, it would appear that Globesat is not suitable to a U.N. format, at least in its formative stages. The large number of competing interests, coupled with fears of exploitation, would likely make reaching agreement on a system very difficult. The overwhelming difficulties that the Law of the Sea Treaty has faced are a case in point. Transition to a U .N. relationship would be an issue for consideration at some future time. In 1978 France proposed, at the U. N., that a remote-sensing agency be established to monitor worldwide military activities and disseminate information to all countries, thereby forestalling aggression. If such a plan were agreed upon, Globesat could be the appropriate entity to operate the system.

A major concern in a system with multiple owners and users is the adequacy of data collection to serve user needs. Telephone, television, and digital data are the principal components of international communications traffic, and common systems can be designed to fit a variety of such users. For Earth observations, however, satisfying user needs is not as simple; the users are not well organized, and their data needs are not standardized or well understood. In addition, the most desirable observation times, frequency of observation, and spectral bands differ from user to user. Hence a difficult set of compromises would be required to establish the satellite system specifications. Combining several sensors on a single platform would be traded off against the advantages of multiple platforms with fewer sensors. Presumably sensors such as those planned for SPOT and Landsat would be candidates, as well as others that may originate elsewhere. In Globesat, the united States would have no guarantee that the compromises would satisfy U.S. needs; however, because the united States would be a major user and source of revenue, it is likely that these needs would be given some priority. There is also no guarantee of continuity of data, but there is no guarantee of data continuity for strictly national systems, either. It seems probable that an international consortium such as Globesat, with broad user and national support, would have a greater commitment to continuity than would be the case for a single U.S. supplier.

The adoption of the Globesat option would imply that several policy options defined earlier would become impractical. For example, creation of a single national regulated satellite operator for U.S. remote sensing would be counter to the principles upon which Globesat would be based; Globesat would substitute for the U.S. operating entity. However, there would be a need for a U.S. representative to Globesat that would reflect the views of various U.S. users. This representative could be a designated Government agency, and existing group, or a new entity that would have responsibility for distribution of U.S. data, as well as coordination of the various user community needs.

An important unknown in considering Globesat would be the position of the Soviet Union. The Soviet Union has operated remote-sensing satellites for many years, and recently announced its intention to provide a “continuous-look” system similar to Western satellites. The Soviets could use such a system to compete with Globesat; alternatively, if they were to join, the difficulties of agreeing on system specifications and operating details might be much greater.

In summary, many of the international concerns about remote sensing could be suitably accommodated within a global consortium that could also fulfill U.S. needs. At this point, it may not be possible to obtain international agreement on such a structure because of the prolonged period of U.S. indecision regarding remote sensing and the resulting efforts by other nations to satisfy their needs through independent systems. It would take a strong U.S. commitment to Globesat for such an entity to be initiated and established.

## Economic Measures

One of the common characteristics of space applications systems is the high entry cost associated with the development and institution of new systems. The principal hurdle has been the high cost and difficulty of transporting the satellite to its proper orbit. A large additional cost results from the absolute necessity for extremely high reliability for the payload, which must function for long periods of time without maintenance or repairs. Complicating factors are the environmental stresses: the shock and vibration of launch, and the vacuum, low gravity, alternating heat and cold, electromagnetic radiation, and solar wind of space. The net result, given the small numbers of satellites actually flown, has been that virtually each satellite has been a new and delicate design requiring its own set of tests.

[t is possible that routine and reliable access to space via the shuttle and the availability of astronauts to perform tasks such as replacement of wornout parts, repairs, or fueling could lead to an era of less costly satellite platforms. As part of the shuttle program, many of these concepts will be explored, including developing a common spacecraft bus that would provide standardized housekeeping functions needed for all satellites, such as command and data links, power, attitude control and station keeping. In addition, NASA has offered small amounts of shuttle payload bay space at very low cost, the so-called getaway specials, for small experimental packages. But these are only the first steps along the road toward lower cost access to space, and it is not likely that significant change will occur, at least in the next decade or so. Satellite maintenance is severely limited by our inability (even with the shuttle) to transport men into geosynchronous orbit, where most communications satellites are located. Thus, although steps are being taken that could lower the high cost of satellites, this will remain a significant barrier to commercial entry into space applications service areas.

Beyond the direct cost of the satellite, there are additional costs for the construction and operation of ground facilities to link with the satellite. Communications and remote sensing require extensive satellite control facilities, ground receiving stations, and data processing systems. Materials processing in space is relatively free of such costs.

With such significant entry costs, private sector involvement in space applications has been limited (see ch. 8). Government policy has served as a primary stimulus for such involvement, primarily in communications, through regulation, joint Endeavor Agreements, and congressional actions such as the COMSAT Act, the National Aeronautics and Space Act (for R&D), and INMARSAT legislation. If there is to be a new thrust to open space applications for commercial exploitation, the economic barriers to entry need to be addressed. Several approaches appear feasible.

### Space Development Bank

Government has used the device of a development bank or system of loan guarantees to finance socially desirable objectives in a wide variety of settings, from international development (World Bank, Interamerican Development Bank) to sale of U.S. products (Export-import Bank) and U.S. housing (Federal Housing Administration and Veterans Administration loans, Federal National Mortgage Association, Farm Credit Administration, Federal Home Loan Bank System). More recently, loans or loan guarantees have been used to make a college education more accessible, to prevent the collapse of major corporations (Lockheed and Chrysler), and to provide incentives to small business. Thus, a determination by the Congress that the growth of space applications was socially and nationally desirable and that the preferred approach was to keep such growth as much as possible in the private commercial sector, would open the possibility of establishing a Space Development Bank (SDB). A similar concept, the Space industrialization Corporation (H. R. 2337), has been the subject of recent congressional hearings. (A more detailed discussion of this specific piece of legislation can be found in chapter 8.)

The role of SDB would be to: 1 ) receive proposals for space applications investments; 2) evaluate these applications; 3) if acceptable, provide funds at preferential loan rates and establish a deferred payback schedule; and 4) monitor the progress of the business plans on the basis of which loans have been made. SDB would require initial authority for drawing rights upon Treasury funds appropriated for this purpose, but in the long term the SDB would be self-sustaining and pay back the initial appropriations. SDB would provide an initial subsidy to qualified entrepreneurs, with the amounts and areas to be determined by negotiation and the developing marketplace.

SDB could also provide incentives for private entities to form joint ventures for specific services for which a single supplier was not available or appropriate. As such, SDB could act as a quasi-regulatory body, controlling entry into space applications fields to maximize social benefit. (It should be recognized that there are limitations to this role. For corporations like COMSAT, with a continuing statutory role in space applications and a large and growing revenue base, entry into new space applications services would not depend on incentives such as SDB would provide. An expansion of COMSAT into other areas, particularly remote sensing, would create—de-facto–a commercial space applications monopoly. As explained earlier, the public interest would likely require that such a monopoly be accompanied by a Federal regulatory authority.)

SDB, on the other hand, would be associated with more open entry. The provision of capital at low rates would serve to attract a broad array of potential suppliers, and a separate regulatory body may, therefore, not be needed.

### Tax Incentives

The tax incentive is another governmental device used to promote socially beneficial actions. It is currently being employed to encourage R&D generally, to stimulate energy conservation and use of solar energy, and to encourage investment in new plant and equipment. The advantage of the tax incentive is that very little additional Government manpower is needed to administer its provisions—and the decision making is almost completely free from Government management and, therefore, more nearly reflects the realities of the marketplace as it is understood by the private firms.

## INTEGRATED POLICY OPTIONS FOR SPACE APPLICATIONS

The previous section outlined a number of individual policy options to address specific issues. In this section, the policy options will be grouped into larger patterns or themes to give a more integrated picture of the range of options available.

It should be recognized that the grouping of policy options presented in the following material is illustrative and may be modified by the addition or deletion of specific elements. The options are not necessarily exclusive of one another. They are presented in this integrated fashion to give a better understanding of the types of actions that may be contemplated and the relationships among the various policy elements.

### Continuing the Current Policy Framework

Current policy, as expressed by the existing legislation, permits a great deal of flexibility to organize and conduct a strong space applications program and gives implicit authority to Government, not only to conduct R&D but also to operate systems. There is, in addition, wide latitude to assign specific tasks to agencies and to permit private-sector participation in essentially any phase of activity. Thus, the role of the private sector in remote sensing could be expanded to include operation of space and ground segments simply by Administrative action. (Transfer of ownership of existing satellites systems, which are Government property, would require separate congressional action. ) The policy framework for space communications is also flexible and permits both Government and private sector roles in a wide range of services, subject to FCC and ITU regulations. The specialized position of COMSAT is defined in legislation and therefore restricts the choices in this area. In transportation and materials processing, there is similar flexibility with respect to the institutional structure and the extent of the private role.

Continuation of the current legislative framework permits policies ranging from strong Government leadership and participation to a laissez faire approach in which Government stands aside and explicitly invites private groups to assume a larger role, without emphasizing or requiring any one approach.

While there is a wide latitude permitted by the current policies, there are no clear goals, no timetable and no overall direction for space applications. As a result, it is difficult for the Government to identify and pursue the benefits of space applications.

If nothing is proposed beyond current policy and practice, neither the U.S. private sector, the Government, nor the public at large will benefit fully from the country's large space investments over the past 24 years. U.S. leadership in many areas will be lost. Viewed in an historical perspective, such a course would raise serious questions about our ability as a nation to pursue long-term objectives when faced with short-term problems.

### Increasing the International Emphasis

A number of policy options hinge upon the approach that is adopted toward international competition and cooperation. This approach suggests a strategy that may be termed "international emphasis." Under this approach, the United States could adopt a general guideline; i.e., "all inherently international civilian space applications should be carried out on a cooperative international basis, and be the subject of an agreed institutional framework." If this approach were followed, we would pursue the establishment of an entity like Globesat for remote sensing and a new communications satellite structure that would vigorously develop the market for small, low-volume users. U.S. needs would be met by these entities, as appropriate; as a consequence, questions of private-sector entry and foreign competition would become moot–given that the necessary international entities were successfully established. The United States could designate COMSAT and/or other entities to represent it in these new international bodies. Other applications such as transportation and materials processing are *not* inherently international and would therefore be treated separately. NASA would continue to do R&D on new technology, but on a much more limited basis. It might also do some development work under contract with international organizations. The requirements of U.S. users would need to be identified systematically and formally in order to provide adequate, timely specifications for Globesat and other entities. Responsibility for convening such groups and incorporating their needs into U.S. positions in the appropriate international bodies would reside with the chosen U.S. representative.

A policy with an international empahsis is attractive because it tends to clarify so many other related aspects of the policy picture. It has the effect of moving operational responsibilities out of the U.S. Government, via an international quasi-private entity, and thereby reducing direct Government expenditures for such systems. It is consistent with U.S. policy in communications, in which we have strongly supported a single global system via INTELSAT and INMARSAT. [t clarifies the issue of international competition in remote sensing by creating a strong incentive to participate in the common, i.e., Globesat, system.

This option also carries with it a number of risks or limitations. The outcome of such a U.S. initiative on the international front is problematic. Sovereign nations will tend to protect their interests and seek advantages in this area as in many others. It would therefore require considerable care in outlining the advantages of a common system (or systems, e.g., using SPOT as well as Landsat technology) and in creating strong incentives for the principal initial partners to join with the United States. Though the optimal moment for this proposal has probably passed, there is still an opportunity to create a common entity—if the United States moves promptly and decisively. Another aspect of this approach is that it implies some loss of independent action on the part of the United States. We would be (as in INTELSAT) foregoing our own independent systems in favor of a cooperative international effort. Arriving at an agreement among the international participants regarding the number of satellites, their sensors, data formats, and other operating characteristics, as well as the procurement guidelines for equipment and services, may be a difficult and prolonged task. The procurement guidelines can be expected to result in mandatory sharing of the development and production tasks among the participants and, hence, a possible reduction in U.S. contracts as well as sharing of U.S.-developed technology with overseas firms.

Finally, the reality of the growing independent space capabilities of other nations means that they will eventually be able to carry out such a plan without U.S. participation, if they choose. Although such a prospect is not likely in the near future, other data collection systems will be launched, if Globesat is not established, each of which will compete for a limited market. The alternative of a common system has strong economic and political advantages.

## Increasing the National Private Sector Role

The approach here would be to extend the current U.S. practice of maintaining an independent data collection system, but one that gives the private sector a stronger role in specifying the system and the method of operation on. The basic principle would be: "/t is ***U.S. policy that the private sector own and operate space systems.*** " There are several basic approaches:

- ***Open entry.*** —This would involve encouraging multiple suppliers to provide services. Incentives would be offered via tax breaks, loans, and other financial aid via an SDB; in addition there might be guarantees of Government data purchase, no Government competition, and measures to preclude a monopoly supplier. In communications, the conditions for regulated, open entry have already been established.

- Private monopoly.—This alternative applies principally to remote sensing. In this case, the entity could be an already established corporation, or a new public-private company. Ground-segment ownership would follow the choice for ownership of the space segment, as explained in an earlier section. The choice of a private-sector monopoly supplier would be accompanied by establishing a regulatory body.
- Government rnonopoly. -Continuation of the current Government monopoly for the space segment would be possible, with increased private-sector participation in the ownership and operation of all the ground data reception and processing stations. This recognizes the currently limited marketplace and the need for continued Government support of operations to ensure maximum public benefit from space applications, particularly remote-sensing systems.

Because this approach is principally an extension of current policies, though increased emphasis is given to the role of the private sector—a point of view strongly supported by the Reagan administration—it probably would be the easiest on which to develop a consensus between Congress and the executive branch. But a national consensus does not necessarily lead to a satisfactory resolution of all the issues, particularly in view of the degree of sophistication and independence found in other nations today. The United States can attempt to meet this competition and continue its own independent developments, including increased private-sector involvement, or it can seek a collaborative and cooperative framework as outlined in the previous section. If we choose an independent course, additional policy questions arise, such as whether U.S. private firms and/or the Government will buy data from foreign systems. The approach outlined here is consistent with a policy that would permit purchase of data from a foreign system by private users without restriction, but subject Government users to whatever purchase agreements had been negotiated with a private U.S. supplier (or suppliers).

## Increased High-Level Policy Focus

Spanning the range of all of the above approaches, there is the suggestion that both current and continuing developments in space policy would profit from increased high-level attention in the executive branch and Congress. There are several approaches that may be taken to accomplish this increased high-level review and decision on national space policy. They are all compatible with the various policy options discussed in the preceding sections. The premise on which they are based is that space policy is sufficiently important to warrant greater attention from both the executive and legislative branches of the Government.

The policy directions set by the different approaches above would require attention by the administration and Congress in the form of implementing guidelines, program direction, and budget decisions—in short, of continuing followup over a number of years. International initiatives, if adopted, must receive high-level endorsement and be integrated into the overall foreign policy stance of the United States: the responsibility to implement such initiatives cannot be left to a single agency. Thus, whatever new approaches are taken, they should be matched by suitable steps to strengthen the process of developing space policy. Without such a step, the other measures are likely to be less than adequate in meeting the many needs identified in this assessment.