TOP SECRET

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SPACE POLICY ALTERNATIVES PAPER

FOR

SPACE POLICY REVIEW COMMITTEE

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CIVIL SPACE POLICY

I. INTRODUCTION

The United States is now completing 20 years of organized civil space activity. We have spent about $100 billion on our diverse space activities, of which some $________________ has been for civil programs. Our national space programs have been important elements of US power and prestige. They have contributed significantly to national security and foreign policy objectives and have resulted in important security and foreign policy benefits.

In May, NSC/PD-37--A Coherent US Space Policy--set forth this nation's principles for space activities. It established policy on the interrelationship between the civilian, military, and intelligence sectors. That policy statement, however, did not attempt to articulate US civil space policy goals in detail. To provide a framework for decisions on such goals, this paper describes the scope of our various civil space activities and sets forth several issues for decision. Before discussing policies and issues primarily focused on the civilian space program, the first ~~section~~ part of the paper discusses technology sharing among the three sectors of the national space program, the strategy to utilize the Space Shuttle, and the issues (and impacts) of a proposal to declassify the "fact of" the existence of the intelligence program. The civilian space policy issues discussed are (a) the government's role in remote sensing, (b) space sciences and planetary exploration, (c) the government's role in communications R&D and public services satellites, (d) longer-term economic activity in space, and (e) public statement articulating civil space policy and goals.

The major directions of the US space program have been determined by Presidential decision and by legislation. President Eisenhower initiated US space exploration programs. The Congress approved the Space Act in 1958. President Kennedy set the national goal of placing a man on the moon in the 1960's. The future space transportation system--the Space Shuttle--was an initiative of President Nixon.

The US civilian space program is acquiring new capabilities, but it needs direction and purpose. Decisions made now will set the goals and dimensions of our civilian space program for the next decades. National space objectives in the civilian sector, beyond deployment of the Shuttle, have not been addressed at the Presidential level. This Administration has an opportunity to put a distinctive stamp on the US space program. There are compelling reasons to believe that today is the time to address this vacuum. First, if this Administration does not fill this vacuum, others will try to do so, and policy might well be made by reaction and default. Some have chided the Administration for going too slowly in setting new goals in space and making imaginative proposals for future space projects. Some have threatened to introduce their own civil space policies. Congressional frustration with the Administration's low profile on space could lead to premature legislated programs; e.g., for satellite power stations. Thus, the time to set policy for the 1980's is now, because of the long lead times associated with major efforts in space. A national space policy must effectively link our near- and long-term objectives.

Moreover, space objectives can be accomplished at various budgetary levels. As the extent and complexity of space exploration and utilization rises, the costs associated increase. The foreseeable national economy and existing national priorities clearly dictate that we make choices concerning our activities in space. With the projected run out in major Shuttle expentitures, the opportunity exists to set directions in space. Options become available, for example, to give new impetus to space applications or to continue our programs at present levels or to contract them. However, since it is not feasible within any projected budget envelope to commit the US now to a high-challenge, highly-visible space initiative comparable to Apollo, steps taken must be evolutionary and controlled. All this comes in a period when the growth of overall expenditures must be reduced.

In addition, opportunities exist for Presidential management direction that could maximize US benefits from space for the resources expended. The efficiency of US efforts in space could be increased through improved coordination, joint planning, and technology transfer among the civil, military, and intelligence sectors, and possibly through more joint projects. In the near term, savings would be modest, but they would hold the potential for larger savings in the future.

The third decade in space will bring increasing worldwide involvement and competition--both between governments and in the business sector. The European

Space Agency's Ariane launch vehicle will be available in 1979. The Japanese have announced an encompassing 15-year space program. Together, the Europeans and Japanese will provide the major competition to the US for the commercial space market and in the economic applications of space technology.

At the same time, the USSR remains the primary US space competitor in national security systems, in space exploration, and increasingly in areas of potential economic value--such as remote sensing. The Soviets place considerable emphasis in space for national prestige building. As such, the Soviets sustain a highly-visible space program--integrated with their military program--and now launch some 115 satellites per year. Technologically, US satellites are more sophisticated--e.g., longer lifetime in orbit--than Soviet systems, and the US therefore needs to launch fewer satellites per year (33 in 1977). The Soviets, moreover, sustain a highly-visible manned program. In this year alone, they have launched four manned flights, broken a US manned endurance record, resupplied a Salyut space station, and brought to fruition a cooperative program--flying Polish and Czech cosmonauts. We believe the Soviets will strive toward equivalence with the US in space prowess, or at least the public image thereof.

A resurgence of domestic interest in space exploration and utilization has been evidenced by press and popular attention to the Space Shuttle and proposals for future space projects. Continuing Congressional interest is reflected in budgetary support for NASA. On the other hand, Federal expenditures in the social and defense areas also have strong advocates.

This Administration stands at an important decision point in the US use of space and the development of US space capabilities. In the broadest terms, it must answer the question: To what degree should the US expand, reorient, contract, or maintain its present use and exploration of space? These considerations or questions must be addressed from the policy perspective, but also in a way that clearly distinguishes between the overall national needs in space and our goals and the specific program decisions that must be made in the context and the evolving space technology and also the budget.

II. SCOPE OF US ACTIVITIES

BACKGROUND. Space exploration, earth applications, and associated civil international programs are pursued by NASA, Commerce (NOAA), and the private sector in support of other departments and agencies. The national space program for intelligence is pursued by the National Reconnaissance Office (NRO). The military program is pursued by Defense. PD-37 dictates that each program will continue to be run by separate mechanisms. Figure 1 shows our overall space expenditures over the past 10 years [redacted] 25X1
[redacted] Each program generally serves basically 25X1
different constituencies and requirements, but as noted below, there is some redundance.

-- The Federal civil program is basically open and unclassified; develops space systems; acquires global planetary and scientific data and monitors weather, earth resources, and natural pehnomena; and develops applications to satisfy the needs of a wide variety of consumers at home and abroad.

-- The intelligence space program is highly classified (even the fact of its existence is currently classified) and is a principal source of information to support national intelligence estimates, the verification of arms control agreements, intelligence for crisis management, and tactical military needs in peace and war.

-- The military space program provides early warning of an attack, communi- 25X1
cations, navigation, weather forecasting, and aids in verification of

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arms control agreements. Space systems provide essential elements of our warfighting capability, and our dependence on them is growing.

— The private sector maintains a $____ million investment in commercial space programs, which have significantly improved domestic and international communications.

Table I shows the US government expenditures for FY 1979 on the different space programs. It also provides a rough approximation of expenditures in the mission areas within the various sectors. The major Federal and private sector projects in all four segments of the US space activities are highlighted in Table II, along with the national needs which they meet. On the left side of Table II are the Federal civil and private sector projects. On the right are the military and intelligence projects. A brief description of these major projects follows under the various sector headings.

NASA PROGRAM. NASA has organized its technical R&D and support activities into the following areas: space sciences, applications, space flight, and tracking and data acquisition. The space science activities are discussed at length under Section VII.

The primary goal in the applications area is to develop and demonstrate applications of space-related technology and to encourage their effective use by government agencies and commercial organizations to provide practical benefits. Significant activities are underway in the earth observation area.

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LANDSAT-C, the third multispectral earth resources satellite, is providing repetitive global coverage at some 40 meters resolution. In addition, SEASAT-A is the first ocean monitoring satellite having the extensive capability to better forecase the ocean environment, monitor the marine environment for economic purposes (i.e., fisheries), and collect data for physical oceanography research.

Space flight activities in NASA provide all the transportation and associated support required to conduct space operations. The current focus is on the Space Shuttle, the first reusable launch vehicle. The Shuttle is the key element of a versatile, economical Space Transportation System (STS) that will provide launch capability for all US satellites and for international users. The Shuttle is now in a final phase of development, leading to its first manned orbital flight in 1979 and to its initial operational capability in 1980. The strategies that various sectors plan to use to transition to the Shuttle and other Shuttle-related issues are discussed in Section IV. The other major component of the STS includes:

-- Spacelab, a multipurpose laboratory which will be carried in the large cargo bay of the Space Shuttle. It is being designed and built by the European Space Agency.

-- The Inertial Upper Stage (IUS), which is being developed by the Air Force to deploy Shuttle-launched payloads to higher-altitude earth and earth escape orbits by mid-1980.

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-- The Spinning Solid Upper Stages (SSUS), which are being developed to provide a capability for launching small payloads to geosynchronous orbits by mid-1980.

Tracking and data acquisition are necessary functions for the return of data to earth from space for analysis and exploitation. These activities include tracking space vehicles for position and trajectory, receiving and relaying telemetry, and commands between ground and the spacecraft. These services are provided by the facilities of NASA's worldwide network of ground stations. In the future two specialized Tracking and Data Relay Satellites (TDRS) in geosynchronous orbit will provide near-continuous two-way communication with most low-earth orbiting spacecraft, including the Shuttle, and will lead to the elimination of a number of ground stations in the present network.

NOAA PROGRAM. Operational environmental and weather satellite services are perated by NOAA. The program includes a series of polar orbiting satellites which monitor the atmosphere and sun regularly with direct readout to ground stations in over seventy nations. The new generation of polar orbiting satellites, TIROS N, will go into service later this year. Two geostationary satellites are located such that they provide images every 30 minutes of the weather patterns over the Western Hemisphere. These satellites produce the images regularly shown on public television and are particularly important to tracking hurricanes and severe storms.

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NOAA and NASA work as partners in developing and launching these environmental satellites. NOAA and Defense work together in developing and operating polar orbiting satellite systems for weather monitoring. Data is exchanged, and both NOAA and Defense depend on the other for back-up in the event of system failure. 25X1

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<u>MILITARY PROGRAM</u>. The military program includes specific mission projects, launch vehicle development, detection and tracking, in addition to supporting R&D. The mission projects--navigation, communications, geodesy, warning, weather, and ocean surveillance--are summarized in Table II. Some significant projects include: the NAVSTAR Global Positioning System which is a planned space-based radio-navigation and time distribution system; the Defense Satellite Communications System which provides communications support through geostationary satellites to US users; the Air Force and Navy communications satellites; and transponders which are to be placed on a number of satellite types and are designed to provide critical 24-hour two-way real-time highest priority command and control communications for military forces and other designated high-priority intelligence users.

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In addition, the Air Force Defense Support Program satellite system provides missile launch detection. The primary weather information program for Defense is provided by the Air Force under the Defense Meteorological Satellite Program. Finally, the Navy has a planned program [redacted] for surveillance and targeting and a data relay system to transmit ASW data. 25X1

The Air Force is the Defense executive agent for the Space Transportation System (STS) and will develop and operate the Vandenberg launch site.

A launch vehicle program is also maintained by the Air Force to provide for maintenance of a national launch vehicle family consisting of Atlas and Titan III space boosters. The extent of this backup and timing of transition to full dependence on the Shuttle is an issue discussed in more detail in Section III.

Defense maintains a satellite tracking and data acquisition system, the Air Force Satellite Control Facility. As mentioned earlier, this Control Facility is shared with the intelligence programs. In addition, Defense maintains a network for tracking foreign spacecraft which is operated by NORAD and called the Space Detection and Tracking System (SPADATS). The Air Force element of SPADATS is called SPACETRACK, which consists of [redacted] sensors deployed at locations throughout the world. 25X1

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PRIVATE SECTOR. Private sector activities have thus far been limited to the area of communications. Privately-owned communications satellites began with

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the Communications Satellite Act of 1962 that established the Communications Satellite Corporation (COMSAT) as the "carriers' carrier" for satellite telecommunications. With COMSAT as a key component, the International Telecommunications Satellite Consortium (INTELSAT)--originally established with 14 member nations in 1974 and now incorporating 101 members--provides global communications satellite services to more than 120 nations. The US is currently a leader in both satellite and ground components of telecommunications systems, but Europeans and Japanese are working toward self-sufficiency in this area.

The Federal Communications Commission's 1972 policy led private common carriers to apply satellite technology to a wide variety of new, private line services to compete domestically. Western Union launched the first domestic system in 1974 (WESTAR). RCA and AT&T were close behind with SATCOM in 1975 and COMSTAR in 1976. Presently, the private sector has invested $___ million in communications satellite systems.

Commercial ground systems for satellite communications in the US are extensive. There are now hundreds of satellite earth terminals to serve public and commercial television and radio. The Federal role in satellite communications research and development has steadily declined. Although four NASA satellites continue to be used for experimental purposes, several are reaching the end of their operational lives. At present, there are no plans to replace them.

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III. TECHNOLOGY SHARING AMONG SECTORS

BACKGROUND. Different needs are met by the civil sector (NASA, NOAA, and the private sector) and the military and intelligence sectors. The programs do interact, however. Civil remote sensing provides data used by the military-intelligence sectors; e.g., LANDSAT is used in estimating Soviet grain production. Some intelligence imagery over the United States (and in some restricted cases over foreign areas) is authorized for use by those Federal civil agencies for military purposes. The private sector, state and local government organizations, and the broad scientific community have no access to these images. As the use of this imagery has grown within the Federal civil agencies, they have pressed for relaxation of security controls. Recognizing this fact, PD-37 encouraged the use of classified products by Federal government agencies.

Technology flow from the military and intelligence sectors to the civil sector is important, but it is difficult to accomplish. The sectors have acted independently because of a Presidential decision in the late 1950's to separate the sectors--a decision that was reaffirmed in NSC/PD-37. As a result, the sectors find it difficult to overcome a wide range of constraints to problems of transfer and cross use. The major problems are:

-- The conflicts inherent between the national security requirements for secrecy and the characteristics of civil programs; ethos of free exchange of ideas and data.

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-- The fact that while civil programs are scrutinized in detail for potential military or intelligence use, the reverse has not been true in that the civil sector seldom has an opportunity to impact the planning for classified projects.

-- The institutional biases toward developing unique solutions to specific mission problems which frequently develop technology that is so complex and expensive that benefits deriving from secondary use of the capabilities are not worth the cost. Another facet of this problem is that the secondary user cannot always depend on the availability of data from a system because of the priority demands of the primary user.

Of these three, the first is the easiest to recognize and deal with. Technological security, designed to provide time protection for a capability, could be preserved by the civil sector as easily and as well as by the military. There are questions of image--if civil elements must deal regularly with classified matters--but these can be accommodated if the returns are warranted. Data security, on the other hand, raises the philosophical issue, in the limit, of classifiying basic knowledge. These can only be handled on a case-by-case basis; i.e., assessing the losses and gains of open dissemination versus classification constraints. No overriding policy can be formulated as a guideline since today's scientific curiosity is so often tomorrow's critical technology.

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The second major problem can be addressed in part by the Federal civil agencies having more knowledge of the classsified programs, but this solution does not assist civil private sector users.

The third major problem, that of institutional biases, is inherent in the level of resources available to the various communities. In many cases, the civil sector does not need the sophisticated technology of the intelligence community. Since the civil sector is diffuse (involving many Federal agencies, local governments, and various elements of the private sector) it is unlikely that any one (or even a few) of these organizations can afford the special equipment needed. Even if they could afford the expenditures, this would lead to serious duplication of effort.

Discussed later in this section are examples of notable transfers of technology between the various sectors. There are intersector mechanisms working on this problem, and some of the transfers have been brought about through the budget process. An improved flow of technology between sectors, however, is needed.

Examples of Intersector Relationships

Data Sharing. In 1973, the CIA began to use LANDSAT data operationally in its assessments of Soviet grain production; [redacted] 25X1

25X1 [redacted] NASA moved a transportable ground receiving station to Pakistan 25X1 in order to assure coverage of critical crop areas. The joint Agriculture-

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NOAA-NASA experiments in global crop forecasting--based on civil remote sensing--have been developed with CIA technical assistance and have contributed to CIA technical expertise. Nonetheless, there has been a continuing debate in the Executive Branch over the relative value and costs of LANDSAT multispectral data in relation to intelligence-type photo imagery. Classification is one major reason why it has not yet proven possible to develop a single earth imaging program that either integrates the use of multiple systems or combines systems into an optimal mix for several users. Other reasons include the information content in the multispectral data versus that in the photographic images, computer processing of digital data versus photo interpretation, and unrestricted access to data by other nations and the private sector.

While there are numerous examples of data sharing in earth-imaging, spacecraft design, and communications equipment, such sharing among sectors usually occurs only when satisfaction of the requirements of an individual sector cannot be met within that sector.

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Space Cameras. There has been significant technology transfer in space cameras between sectors. NASA's 1966 Lunar Orbiter program used a camera system originally developed in the SAMOS program. The Apollo 24-inch optical bar lunar mapping camera was a derivative of the intelligence community's obsolete photo reconnaissance system. The Skylab 18-inch earth resources camera was originally an Air Force aircraft reconnaissance system. [redacted]

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NAVSTAR Global Positioning System. For several years the White House Office of Telecommunications Policy (OTP) (now NTIA in Commerce), the General Accounting Office (GAO), and Congress have expressed concern over the growing proliferation of government-sponsored radio-navigation systems, with attendant costs to both government and users. The proliferation has generally been attributed to two primary reasons--first a reluctance to phase out older systems as new ones come into service and second, a lack of coordinated planning within the government.

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A number of existing or planned radio-navigation systems could be replaced by the proposed military NAVSTAR Global Positioning System, which could serve both military and civil needs. Key issues are the need to protect the use of high-precision position and velocity data of military value for US forces and preventing its exploitation by potential adversaries, on the one hand, and, on the other hand, the rate of adoption of this new technology with its receiving systems into the highly-diversified civil sector--airlines, general aviation, and maritime and recreational boating. A consolidation of radio-navigation systems using the NAVSTAR GPS has been proposed. OMB has been serving as the focal point in the Administration's review of this proposal. An interagency group is examining the totality of Federal government involvement in radio-navigation systems, with particular emphasis on applicability of GPS to civil use. A Decision Memorandum on this issue will be submitted separately.

Proposed National Oceanic Satellite System (NOSS) Operational Demonstration. NOAA, NASA, and Defense are considering a joint effort to build upon the experiences gained on NASA's Seasat A and NIMBUS G experimental satellites. Seasat A and NIMBUS G are demonstrating the contributions that satellites can make to meeting the national and international needs for oceanic data. NASA, NOAA, and Defense now are considering the next step: the first full-scale operational demonstration spacecraft designed to meet the needs of both the military and civilian communities.

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This approach to technology sharing should result in economic benefits. Under the proposed multi-agency effort, NASA would be responsible for the design and delivery into orbit of two Shuttle-retrievable satellites. Defense and NOAA would be responsible for the design and operation of the satellite command and control system and of the joint data analysis of distribution systems. This multi-sector development concept--if approved--will have to take special precautions to protect certain national security aspects of an essentially open system and represents a considerable change in the character of civil space activities.

MECHANISMS FOR COORDINATION. There are existing mechanisms to manage inter-sector coordination, controls, transfers, and functional assignment between the four Federal space programs. Nonetheless, none of these review elements has performed a comprehensive cross-cut on a continuing basis.

The most important intersector mechanism is the Program Review Board (PRB), established in 1975 as the successor to an earlier interagency group initiated in 1966. The Board principals are the Under Secretary of Defense for Research and Engineering, the Director of the National Reconnaissance Office, the Deputy Administrator of NASA, the Deputy Director of Central Intelligence for Science and Technology, and--when matters involving meteorology are discussed--the Associate Administrator of NOAA. The Board's responsibility is to identify and solve intersector problems--especially in the highly classified and sensitive areas--and to refer irreconcilable issues to the Space Policy Review Committee or Presidential level for resolution.

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Other interagency mechanisms include:

-- The Space Transportation System Commmittee, cochaired by the Air Force and NASA, under which the Space Shuttle has been developed to satisfy both civil and military space launch requirements.

-- The Defense/NASA Aeronautics and Astronautics Coordinating Board (AACB), dealing with, among other things, manned space flight, launch vehicles, and unmanned spacecraft.

-- The Polar Orbiting Operational Meteorological Satellite Coordinating Board that has Defense, NASA, and NOAA representation and reviews orbiting meteorological satellite programs.

-- The Space Research and Technology Review Group which jointly reviews and redirects space programs in both NASA and Defense (Air Force).

IMPROVEMENTS IN TECHNOLOGY FLOW. In addition to formal mechanisms for coordination and review, there are other forces that act to foster intersector transfers. An important element of the latter is the US industry which works for all the sectors and is always anxious to move its products and capabilities across sectoral boundaries. Another factor is the chronic shortage of resources, which effectively dampens institutional independence and fosters cross servicing.

The Executive Office and Congress perform some cross-cut of programs, technologies, and resources on programs that have reasonable visibility. Some of the examples cited above, in fact, were precipitated by these elements. 25X1

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As space technology continues to evolve, technical civil/military/intelligence some systems requirements will continue to converge. Moreover, some of the earliest developments exploiting the Shuttle capabilities (e.g., assemblage of larger structures) might fulfill military needs long before there are comparable civil needs. Distinctions between programs will become less and less clearcut. In addition to the technical benefits that would accrue from an improved exchange program between sectors, the potential exists for a long-term savings in cost. A very expensive portion of any space program occurs in the R&D phase, which makes this phase such an attractive target for minimizing duplication.

Recommended Action

The existing Program Review Board (PRB) will identify steps that can be taken to further reduce barriers between the sectors and submit an implementation plan to the Space Policy Review Committee (SPRC) by November 1, 1978. In addition, the PRB will submit subsequent progress reports at 6-month intervals to the SPRC. The objective would be to maximize efficient utilization of the sectors and demonstrate lesser concern over maintaining the distinction between the sectors while maintaining necessary security as directed in PD-37.

Included in this implementation plan will be ways to establish a common technology and accounting format to be used by all space sectors. Consideration should also be given to establishing technology transfer groups under each Project Office with technical representatives from other appropriate sectors.

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The PRB will identify functional areas, while maintaining necessary security, where overall national needs could be better met by reassigning functional space responsibilities in the semi-annual report to the SPRC.

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IV. STRATEGY TO UTILIZE THE SPACE SHUTTLE

BACKGROUND. The Space Transportation System (STS) soon will allow the United States to enter a new era in the use of space. Instead of depending on expendable, one-shot launch vehicles, we will have a reusable system with a piloted orbiter and a wide range of capabilities. The Shuttle will provide new opportunities for on-orbit checkout, maintenance, and repair; for spacecraft retrieval and return to earth; for routine manned operations in space; and for the assembly of larger structures in orbit.

The STS will serve as a national system, carrying out civil, military, and national intelligence missions. This raises new technical security problems concerning the protection of classified activities and information which require imaginative management and organizational solutions.

As the US enters this new era of space transportation, it is important that it have a sound strategy for the best use of the Shuttle. The goal of that strategy must be to make the most cost-effective use of the STS for civil, military, and national intelligence purposes, improving the ability of each sector to carry out its missions while protecting the legitimate concerns of all sectors. Much of this strategy has been worked out, and management mechanisms and policies have been developed. However, there are some concerns which lie ahead:

-- The transition rate from expendable launch vehicles to the Shuttle.

-- The evolution of Shuttle management responsibilities; i.e., whether we should have separate civil and classified mission control facilities.

-- Whether additional capabilities for space transportation are needed.

-- The survivability of the Space Shuttle against attack.

Space Shuttle. The final Space Shuttle performance requirements are to deliver--into a 150 nautical mile circular orbit--65,000 pounds due east from Kennedy Space Center and 32,000 pounds into a 98° inclination from Vandenberg Air Force Base. The Shuttle will provide for routine operational return of 32,000 pounds of payload but can accommodate the contingency return of 65,000 pounds. The Shuttle is capable of a once-around return to the launch site. The first orbiter is scheduled for delivery to Kennedy Space Center in late 1978 or early 1979. Delivery of orbiters 2, 3, and 4 will be spread over the next 5 years; options for a fifth orbiter are being maintained, with delivery projected for fall 1984 or later pending Presidential approval.

(NASA STATUS REPORT ON SHUTTLE NEEDED HERE.)

The Shuttle system provides for services of from two to seven crewmembers for up to 30 days of on-orbit operations. Allowing all orbiters to operate out of either launch site, the four-orbiter fleet will eventually be capable of 38 to 53 flights per year. Addition of a fifth orbiter would increase the range to between 53 and 70 flights per year.

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Upper stages are required for altitudes beyond the Space Shuttle's capability, particularly for geosynchronous missions. As mentioned earlier, the Inertial Upper Stage (IUS) full-scale development is well underway with an initial operational availability in mid-1980. The smaller Spinning Solid Upper Stages (SSUS) for smaller payload requirements are under development with initial operational availability in mid-1980.

Launch and Landing Sites. NASA's Kennedy Space Center (KSC) will be ready in mid-1979 to support initial orbital flight tests and operational missions by mid-1980. The Air Force's Vandenberg Air Force Base (VAFB), using an existing launch site and many other modified existing resources, is planned to be available to support operational Shuttle missions in mid-1983. Orbiters shall be capable of launching and refurbishing at either site.

Mission Operations. The Johnson Space Center (JSC) Mission Control Center is being modified by NASA to provide orbiter flight control and support for STS missions. Orbiter flight control for both civil and Defense missions during early phases of operations will be handled by NASA at the JSC Mission Control Center. Future mission characteristics, security requirements, flight rates, or survivability needs may eventually require an additional separate flight control center.

As mentioned earlier, different worldwide tracking and receiving stations will support spacecraft operations depending on the sector involved. Defense payloads will be supported by the tracking station network of the Air Force

Satellite Test Center. Civil payloads will be supported by the NASA Space Tracking and Data Network. The NASA network will be phased down as the Tracking and Data Relay Satellite system, mentioned earlier, becomes operational.

Priorities. NASA has the overall responsibility for developing the scheduling for Space Transportation System ground and flight operations. The scheduling can be significantly impacted by on-orbit system failures, changing international situations, or natural disasters. Within the projected mission model, there are space programs of high national security priority, essential programs requiring continuity of operation, contracted-for launch services, and programs with unique and infrequent launch windows. Defense and intelligence missions have been given the highest priority.

Security. Defense and the intelligence community transition to the STS have required that, for many missions, the flight and ground systems designs, operating procedures, and data handling satisfy the security requirements of classified space programs. The STS presents a significantly changed operational environment from that of expendable launch vehicles. The NASA/Defense Aeronautics and Astronautics Coordinating Board, mentioned earlier, is studying the lowest cost approach that ensures security adequacy.

TRANSITION PLANS. During the transition periods the highest priority spacecraft are being designed for launch on either ELV's or the STS (i.e., to be dual compatible) but are being scheduled for launch on the STS. Dual compatibility provides for the assured launch of highest priority payloads while Shuttle reliability is being proven.

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The Delta and Titan expendable launch vehicles to be procured for backup will be compatible with operations from either coast. Launch vehicles which are unused at the east coast can be transferred to the west coast. Although ELV costs are the price of early transition and of assurance of launch capability in the event of unforeseen problems, they are being minimized by buying a mix of complete vehicles and long-lead time hardware.

NASA Plan. All payloads to be launched by NASA during the transition period are scheduled on the Shuttle. NASA plans no ELV operations after Shuttle initial operational capability (IOC) is attained. Early expendable launch vehicle backup is provided only for missions having a limited launch window or for which continuity of data and service is particularly significant—e.g., for operational meteorological and communications satellites. The last Atlas-Centaur--which is typically used for launching communications satellites--is currently scheduled to be launched at about the time of completion of the Shuttle orbital flight test. The Delta launch vehicle will be phased out at the Western Test Range upon activation of STS capability.

NASA, however, currently plans on the partial production of four Delta vehicles with an option for two additional vehicles to maintain as a backup to the Shuttle. Production of these vehicles will be phased to require a minimum progressive investment in the event that critical needs can be met without them. NASA will review the Delta backup situation at appropriate decision points. The resulting transitions are reflected in Table III--East Coast Mission Model and West Coast Mission Model.

EAST COAST MISSION MODEL

FY	78	79	80	81	82	83	84	85	86	87	88	89	90	91
			▼ SHUTTLE AVAILABLE											
CIVIL PROGRAMS														
RESEARCH AND DEVELOPMENT														
SPACELAB				4	4	4	6	8	11	11	10	11	10	11
SPACE SCIENCE	(3)	(1)	(3)		2	4	2	6	4	7	4	6	4	5
APPLICATIONS	(1)			1	1	2	3	3	1	1	1	2	1	1
TECHNOLOGY				1		1	1	1	3	3	3	3	3	3
OPERATIONS														
METEOROLOGY	(2)		1	2		1	1		1	1	2	2	2	3
COMMUNICATIONS	(2)	(2)	(3)2	7	2	5	7	6	8	2	10	7	12	-
OTHER											1	2	1	2
FOREIGN														
SPACELAB					2	2	2	3	4	5	5	5	5	5
SCIENCE					2		1			1		1		1
APPLICATIONS	(4)		1	3	5	5	5	3	2	7	5	6	8	12
MILITARY PROGRAMS														
COMMUNICATIONS	(4)	(2)	(2)	(1)	1		3	2	3	3	2	3	4	3
DATA RELAY	(1)	(1)	(1)		1		1	1		1	1		1	1
EARLY WARNING	(1)		(1)	(1)	(1)	1	1		2	2	2	2	1	2
NAVIGATION	(3)	(3)	(1)	(1)	(3)1	(2)1	2	4	4	2	2	2	2	2
TECHNOLOGY		(1)		1			1	1	1	1	1	1	1	1
SPECIAL MISSIONS														

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WEST COAST MISSION MODEL

FY	78	79	80	81	82	83	84	85	86	87	88	89	90	91
						▼ SHUTTLE AVAILABLE								
CIVIL PROGRAMS														
RESEARCH AND DEVELOPMENT														
SPACELAB							3	4	4	4	4	4	4	4
SPACE SCIENCE	(1)	(2)		(1)			1	1	3	1	3		3	4
APPLICATIONS	(3)	(1)		(2)		2	5	5	1	2	1	1	2	
OPERATIONS														
METEOROLOGY	(1)	(1)	(1)	(1)	(1)	1	2	1	1	1	1	1	1	1
OTHER								1	5	2	5	3	5	2
FOREIGN														
SPACELAB									1	1	1	1	1	1
APPLICATIONS									1	1	1	1		2
MILITARY PROGRAMS														
METEOROLOGY	(1)	(2)	(2)	(1)	(1)	(1)	1	1	1	1	1	1		1
OCEAN SURVEY						1	1		1	1		1	1	
EARLY WARNING										2	2		1	2
NAVIGATION	(1)	(1)	(2)	(1)		1	1	1						
TECHNOLOGY	(1)			(1)			1	1	1	1	1	1	1	1
SPECIAL MISSIONS														

( ) = ON EXPENDABLES

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TABLE III

Defense and Intelligence Plan. The Defense and Intelligence transition plans are reflected as well in Table III. Satellites intended for national security purposes require higher confidence in the new launch system by defense and the intelligence community. Overlap of ELV and Shuttle launches is also the result of contractual obligations and the additional cost to modify satellites on contract in order to transition earlier. For instance, to redesign these spacecraft to fly on the Shuttle in FY 1981 and FY 1983 respectively would require redesign and restructuring of the program at additional costs (both schedule and dollars).

Defense and Intelligence recently reviewed whether the transition plans for their satellite systems were appropriate. Obviously, some satellite systems are more critical than others. Roughly speaking, those satellites dealing with strategic indications and warning, communications intelligence, and strategic arms treaty verification were placed at the highest level of priority. Navigation satellites, weather observation satellites, and some communications satellites are somewhat less important on the average. Satellites which tend to be the sole source of data collected are more important than those which form just one portion of a data collection system. Priority judgments of this kind were combined with an assessment of the technical risks; that is, the technical changes that must be made to a spacecraft system in order that it can fly safely on the Shuttle and the technical problems with the Shuttle's main engine and programmitic delays. Generally, a more conservative transition approach was recommended on high priority programs.

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The Defense and Intelligence backup ELV plan provides protection for payloads scheduled for Shuttle launch from Kennedy Space Center and from Vandenberg through FY 1985. This plan protects against the chance of Shuttle grounding, slippage in IOC, and shortfall in expected Shuttle performance. The backup ELV procurement strategy is similar to that being used by NASA in that it

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minimizes sunk costs while retaining the option to complete launch vehicles if required. The present procurement strategy consists of starting three complete Titan vehicles in FY 1979, two sets of vehicle components which would be assembled within 12 months, and four sets of long-lead materials which would permit assembly of complete vehicles within 24 months. 25X1

Table VI shows anticipated Defense and Intelligence funding for backup ELV's as a function of the date of the first time the Shuttle meets its performance milestones--a saving after late FY 1979 of [redacted]

25X1 declining to [redacted] by mid-FY 1982. Thus, under the best conditions

25X1 [redacted] could be avoided, while the remaining set of launches would entail extra costs. It is obvious that the key determinant in savings is the readiness of the Shuttle.

NEW OR EXPANDED CAPABILITIES. While the STS provides the foundation of the national space activity for the next several decades, it is necessary to look beyond this era by continuous application of technological advances. There are new and expanded space capabilities which are under varying phases of consideration and evaluation which may be required to meet future space mission objectives. The areas discussed here range from augmentation of Shuttle capabilities to completely new concepts.

Extended Duration. The 25 kw non-nuclear power module under design definition study by NASA will offer on-orbit durations for the orbiter of over 30 days and increase power available to payloads by two to four times. Launched by 25X1

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the Shuttle, the power module can be used while docked to the orbiter, used in a free-flying mode, serviced on-orbit, and returned to earth for refurbishment and reuse.

Upper Stages. Considerable study has been accomplished on upper stage capabilities beyond those of the Inertial Upper Stage (IUS). A reusable space tug could deploy payloads and return to the Shuttle and ultimately retrieve payloads from high altitudes for return and refurbishment. A higher capability manned orbital transfer vehicle could perform the functions of the space tug and would extend man's utility from low altitude Shuttle mission orbits to geosynchronous altitude to support many of the complex activities involving construction and maintenance at high altitudes. The solar electric propulsion stage, with its extremely high specific impulse, will augment the STS capability in performing a variety of cargo transport missions in high earth orbits and in interplanetary regions of space.

Heavy Lift Launch Vehicle. Studies have been made of a Shuttle-derived vehicle wherein a large cargo module is substituted for the orbiter. This vehicle could transport very heavy (over 150,000 pounds) and large (over 22 feet in diameter) payloads to low earth orbit to support, for example, fabrication of very large structures for such missions as communications or solar energy collection.

Reusable STS. Another extension of STS capability to enhance its operational flexibility and its cost-per-flight economics could be a reusable first stage or flyback booster. A number of technically feasible concepts have been studied which could form the basis for future effort if warranted by the long-term future trends of the national space activity.

Single-Stage-to-Orbit. Single-stage-to-orbit vehicles under current study offer the potential for further reduction in operational costs over staged systems. These systems might also offer significant operational flexibility by avoiding most of the operational constraints of either expendable launch vehicles or the Space Shuttle.

RECOMMENDED ACTIONS

Rate of Transition to Shuttle. Although there is an obvious sequence in transition steps, each has its unique constraints. Furthermore, the timing of each step is critically dependent upon the development progress of Shuttle flight and ground systems and on program and budget considerations.

NASA's transition plan calls for the partial production of four Delta vehicles with an option for two additional vehicles. The cost of this insurance investment in FY 1979 is approximately $16 million (about the cost of one Delta launch). [redacted] As a result of Defense and Intelligence review, an accelerated rate of transition to the Shuttle is recommended [redacted]

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Recommended Action

In taking into account the Defense and Ingelligence recommendations for accelerating transition of systems to the Shuttle, the planned schedule for transition provides at this time the most effective balance between costs and risks. This transition maintains redundant launch capabilities before becoming too dependent too soon on a new system--the Shuttle--whose reliability has not been established. The key determinant is the readiness of the Shuttle that cannot be determined at this time. Until the Shuttle milestones are demonstrated, no additional reprogramming is warranted at this time.

OMB will assess the appropriateness of the additional costs resulting in the accelerated transision recommended by Defense and Intelligence [redacted] 25X1
[redacted] in the FY 1980 budget review. In addition, OMB will explore opportunities for cost savings in subsequent budget reviews through accelerated transition rates to the Shuttle by all agencies. As such, Defense, the DCI, and NASA will prepare semi-annual charts on the Shuttle development schedule, transition schedules, and alternative cost paths. 25X1

Operations Management Responsibility. The organizational separation of space sectors during the past two decades has resulted in redundancy in three support functions: launch control, mission control, and user control facilities. In general, NASA has controlled most launch operations from the Eastern

Test Range--with the exception of geosynchronous launches by Defense--while Defense has controlled launch operations from the Western Test Range. This separation of launch control was encouraged and promoted by the unique mission requirements of each sector, particularly the security and operational requirements.

As we move toward Shuttle, it is appropriate to review our policy on separate organizational control over support facilities to determine whether potential cost savings are possible. It may be possible to consolidate control functions now, so fewer new facilities will have to be constructed, and fewer older facilities will have to be modified.

At issue is whether the operational responsibilities of Defense and NASA should change as the Shuttle transition and operational periods approach.

There are several approaches which include: (a) Retain the current arrangement of having separate Shuttle mission control facilities for the civil and military sectors. (b) Place total operational management control over Shuttle with NASA. (c) Place total operational management control over Shuttle with Defense.

Recommended Action for FY 1980 Budget Review

The total cost in both near and far term, not only due to the duplication of facilities but also due to the duplication of operating methods and procedures, needs to be addressed. As such, OMB will complete a budget cross-cut on Shuttle operational management responsibility and make recommendations on this issue during the FY 1978 budget review over the next few months. Points that need to be considered in addition to potential cost savings include: NASA being able to provide access to a wide range of uncleared civil and foreign space customers; Defense and Intelligence being able to afford the maximum protection for classified programs; and whether to maintain the separation between the civil and military sectors.

Additional Space Capabilities. The Shuttle and the other elements of the STS will be the backbone of space capability through the 1980's and well into the 1990's. Nevertheless, they represent today's technology, today's understanding of the opportunities afforded by space, and today's understanding of the position of the United States in the world. These will change as our perception of the use of space in support of national goals change. Finally, the position of the United States in the world is not static. Chainging pressures will alter the priorities which we assign to space activities.

Recommended Action

Recognizing the 7- to 10-year development cycle for large space systems, NASA will head an interagency task force to examine what Shuttle augmentation and follow-on systems are required to serve the nation's space needs in the 1980's and beyond. Representation will include Defense, the DCI, Commerce, OMB, NSC, OSTP, State, and others as appropriate.

This task force will submit the findings of this examination to the Space Policy Review Committee for transmittal to the President by August 1, 1979. As appropriate, augmented capabilities will be initiated during the annual budget process.

Implementation of Shuttle Survivability. It is US policy that survivability of space systems will be pursued commensurate with the planned need in crisis and war and the availability of other assets to perform the mission. The threats to survivability of the STS and its resources include, among other things, accidents, terrorism, communications jamming, and direct attack while on orbit. Given the current posture of Space Shuttle design and fabrication progress, major vehicle modifications for survivability would significantly impact development and/or production schedules and cost, or require deferment of implementation to an orbiter block change.

Recommended Action for the FY 1981 Budget Process

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[redacted] Concerned agencies--NASA, the DCI, and Defense--will study what future step might be necessary and make recommendations to the Space Policy Review Committee by August 15, 1979, so that appropriate findings can be reflected during the FY 1981 budget process.

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V. SATELLITE RECONNAISSANCE SECURITY POLICY ALTERNATIVES

INTRODUCTION. When the United States started its space reconnaissance program in the late 1950's and early 1960's, there was considerable uncertainty as to foreign reaction. The Powers U-2 incident in 1960 emphasized the high potential for a major confrontation and embarrassment, yet the need for strategic intelligence was overpowering. The US strategy was to be as unobtrusive as possible, keeping the existence of the program covert and avoiding the necessity for foreign acknowledgement. In concert, the civil space program and benign applications, such as verification of arms control agreements, were emphasized in public and led, over the years, to implicit general acceptance of remote earth sensing for a variety of purposes.

The fact that the US and the USSR use satellite reconnaissance monitoring techniques is a notorious non-secret. For example, a recent book by former DCI William Colby--cleared by the CIA prior to publication--discusses the use of satellites for intelligence collection. Furthermore, Secretary of State William Rogers stated in 1972 that surveillance satellites were one of the means used to monitor SALT I. Back in the mid-1960's President Johnson in a speech in Tennessee extemporaneously stated that the US used satellite photography to observe Soviet ICBM deployment. He in fact added that this activity alone justified the expenditures on our space program.

Presidential Directive NSC-37 revised the security policy for space intelligence activities by downgrading the fact that the US conducts satellite

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reconnaissance for intelligence purposes--without disclosing the generic type--to CONFIDENTIAL (XGDS). PD-37 specifies that the special product controls (over imagery and other space-derived data) is to be used sparingly by the DCI.

This section examines two possible revisions to the current policy:

-- First, a simple declarative declassification only of the fact that satellite photoreconnaissance is one of the means used by the US to monitor SALT compliance.

-- Second, a possible extension of this declassification to selectively declassify and release photoreconnaissance imagery for furthering economic, social, and political objectives of the US.

<u>Declassification of the "Fact of"</u>

<u>BENEFITS AND RISKS</u>. There exists concern among the general public that the SALT II agreement now being negotiated is unsound, in part because of public perceptions that the Soviets cannot be trusted to comply with its terms. Opponents of a SALT agreement charge that the Soviets have cheated on SALT I and that the US has an inadequate ability to verify compliance with SALT II. In answering these charges, government spokesmen are prohibited from stating that the US conducts satellite photography to verify SALT compliance. They are restricted to using the euphemism National Technical Means (NTM) when

describing verification capability. Members of Congress have been briefed on US monitoring techniques and the fact that NTM includes satellite photography is well known by the press and much of the informed foreign affairs community. The term NTM, however, is lost on most of the lay public. Moreover, the current necessity to talk by indirection easily converts in the public mind to a feeling that the Administration is being evasive and is trying to cover up an inherently weak case for SALT.

Declassifying the "fact of" photo-satellite reconnaissance could enable government spokesmen to make a more effective case for a SALT II agreement. The ability to refer to easily-comprehensive intelligence capabilities would help allay public concern that we can adequately verify Soviet compliance with the terms of the agreement.

There are, however, risks associated with the declassification of the "fact of." They are:

-- The classification of the "fact of" satellite reconnaissance has served as the first line of defense for the security of overhead intelligence programs. After declassification, US agencies and officials could be under considerable pressure, both legal [Freedom of Information Act (FOIA)] and otherwise, to provide ever increasing information about the reconnaissance programs, as well as imagery itself. Some agencies believe this pressure may be virtually irresistible and irreversible. Other agencies believe that the line can be drawn in this case as in others (e.g., nuclear weapons developments), especially since the "fact of" is already widely known, even if not officially acknowledged.

-- There may be adverse Soviet reaction to a public statement that we use photoreconnaissance satellites and subsequent harmful consequences in various arms control discussions (e.g., ASAT, EGB) and other outer-space issues. High-level consultation with the Soviets on the scope and implications of the US proposal should therefore precede any public announcement.

-- There may be adverse reaction in the UN Outer Space Committee to prominent US acknowledgement of its photoreconnaissance activities, particularly on the part of the developing countries who have already expressed concern that civil remote sensing activities pose a threat to their military and economic security. The LDC record at the UN has been one of narrow self interest. This would probably result in increased pressures for controls on remote sensing from satellites and possibly demands that "military" satellites be banned. On the other hand, the fact is already widely known.

<u>Issue for Decision</u>

Some believe that with appropriate preparation, the "fact of" can be declassified with real but not unacceptable risks to intelligence security and to US foreign and domestic policy. According to this view, we could proceed now to publicly state that photo-satellite reconnaissance programs are among the means used by the US to verify Soviet compliance with SALT and other arms control agreements. There is an obvious, commonsense value to the forthright admission of what is already widely known. Furthermore, they believe that contingency plans should be developed prior to public announcements on this matter. These would include:

-- A low-key, informal release stipulating that (1) declassification of "fact of" is limited to photoreconnaissance for SALT and (2) all data derived from overhead reconnaissance remains classified and compartmented in accordance with existing guidelines.

-- A revised security plan so as to maintain intelligence discipline.

-- Prior consultations with allies and the Soviets.

Others believe that the "fact of" satellite photography can be declassified but with a probable near-term and long-term impact on US satellite reconnaissance. They further believe that acknowledgement of the "fact of," without some public use of information or imagery from space reconnaissance, is insufficient. Further, they believe that prior to a decision on implementation more study is needed over the next 5 months. This study would evaluate the ramifications of declassifying the "fact of" and develop a full and detailed execution plan that would include: a security plan to maintain intelligence discipline; a consultation strategy with our allies, the Soviet

Union, and members of the US Outer Space Committee; and contingency plans by responsible agencies.

Declassification of Photoreconnaissance Imagery

Any decision to go beyond declassification of the "fact of" and to additionally include a selective and phased public release of substantive imagery increases both risks and benefits. It is believed that the risks and the potential long-term benefits of such a policy revision warrant a careful assessment of this possibility before acceptance or rejection. But, of course, such an assessment would be pursued only if the "fact of" were declassified.

POTENTIAL BENEFITS/RISKS. The broader use of previously-classified data could well be an efficient means of meeting certain domestic needs for an authoritative data base supplementing (or in some cases replacing) imagery sources currently available to the private and public sector. For example, stereoscopic imagery of cartographic quality has already been collected over most of the world; its exploitation has been strictly limited to government intelligence and mapping functions; its value to mineral and petroleum exploration--either in raw image form or as analyzed thematic geological map products--is likely to be high if properly used, representing as it does a quantum increase in the exploration data base.

Other economic applications of such data include: land use changes, disaster assessment and relief, environmental monitoring, forestry inventories, and crop productivity. Some of these applications require the repetitive coverage being offered by civil systems and not envisaged for intelligence systems. Civil uses, however, would benefit from the availability of a high-quality imagery data base in many instances even if it were quite old. Much stored imagery could be made available today.

While declassifying solely the "fact of" may enhance public confidence in SALT II, flexibility could be provided in the US in international affairs by less-constrained use of remote sensing data. Verifiability and verification could be more credibly demonstrated with the release of imagery or information derived therefrom. Peacekeeping possibilities might include private or public release of visual evidence or information and analysis of impending crisis, hostile actions, or threatening situations (weapons shipments, border violations, nuclear capabilities); selective economic development information could be provided without subterfuge as to data sources.

The risks associated with limited unclassified disclosure of selected satellite imagery can be categorized as follows:

-- Current international concerns relate to publicly released imagery. Imagery from intelligence systems provides information on militarily significant targets such as airfields, missile deployments, etc. With frequent monitoring, military deployment and levels of military production can be determined. As this realization is appreciated--more directly relevant to the national interests of the non-major powers--we could expect resistance and pressure for restrictions by other countries.

-- Such disclosure could be expected to lead to questions as to the other uses of the space systems. The Outer Space Treaty reserves the use of space for "peaceful purposes." Privately, the United States has interpreted the term to mean non-aggressive purposes, but that defensive military and intelligence functions are legitimate. There is no international foundation for this interpretation, except the absence of a public international confrontation.

-- The Soviets have maintained the basis for flexibly distinguishing between legitimate and illegitimate remote earth sensing. Disclosure of the imagery surely would force discussion throughout the international community--not just the communist bloc, but the non-alligned countries as well as our allies. The Soviets may also use the release of imagery to attempt to legitimate their ASAT activities.

-- Disclosure of selected imagery provides some information on the design and capabilities of the imaging system. For film return systems, this may be acceptable as their capabilities are generally known already, although the implications of this could cause adversary nations to increase concealment measures.

IMPLEMENTATION CONSIDERATIONS. Should the additional decision be taken to selectively release imagery, a number of additional factors would have to be taken into account in formulating another implementation plan. Certain of the factors are summarized below.

The USSR. The USSR is sensitive to world opinion about the relative technological capabilities of the US and the Soviet Union. Comparisons between Soviet and US imagery capabilities produced by US release of imagery, would tend to cast the USSR in an unfavorable light. Second, the Soviets could view a public policy change as casting doubt on their ability to prevent "espionage" from outer space. For internal and international prestige reasons, they might choose to take a hard line, including a more negative posture in ASAT negotiations, augmented development of their ASAT systems, and renewed efforts in the UN to establish stringent limitations on the conduct of remote sensing activities. Last, declassification could be viewed as a form of international "one-upsmanship" by the US, especially in light of current US-USSR tensions. If imagery release were contemplated, any assessment would have to examine whether to inform the Soviets beforehand of the scope, purposes, and timing of any release. The Soviets would react more strongly to a US decision to release imagery than to declassification of the "fact of." As such, a risk-benefit analysis of declassifying imagery must take Soviet reactions into account.

Intelligence Security. The classification of the "fact of" satellite reconnaissance has served as the first line of defense for the security of overhead space intelligence programs. After declassification, US agencies and officials would be under considerable pressure to provide more information. More importantly, however, information obtained from photography alone is often ambiguous; intelligence judtments are derived from analysis of data from a variety of sources, including SIGINT. We should not compromise other intelligence sources and methods as a result of releasing photography. Well-thought-out strategies of information release and management of requests are necessary preconditions to even take steps toward declassification of imagery.

Impact on Other Issues. Decisions on the future organization of the US remote sensing program would be impacted by decisions to release previously classified imagery. If the US sets up a new organization structure for remote sensing from space, for example, this could raise issues concerning the future management of satellite reconnaissance, particularly if the imagery presently classified were declassified for wider civil application. Selective release of imagery would also blur the line between civilian and military-intelligence remote sensing. The heretofore highly touted US policy of open dissemination of remote sensing data would lose credibility, and new policies will have to be examined.

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<u>International Reactions</u>. Existing programs of international civil remote sensing and widespread recognition of the arms control verification by satellites have lead to widespread tacit acceptance of the principle of data collection from space. Announcement of the "fact of" the existence of photo-reconnaissance satellites and the release of imagery may force governments to take positions they have heretofore avoided taking.

With the release of imagery, countries previously quiescent about overhead reconnaissance might be forced to take a position on the basic questions concerning sovereignty and exploitation by more powerful states. Many developing countries (LDC's) increasingly recognize that they can benefit from remote sensing. However, the LDC's generally are arguing for a restrictive legal regime governing these activities, asserting that release of remote sensing data to third parties without their prior consent is a violation of their national sovereignty and poses a threat to their economic and national security. The effect of a US release of high quality imagery could be to stiffen their resolve to restrict overhead reconnaissance. One would expect that the obvious international benefits of strategic arms control would soften such arguments. Many, indeed, recognize that satellites are essential for arms control. The record of the LDC's in the United Nations, while largely one of narrow self interest, may not be an accurate measure of real LDC responses. In fact, some segments of LDC's may in the long run see it in their interest to gain access to better quality imagery.

US Public Reactions. The announcement of the "fact of" would serve to affirm the commitment of the Administration to greater openness in government and the promotion of space operations for keeping the peace. Without public examples of data quality, however, there is some question as to the degree of public satisfaction of verifiability.

There is no question that data on space intelligence would be sought under the FOIA and that, in all probability, legal proceedings could force disclosures inimical to the intelligence discipline and national security. Even if impeccable guidelines were established and maintained as to what is classified and why, the courts would not be bound to adhere to them in deciding FOIA cases. Such guidelines could be established by Presidential Directive.

Recommended Action

Preliminary review suggests the possibility of a new national policy in the use of remotely-sensed imaged data for a spectrum of US interests, both domestic and foreign. The focus would be on the use of remotely-sensed data and the information that can be derived therefrom, not on the management of the collection systems which acquire such data. All agencies agree that further study is necessary that would include full and detailed execution and contingency plans developed well in advance of policy revision to release substantive imagery.

Further work on analyzing the concept of a space intelligence policy which looks beyond the "fact of" change should fall into four phases:

1. An intensive analysis of the points and possibilities noted in this paper by selected individuals from the Departments of Defense and State, the Intelligence Community, and the Executive Office of the President under the direction of the NSC staff. This will be accomplished in 2 months.

2. Presidential review and decision on desirability of change and appropriate scope.

3. Detailed development and setting in place of the implementation elements--consultation strategies, security planning, contingency plans--by the responsible agencies over a period of at least 3 months.

4. Execution after final Presidential review and approval.

VI. GOVERNMENT ROLE IN REMOTE SENSING

INTRODUCTION. The United States has and will continue to derive many benefits from space applications in meeting national defense, foreign policy, and economic needs and objectives. The US has pioneered the development in both classified and unclassified programs of space application technology, notably in communications, navigation, and various technologies for remote sensing.

Earth remote sensing from space is an application of current and potential significance in the four sectors mentioned earlier in Section II: Federal civil, intelligence, military, and private. Remote sensing from space can contribute to national needs and goals, including:

-- Contributing to national security in support of a wide variety of military and intelligence activities.

-- Maintaining US leadership in space technology and its application, to the benefit of our security and the balance of trade.

-- Assessing domestic and foreign resources for economic development, energy sources, conservation, world's food supply, etc.

-- Improving weather and other environmental forecasts and enhancing our scientific understanding of earth on a global basis.

-- Promoting international cooperation and stability.

This section addresses the status and next steps in Federal civil sector remote sensing programs, including interrelations with the military and intelligence programs and the involvement of the private sector. In this area many decisions depend on the future evolution of technologies with many unknowns; others require further consideration by the responsible agencies or the Space Policy Review Committee. Decisions on specific programs will come to final decision in the normal budget process. This section has five parts, addressing remote sensing activities for the atmosphere, the ocean, over land, the integration of systems, and private sector involvement.

ATMOSPHERIC PROGRAMS. The first meteorological satellite was launched by NASA in 1960. The civil operational system was established with NOAA in 1966. NASA has developed the spacecraft in conformance with specifications and schedules provided by NOAA. The entire procurement and launch of the space equipment as well as all the data are unclassified. Data are provided to the US and numerous foreign weather services. Many foreign countries have direct readout satellites for the data. The US is the leader in developing worldwide meteorological satellite systems, although other countries (including the USSR, Japan, India, and Some European countries) either have their own meteolological satellites or are planning them.

In a parallel activity, Defense operates the Defense Meteorological Satellite Program (DMSP). DMSP was initiated to provide worldwide cloud cover data in support of intelligence photorecommaissance satellites since the imaging satellites were film limited. Because of technological advance, timely weather information remains important but not critical. DMSP's operation now has been essentially declassified, although the data transmissions remain protected through encryption. The military Air Weather Service uses DMSP data along with other military and civil data to supply military customers worldwide. The DMSP data are routinely made available to NOAA for use by the weather service and to some foreign governments. NOAA's program is coordinated with Defense's through the joint Defense/NOAA/NASA Polar Orbiting Operational Meteorological Satellite Coordinating Board mentioned earlier.

Next Steps. The current operational capability is scheduled to continue with improvements introduced as feasible and necessary. Several improved or new sensors are now planned for introduction into the operational systems during the period 1978-83. Operational spacecraft being procured now for the NOAA and DMSP systems will provide coverage until 1984-85. If operational continuity is to be maintained, design and procurement of follow-on spacecraft must be initiated in FY 1980-81.

OCEAN PROGRAMS. In mid-1978 NASA launched SEASAT-1, the first civil remote sensing R&D satellite exclusively dedicated to observing the dynamic characteristics of the ocean surface. Wave characteristics, ocean surface temperature, and sea ice dynamics can be derived from SEASAT observations. Data could contribute to improved ship routing and coastal disaster warning. In addition, maps of ocean current patterns and temperatures will be used in fishing, pollution dispersion, and iceberg hazard avoidance.

Several Federal agencies--NOAA, NASA, Office of Naval Research, Coast Guard, US Geological Survey, and NSF--are funding selected scientific experiments using SEASAT-1 data. Incremental development aimed at contributing to ocean observations has been carried on with instruments flown on the Nimbus satellites. For example, a coastal zone color scanner designed to observe the color changes associated with contaminants will be flown on Nimbus-G, which is due for launch later this year.

Next Steps. Requirements for large-scale ocean observations--which are needs of the NAVY, NOAA, and others--indicate that these uers could benefit from a system based on the SEASAT and Nimbus-G technology. There are a number of aspects, however, that need to be verified. NASA, Defense, and NOAA are expected to propose as a FY 1980 new start the implementation of an operational demonstration of a National Oceanic Satellite System (NOSS). It would be launched in 1984 and operated for a 5-year period. After 3 years of operation, a decision on whether or not to continue the system in a fully operational status would be made. A joint project structure now is in the planning stage pending program decision and has been described in the section on technology flow between sectors. The incremental cost for NOSS is estimated at about $50 million per year (average annual cost) during the fabrication and launch stage and $20 million annual operating costs thereafter.

LAND PROGRAMS. In 1972 NASA launched the first experimental remote sensing R&D satellite specifically designed to observe surface features of the earth. Now called LANDSAT, this program has demonstrated the potential for multispectral observation from space for earth resources. LANDSAT-C, recently launched, provides direct data readout and has ground resolution of 30 meters. LANDSAT-D is approved for launch in late 1981 and has a programmed life through the end of 1984. It will have ground resolution of 30 meters. LANDSAT-D' is planned as a backup to LANDSAT-D, but it could be used to extend through the end of 1985 (assuming a successful launch in 1982). Multispectral LANDSAT data are the only unclassified satellite imagery presently available for general use. Domestic applications include the following:

-- Agriculture is engaged in a cooperative effort with NASA and NOAA to develop and test technology based on LANDSAT to monitor crop conditions and provide production forecasts.

-- Defense and the Intelligence Community use LANDSAT data for monitoring and mapping. Since 1973, CIA has used LANDSAT data in conjunction with classified photographic imagery in estimating Soviet grain production.

-- Energy is exploring the potential contributions of LANDSAT data for energy policy and planning; e.g., exploration, exploitation, power plant siting, and environmental assessment and monitoring.

-- Interior is using data for small-scale mapping, exploration for minerals and fuels, pollution detection, and inventories of irrigated land.

-- Several states are using data for planning and management of their natural resources and demonstration projects in land cover inventory, surface water inventory, and flood control mapping.

-- Private oil and mineral companies are known to be using LANDSAT data in their search activities.

-- Experimentation is now underway to develop remote sensing applications of satellite data in forest management, land use classification, and conservation practices assessment.

Cooperative international activities undertaken by the US using LANDSAT have involved many countries. The US policy has been to disseminate LANDSAT data to anyone at a nominal charge. In addition to applying LANDSAT-derived natural resource information in traditional development projects, the US government has invested $14 million in bilateral programs building up national remote sensing laboratory centers in less-developed countries. Project AIDSAT helped establish three regional remote sensing training and user assistance centers, partially funded by AID. Other foreign receiving stations exist in Canada, Brazil, and Italy, with stations being built in Japan and Iran. Additional stations are planned in seven countries. To date, no direct US funding has been used--other than in the AIDSAT project and support of temporary receivers--to support the development of a foreign LANDSAT receiving station.

Next Steps. Some improvement in the current ground data handling system would be desirable to reduce the time delay in making data available. The next steps as now seen include the following:

1. Some improvements in the current ground handling systems for LANDSAT data. From the standpoint of the user community (especially in time-dependent applications like agriculture) it would be highly desirable to reduce the time delay in making data available. Measures to accomplish this are expected to be proposed and reviewed in the FY 1980 budget.

2. Assurance of data continuity. Current and prospective users and experimenters (Federal, private, and international) relying on LANDSAT data need a reasonable degree of assurance that LANDSAT or similar data will continue to be available after LANDSAT-D, in order to justify the programmatic and financial commitments their uses entail. This is especially important to encourage private and other non-Federal users of and investments in remote sensing.

3. As presently conceived, a minimum system based on sensors derived from LANDSAT technology would consist of two spacecraft in orbit for coverage every 9 days plus a back-up on the ground for minimum interruption in service in case of failure. The data system would be configured to make

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processed data available within 48 hours of observation time. Present estimates for implementing this option are an average annual cost of almost $75 million for spacecraft construction and launch (initial phase, about _____ years) and approximately $20 million per year thereafter for systems operation and maintenance.

INTEGRATED CIVIL REMOTE SENSING SYSTEM. Until now, civil space programs for the observation of the atmosphere, the land, and the sea have been conducted more or less separately. However, there are new developments and considerations that make the establishment of an integrated national system for observing the earth worthy of review:

-- The Shuttle and new satellite data relay technology make possible combining sensors on the same platform on an economic basis without compromising reliability.

-- The array of sensors now emerging for the observation of the atmosphere, land, and oceans, and examination of data needs, indicate that a select group of several sensors on a limited number of common platforms can meet a large number of requirements.

-- The feasibility of using a National Oceanic Satellite System to meet joint civil and military requirements in the ocean area, without jeopardizing military security or civil and international space policies.

-- The potential for introducing previously classified imagery for broader application.

-- Establishing a pricing policy, since to date the pricing for remote sensing has been primarily the cost of reproducing the data for the individual user, plus, in the case of foreign ground stations, a slight access fee--some $200,000 per year.

The global and political nature of remote sensing from space requires proper focus and government authorization and supervision. Historically, there have been a number of research and development organizations, two operating organizations, and AID making international arrangements. The policy had been effective in encouraging users, but uniformity and careful consideration of implications and precedents have been difficult. The worldwide interest in remote sensing and growing capability of other countries assure that international activity will increase.

PRIVATE SECTOR INVOLVEMENT IN REMOTE SENSING. To date remote sensing activities have been primarily a Federal function. Several private sector companies and groups have expressed interest in the commercial exploitation of remote sensing satellites. Some would like to be able to sell imagery to any prospective purchaser. Others, such as the GEOSAT Committee, would like to see remote sensing spacecraft specifically designed to carry out certain missions of interest to private companies (e.g., geological mapping).

Private sector roles could include a broad range of possibilities: (1) management and provision of commercial services, such as COMSAT provides for communications; (2) delegated operational responsibility for major components of remote sensing systems (e.g., a US centralized data receptiona and processing center, marketing and pricing functions); and (3) normal contractor roles in providing contractual services on products and in building R&D hardware and software.

Prior to PD-37 more active participation of the private sector in civil remote sensing has been discouraged because of security problems. PD-37, however, provides the basis for a more active but government-regulated private role. Higher resolutions that would be attractive to industrial, commercial, public agency, and idnividual users are now possible. As PD-37 is quite recent, NASA and the other agencies need more time to actively explore private sector emerging interests and roles.

ISSUE FOR DECISION

Issue #1--Should we establish an operational civil remote sensing system based on LANDSAT?

Option 1--Defer a decision at this time and continue with LANDSAT as a developmental satellite program expected to provide data through 1985.

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Option 2--Guarantee the continuation of remote sensing data and commit to further technological evolution as operational experience is gained. Decisions on specific LANDSAT projects would be made in the context of the annual budget process.

Option 3--Commit now to an operational remote sensing satellite system based on LANDSAT with full development of the technical and organizational arrangements necessary for an operational system.

Under Option 1, experimentation and demonstrations would continue, operational uses of data from the experimental system would continue to be made by public and private users prepared to do so, and further effort could be undertaken to aggregate prospective user demand and assess the potential economic and other values of various applications of civil remote sensing. An official policy declaration supporting the continuation of experimental and demonstration programs would be issued, but no policy commitments would be made for the future.

The advantages of Option 1 are: (a) It minimizes the Presidential commitment through policy and budget commitments in an area where there are many technical, qualitative, and management uncertainties. (b) While a successful experimental program, many users are unwilling to commit now to LANDSAT data services in lieu of other current and potentially better technologies (e.g., aerial photoreconnaissance). (c) It prevents premature exclusion of the private sector in providing "LANDSAT-type" sensing services. (d) It preserves the myriad of future international options.

The disadvantages of Option 1 include: (a) It reinforces the widely-held perception that the Executive Branch cannot make up its mind. (b) It delays a commitment to a practical space technology that has numerous applications, thereby delaying further expansion of users. (c) It runs counter to strong Congressional interest expressed in various bills that would commit the Executive Branch to programs and financial resources that may not be warranted. (d) It increases the likelihood that other nations may achieve competitive advantage in exploiting remote sensing technology.

Under Option 2 it would be national policy to guarantee the active exploration of remote sensing data with the intended provision to make improvements. Data continuity would be guaranteed through 1985 with an implied commitment beyond. Specific details and configurations of this "LANDSAT-type system" would evolve over the next several years during the annual budget process.

The advantages of Option 2 are: (a) It provides policy assurance that the US is committed to the continuity of data in the remote sensing area for both domestic and international users. (b) It minimizes the impact on the FY 1980 and 1981 budget but provides policy commitment beyond. (c) It permits considerable flexibility and time to understand better the aggregation of user requirements, the appropriate operational roles, and any international involvement.

The disadvantages of Option 2 are: (a) It delays commitment and runs counter to Congressional interest described under the disadvantages of Option 1.

(b) A policy guarantee for the continuity of data and technology development may still not be enough to get users to commit to LANDSAT. (c) Assignment of Federal agency roles and missions will not be made any easier under this approach.

Under Option 3 NASA would take the lead with other mission agencies to actively begin to construct a national system based on LANDSAT to become operational in the early 1980's. Private sector involvement as well as government operations of the system would be analyzed. Recommendations on organization arrangements and optimum system design would be submitted to the Space Policy Review Committee by September 1, 1979. Congressional authority would be sought to support the recommended approach.

The advantages of Option 3 are: It would be a visible and bold Presidential initiative that assumes that the benefits have been demonstrated--or are confidently expected to be by the early 1985's--when an operational system would come into being. (b) It recognizes the maturing of remote sensing technologies and that current domestic and international users need data on an operational basis. (c) It provides a clear signal of the government's long-term intentions which may stimulate private investment. (d) It provides opportunities for constructive US initiatives in the international arena.

Disadvantages of Option 3 include: (a) Its impact on the FY 1980 and 1981 budget would be considerable since a Federal commitment on operational status would be meaningless unless accompanied by budgetary support. (b) Private investment may not be as forthcoming as expected at the present state of technology development without considerable Federal subsidy. (c) It presumes a greater certainty about appropriate mix of technology suited for an operational system than currently exists. (d) It presumes a better understanding of alternative organizational and management arrangements--including the private sector--than currently exists.

ADDITIONAL ISSUES FOR FURTHER REVIEW

Atmospheric Programs. The organizational separation for meteorological satellites between NOAA and Defense over the past two decades has led to redundancy. It is appropriate to review our policy on separate organizational control over meteorological programs to determine whether potential cost savings are possible. There are several possible approaches which include: (a) Retain the current arrangement of having separate NOAA and Defense programs. (b) Place all weather satellites under NOAA. (c) Place all weather satellites under Defense.

Recommended Action for FY 1980 Budget Review

In the FY 1980 budget review OMB, Defense, and NOAA will conduct a cross-cut review of meteorological satellite programs to determine the potential for budgetary savings and program efficiency. Recommendations will be made on the feasibility of program consolidation and the degree to which special needs of Defense users--including the encryption of data--require a separate program in the 1980's.

Ocean Programs. Large-scale ocean observations--which are needs of the Navy, NOAA, and others--could be met from a program described as the National Oceanic Satellite System (NOSS). Many aspects of this proposal still need to be verified.

Recommended Action for FY 1980 Budget Review

NASA, Defense, and NOAA will propose as an FY 1980 new start the implementation of an operational demonstration of NOSS. Any policy decision on this program proposal will be made during the FY 1980 or future budget reviews.

Integrated Remote Sensing System. Experience with the several remote sensing satellites clearly suggests that an active exploration of integrated systems collecting atmospheric, oceanic, and land data should be carried forward. A comprehensive plan covering expected technical, programmatic, and institutional evolution is needed.

Recommended Action for FY 1981 Budget Review

All agencies support moving to an integrated system for observing the atmosphere, land, and oceans from space. NASA will chair an interagency task force to examine the conceptual design, management approach, and operating framework for an integrated national system. Agency participation will include Commerce, Defense, the DCI, Agriculture, Interior, Energy, State, AID, OMB, NSC, and

OSTP. This task force will complete the review by August 1, 1979, and submit recommendations to the Space Policy Review Committee for forwarding to the President prior to the FY 1981 budget.

Private Sector Involvement. Regardless of what is decided on whether to proceed towards an operational remote sensing system, PD-37 stated that we would encourage the commercial private sector into remote sensing applications under government supervision and regulation. To date no framework has been established to receive proposals from the private sector.

Recommended Action

NASA and OMB will encourage private investment and direct participation in the establishment and operations of civil remote sensing systems. These agencies will assure that in planning for the operational system, the government would actively develop alternative modes for private investment and direct participation. Possibilities of guaranteed pruchases of services by the government or other incentives will be explored. NASA and OMB will be the contacts for the private sector on this matter and will submit any proposals received to the Space Policy Review Committee for consideration before forwarding to the President.

VII. SPACE SCIENCE AND PLANETARY EXPLORATION

BACKGROUND. Space science and planetary exploration programs include research on the terrestrial atmosphere, ionosphere and magnetosphere, the sun, the planets, and astrophysics. Extraterrestrial biology and studies of human adaptability to space are also included in space science. In the past two decades, results in these fields have been enormous due, in part, to a growing technical ability to build sophisticated spacecraft with extremely sensitive instruments, durable power sources, and communications systems. The resultant knowledge has produced a major advance in our knowledge of the solar system, our galaxy, and the universe.

The space science programs are administered by NASA and consist of four elements--the planetary, astrophysics, solar terrestrial, and life sciences programs. Logical scientific progress in each element is achieved by a balanced program of flight projects complemented and supported by ground-based theoretical, laboratory, and observational activities and by suborbital observations funded by NSF and NASA. Scientists and engineers in universities, industry, and Federal laboratories participate in the program. The purpose, number, timing, and chronological order of flights are defined in response to--and in conjunction with--representatives of the scientific community through the mechanisms of advisory groups, workshops, and mission teams. The prime source of overall scientific advice and strategy is provided by the Space Science Board of the National Academy of Sciences and by periodic reviews of entire discipline areas by the NAS.

PLANETARY PROGRAM. The goals of planetary exploration are to extend our understanding of the formation and evolution of the solar system through study of solar system bodies (planets and their satellites, comets, and asteroids) and to apply that understanding to continual assessments of past, present, and future processes on earth. Our strategy for accomplishing these objectives uses a three-stage approach: reconnaissance, exploration, and detailed study. The near-term, general objectives to be accomplished in the next few years are to:

-- Initiate reconnaissance of comets and asteroids in the solar system through a detailed reconnaissance of a comet and a later multiple asteroid rendezvous mission.

-- Continue the program of comparative planetology with a detailed investigation of the surface topography of Venus and a comprehensive exploration of the Saturnian system.

-- Initiate an intensive Mars exploration program and examine sample return as the key long-term goal of the program.

Reconnaissance. Fly-by missions provide preliminary information and a "close look" not available from earth.

Past Targets: Mercury (Mariner), Venus (Mariner), the Moon (Ranger), and Mars (Mariner).

Current Targets: Jupiter and Saturn (Pioneer 10 and 11, Voyager).

Planned Targets: Comets (1981) and asteroids (mid-1980's). These primitive bodies are expected to play a key role in theories of solar system evolution. The long-duration missions depend on development of the solar electric propulsion stage. Missions to the most distant planets (Uranus, Neptune, and Pluto) are being considered for the late 1980's and beyond.

Exploration. Using Orbiters and/or Landers, this provides scientists detailed information on global climate, evolution, and surface characteristics.

Past Targets: Moon (Orbiter, Surveyor), Mars (Mariner, Viking).

Current Targets: Venus (Pioneer, Venus Orbital Imaging Radar), Jupiter (Galileo).

Planned Targets: Venus (Orbital Imaging Radar), Saturn (Orbiter/probe). Venus is the planet most like earth in size and climate, and a detailed atmospheric and topographic program is vital to our understanding of the planet and imporved comparison with our own. A comprehensive exploration of the Saturnian system is needed so that the two giants of the solar system, Jupiter and Saturn, can be compared.

Intensive Study. This provides very detailed information including sample returns and focuses on specific questions of high importance.

Past Targets: Moon (Apollo).

Current and Future Targets: Mars. The next step could be a sample return mission which could be launched in the late 1980's or early 1990's and would cost $1.5-2.5 billion. No decision is needed now, but detailed studies must begin to insure adequate information for the 1982 decision point.

ASTROPHYSICS PROGRAM. The goal for astrophysics is to understand the origin and continuing evolution of the cosmic environment and the fundamental laws of physics that govern observed cosmic phenomena. In the next few years the program is designed to focus on:

-- Studying high energy processes occurring in neutron stars and black holes, the creation of elements in super nova explosions, gamma ray background radiation, and the source of gamma ray bursts.

-- Determining, with high spatial resolution, the position and structure of pulsars, quasars, galaxies, clusters of galaxies, and the intergalactic medium.

Current Programs and New Initiatives. The first space facility using Shuttle payload capability and the single most important element of the astrophysics program, is the 2.4-meter space telescope currently under development. This orbital facility operates in the visible and near-visible range of the spectrum. It may detect planets orbiting nearby stars, look back into time some 15 billion years, and help decipher the now-unexplained energy generating mechanisms of stellar systems and their constituents.

Another set of national facilities will operate in higher ranges of the frequency spectrum. There is a scientific requirement for comprehensive study of high-energy processes that occur in the universe. The high energy astronomical observatory (HEAO) series will provide information over the next 2 years, but follow-on observatories are required. The planned gamma ray observatory (GRO) would provide the first comprehensive study of the high-energy process of neutron stars and the "black holes." The advanced X-ray astrophysics facility--under study--would provide a national facility in the X-ray spectrum range.

Future Activities. Because of the differences in detection requirements for various parts of the electromagnetic spectrum, we need to develop sensing systems for general use in each segment of the spectrum. Future facilities under consideration include:

-- A large, free-flying cosmic ray observatory.

-- A large area modular array of X-ray detectors.

-- An orbital very long baseline inferometer to provide radio "pictures" of sources like galaxies, quasar nuclei, and galactic water vapor.

Missions such as Mercury orbiter and solar probe would permit relativity tests near the sun. Other planned studies will help determine our ability to detect gravity waves and observe relativistic effects from earth orbit.

SOLAR TERRESTRIAL PROGRAM. In this area the objectives are to understand our local star (the sun) as an astronomical body, as the source of earth's light and heat, and as the major source of energy for the earth-space system and therefore the climate. In addition our objectives are to understand the character and variability of the earth-space system; to understand the physical processes that shape, control, and link the individual elements of the system; and eventually to predict the potential effects of naturally-occuring and human-caused perturbations of the earth-space system. Missions planned for the next several years will focus on the following objectives:

-- Study long-term variability of atmospheric conditions and the interactions between different regions of the earth's atmosphere.

-- Investigate the physical processes that transfer matter and energy between the solar wind, earth's magnetosphere, and earth's ionosphere; and particularly study the causes and effects of magnetic substorms.

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-- Determine the processes that heat and accelerate the solar wind and solar energetic particles, investigate the internal distribution of matter in the sun, and conduct precise relativistic and gravitation experiments.

Current Programs. The three-element international sun-earth explorer program is investigating the dynamic interactions between the solar wind, energetic particles, and the earth's magnetosphere. This mission is a key element in a worldwide international magnetospheric study. Other programs include:

-- Solar mesosphere explorer, studying the ozone layer.

-- Solar maximum mission, to be launched in late 1979, to study solar flares and coronal transients and provide support to ISEE studies.

-- Solar polar mission, one of a series of missions to explore the "quiet time" of declining solar actitivy, to be launched in 1983 to study variations in the solar wind, magnetic field, and particle emissions in as yet unexplored high-latitude regions of the sun.

New and Projected Initiatives. Concurrently with the solar polar mission, a complementary system of near-earth satellites is planned for deployment in the solar wind, the magnetosphere, and the magnetotail to investigate the processes that transfer matter and energy from the solar wind and ionosphere into the magnetosphere. Other projected projects include:

-- Spacelab experiments with optical, ultraviolet, and X-ray imaging equipment to study the sun.

-- Origins of plasma in earth's neighborhood, a series of earth-orbiting satellites to support the solar polar mission.

-- Atmosphere, magnetosphere, and plasma in space program, a series of experimental pallets to be flown in the Space Shuttle for short-duration missions.

-- A re-equipped solar maximum mission spacecraft to serve as a free-flying observatory for long-term monitoring of solar winds near earth.

-- A solar probe, to approach within four solar radii of the sun and investigate interior composition.

-- A "space scale" pinhole camera/coronograph for high resolution studies of high energy solar events.

<u>LIFE SCIENCES</u>. The objectives in life sciences are to ensure human health, well being, and effective performance in space flight; to utilize the space environment and space technology to advance knowledge in medicine and biology; and to understand the origin and distribution of life in the universe. Past life sciences flight observations have focused on evaluating possible hazards to crew health and on identifying factors that could impair crew performance.

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While those activities will continue to be important, the Shuttle-Spacelab will enable us to conduct a significantly greater number of types of flight experiments. The program objectives for the next several years will:

-- Use the space environment to investigate the fundamental effects of gravity on living systems.

-- Seek to understand the mechanisms leading to the physiological changes that have been observed in humans exposed to zero-gravity environment.

Current Programs. The first of the Spacelab life sciences flight experiments is scheduled on Spacelab 1, and the first vestibular function research units will fly on the third Spacelab mission. Research during early Spacelab missions will focus on the causes and alleviation of space motion sickness.

Projected Activities. The Shuttle-Spacelab will not provide sufficient flight time for some experiments and processes in space. Eventually, long-duration (6 to 12 months) flights will be necessary to develop components for partially- and fully-closed regenerative life support and environmental control systems for space flights of even longer duration. The problems of small groups of people living and working in a confined environment for long periods will also be studied, as will the potential application of the Shuttle-Salyut concept to longer duration missions. Future plans also include searching for extra-terrestrial and unique terrestrial life forms in an attempt to answer questions on the origins of life and the existence of intelligent life in the universe.

NATIONAL COORDINATION. NASA programs in space science are complementary to those of other government agencies and must be placed in context to be evaluated. For example, there is a national program in astronomy. While the major responsibility for ground-based astronomy lies with the National Science Foundation, the data obtained about phenomena or objects accessible to the ground-based astronomer is tremendously enhanced by data obtained above the atmosphere from space platforms. Thus NASA and NSF work closely together to prioritize and coordinate mission requirements.

Similarly, there is a national program in atmospheric research, made up of NASA, NSF, and NOAA programs with unique capabilities and charters. Both NSF and NOAA have active research programs, and NOAA has sensors for research on some of its weather satellites. Each program is dependent in part on the other for filling gaps in data, for corraboration, and for the synergistic effect obtained by examining problems from differing vantage points.

INTERNATIONAL COOPERATION. International cooperation in space science provides an important tool for political interaction with other nations and is a valuable instrument in our effort to maintain an international free flow of science information. The US space science program is open to worldwide participation on a competitive basis. Over 45 foreign experiments have been carried on US spacecraft. A number of missions have been truly cooperative projects with foreign governments or the European Space Agency supplying major spacecraft (now over 29) or spacecraft components. There is currently about $400 million (run out) of such foreign-funded cooperative effort now underway or expected.

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This is dominated by the European Space Agency (international sun-earth explorer, space telescope, solar polar mission, and international ultraviolet explorer), the Netherlands (infrared astronomy satellite), and Germany (Galileo). For the most part, there has been no indication, other than possibly by Japan, that there is a desire to greatly increase the number of cooperative programs. In fact, in ESA there has been a definite move to identify more programs which carry the ESA mark vice US-ESA. In most of the individual European countries there are diminishing prospects for major new cooperative efforts because these European efforts are becoming more able to run their own space programs without US involvement.

The current level of international cooperation can probably be sustained, and there are prospects that increased coordination may be attainable. Increased coordination of programs is desirable. It would mean more science for the resources invested, on a worldwide basis. However, potential program overlap is small because most other countries have avoided (or cannot compete in) scientific experiment areas where the US dominates.

Recommended Action

Space science is an especially appropriate endeavor for government support because as basic research the long-range benefits accrue to all mankind, and the initial investments are beyond the range of private industries or foundations. It is possible to construct a plan at any given time which includes a large number of high-quality scientific missions. Their number has always exceeded the capability of the available budget to support it, and this condition will prevail, as is evidenced by the above capsulated summary of scientific opportunities. Proposed new projects will be evaluated on their merits and in consideration of the budgetary constraints. Long-range, broad goals can be set, however, to establish the directions in which to proceed to provide a focus for long-term research activity and to provide a context in which to judge new proposals.

At current budget levels and considering relative priorities, it has been possible to maintain a balanced program of space science and planetary exploration. The philosophy of establishing a balanced program can be maintained. A decreased budget would result in a lack of timely new data such that scientists would divert their interests to non-space areas. A long-term cut of 20-30 percent would cause the deletion of major program elements.

We will articulate broad space science and planetary goals. Specific programmatic decisions will be resolved in the annual budget process. In some years we would do less because of budget constraints, in other years more. Our broad goals for the next decade will include:

— We will maintain US leadership in space science and planetary exploration and progres at a measured pace along a balanced front. Priorities at any given time will depend upon the promise of the science, the availability of particular technology, and the budgetary situation.

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-- The US will continue a vigorous program of planetary exploration. Our goal is to understand the origin and evolution of the solar system. We have considerable knowledge of the moon, a major insight into Mars, and will soon obtain our first close-up view of Saturn. As yet we have only scant knowledge of coments, the most primitive objects in the solar system.

-- Our goal in the 1980's is to begin the reconnaissance of the outer planets and to conduct more detailed exploration of Saturn, its moons, and its rings; to continue comparative studies of the neighboring planets, Venus and Mars; and to conduct reconnaissance of comets and asteroids.

-- In the early to mid-1980's we will see the completion of the first all sky surveys across the electromagnetic spectrum. On completion of those surveys, space astrophysics will move in two directions. One will be towards observatories such as the space telescope that, like ground-based counterparts, will last decades. The second direction will be to launch free-flying satellites which detect energy from distant sources in other galaxies and intergalactic space. Using these new capabilities we will explore quasars, pulsars, and black holes and expand our appreciation for the basic wonders of the universe.

-- It is our goal to develop a better understanding of our sun and its interaction with the terrestrial environment. Space probes will journey towards the sun--the nearest star--to investigate its makeup and processes.

Earth-orbiting satellites will measure the variation in solar output and determine the resultant response of the earth's atmosphere.

-- The Space Shuttle and Spacelab will open up new opportunities in space biology. Our goals will be to exploit the Spacelab to conduct basic research that complements earth-based life science investigations and human physiology research.

There is an interagency consensus that our policy in international space cooperation should include these primary elements:

-- Support the best science available regardless of national origin, but expand our international planning and coordinating effort.

-- Seek supplemental foreign support only for selected experiments-spacecraft which have been chosen on the basis of sound scientific criteria.

-- Avoid lowering cooperative activities below the threshold where momentum would be lost and our competitive position, science, and international cooperative efforts would suffer.

VIII. COMMUNICATIONS SATELLITES

Communications satellites are one of the most successful applications of space technology. They are also the only example at this time of a major functional activity in space being operated by the private sector. The communications satellite business is profitable; companies have invested over $____ million in communications satellites, and income is about $____ million a year. In addition to COMSAT, two other US corporations have put up their own communications satellites. While the private sector has played a leading role, United States leadership in this field for numerous years was sustained in part by government research and development and Federal assistance.

Emerging problems in the communications field may require new solutions. Most communications satellites are in geosynchronous orbit, and the number of useful slots available in that orbit is shrinking as more satellites are put up. Some communications satellite applications--such as educational and health services for remote areas--often involve low-volume and intermittent use and may not be of interest to commercial satellite operators unless public service demands can be aggregated, combining functions on one or a few satellites.

As we move forward with communications satellite services, two basic questions face the Administraiton:

-- What role should the Federal government play in actively stimulating civilian satellite communications research and development?

-- Should the Federal government facilitate or develop public service satellite systems for domestic use and for international assistance programs?

A. FEDERAL ROLE IN CIVILIAN COMMUNICATIONS SATELLITE R&D

BACKGROUND. US participation in commercial communications satellites started with COMSAT, established by legislative mandate and Federal subsidy of $____ million in 1962. COMSAT holds 53 percent ownership and manages INTELSAT which launched the first international communications satellite in 1965. Satellite telephone charges are one-fourth of the 1965 rate, and television rates have been reduced 80 percent over the same period. Despite rate reductions, INTELSAT collected revenues of $140 million in 1977, paying a 14 percent return on investment to 102 participating countries. Satellite technology to support communications needs has been rapidly developing in recent years. United States leadership in the development and operation of communications satellite systems for a number of years was sustained by government research and development, quasi-Federal involvement through COMSAT, and Federal assistance to the private sector.

In 1972, the Nixon Administration, through the budget decision process, decided to rely more heavily upon the private sector for development of advanced satellite communication technology and services. The decision to de-emphasize the Federal government's role in satellite communications research and development was reached in part because of budget pressures, but there was also a determination that the private sector activity had matured sufficiently to assume primary responsibility.

To meet commercial communications requirements, the private sector has designed and built and is currently operating sophisticated commercial satellites on orbit. At present these satellites are adequate to meet the needs of the private sector and much of the government needs. Future communications satellites, to greatly increase their capacity, will require major investments in R&D. It is not clear that there is presently an adequate financial incentive for industry to invest the large resources required. In some new applications--direct public service or home television transmission--the private sector seems unlikely to provide the major financial investment required to take experimental steps.

Since 1972, various groups have called for a re-entry by the Federal government into satellite communications research and development. The potential return on Federal investment at this time would be to initiate research and development that would explore concepts and hardware which would enter into use in the 1980's or 1990's.

The general attitude of private industry toward Federal R&D has been assessed through recent NASA and OSTP surveys. The prevailing view among common carriers (but not among hardware manufacturers or Federal users) is that technological development is proceeding adequately in most areas but that, while the United States currently has the technological lead, the trends show some erosion of this position. These surveys identified several areas where government R&D could foster development of new technology; e.g., low-cost ground terminals, orbit and spectrum sharing. The hardware manufacturers expressed some concern over technological developments by European and Japanese industries. The manufacturers felt that emerging markets and government programs, should they develop, would provide an adequate stimulus for their further investment. The manufacturers suggested a circumscribed government role mainly related to research and development, not demonstration. The manufacturers' view generally is based also on their knowledge of the technological developments supporting the Defense sectors.

While NASA-supported communications R&D is currently limited, Defense planning activities include numerous technology development projects. This needs to be taken into account when considering additional Federally-supported R&D.

Issue for Decision

Issue #3--What role should the Federal government play in actively stimulating civilian satellite communications research and development?

Option 1--Maintain a minimal level of funding for communications satellite R&D programs--the current level--and leave major R&D responsibility to the private sector.

Option 2--Undertake selected communications R&D projects at NASA. The scope and funding level would compete against other applications in the normal budget process.

Option 1 would be geared to a study activity and would enable NASA to maintain some competence in this field. There would not be any significant hardware research and development, flight testing of hardware,, or demonstration program sponsorship to improve the utilization of communications satellite capabilities. This option represents a posture in which the achievement of national goals would be heavily dependent on private industry's R&D efforts.

The advantages of Option 1 are: (a) Evidence to date suggests US industry has not lost their competitive edge because of NASA's withdrawal from civil R&D support. Industry has received considerable technological support from Defense for technology development. (b) Many in industry argue that impediments are regulatory, not technological. (c) It has the least budget impact. (d) It gives a clear signal that the government does not intend to fund such R&D which might stimulate more private sector involvement. The disadvantages of Option 1 are: (a) The status quo has caused the perception this nation has lost some technological superiority in satellite communications and may lead to further erosion. (b) Long lead time is inherent to significant developments in this area, and indecision now may prove very costly in the future. (d) It may turn the future satellite communications system market over to Western Europe and Japan, whose programs receive greater government support.

Under Option 2 the Federal government would reenter advanced communications R&D as the NASA Applications Satellite Program did in the 1960's and early 1970's. This program could provide for substantial system and hardware developments, as well as their integration and flight testing. If a positive decision is made for a Federal initiative in this field, specific candidate projects selected would then have to compete with other applications activities in the normal budget process.

The advantages of Option 2 are: (a) It would support US technological leadership in satellite communications technology, but competitively with other Federal expenditures for space. (b) It could provide technology for the use of new and current frequency bands in an efficient manner so that the foreseen exhaustion of communications frequency capacity may be avoided. (c) It could expand the use of the allocated spectrum practically indefinitely by developments in state-of-the-art and in spacecraft systems. (d) It would provide expanding support to the US manufacturer and carrier industries. (e) It responds to industrial, Congressional, and user support for Federal R&D in this area based upon current and foreseen needs for transmission capacity.

The disadvantages of Option 2 include: (a) A Federal program with these elements might duplicate some efforts in the private sector. (b) It places the Federal government in the role of civilian R&D in support of an industry that is at present very solvent. (c) It could have a budget impact of up to $35-50 million per year. (d) It reintroduces the government into communications R&D in a big way when industry generally may be looking for only a few selected high technology R&D developments.

B. SATELLITE COMMUNICATIONS AND PUBLIC SERVICES

BACKGROUND. Many of the services provided by public agencies (such as the Federal government, educational institutions, health centers, and professional groups) are heavily dependent on the use of communications. Some of these services can be improved in cost or efficiency by improved communications services. Demonstration programs over the past two decades--largely subsidized by the Federal government--have shown the technical feasibility of applying satellite communications to some public service needs (e.g., education in remote areas and video training links between Veterans' Administration hospitals). The results of this work have led the Veterans' Administration, AID, HEW, and other user agencies to invest their funds in transitional experiments, but as yet none have become operational. While assessing the future savings to be obtained from advancements in technology is always an uncertain activity, we now have a substantially stronger base for estimating communications systems costs than was available in 1972. The key remaining uncertainty is the willingness of users to shift to advanced telecommunications services and the size of the resulting markets to share the system costs.

Direct costs savings to the Federal government and to non-Federal public service agencies would probably result if advanced satellite systems could be put in place and if adequate markets can be aggregated.

The need for operational systems to provide delivery of public services to address basic human needs is not limited to only our domestic requirements.

Technological advances required for a new generation of domestic services is also necessary to meet the needs for international communications and a wide variety of rural and urban communication needs in developing countries. The US has made commitments to assist developing countries' programs (e.g., Nairbi, Kenya, in May 1976 and October 1976; OAS in April 1977; and New Delhi, India, in 1978).

Planned future commercial communications satellites, such as the COMSAT General, IBM, and AETNA Company's Satellite Business Systems (SBS) are oriented toward private sector users with high-volume communications--those who spend $10 million or more annually on telecommunications. The SBS satellite system, like others now on the drawing board, is not being designed to economically facilitate users who have communications requirements outside of the large metropolitan markets. It requires a complex and expensive ground terminal for high-volume communications and uses a relatively simple satellite design. For future low-volume systems, user costs would be lessened with the required complexity placed in the satellite, enabling the use of smaller ground terminals with costs commensurate to the lower volume and usable by an unskilled community.

How the carriers would react to proposals of additional services that would meet the needs of rural areas, smaller communities, and some of the lesser-developed country needs is not clear. Past approaches to the industry have tended to be by individual agencies or by segments of the private sector. These various groups and the various Federal agencies could get their needs organized so that the aggregate volume was a clear opportunity for business. The current carriers and builders might then be willing to provide additional reasonable service with existing satellites and invest in new systems. The recent creation of the National Telecommunications and Information Administration in Commerce provides an opportunity to the government to explore these public policy issues.

Issue for Decision

Issue #4--Should the US government facilitate public service satellite systems for domestic use as well as international assistance programs?

Option 1--At this time, do nothing to initiate a new public service satellites program and continue to plan for the phasing out of existing experimental satellite programs.

Option 2--Designate a lead agency to assist in market aggregation, technology transfer, and development for domestic and international public service satellites.

Option 3--Specify and underwrite the development of a first generation public service satellite system that would compete with other applications in the normal budget process.

Option 1 would involve phasing out the limited effort now being carried out by the NTIA Interagency Committee on Satellite Telecommunications Applications and the current $3 million per year program at NASA. This option would not entail a special Federal effort to aggregate the public service community. Federal user agencies would work with OMB and their own procurement officials to purchase commercial satellite services where economically justified. No significant investments would be made in research or development of technologies for widely-dispersed, low-volume users and, therefore, this option would not address the needs of rural America and the LDC's.

Advantages of Option 1 include: (a) It will not impact on the budget. (b) The private sector may eventually (after 1985) provide some of the needed services if they become economically more attractive without any special Federal effort. (c) The delay would permit analysis of the costs and benefits of low technology alternatives (such as improved use of the telephone or mails) and the next generation of satellites before Federal effort is justified in the satellite field. The selection of this option has the following disadvantages: (a) It fails to take into account the need of public service agencies for improved communications and of international assistance commitments. (b) The potential savings of a coordinated Federal purchase of satellite services would be lost. (c) The private sector may continue to see little reason to plan for the low-volume consumer, and, therefore, would not plan for these services in the next generation of communications satellites. (d) It ignores the past success of national and international demonstrations and experiments and may force ongoing programs such as the Appalachian Educational Satellite Program to close down.

Option 2 calls for a concerted effort to stimulate the aggregation of the public service market and for applied research and development of technology for low-cost services. Under Commerce's National Telecommunications and Information Administration (NTIA) this effort would include: (a) an Administration policy statement supportive of public service satellite application; (b) OMB forward approval of user agency budget items permitting them to enter into multi-year contracts to purchase commercial communications satellite services; (c) an indentified 4-year core budget for Commerce to establish a management structure--competitive against other budgetary priorities in Commerce--to purchase bulk services; (d) modest support for R&D on technologies to serve users with low-volume traffic requirements subject to its competitiveness against other applications expenditures; and (e) AID to work with NTIA in translating domestic experience in emerging public service programs into potential programs for lesser-developed countries.

Advantages of Option 2 include: (a) This option would assure limited success of some important innovations in public service uses. (b) This option would advance space technology for public service users but by the private sector. (c) Appropriate service tariffs could be established, and public agencies would become accustomed to paying direct costs. (d) The Federal financial obligation to operations would be concentrated on services. The major disadantages of this option are: (a) It could be viewed as a retreat from international assistance commitments made by former and present Administrations. (b) It may reflect too much confidence in the readiness of public service agencies to take advantage of new communications services.

Option 3 adds to the tasks proposed in Option 2 and provides for a Federal program to specify a satellite system suited for public service users. The system would be designed to extend communications into rural and developing areas. In addition, new services, such as emergency and disaster relief communications via satellite, would be made available on an experimental basis. The system could be commercially operated but would require substantial Federal investment at the start ($300-350 million over 7 years). Federal assistance which would phase out gradually, but completely, by the end of the design life (e.g., 7 years) of the satellite.

Advantages of Option 3 are: (a) This option would assure some success of some important innovations in public service uses. (b) This option would advance space technology for public service users that could be transferred to the commercial sector. (c) New communications services (e.g., mobile and emergency radio radio services) would be established. (d) It would expand and complement the Administration's commitments to LDC's for the transfer of appropriate technology to provide a cost-effective system to meet user needs. (e) It would provide, both domestically and internationally, relevant services to meet the needs of dispersed low-volume users. Disadvantages of Option 3 are: (a) Given sufficient aggregation of the market under Option 2, most of these needs may be fulfilled by the private sector by the late 1980's, thus not requiring a uniquely designed satellite. (b) Projections of cost savings for government services under this option are based upon the long-term uncertainties of market prediction for these services. (d) This approach would have the greatest budget impact.

IX. LONGER-TERM ECONOMIC AND DEVELOPMENT ACTIVITIES IN SPACE

INTRODUCTION. The space flight capabilities the US is developing--particularly the Space Transportation System--will make possible a wider range of activity in space, including larger-scale projects. Eventually economic uses other than communications may emerge. A number of proposals have been made for space industrialization; e.g., materials processing in the weightless environment and solar power satellites. The basic issue is: To what extent should the Federal government attempt to stimulate expanded economic activity in space by supporting the development of the new technologies and through demonstration projects?

Other nations have shown interest in some of these concepts. The USSR is conducting experiments related to possible future economic activity; advance planning for the European and Japanese space agencies includes economic concepts, beginning with space processing experiments in the Shuttle and Spacelab.

In the United States, we assume that economic activity ultimately will be pursued by the private sector. However, the government has the option of playing a significant early role. This role could be critical given initial uncertainties and high investment costs. Furthermore, such a role would be consistent with the historical roles of the US government and private enterprise in the development of new frontiers and technologies.

Space industrialization could have major long-term benefits by generating new or better processes, products, and services. In 1978, however, the payoff is difficult to measure since so many factors are still uncertain, and some key technologies are yet to be developed. Nevertheless, US support for the general concept of space industrialization would appeal to a variety of constituencies, particularly private manufacturing firms, aerospace labor organizations, part of the energy community, and those in the general public who support an imaginative, forward-looking US space program with eventual economic payoff. The problem is how to state the longer-term goals so that there is necessary flexibility for the step-by-step technological development and validation of decision points on individual projects without undue commitment of resources or unrealistic public expectations.

Basic Concepts and State of Progress

Space Processing and Manufacturing. The space environment offers unique characteristics for materials processing and industrial operations; near-zero gravitational acceleration; easily-available near vacuum; and full-time solar energy. As a result, the space environment will facilitate scientific investigations into materials processing and properties, production of exemplary prototype materials, and performance of industrial processes in unique ways (possibly producing better products such as special glasses and more sensitive infrared detectors).

NASA has had a small space processing research effort underway since the late 1960's to establish the scientific base for materials behavior, to demonstrate the potential of space processing to the commercial user, and to provide opportunities for independently-funded users to exploit the space environment for processing. Further experiments will be conducted on the Space Shuttle. A committee of the National Research Council recently studied progress to date and concluded that, while the production of finished products in space is not yet justified, further research is desirable. The committee's report recommended that the NASA program consist of two stages: First, development and demonstration for perhaps 5 years; second, management of national space laboratory facilities. Gaps in our scientific knowledge need to be filled.

In the development of any space manufacturing program, provisions should be made so that industry can participate in special projects of interest on a joint basis. Presently-planned space systems would support scientific research in materials processing, but not large-scale manufacturing which must await better understanding of the processes and expected use of manufactured materials in space or on earth.

Satellite Solar Power. Engineers have proposed that huge arrays of solar cells in geosynchronous orbit collect solar energy and beam it by microwave to antennas on the earth, where it would be converted into electricity for power grids. A solar power satellite (SPS) would be an immense engineering project, perhaps several miles long. If the concept proves to be technologically, economically, and environmentally feasible, an SPS system could be a tool of US foreign and economic policy, and could contribute to energy requirements of the United States and other industrialized countries. It is a turn-of-the-century development under best estimates.

The basic questions about the SPS concern (1) technological and engineering feasibility, (2) economic feasibility, and (3) environmental and societal impact. Initial studies indicate that the SPS probably would be feasible in technological and engineering terms, though it might require an additional earth-to-orbit transportation system (the heavy lift launch vehicle), new techniques for assembling large structures in space, and new energy conversion systems. Very preliminary economic analyses suggest that, if cost targets are achieved for the SPS, it could be a competitive energy source in the early 2000's. Environmental questions--perhaps the most serious--concerning the effect of the microwave beam on the environment and the impact of large numbers of space launches require substantial study. An alternative power transmission concept using lasers and the use of materials processed in space (from the moon) to build the satellite solar power stations are also concepts to be evaluated.

Development of the first SPS, including the costs of development and the HLLV, has been estimated to cost $75-90 billion; subsequent units would cost an estimated $10-15 billion each. These high front-end costs are a principal disadvantage of SPS. However, these costs would be amortized over the 30-year-plus lifetime of the system. Advocates of satellite solar power point out that the US already funds large-scale research in long-range energy systems (e.g., some $0.5 billion a year for fusion). Further, cost sharing with other nations may be possible.

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Energy and NASA are examining baseline concepts to make comparative assessments of SPS and terrestrial power systems. Next step program recommendations are to be made in June 1980. Initial planning has begun for a ground-based exploratory research effort beginning in FY 1980.

Advanced Communications Systems. Several proposals have been made to deploy or build large frameworks in orbit that could support a variety of advanced communications applications. Proposals include antenna farms which would concentrate the functions performed by a number of satellites into one location in orbit. This could help solve emerging problems concerning the international allocation of geosynchronous orbit locations and of electronic interference among the growing number of satellites. Very large antennas in orbit could allow new or better communications services to be performed. It may also be possible to build large complexes in space for data acquisition, principally for observation of the earth.

COMMON PROBLEMS AND NEEDS. The economic development of the space frontier, as in the case of other frontiers, will require these fundamentals: a reliable and economic transportation system, efficient communications, abundant and reliable energy, and places for people to live and work for extended periods of time. In addition, space industrialization will require techniques and technologies for fabricating and assembling large structures in space.

While we have the transportation and the communications for near-term conceptual testing--in space--of the longer-term developments such as those discussed

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here, additional stages or vehicles are necessary for economic heavy lift to low-earth orbit and operations in higher orbits, particularly geosynchronous. The 25 kw power module would provide power necessary for the first testing of concepts, including materials science and processing experiments, but would not support greatly expanded space operations.

Many space industrialization projects imply the need for human presence as construction and factory workers. We will need human-rated systems and habitable facilities at the site of the economic activity. The Shuttle orbiter will be able to remain in orbit for about a week with its internal fuel cell power supply, though its non-fuel payload goes down as stay time in orbit lengthens. However, the orbiter was designed as a transportation system, not as a space station. These longer stay time capabilities must also be developed as a part of longer-term industrialization projects. The technology and human experience in space necessary for these longer stay time needs must also evolve. While there are many paper studies of these questions, the body of experience acquired with the Shuttle will be the next logical space development on the way to more distant and more permanent habitation.

Bridging Technologies and Test Facilities. The Shuttle, projected developments that would enhance the Shuttle's usefulness (e.g., an orbital 25 kw power supply), and the first civil and Defense missions will yield valuable experience for further conceptual study of the longer-term prospective economic and industrial developments. Moreover, some prospective mid-term (1980's and 1990's) missions supporting both civil and military objectives

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will likely create a body of experience in the assembly of large structures in space.

The next evolutionary step might be the development of an experimental or test platform in low-earth orbit--the Multi-Purpose Platform/Facility (MPPF). It would bring together technologies and facilities required for long-term space processing experiments, satellite power system development, and long stay times in orbit. It could provide an intermediate step toward the realization of space processing and satellite power systems without a full-scale commitment to either of those proposed projects. The platform would be a large framework connected to a large power module, perhaps 200-500 kw. This generator could provide an in-orbit energy source for a wide variety of operations on or near the platform, and it might be designed to beam energy to other points for application there. The platform itself could provide a mounting for a wide variety of unmanned experiments and applications requiring an energy source, including some related to space processing and space manufacturing. A power module of this size would allow the testing in space of most of the technologies needed for a possible future satellite power station, perhaps including the transmission of microwave power to earth.

The MPPF concept requires much further review prior to any commitment, and it has not been recommended now. It is, however, illustrative of the step-wise evolutionary development that could take place over the next 20 years.

GENERAL CONCLUSIONS. It is too early to make a commitment to the development of a satellite solar power station or space manufacturing facility now due to the technological and economic risks and environmental concerns. However, there are very useful intermediate steps that would allow the development and testing of key technologies, and experience in space industrial operations, without implying a commitment to a full-scale SPS or space manufacturing project. It is possible to design evolutionary programs that will build on current technology and open new options for space industrialization without large financial commitments in the near term. As such, these will be reviewed when appropriate within the Space Policy Review Committee and normal budgetary process.

The principal issue in longer-term space industrialization is the difference of view between those who would support a step-wise evolutionary development that will be provided by the Shuttle and those who would make more rapid and costlier commitments to space engineering. The enthusiasts will never be satisfied with less than an "Apollo-like" program. The Administration needs to articulate the way in which commitments that have been and will be made to nearer-term objectives can serve as the basis for making longer-term decisions at appropriate points.

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