

TIONAL SPACE COUNCIL Report to the President May 1992











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THE VICE PRESIDENT WASHINGTON

MAY 1 1992

President Bush reestablished the National Space Council in April, 1989 to bring coherence and national leadership to our nation's civil, military, and commercial space efforts. During the past three years, the President has demonstrated his commitment to space leadership by issuing a series of National Space Policy Directives to ensure that the American people reap the full benefit of our investments in space

New initiatives such as Mission to Planet Earth and Mission from Planet Earth, new technologies such as the National Aerospace Plane, and programs such as the New Launch System and Space Station Freedom are representative of this Administration's investment in space leadership and in aerospace jobs, now and for the future. As the Chairman of the National Space Council, I have worked to ensure that all of the Council's policy deliberations are based on full participation by all involved agencies with assurance that unique departmental needs are included in the process of meeting America's overall space objectives

The President's leadership has fostered significant increases in private sector investments in space hardware, systems, and services. We have cleared the thicket of accumulated regulatory barriers that were impeding the growth and competitiveness of the commercial space industry. The President's commitment to commercial space is evidenced by his policy to procure space services, including launch, from the commercial sector resulting in the emergence of a multi-hundred million dollar commercial space industry.

When the President and I talk about our objectives for the space program, we think in terms of investments rather than expenditures. For us, space is an investment in our nation's future. Our accomplishments, the new knowledge gained, and the stream of future benefits are a valuable legacy for our children and for future generations of Americans.

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Executive Summary

Last year, the National Space Council generated a series of space policy issues. Most significant among them was the development of a U.S. strategy designed to lead America's national security, civil, and commercial space resources in a coherent, consistent, and cooperative effort to chart a prudent, but progressive path toward the future

The Council's progress this year has been no less significant We have refined the elements of our strategy, articulated it to America's government and private sector space activity participants, and developed a broad consensus of support for the five critical elements of that strategy

Informed by our strategy and encouraged by the President's unwavering commitment to leadership in space, America's national security, civil, and commercial space sectors made progress this year toward the President's goal of "harnessing the potential of space to benefit our great nation and serve all mankind "

This year, the National Space Council put into action the elements of the strategy described in 1990 To accomplish this, the Council convened groups of highly respected experts to begin the important work of turning policies and strategies into specific plans of action

One such group, the Advisory Committee on the Future of the U.S. Space Program, chartered by the President but operating under the National Space Council umbrella, examined the organization of the nation's civil space effort and the National Aeronautics and Space Administration (NASA) Chaired by Norman Augustine, President and CEO of Martin Marietta, the Committee identified a series of improvements for NASA's organization and for civil space in December of 1990 These recommendations are in the process of being implemented

Another group, the Synthesis Group, brought together an impressive collection of scientists, technologists, and policy experts from all government agencies involved in space, as well as individuals from industry and academia, to evaluate ideas and recommendations from throughout the country with potential application to America's space exploration

efforts. Led by former astronaut and retired Air. Force Lieutenant General Thom is P. Statford, the Synthesis Group surveyed government, academia, and industry. After extensive review, they put together a comprehensive report charting our future course in space, including establishing a permanent presence on the Moon and human missions to Mars

Other National Space Council sponsored activities addressed the nation's launch needs, which resulted in a new National Space Launch Strategy, a Commercial Space Launch Policy, and the U.S. Commercial Space Policy Guidelines

Through groups like these and the activities of the Council's member agencies, progress was made on each of the five key elements of our strategy which is described in greater detail in the remainder of this report

Developing space launch capability and supporting infrastructure as a national resource

Achieving an appropriate mix of manned and unmanned, commercial and

government launch vehicles remains one of our highest priorities With the National Space Council's guidance and support, the government's national security, civil, and private space sectors achieved notable levels of coordination and cooperation The Council sponsored a new launch strategy, approved by the President in July, 1991, that exemplifies the broadly supported initiatives underway to ensure that America has the robust, diverse, and reliable launch capability essential to our future in space

Opening the frontiers of space

The Council has fostered a growing base of popular and professional support for the Space Exploration Initiative - the bold challenge of



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Bush set a course toward unprecedented scientific discovery with virtually limitless potential to benefit mankind Our ability to successfully meet this tremendous challenge is possible only by combining the technical and scientific excellence of America's private, academic, and government sectors The Council's Synthesis Group made significant progress toward building such cooperation. The Group cast its net wide to capture a vast array of ideas about space exploration and potentially beneficial technologies from across the nation Public and private sector response was tremendous, and the Synthesis Group's report will contribute greatly to focusing the nation's effort Council initiatives to expand international cooperation contributed to the solution of problems here on earth Particularly noteworthy were the agreements for environmental and life sciences cooperation in space between the US and the former USSR achieved at the July, 1991 Summit meeting

Using space to solve problems on Earth

Space continues to offer mankind a unique opportunity for creative solutions to seemingly insurmountable problems



Already useful to scientists addressing climatic, ecological, and energy problems on Earth, efforts such as NASA's Mission To Planet Earth will unlock new solutions to terrestrial problems

In the past year, the importance of space was dramatically illustrated during the coup attempt in the former Soviet Union where space assets provided the only link for urgent communications to world leaders In Desert Storm, the instantaneous communications offered by satellite relays enabled American and Coalition armed forces to achieve victory Military and commercial satellites provided General H Norman Schwarzkopt and his torces with vital communications, navigation, and intelligence as well as early warning to our Patriot missile units when Iraq launched Scud missiles at Saudi Arabian and Israeli cities Equally important, communications satellites were a vital link in giving citizens of all nations

immediate reports about progress throughout the Gult crisis

Generating economic wellbeing and national competitiveness

America's economic well-being and ability to compete in rapidly expanding global markets



depends on the strength and endurance of our industrial and technological leadership Historically, Americans have been pioneers and innovators, our history is one of discovering new technologies and developing them for commercial success. Space represents an opportunity for significant economic growth. In the near term, commercial space industries are expanding their participation in space launch, communications, and other areas. For the more distant future, space offers the potential for new industrial processes, new materials, and even whole new industries.

The National Space Policy places a high priority on both the near term goal of strengthening and expanding America's existing commercial space industry and the longer term goal of using space to develop new commercial opportunities

Within the framework of the Commercial SpaceLaunch Policy, the United States Trade Representative is engaged in pioneering talks with the European Space Agency to develop "rules of the road" which will foster free and open competition in the international launch marketplace

In addressing the development of commercial opportunities, the National Space Council encouraged an atmosphere of opportunity for commercial enterprises, including the growing commercial launch and communications satellite industries. The Council will continue to look for ways to clarify the Commercial Launch and Commercial Space Policy Guidelines as well as monitor and integrate their implementation. For the longer term, the Council will maintain its efforts to build the scientific and technical base needed to sustain American space leadership into the next century. New opportunities for commercial



enterprises in space-related industries have been identified and publicited. Creative government approaches were emphasized to encourage commercialization of space technologies---such as NASA's integration of commercial, government, and academic sectors in the Centers for Commercial Development of Space.

Ensuring freedom to use space

Our Desert Shield and Desert Storm.experience demonstrates the critical importance of space systems to the nation's defense. Clearly, we must maintain



free access to space for protection of America's vital interests worldwide and to identify and respond to emerging threats to security wherever they arise.

But America's dependence on space goes beyond traditional defense needs. Unrestricted access to space will become as important to our commercial health as freedom of the oceans. Every segment of our economy uses space for communications: from telephone calls to friends and relatives, to the beaming of television news programs across the nation, to participation in global financial markets—all depend on free and uncompromised access to space. Our future is significantly linked to the use of space as we step boldly into the next American Century. To continue building economic vitality, America will employ its traditional strength—our creative, technological, and industrial genius—and that will focus us inevitably on space. Further, as we continue to face the challenges of depleting natural resources, environmental and ecological concerns, population growth, and uncured diseases, space offers opportunities for solutions that mankind cannot—must not—ignore.

Protecting our future in space requires the ability to see, monitor, and eventually influence all that happens in space. We must be able to alert owners and operators of space systems when threats exist. And ultimately, if necessary, we must be able to intervene for the protection of vital space assets.

During this past year, the Council has focused its attention on implementation of the five key elements of our space strategy. We have made progress toward building the kind of integrated, coordinated, and unified space:effort envisioned by the President as the key to America's future. A future where "...first in space will mean first on Earth. And America intends to stay Number One." The following pages describe the National Space Council's efforts toward that future.

Leadership in Space



President George Bush

international cooperation in space exploration The dialog to be established with the Commonwealth of Independent States and other nations will provide a foundation for additional cooperation on a range of space initiatives for America's greatest extraterrestrial effort, the Space Exploration Initiative

Significantly, the President announced that he and former Soviet President Gorbachev, "reached an agreement on important new ways in which our two countries can join in the peaceful use of outer space" The resulting initiatives, which the President described at the July 1991 summit as " a significant expansion of our current cooperative projects," will focus on environmental and life sciences programs

The President's initiative with the Soviets also contained an agreement to explore additional areas for cooperation through annual consultations on civil space issues and cooperation between the two governments Clearly, the President opened the door to a new era of complementary space effort that promises continuing and increasing benefit to mankind

These new initiatives will further enhance American leadership in space But it is not leadership for its own sake The nature of these initiatives, as well as existing cooperative projects—such as the multi-nation coalition

This past year President Bush reinforced and extended the vision of America's role in space The United

States will continue to evercise policy leadership in the international arena President Bush's diplomatic initiatives with the former Soviet Union brought significant progress toward increased supporting Space Station Freedom—are focused on improving life on Earth and preserving its bounties for future generations. As Vice President Dan Quayle noted, "President Bush has provided decisive leadership. His goals are clear—a commitment to using space for improving our stewardship of the environment and to further exploring and developing our solar system."

The President has renewed our national commitment to space He convened the first Presidential meeting devoted solely to space with the Congressional leadership in more than 20 years. In achieving consensus for space exploration—manned and unmanned—the President has laid the foundation for an enduring national commitment

In keeping with the National Space Council's ongoing efforts to tap the best and brightest minds in the country, and consistent with the Space Council's Executive Order, the Vice President's Space Policy Advisory Board was established in 1991

Vice President Quayle selected Dr Laurel Wilkening, a distinguished space expert and Provost and Vice President for Academic Affairs at the University of Washington, to serve as the first Chair of the Board In addition, thirty-three individuals were selected to serve on the Board, reflecting a broad and diverse base of experience for America's space program

At the specific request of the Vice President, the Board will review current civil, commercial, and national security space policy issues and will assess scientific, technological, engineering, manufacturing, economic, international, or other factors bearing on national space policy questions Based on these analyses, the Board will recommend courses of action, options, or positions to the Vice President and the Space Council

There are no limits to where this nation will go in search of excellence. The genius of the American people in science and technology, coupled with our unwavering commitment to international cooperation and the peaceful use of space, represents a sound and safe investment in the future "More than thi years ago, ou country's leaders a solemn decisu that America's sj program would al lead the world the National Sp Council, and for entire space apparatus, yester pledge is today mission "

> Vice President Q July 24, Vandenberg Cali



Vice President Dan Quayle

The National Space Council

The National Space Council is responsible for the coordination of U.S. space policies and strategies and for monitoring their implementation. It was created by an act of Congress in 1988 and was established by President Bush's Executive Order No. 12675 on April 20, 1989. In signing the Order, the President said that space is of vital importance to the nation's future and to the quality of life on Earth, and he charged the Council to keep America first in space.

The Council is chaired by Vice President Dan Quayle, who serves as the President's principal advisor on national space policy and strategy Other members of the Council include-

- The Secretary of State James A Baker, III
- The Secretary of the Treasury Nicholas F Brady
- The Secretary of Defense Dick Cheney
- The Secretary of Commerce Barbara Franklin
- The Secretary of Transportation Andrew Card
- The Secretary of Energy James D Watkins
- The Director of the Office of Management and Budget Richard G Darman
- The Chief of Staff to the President Samuel K Skinner
- The Assistant to the President for National Security Affairs Brent Scowcroft
- The Assistant to the President for Science and Technology
 - D Allan Bromley
- The Director of Central Intelligence Robert Gates
- The Administrator of the National Aeronautics and Space Administration Daniel S Goldin

The Vice President invites the participation of the Chairman of the Joint Chiefs of Staff, the heads of other departments and agencies, and other senior officials in the Executive Office of the President when the topics under consideration by the Council so warrant

The National Space Council is supported by an Executive Secretary appointed by the President — The first Executive Secretary of the Council, Mark Albrecht, leads an elevenmember policy staff — The Council is turther sup-ported by a sub-cabinet-level interagency Policy Implementation and Review Committee (PIRC) composed of senior representatives of each member of the Space Council and chaired by the Space Council's Executive Secretary Interagency working groups, chaired by Space Council staff, prepare policy studies, develop strategy alternatives, and provide advice and recommendations to the PIRC



Secretary of State



Secretary of Defense



Secretary of Transportation



Director of the Office of Management and Budget



Assistant to the President for National Security Affairs



Director of Centra Intelligence





Secretary of the Treasury



Secretary of Commerce





Chief of Staff to the President



Assistant to the President for Science and Technology



Administrator of NASA

The National Space Council carries out activities to integrate and coordinate civil, commercial and national security space activities, and has taken major steps toward their implementation

The Council's planning process consists of four phases

- Define broad goals and objectives for the U.S space program,
- Determine strategies to implement those goals and objectives,
- Monitor the implementation of these strategies, and
- Resolve specific issues that arise during the implementation process



Executive Secretary Mark Albrecht

Key Elements of National Space Strategy

The National Space Council provides a policy oversight and stategy process or America's space programs. Essentially, the Council provides a compass heading for the nation's space agencies—ensuring that programs remain consistently focused on the goals of the National Space Strategy.

To accomplish this mission, the Council distilled five key elements (listed below) from the strategy. Each of these elements has public and private sector dimensions. The elements are not discrete—each is related and integrated with the others. The plans and activities of U.S. Government space agencies are incorporated within the key strategy elements.

The five key elements of U.S. National Space Strategy are:

I To develop U.S. space launch capability — our transportation to and from space — as a national resource, the space transportation infrastructure will be to the 21st century what the great highway and dam projects were to the 20th. We will ensure that this infrastructure provides assured access to space that is sufficient to achieve all U.S. space goals

2 To open the frontiers of space through both manned and unmanned exploration, we will build on the successes of Viking and Voyager and proceed to comprehensively explore the solar system with Magellan, Hubble, Ulysses, and other ambitious unmanned programs. The President's call to complete Space Station Freedom, return to the Moon to stay, and the journey to Mars has finally given a much needed tocus to our manned efforts. New ideas will be synthesized into varied approaches to undertake these premier space flight missions of the future

3 To intensify our use of space in solving problems here on Earth, we already use space systems to verify arms control treaties and to provide our defense forces with warning, communications, navigation, meteorology, and other functions vital to our national security. Satellite communication networks link peoples around the globe and contribute to the increasingly successful fight against repression and totalitarianism. Remote sensing from space contributes to a variety of land and ocean use applications and helps us understand, and potentially mitigate, the process of global climatic change.

4 To foster our economic well being, we will capitalize on the unique environment of space to investigate and produce new materials and medicines and develop clean and abundant energy for all. The resulting private investment will create jobs, boost the economy, and strengthen our science, engineering, and industrial base. Along the way, new commercial space markets will be created and existing industries will become stronger and more competitive in the world marketplace.

5 To ensure the freedom of space for exploration and development, there are currently numerous spacetaring nations, with many others on the way. Space will become to the future what oceans have always been — highways to discovery and commerce. But the sea lanes must be open to be usable, and as we know from past conflicts, they are subject to disruption. Thus, we must ensure the freedom to use space for exploration, development, and security for ourselves and all nations.









Developing Space Launch Capability and Infrastructure as a National Resource



are essential to every space program Currently, America has a substantial and diverse space launch capability, which includes the Space Shuttle for manned missions and several expendable launch vehicles, or rockets, for unmanned missions While

Space launch capabilities

the Shuttle gives America unparalleled flexibility for manned operations in space, our Delta, Titan, and Atlas rockets provide reliable, efficient lift for unmanned payloads

But we have to face the facts Our nation's launch capabilities are aging The Shuttle, for all its marvelous capability, was designed in the early 1970s The expendable rockets, all of which grew out of early ballistic missile programs, are based on even older technologies

Yes, today's launch systems can get today's critical missions into space, but the cost of getting there is high In addition, we lack the ability to respond quickly to changing priorities And while our reliability is as good as, or better than any in the world, space launch is still a risky business

In the early days of the space program, Americans had to accept these limitations The world's ability to use space was limited by technology to a few expensive but very important missions This is no longer true Today America has the technology to do much more in space—protect our nation, explore, and make life better on Earth Today the barriers are not technology, they are cost and risk

But these are very real deterrents to increased use of space

To address these concerns, the Space Council prepared, and President Bush approved, a new National Space Launch Strategy This strategy provides a long-range plan to meet America's launch needs well into the next century It is a blueprint for change which will bring our space launch capabilities into line with the enormous technological advances of the past 20 years and will open the highway to space for the 21st century

A key element of this new strategy is the

recognition that space launch is an essential

component of the nation's transportation infrastructure Like the great highway and dam projects of the past, the nation's space launch infrastructure must serve as a catalyst to benefit society and enhance the economy Our goal entails much more than just meeting currently defined mission launch needs We are seeking to make space more accessible, more affordable, and more routine We are looking to a future where space has a much broader set of applications—civil, military, and commercial than it does today

If America could be content to provide only the minimum performance and capability necessary to meet immediate and well-defined needs, the strategy would probably call for incremental improvements in current systems Such a strategy would leave all the current barriers to future space activities in place But this is not our plan

We have chosen to move down a different track

- First, we intend to develop a new family of launch vehicles, with a first launch by the year 2002, which will take advantage of current technologies to reduce cost and increase reliability
- Second, we will maintain a focus on the future through a tobust space launch technology program This technology effort, involving NASA and the Departments of Energy and Defense, will include system components and new launch system concepts, such as single stage to orbit concepts including the National Aerospace Plane, which offers the prospect of truly revolutionary improvements for the next century

This new strategy will meet real needs for both NASA and the Department of Defense (DoD) It will also provide the basis for a new commercial launch vehicle capable of competing effectively in the international marketplace

By sharing the management and funding between NASA and DoD, the impact on their individual agency budgets will be held to a minimum





The Delta expendable iaunch vehicle



new launch system is that the time to make decisions for the future is now. Over the next several years, a host of critical decisions must be made that will decide the design configuration of a wide variety of future satellites. If we do not begin to move foward with a new system now, these missions will have to be designed for launch on current vehicles. Were we to let this happen, America would be locked into continued reliance on our current vehicles and their 20 to 30 year old technology for another generation.

Of course, as we invest for the future, we must also ensure that existing space launch capabilities, including support facilities, are sufficient to meet all of the current needs. Systems like Atlas, Delta, Titan, and the Space Shuttle will certainly provide America's primary launch capabilities through this decade, and will be important contributors well into the first decade of the 21st century. The new strategy provides guidance that will ensure their continued availability.





Today we rely on expendable rockets for our unmanned launch requirements. That is a sound policy. The Space Shuttle, with its precious human cargo, is just too valuable a national resource to risk on missions which can be performed better by other means.

We will continue to rely on the Space Shuttle well into the first decade of the next century to meet America's manned spaceflight needs, but the launch rate demands will be relatively low. The Shuttle system will be operated conservatively and steps are being taken to extend the operational life span of the fleet, precluding the need to add more orbiters to the existing fleet.

Commercial space launch has taken on increasing importance. Looking to the future, we believe that the role of the private sector in space will continue to increase. New commercial uses of space will evolve, international competition in space launch will increase, and the relationship between federal government agencies and industry will become more like a partnership.

The new strategy provides specific guidance that will strengthen public/private partnerships and enable the U.S. private launch industry to compete freely and fairly in the international marketplace. It provides for broader industry participation in space launch and opens up new channels of communication with industry and with state and local governments.

Additionally, the strategy will encourage new approaches and new ideas that will benefit both commercial competitiveness and government needs.



Above: The Space Shuttle lifting off with its cargo, the Ulysses satellite

Top Left: Ulysses in space

Left: Titan IV on the launch pad





Above: New commercial space launch designs will enhance commercial space development

Commercial Space Rolley, Implementation

US commercial space policy is an integral element within the national effort to ensure reliable and affordable launch capability into the next century Increasing commercial capabilities and space support infrastructure, coupled with the many advantages of the competitive marketplace, will play an increasingly significant role in putting American public and private sector payloads into space

On February 12, 1991, President Bush signed the U S Commercial Space Policy Guidelines The guidelines are the product of a nine month interagency review of existing and potential commercial space endeavors conducted by the National Space Council

These guidelines define—for the first time—what is meant by commercial space activities They outline existing commercial market areas and describe how the government can interact with the commercial space industry to foster its development and enhance the nation's overall space effort



The guidelines respond to the growing and diverse demand for space-based products and services Further, they recognize the broad range of existing and potential commercial space activities The guidelines will be useful in promoting new entrepreneurial firms and state and local government participation in addition to traditional aerospace firms and established corporations from outside the aerospace community

The commercial space sector is generally comprised of five specific industries satellite communications, launch and vehicle services,

Above Right: The Gamma Ray Observatory is released from the grasp of Atlantis' Remote Manipulator System

Right: international Microspace's Orbital Express™ launching from the commercial spaceport, Poker Flat Research Range, Alaska



commercial infrastructure. These sectors vary in degree of maturity and dependence upon one another For example, the satellite communications arena is the most mature and demonstrably successful sector, while materials processing remains embryonic The launch services and commercial infrastructure sectors support all commercial space applications

The guidelines also recognize the contribution of the commercial sector to efficient exploitation of space, and therefore serve to provide an atmosphere in which commercial enterprise is encouraged and nurtured Critical to this goal is the need for a predictable and stable relationship between the commercial and government space sectors

A series of important principles are included in the guidelines to ensure that government policy serves to strengthen the commercial space effort Basically, these guidelines charge the government

- To use commercially available space products and services to the fullest extent feasible,
- To promote the transfer of governmentdeveloped technology to the private sector,
- , To make unused capacity of space assets,
 services, and infrastructure available to the commercial sector,
- To make available any assets that are excess to government requirements,
- To avoid regulations that unnecessarily preclude or deter commercial space activities,
- To work with the commercial space sector to promote the establishment of technical standards for commercial space products and services,
- To enter into appropriate cooperative agreements that will encourage and advance private sector basic research, development, and operations,
- To work toward an international trading environment that encourages marketoriented competition



Each of these guidelines is associated with the criteria U S Government agencies have agreed to use when determining whether a commercial proposal qualifies for support. It is hoped that such guidance will help the private sector by eliminating those political and management uncertainties over which the government exercises control

Recognizing the critical role that commercial ventures will play in ensuring the nation's launch capability and other space efforts in the future, the Council's Commercial Space Working Group continues to monitor progress in implementing these guidelines These guidelines are viewed as a "living document" and will be clarified and revised as U S agencies gain practical experience in carrying them out

Opening the Frontiers of Space

where who may and a checks on constrained and a characteristic of



The Space Exploration Initiative

President Bush's vision of America's future in space, the Space Exploration Initiative, consists of long-term goals for our

national space endeavors: a return to the Moon. and exploratory trips to Mars. This challenges us as a nation to carry the mantle of world space leadership through a series of bold and imaginative steps and blaze new trails into the 21st century. This initiative continues to be a major activity of the Space Council.

The Space Exploration Initiative is the ultimate investment in America's future. Enroute to Mars, we will advance earth sciences,



Michael Collins, Gemini X, Apollo 11

explore the Moon, and develop new, innovative technologies for Earth. We can tap lunar, Martian, and solar energy resources as we explore the heights of human talent and ability. Along the way, American drive, initiative, ingenuity, and technology-all those things that have made this nation the most successful society on Earth—can propel us toward a future of peace, strength, and prosperity. In accomplishing this, the Space Exploration Initiative increases our knowledge of the universe and our place in it, stimulates interest in science education and engineering, demonstrates leadership on a global scale, develops technological innovation with commercial and terrestrial applications, enhances the commercialization of space, and strengthens our economy.

This visionary undertaking requires a plan that includes technology development, a sound scientific strategy, and both human and robotic spaceflight. Thus the Space Exploration Initiative is not the next program for an agency, but represents a framework for the exploration of space. This plan does not set priorities among existing and planned programs, but rather identifies logical arrangements of program elements that can support our future exploration of space.

The Space Council endorsed an Outreach program and Synthesis activity to define our technology and architecture development for the Space Exploration Initiative. The Synthesis Group, chaired by Lieutenant General Thomas P. Stafford, reported to the Vice President and the membership of the National Space Council. The Synthesis Group report, "America at the Threshold", forms the blueprint for our future exploration of space. The report recommends four alternative architectures, fourteen key areas of technological development, and ten specific recommendations for the initiative's implementation.

The National Space Council has undertaken the responsibility for leadership in



implementing the President's vision of space exploration To establish a firm foundation and clear direction for the Space Exploration Initiative, actions have been undertaken to establish an exploration office led by NASA's newly designated Associate Administrator for Exploration This office will be staffed by , representatives from NASA, the Departments of Defense and Energy, and other participating agencies The expertise provided by these agency representatives in such areas as technology, logistics, and operations will be of immense value in executing this national effort Efforts currently underway in the laboratories and test facilities of the Department of Defense and the Department of Energy will significantly contribute to the Space Exploration Initiative

A Strategic Plan is being developed which will establish the basis for integrating existing and future Space Exploration Initiative related activities This plan addresses research, technology, program development and operations, and identifies the relationships between the US space infrastructure and Space Exploration Initiative mission elements This Strategic Plan will be presented to the National Space Council in 1992, and will initially focus on technology development and mission architectures





Above: The space exploration initiative is the ultimate investment in America's future

Left: Lunar Rover

Below Left: Viking 2 Mars lander





Conducting research in space

A Steering Committee for space exploration is also being established, chaired by the NASA Associate Administrator for Exploration, and includes representatives from participating agencies. The Committee will be the senior forum for coordinating interagency interfaces, reports, plans and activities, Space Exploration Initiative related programs and budgets, and identifying those issues requiring consideration by the Space Council.

Critical, long-lead research and technology development activities supportive of the exploration strategic plan are being conducted, including space nuclear power and propulsion. These will be accomplished in a safe and environmentally acceptable manner consistent with existing laws and regulations.

Education is a principal theme of the Space Exploration Initiative. Space exploration offers unique opportunities to expand our national interest, capability, and awareness in the sciences and technical areas of endeavor. Each participating agency is thus emphasizing the relationship of space exploration to science, engineering, and technology in their respective educational programs. Maximum advantage is also being taken of university research capabilities and cooperative education programs in Space Exploration Initiative related activities.

The National Space Council has helped ensure the Space Exploration Initiative's implementation in pursuit of the President's vision for the future of the U.S. Space Program. The Space Exploration Initiative revalidates the direction of U.S. space efforts, reaffirms the use of space exploration in support of our national well being, and recognizes that leadership requires American preeminence in key areas of space activity.

The Space Exploration Initiative will initially require a modest commitment of resources. Refocusing ongoing technology programs will enable us as a nation to take the first steps toward a robust, safe, and affordable future in space. It encompasses manned and unmanned activities, technology, commercialization, and international cooperation and provides significant terrestrial benefits. It does not set priorities among



support the initiative. It represents our Strategic Plan for the exploration of space.

By offering direction and purpose, the Space Exploration Initiative will invigorate our sense of challenge, competitiveness, and national pride. The Space Exploration Initiative is a positive, social endeavor. In a world of uncertainty, it has the capacity to inspire people, to stimulate them and to cause them to reach deep inside for the very best they have to offer.

Great nations have always explored and profited from new frontiers and territories. Space is the new frontier of the industrialized world in the 21st century. Benefits from space, and the technologies needed to journey there, become increasingly important in the next century. As Americans, we must ask ourselves what our role will be in human exploration of the Solar System: to lead, follow, or step aside.



Solar flare

Lunar mining operations in the production of liquid oxygen





The Canadian robotic arm

International Cooperation in the Space Exploration Initiative

Our National Space Policy calls for increased international cooperation and the President has decided to invite participation by other nations in the Space Exploration Initiative

Acting on the recommendations of the Vice President and the National Space Council, the President announced on March 30–1990, that

- The United States will take a sequential and orderly approach to involving interested countries in the Space Exploration Initiative
- We will seek an exploratory dialogue on international cooperation in the Space Exploration Initiative with Europe in space faring nations, Canada, Japan, the Commonwealth of Independent States, and other nations.

Plans are proceeding, consistent with emerging program definition for the dialogue with other nations. The dialogue will focus on conceptual possibilities for cooperation in accordance with the National Space Policy The Council is responsible for ensuring thorough interagency review during the development of potential international participation

Space Station Freedom

The Administration and the Congress realfirmed their intention to proceed with Space Station Freedom. In late 1992. an extensive reexamination was undertaken of the program's technical approach schedule and cost consistent with the recommendations of the Advisory Committee on the Future of the U.S. Space Program and the funding guidelines issued by the Congressional Appropriations Committees In the Spring, a restructured program plan was reviewed by the Administration and then recommended to the Congress. The new plan features a lower annual funding requirement self-sufficient capabilities at the man-tended phase of assembly, reduced demand for Shuttle flights, tewer extravehicular activities for assembly and maintenance, and lower technical risk

During the Congressional Fiscal Year 1992 funding debate, the Space Station was threatened with cancellation. This threat sparked a serious debate over the tole of manned space flight within the civil space program. President Bush and Vice President Quayle played critical roles in marshalling Congressional support. At the end of the Congressional budgetary process, the Space Station was funded at the level requested by the Administration

In September, 1991, the Space Station systems, which were changed in the restructuring process, successfully passed their preliminary design reviews. Looking torward to the future, key subsystems will continue to undergo engineering tests to increase the level of design maturity. Flight equipment production will begin for several key subsystems, such as the photovoltaic solar arrays and flight computers.





Above: Space Station Freedom

Left: Life and work aboard Space Station Freedom



Using Space to Solve Problems on Earth



Space provides a unique vantage point for Earth of servation, as well as an intraensely useful life ratory for life sciences, medicine, inceallurgy, and a host of other disciplines Americans already benefit trom the knowledge ganed in space and will

trets S att

continue to do so at an even faster pace in the future. Indeed, all mankind benefits daily from space-based communications, and nations benefit from the level of national security available from space sensors and navigation. Experimentation in space offers unique and vitually unbounded opportunities to solve Earth's ecological, environmental, energy, and medical challenges in the years ahead.



Landsat satellite

Opening the Frontiers

For space science and for developing civil applications of space technologies, 1991 was an eventful year with the launch of several important missions — The Space Shuttle placed the second of our planned great observatories, the Compton Gamma Ray Observatory into Eirth orbit in April—This spacecraft will study extraterrestrial gamma ros — the highest energy radiation in the electromagnetic spectrum — with unprecedented sensitivity and resolution

In September, the Shuttle deployed the first major satellite in the Mission to Planet Earth

program, which seeks to exploit the unique opportunities space offers for Earth observation. This first satellite, the Upper Atmosphere Research Satellite, is already improving our understanding of the dynamics and chemistry of the Earth's upper atmosphere. It will also study the effects of solar activity and the effect of changes in key elements of the atmosphere, such as ozone.

Our understanding of how the human body adjusts to microgravity conditions increased significantly in 1991. Space Shuttle missions, especially the first ever Spacelab mission dedicated to life sciences research, revealed that the body reacts to weightless conditions much faster than previously believed. The experiments conducted on metabolic, cardiovascular, and neurovestibular functions on this mission and planned future missions will provide the information needed to develop procedures for safe and healthy long duration space flights.

Mission to Planet Earth

Mission to Planet Earth puts America's tremendous space technologies to work in order to benefit our own planet. In an effort to better understand the Earth as an integrated system, we are using the same remote sensing capabilities that allow us to observe distant planets. The information gained from this program will be useful in exploring climatic, ecological, and environmental changes on earth

Mission to Planet Earth directly supports the United States Global Change Research Program, one of our nation's highest scientific priorities. Data obtained from space-based observation systems will reduce the uncertainty in the global warning hypothesis. Well characterized data from these observation systems are used to validate and refine the predictive models for the Earth's climatic behavior. From these predictions, the U.S. and other nations can establish or change environmental policies

Our long-term observation effort involves NASA, the Departments of Commerce, Defense, Interior, and Energy and the



During 1991 the Space Council, working with NASA, established the Earth Observing System Engineering Committee headed by Dr. Edward Frieman, to provide advice regarding implementation of the Earth Observing System. The Committee came up with significant recommendations that crucial instruments should be flown on intermediate and small spacecraft to rapidly gather key climate and Earth process information needed for the U.S. Global Change Research Program. It recommended the Department of Defense and the Department of Energy should proceed with instrument development to provide measurement capability for climate monitoring in space by 1995. The Committee also. recommended that a review be conducted of the Earth Observing System Data and Information System to establish the best way to proceed.

These recommendations are significant in that they are in keeping with the new national space strategy. They recognize the need to use the capabilities and expertise within the government, be they NASA, DoD, or DoE. The recommendations also reflect a change relative to relying on large systems. Considering the cost constraints, and the need to provide early information, there may be advantages to developing smaller mission-specific satellites that can fly with shorter development times. The EOS Data and Information System is one of the largest data and information systems contemplated by the nation. The recommendation relative to the Data and Information System stresses the need to have a system that is flexible and doesn't develop a life of its own. It must be supportive of the satellites and systems that fly. This approach could well set the pattern for not only the Earth Observing System, but for our early exploration missions – small unmanned satellites and probes that can provide significant return with short development times.

Earth Remote Sensing

In 1989, the National Space Council conducted a comprehensive review of United States' policy regarding Earth remote sensing. This review yielded three basic findings:

- The current Landsat satellite program makes important contributions to many civil government agencies and provides essential national security data to DoD.
- The civil character of the current program is important both in terms of commercial utility and in furthering U.S. foreign policy objectives.
- Insufficient market demand makes full commercialization of Landsat impractical for the foreseeable future. The U.S. Government is currently the largest user of Landsat data.

Based on these findings, President Bush established a policy to ensure the continuity of Landsat-type remote sensing data. To implement this policy, the President directed actions that continued operation of Landsat satellites 4 and 5 and allowed completion of Landsat 6, which is now scheduled for launch in the fall of 1992.

Since the President's decision, the utility of Landsat-type data has expanded in two areas:

- Operation Desert Storm demonstrated the military importance of broad area, multispectral imagery and also pointed out the requirement for improved resolution to support needs such as the preparation of tactically useful maps.
- Existing Landsat data and a continuing Landsat program throughout the lifetime of the Earth Observing System (EOS) is an essential component of the U.S. Global Change Research Program.

Therefore, in 1991 the Space Council concluded that remote sensing data collection to support national security, global change research, and other U.S. government needs beyond Landsat 6 necessitates the acquisition and operation of a Landsat 7. NASA and DoD will undertake the development and operation. of this system. Specific technical and programmatic details, as well as administration proposals concerning data policy, are being developed for consideration.





Landsat change pair showing the progres center pivot irrigati Saudi Arabia Top: December 25, Bottom: February 15





Defense Support Program (DSP) Satellite being prepared for shipment to the launch pad

National Security

Our national security satellite systems provide support to decision makers from the national to the tactical military level. Satellites are always on watch for ballistic missile launches to provide early warning of hostile acts. Information from satellite systems also assists in arms control treaty monitoring, and enhances global stability by reducing the possibility of surprise.

The Desert Storm operation provided an excellent example of how space-based assets can increase the combat capability of our forces. The Arabian deserts have few landmarks and the space-based Global Positioning System—a constellation of satellites that provide extremely accurate position data to forces on the ground was invaluable in aiding navigation of our forces. In fact, several Iraqi units became lost in their own country while U.S. soldiers had precise location information. Variants of this system are being used today by the commercial and civil sectors.

Existing space systems also provided communications and meteorological support to Desert Shield and Desert Storm operations. Space systems were used to warn of Scud launches by Iraq, which gave America's Patriot defensive missiles an edge in defeating missiles. headed for Saudi Arabia and Israel. In the future, space systems may provide defensive measures to protect any part of the planet from a ballistic missile attack. The preservation of peace will require even more advanced national security space systems to support informed decision making and to take appropriate action to defend America's global vital interests from threats that may arise quickly and with great lethality.

Long-Term Impacts

Humans are an expansive, curious, and ingenious group of beings. We have explored and charted our planet, and used its resources to achieve tremendous technological, scientific, architectural, and engineering feats. Unfortunately, our progress has not been without cost to the environment and our progress has strained our natural resources.

While we can accept that there are limits to growth, that does not mean that we are doomed to an inevitable downward spiral in the average standard of living. Instead, we can pursue the bounties of space — harvesting new energy sources, raw materials, and products. Exactly how we can do this, we do not know. But we do know that in the long term space has the potential to provide clean, essentially unlimited sources of energy and raw materials. It is imperative that we come to understand our planet and find new resources to provide a rich future for all humankind.

Background Right: Landsat image of Desert Storm theater of operations

Above Right: Oil well fire in Kuwait

Bottom Left: Trimpack global positioning satellite receiver in use by Desert Storm troops

Generating Economic Well Being



Creating New Industrial Capability and Jobs

The National Space Policy explicitly recognizes the importance of the commercial space market

and its potential to generate real economic benefits by creating new technologies, products, and services—which translate into new jobs and opportunities. According to the 1992 edition of the U.S. Industrial Outlook published by the Department of Commerce, the total U.S. commercial space sector revenue is estimated at \$4.7 billion, a 20 percent increase over the previous year. Most of these revenues were generated by the production and delivery of satellite communication space systems, ground stations and equipment, and the communications services they provide.

Opportunities for commercial enterprises are growing in a number of space-related fields, including:

- satellite communications
- space launch and transportation services
- remote sensing satellite development and data analysis and enhancement
- position location signal receivers and applications



- material processing and research in space
- ground-based infrastructure and support
- on-orbit space industrial facilities
- commercial launch facilities
- payload processing services
- spaceport safety management
- financing services
- space insurance

Of these, the space communications industry is the most mature and the fastest growing, with 1991 revenues estimated at more than \$5 billion from all segments of the international communications market. Although the international communications satellite market is very competitive, the U.S. is still the major producer with a 59 percent market share.

One of the most promising developments in space communications is the application of the lightweight satellite, or lightsat. Using new technologies in sensors, electronics, and computers, lightsats weighing a few hundred pounds offer potential for a range of specific space functions. Several U.S. firms are leading the development of communications applications for small satellites to provide mobile voice and data communications services.

The second largest element of the commercial space sector is spacecraft launch services. The Department of Transportation's. Office of Commercial Space Transportation. which licenses and promotes commercial space transportation services, estimates that the U.S. launch service industry will generate \$520 million in 1991. U.S. launch service companies currently have approximately 38 firm orders for launch services valued at \$1.5 billion through 1995. One major American launch supplier estimates that approximately 20,000 prime contractor and subcontractor jobs are directly affected by the commercial space transportation market. In addition, U.S. commercial launch companies report that they have invested more than \$700 million to date in this business market.

The remote sensing market sector. continued to grow in 1991, with data sales and value added services of \$170 million — a \$30 million increase from 1990. Landsat satellite data sales and enhancement services were major

Using the StarView tracking and display workstation for efficient fleet management



contributors to the revenue base. A fast emerging product line, known as Geographical Information Systems, creates automated navigation systems for automobiles, ships, and aircraft from remote sensing satellite and global positioning satellite data.

Using Space Technology

The government contributes to the commercial space economic sector as a customer for private sector goods and services. Current government purchases of launch services are potentially important contributors to economic growth. American businesses are looking to space for new opportunities and, as new fields of space commerce develop, new products and services will create increased demand for launch services and related infrastructure. This promise of new products and services holds the greatest potential for expanding the U.S. economy and contributing to the gross national product. Firms developing these new products and services will also serve as a major market for entrepreneurial infrastructure and transportation companies.

The U.S. Commercial Space Guidelines, announced in February 1991, provide government organizations with specific guidance to encourage the growth of the U.S. commercial space sector. NASA has responded to these guidelines with aggressive initiatives to support this effort.

The first phase of the commercial development process involves conducting research on technologies that could result in new products or services in the future, while at the same time guiding the necessary supporting transportation capabilities and other infrastructure. NASA's Centers for Commercial Development of Space (CCDS) are a consortia of government, industry, and academia that focuses on research with commercial potential. These centers have two major responsibilities: one, to leverage a broad industry base to develop product-oriented technologies in which industry is interested; and two, to stimulate commercially costeffective transportation and infrastructure ventures in support of the product development initiatives:

To mature promising technology, the CCDSs must conduct testing in space. CCDSs are planning and initiating a variety of hardware development projects to provide CCDS researchers with cost-effective, entirely commercial means of conducting these experiments. One such project, in its third year of development by the Space Vacuum Epitaxy Center at the University of Houston, is a "wake shield" facility for high vacuum materials research for use on the Space Shuttle.

Since Shuttle missions are at a premium, and access to them is costly, the CCDSs initiated a plan for a commercially developed system for launching and recovering spaceborne experiments, called COMET. The CCDSs will be totally responsible for system design, fabrication, test, launch, and operations of COMET. Fourteen firms submitted 15 proposals in the competition to develop COMET. On January 28, 1991, the final decision on the selection of the three industrial firms that will be responsible for establishing launch and recovery of the COMET space system was announced. The 18-month development program for COMET will lead to a launch date in late 1992. By contracting commercially for the entire COMET program, the CCDSs ensure that the technology develops at a rate commensurate with the industry's needs and improves the position of the space transportation industry vis-a-vis the increasingly competitive international market.

The concept known as "anchor tenancy" is an innovative measure being taken by the government to provide necessary support for a commercial venture to become viable in the



Above: Ground dish receiving informatic satellite

Top Left: Communic satellite relaying information





The Space Shuttle at work with a SPACEHAB payload.

long term To support additional CCDS flight tests, NASA has leased two-thirds of the space in a commercial middeck augmentation module, provided by SPACEHAB Incorporated, during the module's first six flights SPACEHAB provides a needed commercial service which will benefit the nation NASA's role as an anchor tenant for SPACEHAB enabled the company to secure the required financing and insurance

Strategic partnerships between government and industry can help overcome cost and risk obstacles to the commercial development of space. Such partnerships can mitigate the upfront technical and financial risk to attract sufficient private capital. Benefits to the economy will be tully recognized when new technologies, services, and products are developed for consumption by private sector markets. Through NASA's CCDS program, the unique talents and resources of government, industry, and academia are synthesized to provide a key catalyst for development of the commercial space technology sector

Technology Development

A sound technology base is the fundamental element for development of new markets and industries A goal of the National Space Policy is to facilitate development of a commercial space sector independent of government support Accordingly, the government can be a very effective partner in nurturing industry efforts in the early years

This role was recognized in the Commercial Space Launch Policy directive giving active government consideration of private sector needs when making decisions on national launch infrastructure. The National Launch System program, which aims at developing 21st Century space transportation capability, is responsive to the commercial sector's concerns. This special program and the Department of Transportation's Commercial Space Transportation Advisory Committee have incorporated the concerns of private launch service entities

NASA, through its CCDS program, is developing technology for direct commercial application in several areas Among these efforts are the development of the COMET system for launching and retrieving space experiments, the first US mobile communications satellite system with the American Mobile Satellite consortium, and the development of the SeaStar spacecraft to provide ocean color data that is useful to commercial fishing fleets and government researchers

The Department of Defense also operates an extensive science and technology complex

Project Agency played a major role in providing seed funding, developmental assistance, and contracting for launch services leading to the successful development of small spacecraft experiments (lightsats) and launch vehicles (such as Pegasus).

The Department of Energy's national laboratories instituted a very successful technology transfer program and engaged in joint research with industry. The private sector gains a large scientific return from these activities.

Strengthening the Industry Base and Technology Development

As the international space markets become increasingly competitive, the government must encourage commercial use and exploitation of space technologies and systems for the benefit of our domestic economy. Two sets of commercial space policy guidelines, the U.S. Commercial Launch Policy and the U.S. Commercial Space Policy Guidelines, were formulated for this purpose.

The two policies identify opportunities for the government to work more effectively with the private sector, for minimizing competition between the government and the private sector, and for fostering an environment more conducive to commercial development.

The guidelines encourage innovative efforts by government space agencies to develop working relationships with commercial shared costs and risks. NASA's Advanced Communications technology program is an example. The program will test and verify advanced technologies in joint experiments. COMET and SPACEHAB, both discussed above, also exemplify this approach.

NASA's 17 CCDSs enlist 241 companies and 71 universities in a network of research consortia centered on moving emerging technologies from the laboratory to the market place. This program provides vital support to U.S. industry in competing with increasingly aggressive foreign entities in several high technology markets, including materials research and processing, remote sensing, space power and propulsion, automation and robotics, and life sciences.



Left: Growing food in a closed environment

Below Left: Launch of Pegasus from a B-52





Ensuring Freedom to Use Space For Exploration and Development



major perhaps even dominant—role in the world arena in the coming years and decades. The importance of satellites for scientific research, surveillance, early warning of attack, navigation, weather

prediction, and communication demands that we have free and unencumbered access to space. Recent events in the Persian Gulf highlight the contribution of space systems. Future confrontations will require an even more sophisticated space force multiplier.

We can ensure our access to space by:

- Being able to monitor space for objects and actions that threaten our assets or those of a friendly nation. As more and more nations have the ability to orbit satellites, we will need to increase our space surveillance capability.
- Developing and deploying the capability to protect our assets from hostile action. Our space systems must be able to detect an attack, notify the owners and operators of such an action, and passively survive. In the broadest sense, we need to be able to

consistent in the ply claracterize the purposes of space activities and warn

when those activities are hostile.

Possessing the capability to actively deny an adversary the use of their space assets.
These active measures must be capable of stopping aggressors before they can use their space systems to threaten our vital interests on Earth.

Simply put, the United States and other nations—indeed the global financial network and worldwide markets—are so dependent on space that protection of our space assets must be a high priority. Additionally, the tremendous scientific, technological, commercial and security benefits of space-based systems are critical to the survival and prosperity of our nation today. Tomorrow, they will be even more important.

Summary and Conclusion

The National Space Council continues its efforts to integrate the unsurpassed technological prowess of America's commercial, academic, and governmental institutions toward common purposes in the space program Concepts and frameworks developed last year for implementation of the national space strategy have taken concrete form in the past twelve months

The National Space Council's efforts reflect an appreciation for the opportunities ahead, and recognition of the simple fact that only a broad coalition of America's industrial, commercial, educational, and governmental institutions will be equal to the challenges we face. As this report demonstrates, we have made progress in our efforts

The Space Exploration Initiative now stands on a firm foundation, solid plans for improvement of government and commercial launch vehicles and infrastructure are now guiding our efforts, growing cooperation between all national space agencies and among space-faring nations create new and exciting opportunities for solutions to mankind's problems, consistent domestic support extending from the President to Congress and broadly across our national institutions enhances our future in space, and the historic reduction in global tension frees both the East and West to focus more clearly on exploiting space for mutual benefit

Today, we stand on the threshold We are poised to tackle the greatest of scientific and technological challenges—to return to the Moon and stay there, and to press forward to Mars—in a bold search for solutions to our Earth's ecological, energy, environmental, and other problems

The questions we must ask now are Is America equal to the opportunity, the challenge, and the potential that lies ahead? Can we, together with our brothers and sisters on Earth, sustain ourselves in the next century of our journey toward a better life for all?

The answers will not be found in our space agencies, industries, and government offices alone The answers are also in America's classrooms and in our own communities The answer lies as much in achieving our national educational goals as it does in our laboratories As President Bush told a group of students earlier this year, "our administration and the nation's governors created six national educational goals—one of which is to be the first in the world in math and science And together you can help say of American education 'All systems are go '''

The answer lies in every segment of American society—for our leadership in space is an expression of commitment to the fundamental ideals of human dignity, freedom, and prosperity that have formed national action for more than two centuries

We have won a great victory in the Persian Gulf, and democracy has achieved an even greater victory worldwide as more and more nations—the Commonwealth of Independent States among them—set a proper and just course for themselves With these victories come historic opportunities to refocus America's attention on worldwide concerns and on the unique potential space offers for solving those problems

It is toward that end that the National Space Council works We are committed to building on our success of the past, to maintaining the cooperative atmosphere—at home and abroad—that now dominates space efforts, and to continue devising useful policy instruments in support of our nation's near and long-term goal of using space for the benefit of all humankind