United States General Accounting Office

GAO

Fact Sheet for the Chairman, Committee on Armed Services, House of Representatives

June 1990

MILITARY SPACE PROGRAMS

An Unclassified Overview of Defense Satellite Programs and Launch Activities

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GAO

United States
General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division

B-238277

June 29, 1990

The Honorable Les Aspin
Chairman, Committee on Armed Services
House of Representatives

Dear Mr. Chairman:

Your July 27, 1988, letter requested that we assess the Department of Defense's (DOD) plans for satellite programs. Specifically, you asked that we develop information on the relationships and cost of DOD satellites, launch vehicles, and launch facilities. In response to your request, we provided a classified fact sheet to you on March 5, 1990.

Your office subsequently requested that we provide you with an unclassified version of the fact sheet. This fact sheet reflects the unclassified DOD satellite program and launch plans to the extent they existed as of October 1, 1989, for activities through year 2004. The information is discussed in appendixes I through V in a format agreed to with your office. However, as DOD noted in commenting on a draft of the classified fact sheet, military space programs are continually reviewed and adjusted to reflect budgetary actions. Thus, the information we present is a snapshot in time of DOD's space program plans and may not always be current. Appendix VI discusses our objective, scope, and methodology.

Satellites

DOD satellites perform a wide variety of missions to support U.S. national security interests and pursue advances in research and technology. The missions include communications, meteorology, navigation, research and development, strategic defense, tactical warning and attack assessment, and other classified missions.

Appendix I describes the missions, requirements, program status, unit costs, schedules, launch vehicles, and launch facilities for current and planned DOD satellites. Appendix IV contains a summary of the launch schedules for each of the satellite programs.

Launch Vehicles

The Challenger space shuttle disaster and two Titan unmanned expendable launch vehicle (ELV) failures in 1985 and 1986 precipitated a major revision of national space policy and DOD's satellite launch strategy. Until the Challenger accident, the shuttle was to become the national

program providing primary access to space for U.S. government users. At the time, DOD had been planning to launch no more than four ELVs a year after 1989.

After lengthy launch delays resulted from the failures, former President Reagan announced several changes to the national space policy in December 1986. The changes directed DOD to pursue a strategy of using a mixed fleet of unmanned launch vehicles and the shuttle to avoid reliance on a single launch system, thereby assuring U.S. access to space. DOD now plans to use a variety of ELVs to perform more than 90 percent of its satellite launches currently scheduled through the year 2004. The remaining scheduled launches are on the shuttle.

To meet most of its ELV requirements for the next 15 years, DOD is acquiring and will launch ELVs in several classes of lift capacity. These include the large-capacity Titan IV; the medium-capacity Atlas II, Delta II, and Titan II; and the small-capacity Pegasus and Taurus. For the rest of its ELV needs, DOD plans to (1) acquire commercial launch services on commercial versions of these vehicles and the large-capacity Titan III, (2) launch remaining inventories of its medium-capacity Atlas E, and (3) employ several of the National Aeronautics and Space Administration's (NASA) remaining inventory of the small-capacity Scout.

Actual lift capacities of the ELVs to 100-nautical mile orbits (a standardized altitude for vehicle comparison purposes) range from 30,300 to 39,000 pounds for the large vehicles; 1,750 to 14,500 pounds for the medium vehicles; and 350 to 1,100 pounds for the small vehicles. By comparison, the shuttle is capable of lifting up to 55,000 pounds to the same altitude.

DOD is also pursuing joint technology development programs with NASA for an Advanced Launch System and National Aerospace Plane. DOD and NASA plan the Advanced Launch System ultimately to be a family of unmanned vehicles of various lift capacities up to 360,000 pounds to 100-nautical mile orbits. They plan the National Aerospace Plane ultimately to be a hypersonic, manned or unmanned, single-stage-to-orbit flight vehicle capable of lifting up to 65,000 pounds to 100-nautical mile orbits.

Appendix II provides detailed information on the launch vehicles, their schedules, and their relationship to DOD satellites and launch facilities. Appendix IV contains a summary of the launch schedules for each of the vehicle types.

Launch Facilities

DOD launches satellites on ELVs from Cape Canaveral Air Force Station and NASA's Kennedy Space Center, Florida, and from Vandenberg Air Force Base, California. DOD also launches satellites, through NASA, on the shuttle from the Kennedy Space Center and on Scout ELVs from NASA's Wallops Flight Facility, Virginia.

The Cape Canaveral, Kennedy, and Wallops facilities are restricted to easterly launches to orbits up to 57-degrees inclination to avoid flights over populated areas and foreign air space.[1] For the same reasons, Vandenberg facilities are limited to southerly launches to high-inclination orbits. However, these limitations may be avoided with the Pegasus, which is an air-launched vehicle that can be launched sufficiently offshore to avoid overflying populated areas. Appendix III describes current and planned launch capabilities at the Cape Canaveral, Kennedy, Vandenberg, and Wallops facilities. Appendix IV describes existing launch schedules through the year 2004 for each of the launch complexes at these facilities.

Space Program Cost Estimates

As of October 1989, DOD estimated total fiscal year 1990 space-related program costs at about $18 billion. It also projected total space-related costs to rise to about $23 billion by fiscal year 1994. These cost estimates take into account the satellites, launch vehicles, and launch facilities, including estimates for support costs such as satellite control networks and operations and maintenance of facilities. Appendix V describes the costs by the various program categories used by DOD to develop the estimates.

Agency Comments

DOD and NASA provided official comments on a draft of the classified version of this report. DOD asked that we consider revising the report to emphasize more strongly the continually changing nature of DOD space activities due to program and budget actions; clarify that the report deals only with DOD satellite activities and not suborbital or nonsatellite programs; and limit information to only approved DOD space programs. We concurred with DOD's concerns on these matters and revised the report accordingly. DOD's comments are provided in appendix VII.

NASA elected to provide official oral comments. Responsible NASA officials took no exception to the information in the report or how the

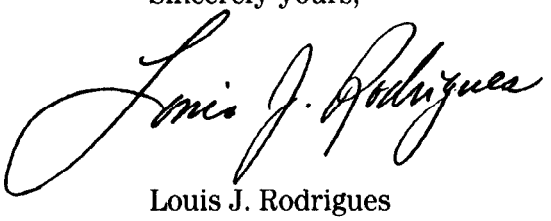
[1] Inclination is the angle made by the intersection of a satellite's orbital plane with the plane of the earth's equator. (See the glossary for further explanation.)

report described the relationship of NASA programs to DOD space activities. In addition, DOD and NASA suggested certain technical changes to more accurately reflect current program status. Their suggestions were also incorporated into the final report.

As agreed with your office, unless you publicly announce its contents earlier, we plan no further distribution of this fact sheet until 30 days from the date of this letter. At that time, we will send copies to the Secretaries of Defense, the Navy, and the Air Force; the Administrator, NASA; the Director, Office of Management and Budget; and other interested parties and make copies available to others upon request.

Please contact me at (202) 275-4841 if you or your staff have any questions concerning the fact sheet. Other major contributors to this fact sheet are listed in appendix VIII.

Sincerely yours,



Louis J. Rodrigues
Director, Command, Control, Communications,
and Intelligence Issues

Contents

Tables

Figures

Abbreviations

AFSATCOM	Air Force Satellite Communications
ALS	Advanced Launch System
BSTS	Boost Surveillance and Tracking System
DARPA	Defense Advanced Research Projects Agency
DMSP	Defense Meteorological Satellite Program
DOD	Department of Defense
DSCS	Defense Satellite Communications System
DSP	Defense Support Program
ELV	Expendable launch vehicle
FLTSAT	Fleet satellite
FLTSATCOM	Fleet Satellite Communications
GAO	General Accounting Office
GPS	Global Positioning System
LEASAT	Leased satellite
LIGHTSAT	Lightweight satellite
NASA	National Aeronautics and Space Administration
NASP	National Aerospace Plane
NDS	NUDET Detection System
NOAA	National Oceanic and Atmospheric Administration
NUDET	Nuclear Detonation
PAM	Payload Assist Module
SBI	Space-Based Interceptor
SBWAS	Space-Based Wide Area Surveillance
SDI	Strategic Defense Initiative
SDS	Strategic Defense System
SPINSAT	Special Purpose Inexpensive Satellite
SSTS	Space Surveillance and Tracking System
UHF	Ultrahigh frequency

DOD Satellites

DOD deploys satellites for a variety of missions—communications, meteorology, navigation, research and development, strategic defense, tactical warning and attack assessment, and other classified missions. The classified missions are not discussed in this fact sheet. The funded satellites and satellite systems with unclassified missions that DOD had deployed as of October 1, 1989, and planned to deploy through the year 2004 are:

- Communications:
  - Air Force Satellite Communications (AFSATCOM) System.
  - Defense Satellite Communications System (DSCS).
  - Fleet Satellite Communications (FLTSATCOM) System, including replacement Ultrahigh Frequency (UHF) Follow-on satellites.[1]
  - Milstar Satellite Communications System.
- Meteorology:
  - Defense Meteorological Satellite Program (DMSP).
- Navigation:
  - TRANSIT Navy Navigational Satellite System.
  - Navstar Global Positioning System (GPS).
- Research and development:
  - Various satellites for space-based tests and experiments.
- Strategic defense:[2]
  - Boost Surveillance and Tracking System (BSTS).[3]
  - Space Surveillance and Tracking System (SSTS).[3]
  - Space-Based Interceptors (SBI).
  - Experiment satellites.

[1]UHFs are frequencies in the electromagnetic wave spectrum from 300 to 3,000 megahertz. A megahertz equals 1 million cycles per second.

[2]This mission refers to Strategic Defense Systems (SDS) being developed as part of the Strategic Defense Initiative (SDI).

[3]May eventually come under Air Force management as a tactical warning and attack assessment system.

- Tactical warning and attack assessment:
  - Defense Support Program (DSP).[4]
  - Nuclear Detonation (NUDET) Detection System (NDS).

This appendix describes these systems in the order listed above and also identifies which vehicles and facilities DOD plans to use for launching them. Procurement, delivery, and launch schedules available from the Air Force and the Navy through the year 2000 are included in the descriptions where they are unclassified. End-of-year on-ground satellite inventories that we calculated based on these schedule projections are also included in the descriptions. Figures I.1 through I.11 show the systems' launch vehicles and launch facilities. Appendix IV contains a summary of unclassified satellite launch schedules. In addition to the programs described, other satellite programs not currently funded, such as the Space-Based Wide Area Surveillance (SBWAS) system, could be developed by DOD and added to the inventory of DOD space programs.

[4]The mission is classified but the name of the program and some information about it is not.

Air Force Satellite Communications System

Mission	Dissemination of emergency action messages to strategic and theater nuclear capable forces and command and control communications among command authorities. Includes use by the ground and airborne command centers, intercontinental ballistic missile launch centers, strategic bombers, submarines, special operations forces, communications relay and reconnaissance aircraft, theater nuclear weapons storage sites, commanders-in-chief, and national command authorities.
Program Manager	Air Force.
Requirements	Primarily UHF transmission. System does not have its own constellation of satellites. System components deployed on DSCS, FLTSATCOM, and commercial satellites in geosynchronous equatorial orbits; Satellite Data System satellites in high-inclination elliptical orbits; and on certain other host satellites.[5] (See glossary for orbit definitions.)
System Status	System scheduled to be replaced in the late 1990s by Milstar and the FLTSATCOM system's UHF Follow-on satellites.
Satellite Life Expectancy	Generally, the same as host satellites.
Prime Contractor	Generally, the same as host satellites but AFSATCOM components may be supplied by other contractors in some cases.
Average Unit Cost	Varies with host from $10 million to $60 million.

[5]The Satellite Data System is a DOD data transmission system that is being phased out. Descriptions of other hosts are classified.

Defense Satellite Communications System

Mission

Secure voice and high data rate transmissions for worldwide military command and control, crisis management, relay of intelligence and early warning data, treaty monitoring, and diplomatic and presidential communication.

Program Manager

Defense Communications Agency (overall program). Air Force (satellite acquisition and deployment).

Requirements

Primarily superhigh frequency transmission.[6] Constellation of five operational and two spare satellites in geosynchronous equatorial orbit.

System Status

Current contract a multiyear procurement begun in fiscal year 1984 for seven DSCS III satellites and last two deliveries scheduled for fiscal year 1990. Follow-on buy for superhigh and extremely high frequency satellites scheduled for fiscal year 1994.[7]

Satellite Life Expectancy

7 years.

Prime Contractor

TRW for DSCS II, General Electric for DSCS III.

Average Unit Cost

$134 million.

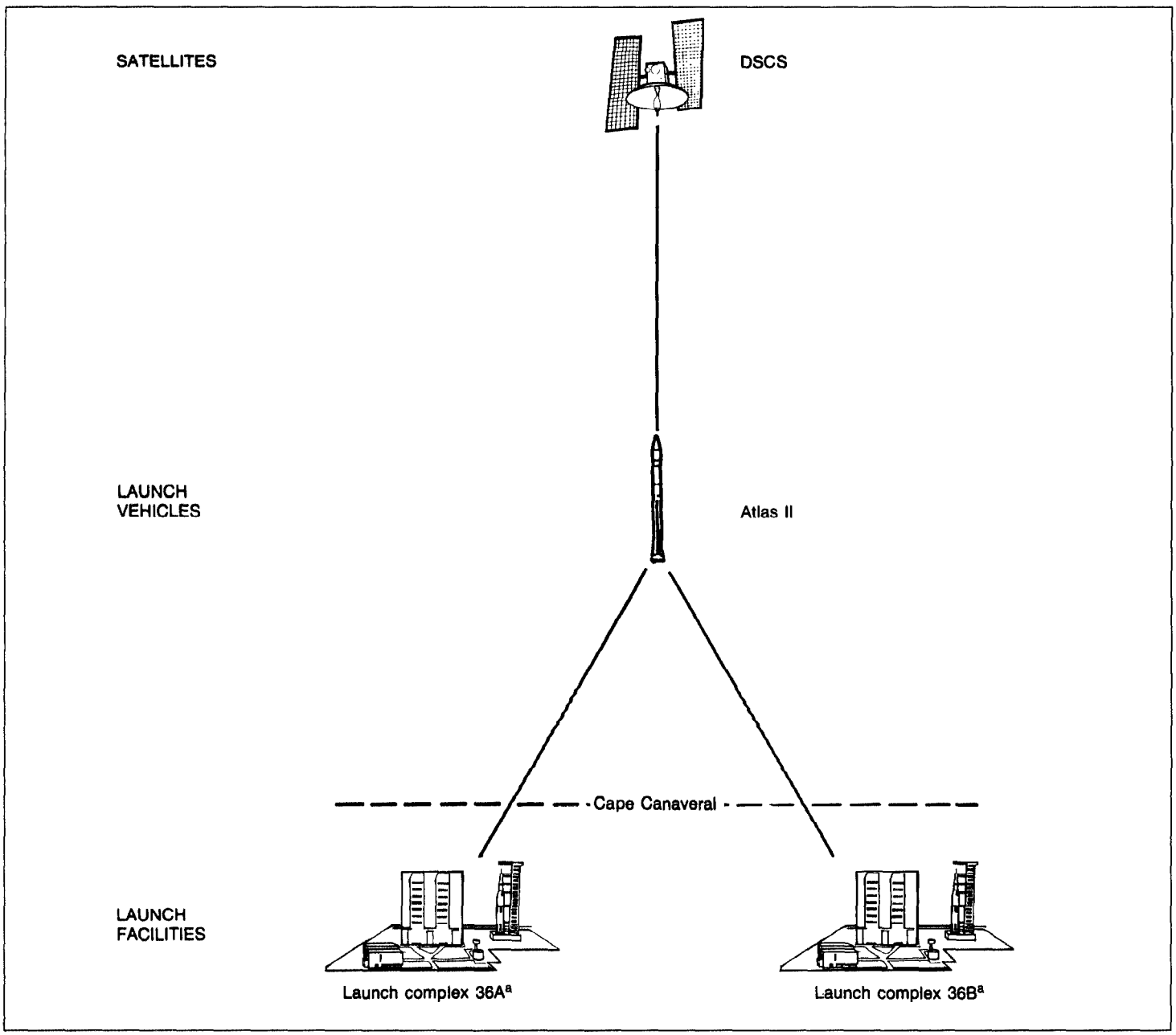
Schedules

	Fiscal years										
Item	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**
Quantity procured	0	0	0	0	1	2	2	1	1	1	1
Quantity delivered	2	0	0	0	0	0	0	0	1	1	1
Quantity launched	(Information deleted)										
End-of-year on-ground inventory	(Information deleted)										

[6]Superhigh frequencies are from 3 to 30 gigahertz. A gigahertz equals 1 billion cycles per second.

[7]Extremely high frequencies are from 30 to 300 gigahertz.

Figure I.1: DSCS Launch Vehicles and Launch Facilities



[a]Initial Atlas II capability planned for fiscal year 1991.

Fleet Satellite Communications System

Mission

Worldwide communications services for DOD mobile forces, including fleet broadcast services and command and control to surface ships, aircraft, and submarines.

Program Manager

Navy.

Requirements

Primarily UHF transmission. Constellation of eight satellites in geosynchronous equatorial orbits with no spares.

System Status

Six Navy-owned satellites ("FLTSAT") and three dedicated leased satellites ("LEASAT") on orbit. LEASATS have 7-year leases with options to buy satellites on orbit at end of lease periods for $15 million each. One LEASAT remains to be launched. Multiyear acquisition of nine replacement satellites ("UHF Follow-on") begun in fiscal year 1988. Follow-on planned to have an on-orbit spare and have some superhigh and extremely high frequency capability. System supplemented with leased channels from commercial communications satellites.

Satellite Life Expectancy

12 years for FLTSATS and LEASATS. 14 years for UHF Follow-ons.

Prime Contractor

TRW for FLTSATS. Hughes Communications and Services for LEASAT. Hughes Aircraft Company for UHF Follow-ons.

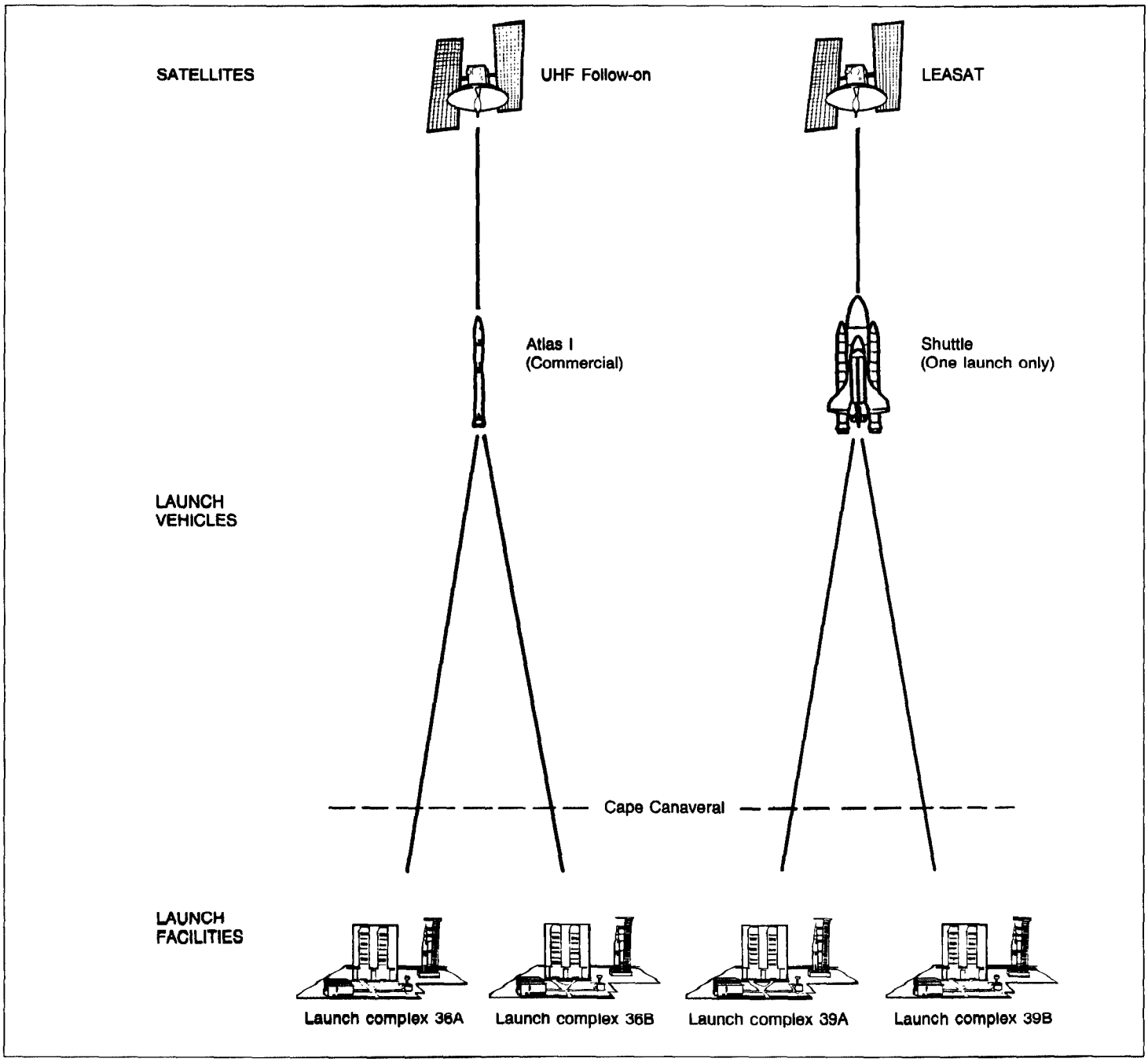
Average Unit Cost

$83 million for FLTSATS. $16.7 million a year each for two LEASATS. $14.8 million a year for one LEASAT. $170 million for UHF Follow-ons with launch services included in the contract.

Schedules

	Fiscal years										
Item	90	91	92	93	94	95	96	97	98	99	00
Quantity procured	2	3	3	1							
Quantity delivered	0	0	1	0	2	3	3	1			
Quantity launched	1	0	1	0	2	3	3	1			
End-of-year on-ground inventory	0	0	0	0	0	0	0	0			

Figure I.2: FLTSATCOM System Launch Vehicles and Launch Facilities



Milstar Satellite Communications System

Mission

Highly survivable, jam-resistant, worldwide, secure joint service communications to meet the minimum essential wartime communications needs of the President and Commanders-in-Chief to command and control strategic and tactical forces through all levels of conflict.

Program Manager

Air Force.

Requirements

(Information deleted.)

System Status

First three developmental satellites under contract. Two more developmental satellites planned for contract in fiscal years 1990 and 1991. First full-production satellite procurement planned for fiscal year 1992.

Satellite Life Expectancy

(Information deleted.)

Prime Contractor

Lockheed Missiles and Space Company for the developmental satellites and first production satellite.

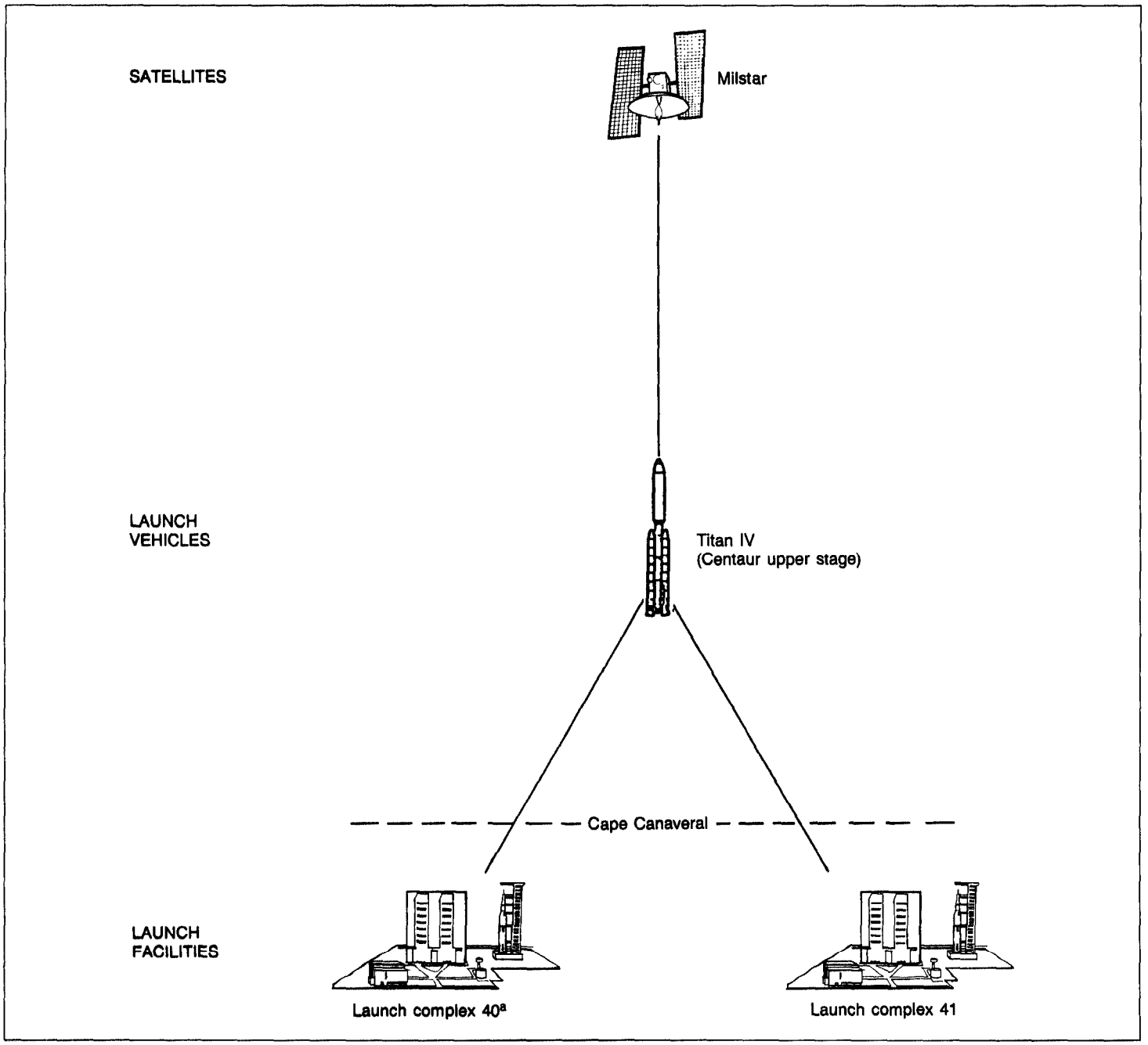
Average Unit Cost

(Information deleted.)

Schedules

	Fiscal years										
Item	90	91	92	93	94	95	96	97	98	99	00
Quantity procured	1	1	1	4	0	0	1	1	1		
Quantity delivered	(Information deleted)										
Quantity launched	(Information deleted)										
End-of-year on-ground inventory	(Information deleted)										

Figure I.3: Milstar Launch Vehicles and Launch Facilities



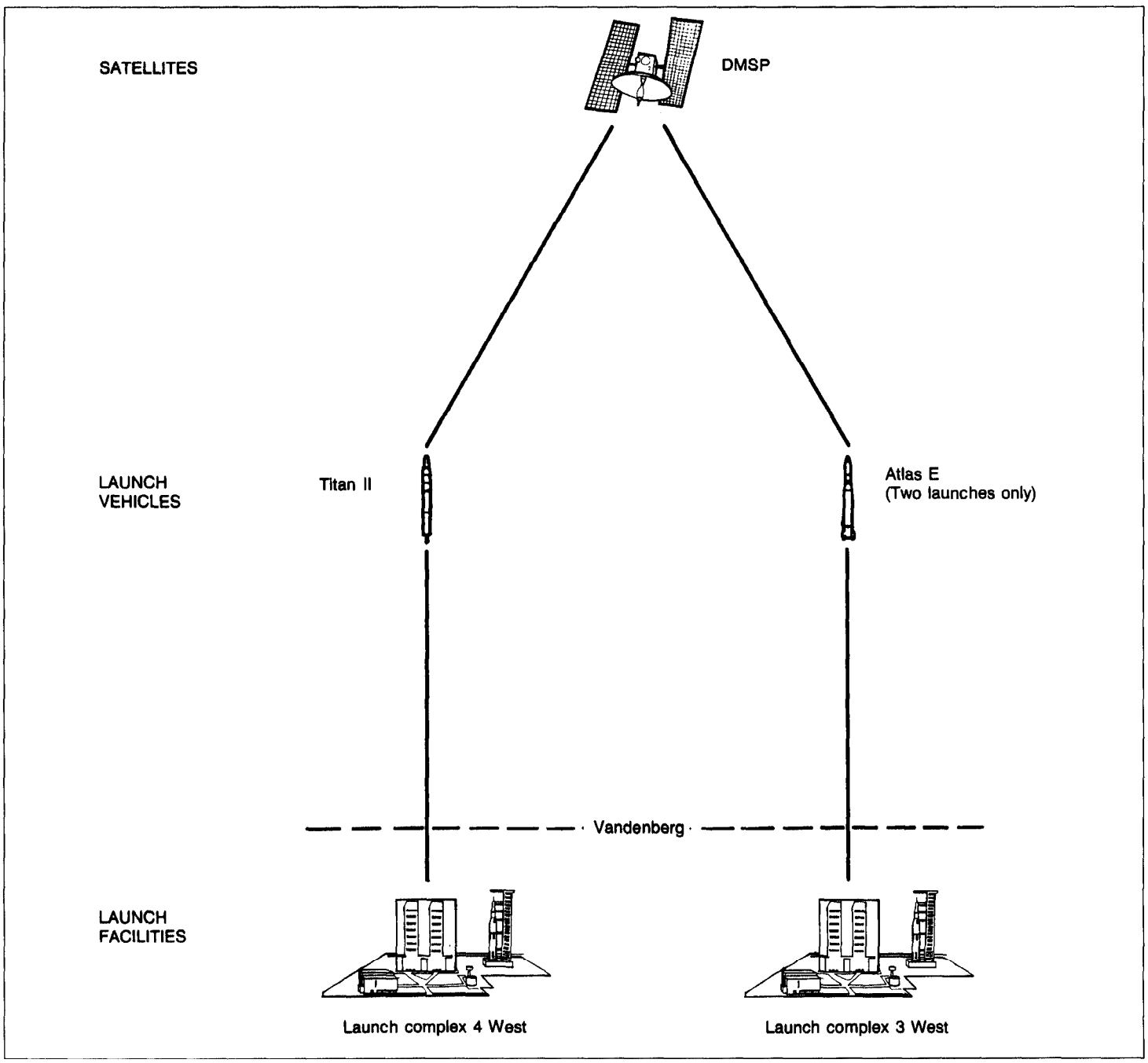
[a]Scheduled to become operational for Titan IV in fiscal year 1992.

Defense Meteorological Satellite Program

Mission	Worldwide visible and infrared cloud imagery and other meteorological, oceanographic, and solar-geophysical information for all military services.
Program Manager	Air Force.
Requirements	Two satellites in sun-synchronous, 450-nautical mile circular orbit at 98.7-degree inclination (see glossary for orbit definition) and two on-ground spares. Each satellite provides coverage of the whole earth every 12 hours.
System Status	Two satellites in orbit and one in on-ground storage. Current contract a multiyear procurement begun in fiscal year 1989 for five satellites.
Satellite Life Expectancy	27 to 39 months.
Prime Contractor	General Electric. (Prime sensors manufactured by Westinghouse Electric.)
Average Unit Cost	$149 million.
Schedules	

	Fiscal years										
Item	90	91	92	93	94	95	96	97	98	99	00
Quantity procured	1	1	2	0	0	0	0	2	0	0	2
Quantity delivered	2	2	0	0	1	1	1	1	1	0	0
Quantity launched	1	1	1	1	1	0	1	1	0	1	1
End-of-year on-ground inventory	3	4	3	2	2	3	3	3	4	3	2

Figure I.4: DMSP Launch Vehicles and Launch Facilities



TRANSIT Navy Navigational Satellite System

Mission	Global two-dimensional position location, originally for fleet ballistic missile submarines and now also for naval and commercial surface vessels.
Program Manager	Navy.
Requirements	Satellites in 600-nautical mile polar orbits. Mean waiting time between fixes of no more than 4 hours, requiring minimum of three satellites operating on orbit.
System Status	Seven operational and five on-orbit spares. No more launches planned. Military use planned to be phased out and superceded by Navstar GPS by 1996. Last five satellites launched in fiscal year 1988. Three latest model satellites hardened against nuclear detonation effects.
Satellite Life Expectancy	12 to 13 years.
Prime Contractor	General Electric. (Designed by Johns Hopkins Applied Physics Laboratory.)
Average Unit Cost	$1.27 million to $2 million for most. $10.7 million for the three nuclear-hardened types.
Schedules	None—no purchases, deliveries, launches, or inventory remaining.

Navstar Global Positioning System

Mission

All-weather worldwide three-dimensional position, velocity, and precise time information for land-based, seaborne, and airborne users. Increase accuracy and availability of current weapon systems, especially at night and in adverse weather.

Program Manager

Air Force.

Requirements

Twenty-one operational satellites plus three on-orbit spares. Satellites positioned in six distinct semisynchronous, 55-degree inclination orbits at approximately 10,900-nautical miles altitude. (See glossary for orbit definitions.)

System Status

Joint service program in transition from developmental to fully operational status. First full-production satellite launched in February 1989. Current contract a multiyear procurement for 28 satellites. A follow-on multiyear procurement of 20 satellites at 4 satellites a year planned to begin in fiscal year 1992.

Satellite Life Expectancy

6 years.

Prime Contractor

Rockwell International for current production.

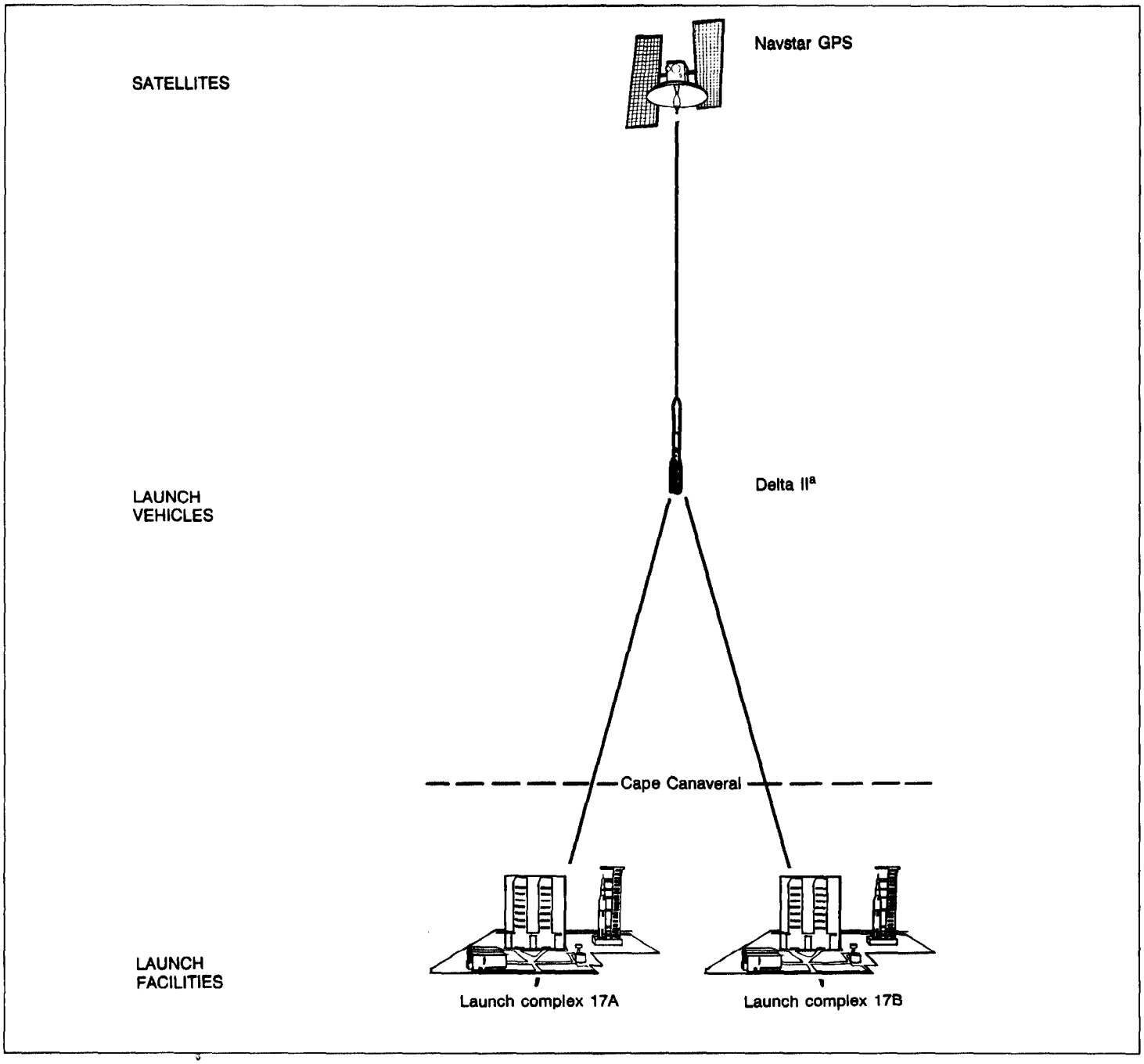
Average Unit Cost

$47 million.

Schedules

	Fiscal years										
Item	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**
Quantity procured	0	0	4	4	4	4	4				
Quantity delivered	7	7	6	0	0	1	3	4	4	4	4
Quantity launched	6	5	5	5	3	1	4	4	4	4	4
End-of-year on-ground inventory	6	8	9	4	1	1	0	0	0	0	0

Figure I.5: Navstar GPS Launch Vehicles and Launch Facilities



[a]Includes a Payload Assist Module (PAM) stage.

Research and Development Satellites

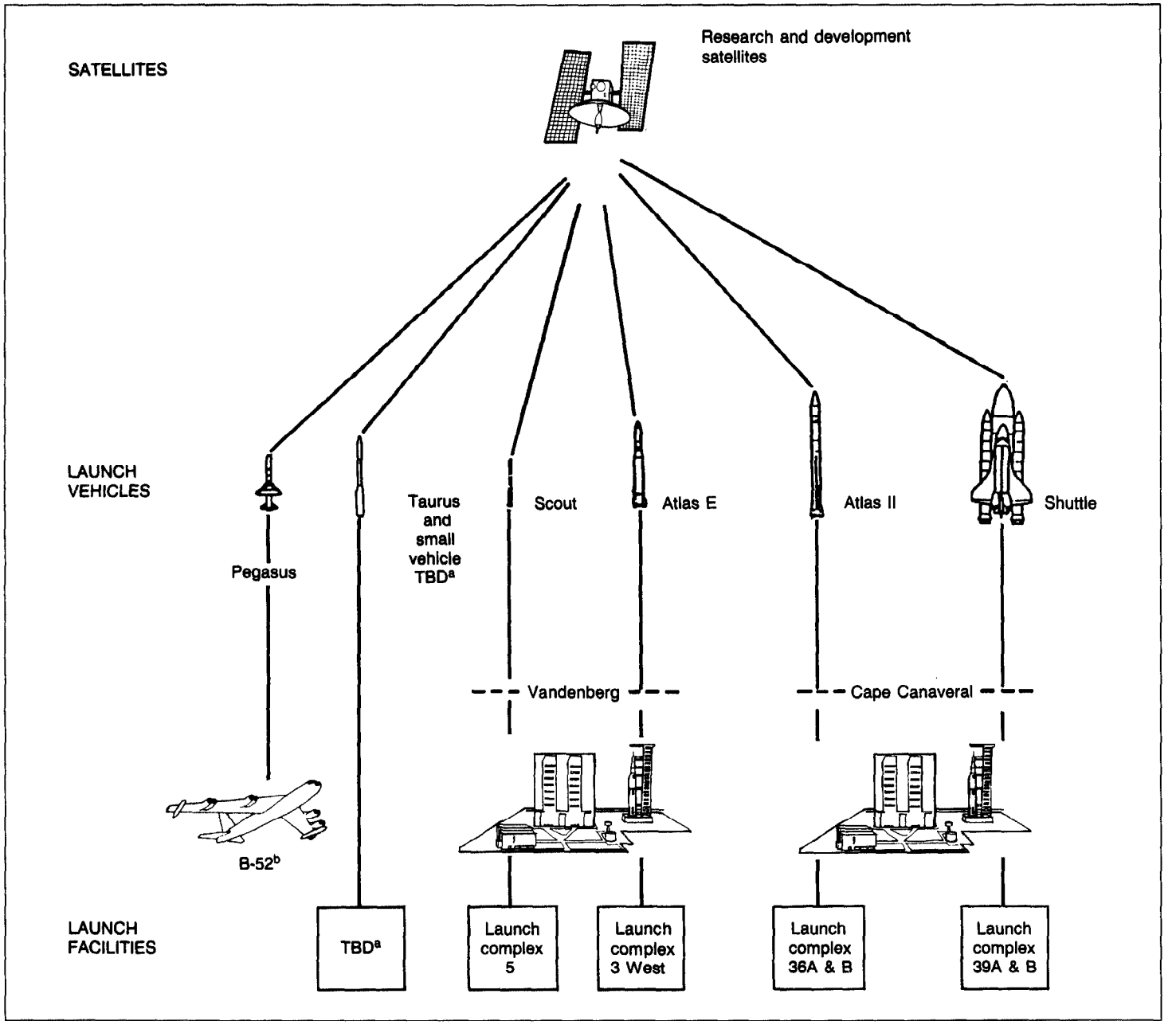
Mission	Support of developing space system technologies, concepts, and designs.
Program Managers	Air Force, Navy, and Defense Advanced Research Projects Agency (DARPA). Most research and development satellites launched under the auspices of the Space Test Program (STP), a DOD-wide program that coordinates and schedules launches for research and development satellites. Air Force is the program manager for STP. Included in the STP are the military-man-in-space program on the shuttle (a nonsatellite program), and special purpose inexpensive satellite (SPINSAT) and lightweight satellite (LIGHTSAT) experiments and demonstrations planned, respectively, by the Navy and DARPA.[8]
Requirements	Varies by satellite.
Status	Varies by satellite.
Satellite Life Expectancies	Varies by satellite.
Prime Contractor	Varies by satellite.
Unit Costs	Varies by satellite.
Schedules	

	Fiscal years										
Item	90	91	92	93	94	95	96	97	98	99	00
Quantity launched[a]	11	5	1	3	4	3	2	2	2	2	2

[a]In 1990, two of the satellites will be launched simultaneously on a single vehicle and seven others on another single vehicle for a total of four 1990 launches. In 1991, two of the satellites will be launched on a single vehicle for a total of four 1991 launches.

[8]SPINSATS and LIGHTSATS are small, lightweight, inexpensive, and rapidly-deployable satellites. Example potential uses of the satellites include tactical communications and data relay, electronic warfare surveillance, and environmental sensing.

Figure I.6: Research and Development Satellites Launch Vehicles and Launch Facilities



[a]One Taurus Launch is scheduled out of Vandenberg but the facility is yet to be determined (TBD). Other launches are anticipated by DOD on yet to be determined small launch vehicles to be selected under competitive contracting procedures.

[b]To be launched while flying over Vandenberg's test range.

Strategic Defense System

SDS is a program to develop space and ground-based systems for ballistic missile and space defense, space surveillance, and tactical warning and attack assessment. It is being developed under the overall management of the Strategic Defense Initiative Organization. SDS is in an initial developmental phase, which includes demonstration and validation of three space systems—BSTS, SSTS, and SBI—and a number of space-based experiments.

Boost Surveillance and Tracking System

Mission

Detect and track intercontinental and submarine-launched ballistic missiles during the boost phase using infrared technology. Provide information to assign targets for defensive weapons such as space-based interceptors. Intended to replace DSP satellites.

Program Manager

Air Force.

Requirements

(Information deleted.)

System Status

In demonstration and validation phase.

Satellite Life Expectancy

(Information deleted.)

Prime Contractor

Not yet determined.

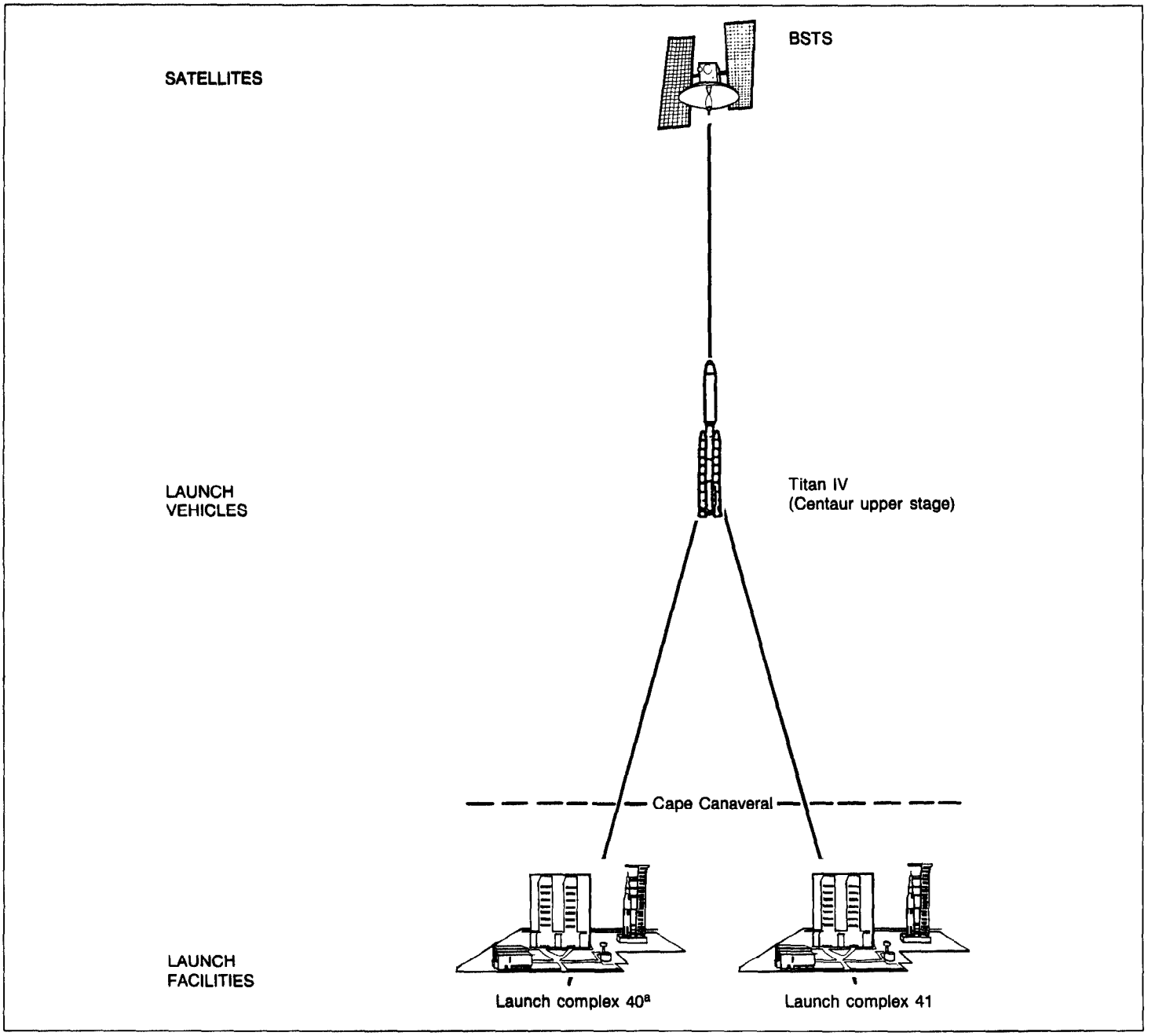
Average Unit Cost

Not yet determined.

Schedules

	Fiscal years										
Item	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**
Quantity procured		4	0	0	0	1	2	2			
Quantity delivered				(Information deleted)							
Quantity launched				(Information deleted)							
End-of-year on-ground inventory				(Information deleted)							

Figure I.7: BSTS Launch Vehicles and Launch Facilities



[a]Scheduled to become operational for Titan IV in fiscal year 1992.

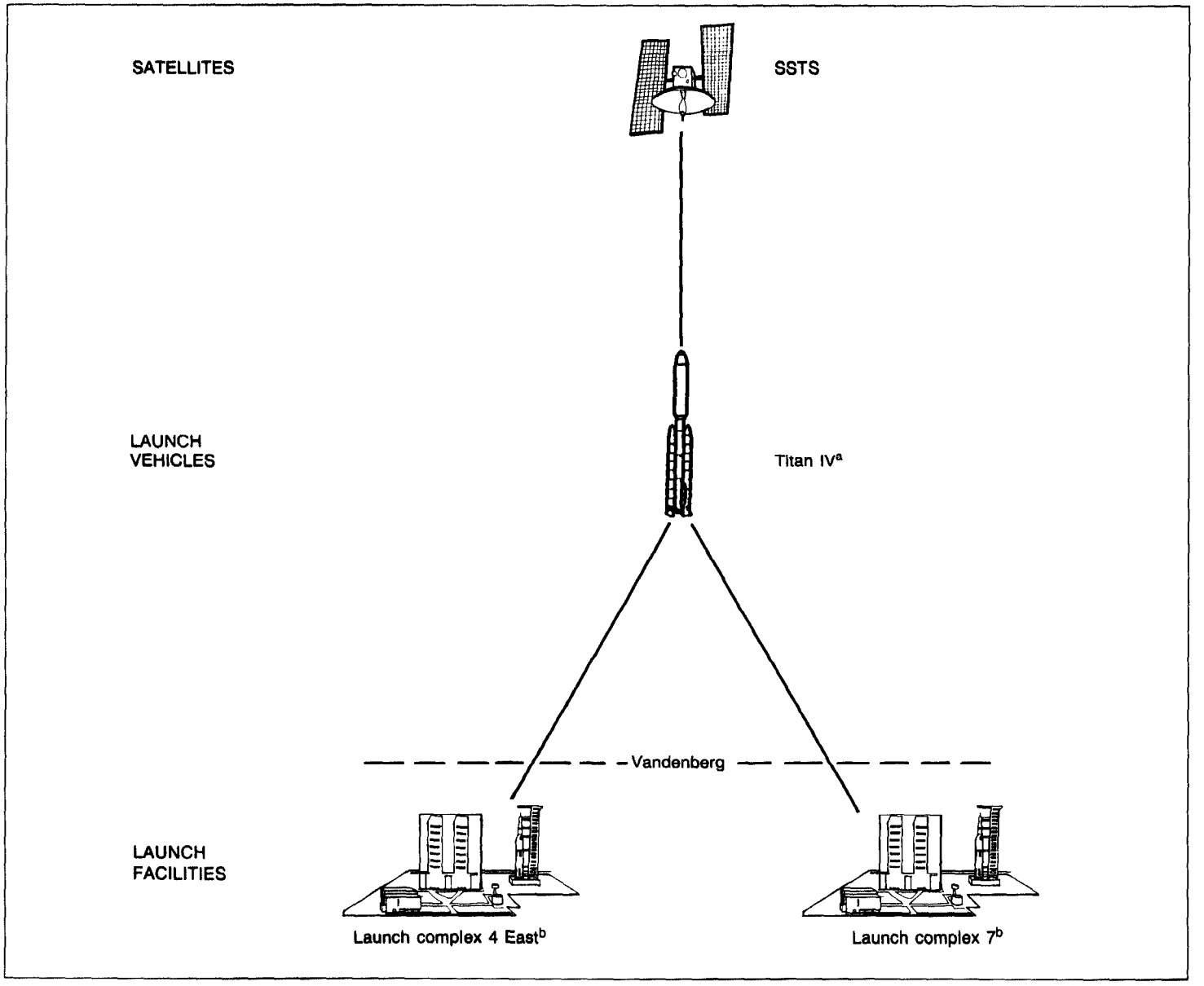
Space Surveillance and Tracking System

Mission	Space surveillance and post-boost and mid-course ballistic missile tracking. Support antisatellite weapons, warn of attacks on U.S. satellites, and monitor and catalog all objects in orbit around the earth. Acquire and track objects; discriminate among warheads, debris, decoys, and other penetration aids; pass target locations to battle managers; and assist in confirmation of target destruction.
Program Manager	Air Force.
Requirements	(Information deleted.)
System Status	In demonstration and validation phase.
Satellite Life Expectancy	Not yet determined.
Prime Contractor	Not yet determined.
Average Unit Cost	Not yet determined.

Schedules

	Fiscal years										
Item	90	91	92	93	94	95	96	97	98	99	00
Quantity procured	Not yet determined										
Quantity delivered	Not yet determined										
Quantity launched	(Information deleted)										
End-of-year on-ground inventory	Not yet determinable										

Figure I.8: SSTS Launch Vehicles and Launch Facilities



[a]The Air Force is considering an alternative plan to launch SSTS satellites on Atlas II vehicles instead.

[b]Initial Titan IV capability planned for fiscal year 1990 at complex 4 East and for fiscal year 1996 at complex 7.

Space-Based Interceptors

Mission	Multiple rocket-propelled, non-nuclear interceptors to destroy attacking missiles in their boost, mid-course, or post-launch phases by extremely high speed impact.
Program Manager	Air Force.
Requirements	To be determined.
System Status	In research and development. DOD is exploring concept variations.
Satellite Life Expectancy	Not yet determined.
Prime Contractor	Not yet determined.
Average Unit Cost	Not yet determined.
Schedules	Not yet determined.

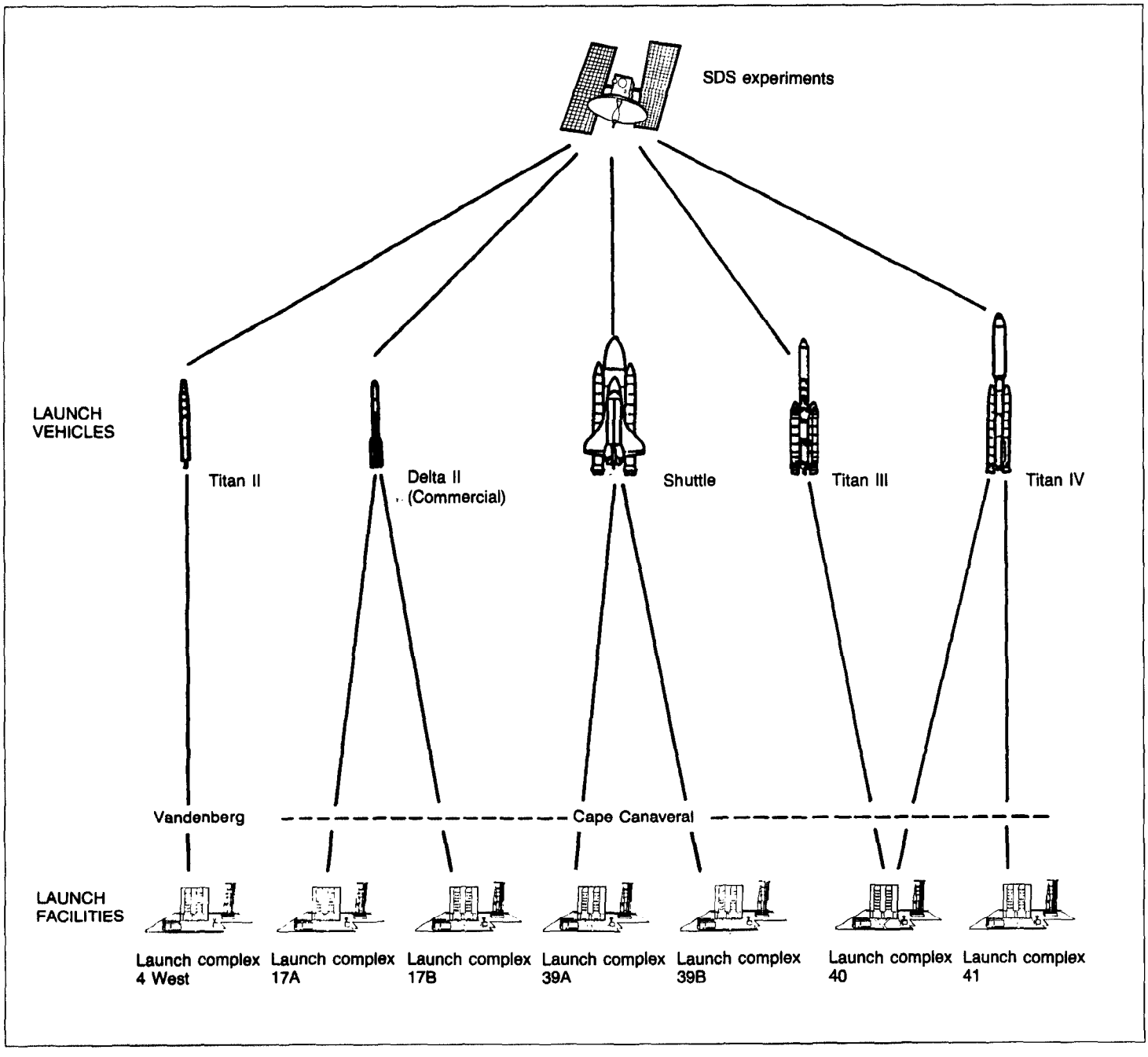
SDS Experiment Satellites

Mission	Conduct space-based experiments in support of SDI development. Objectives of experiments vary.
Program Manager	Strategic Defense Initiative Organization.
Requirements	Varies with experiments.
Status	Varies with experiments.
Satellite Life Expectancy	Varies with experiments.
Prime Contractor	Varies with experiments.
Average Unit Cost	Varies with experiments.

Schedules

	Fiscal years										
Item	90	91	92	93	94	95	96	97	98	99	00
Quantity procured	Not applicable										
Quantity delivered	Not yet determined										
Quantity launched	1	3	1				1	2			
End-of-year on-ground inventory	Not applicable										

Figure I.9: SDS Experiment Satellites Launch Vehicles and Launch Facilities

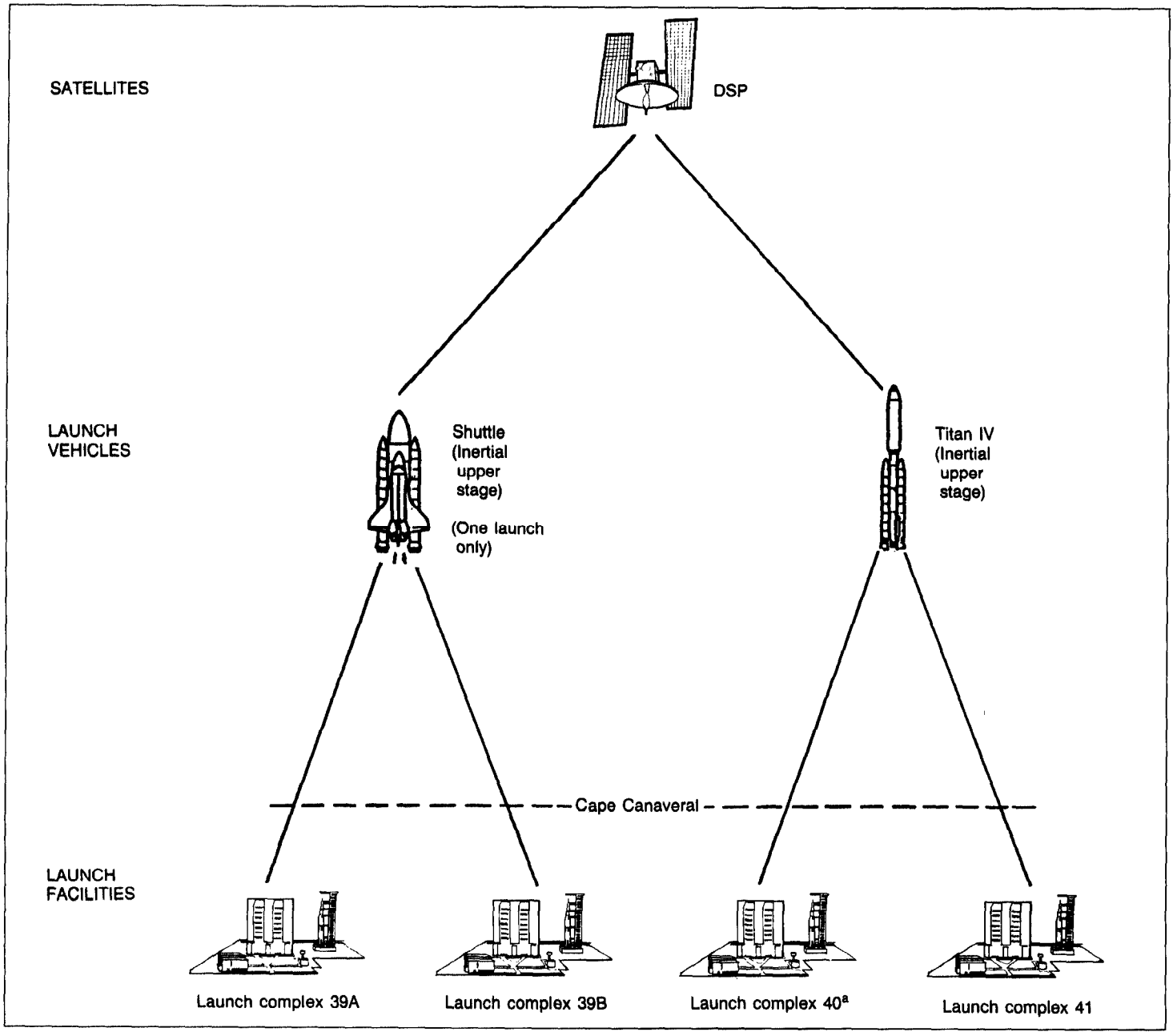


Defense Support Program

Mission	(Information deleted.)
Program Manager	Air Force.
Requirements	(Information deleted.)
System Status	(Information deleted.)
Satellite Life Expectancy	(Information deleted.)
Prime Contractor	TRW for spacecraft and integration. Aerojet Electrosystems for prime sensors.
Average Unit Cost	$261 million.
Schedules	

	Fiscal years										
Item	90	91	92	93	94	95	96	97	98	99	00
Quantity procured	1	1	2	1							
Quantity delivered	(Information deleted)										
Quantity launched	(Information deleted)										
End-of-year on-ground inventory	(Information deleted)										

Figure I.10: DSP Launch Vehicles and Launch Facilities



[a]Initial Titan IV launch capability planned for fiscal year 1992.

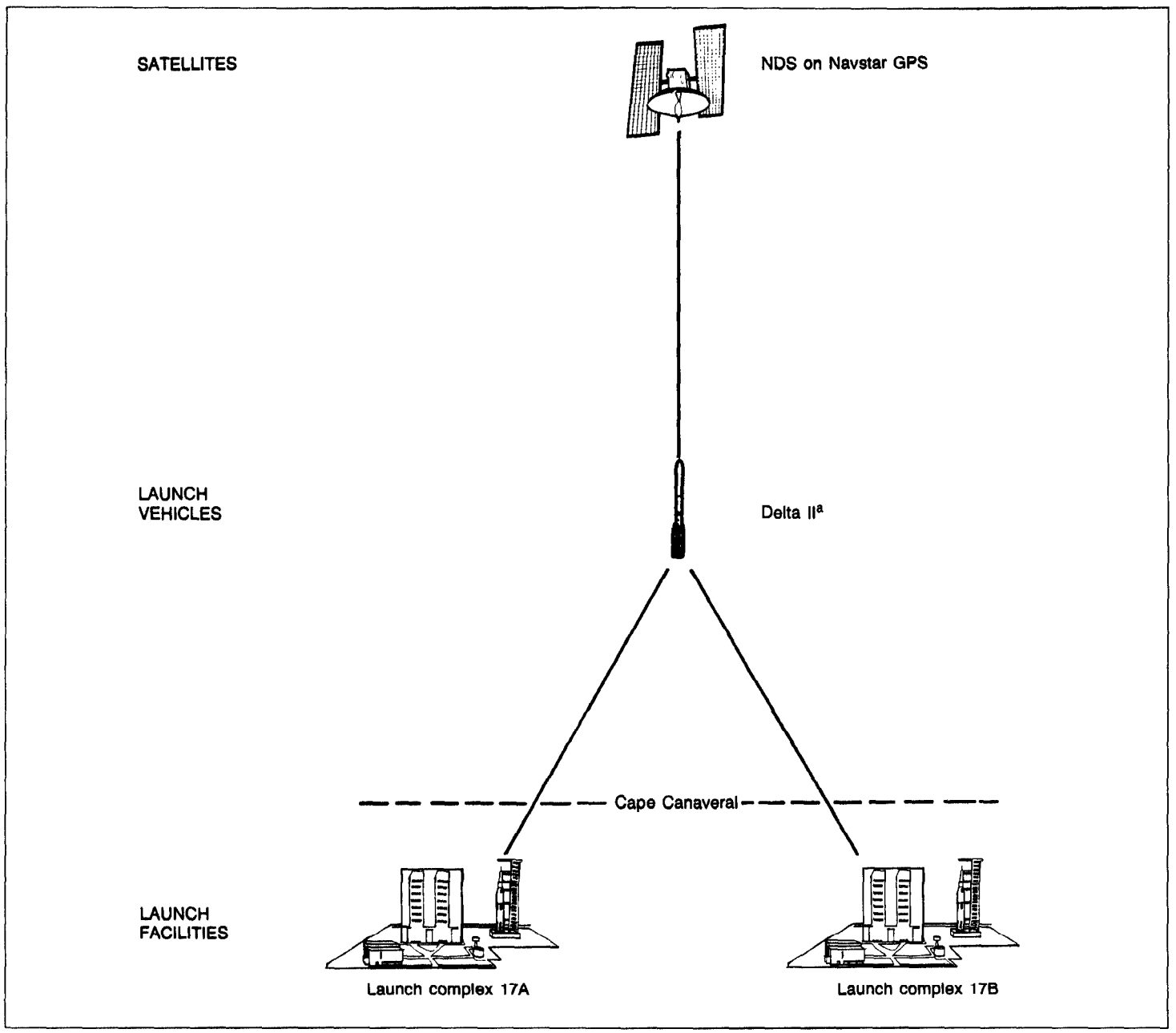
Nuclear Detonation Detection System

Mission	Detect, locate, and report nuclear detonations on a global, near real-time basis.
Program Manager	Air Force.
Requirements	Does not have its own constellation—system sensors deployed on Navstar GPS satellites (21 operational satellites and 3 spares in 6 semisynchronous circular orbits at 10,900-nautical miles altitude).
System Status	In transition from developmental to fully operational status. First full production satellite launched in February 1989. Current contract a multiyear procurement for 28 satellites. A follow-on multiyear procurement of 20 satellites at 4 satellites a year planned to begin in fiscal year 1992.
Satellite Life Expectancy	6 years.
Prime Contractor	Sensors produced by the Department of Energy and integrated into the Navstar GPS satellites by the GPS contractor (Rockwell International for current production).
Average Unit Cost	Included in Navstar GPS unit cost ($47 million).

Schedules

	Fiscal years										
Item	90	91	92	93	94	95	96	97	98	99	00
Quantity procured	0	0	4	4	4	4	4				
Quantity delivered	7	7	6	0	0	1	3	4	4	4	4
Quantity launched	6	5	5	5	3	1	4	4	4	4	4
End-of-year on-ground inventory	6	8	9	4	1	1	0	0	0	0	0

Figure I.11: NDS Launch Vehicles and Launch Facilities



[a]Includes a Payload Assist Module (PAM) stage.

Launch Vehicles

For planning purposes, DOD projects its satellite launch needs up to 15 years into the future. DOD plans through fiscal year 2004 are to use a mix of DOD, NASA, and commercial unmanned launch vehicles and NASA's manned space shuttle. This appendix describes these vehicles and the unclassified portions of information on their launch schedules, the satellites they are scheduled to launch, and the launch facilities they are scheduled to use. It also describes a joint DOD and NASA technology development program for a potential future manned launch vehicle, the National Aerospace Plane (NASP), that is projected to be deployed after the year 2004.

DOD plans through the year 2004 projected over 90 percent of DOD's satellite launches to be accomplished with DOD-purchased ELVs that have already been developed. The plans also projected the use of a yet-to-be-developed family of unmanned Advanced Launch System (ALS) vehicles beginning in 1998. However, according to DOD officials, ALS program plans are pending future funding decisions and DOD has not yet projected specific launch schedules for ALS vehicles. Consequently, it is undetermined at this time as to how and to what extent DOD may supplement or replace other launch vehicles with the ALS during the next 15 years.

DOD plans to meet its remaining launch needs through the year 2004 by (1) employing NASA to launch satellites on the space shuttle and NASA-owned ELVs and (2) contracting for launch services on commercial launch vehicles. In the latter case, launches are provided by the contractor without DOD purchasing the vehicles. Through interagency agreements, DOD also plans to provide cost-reimbursable launches on DOD-owned ELVs for a number of NASA and National Oceanic and Atmospheric Administration (NOAA) satellites.

The Air Force is the DOD agency with primary responsibility for acquiring DOD launch vehicles, managing launches from DOD facilities, and acquiring launch services from NASA and commercial launch service companies for DOD satellites. However, other DOD agencies may also acquire launches for DOD satellites on occasion. For example, the Navy has arranged for commercial launches of its UHF Follow-on satellites and DARPA has contracted for a number of research and development satellite launches on two new small satellite launch vehicles, the Pegasus and the Taurus. NASA is the executive agency responsible for launching or acquiring launches for non-DOD government satellites.

DOD classifies launch vehicles by their lift capacities as large, medium, and small. The vehicles DOD plans to use from fiscal years 1990 through

Space Shuttle

Manufacturer

Rockwell International (orbiter, main engines, and integration); Martin Marietta (external tanks); and Morton Thiokol (solid rocket boosters).

Program Manager

NASA.

Status

Ongoing manned flight program. Shuttles owned and launched by NASA only. Three NASA shuttles in use, one under construction.

Launch Capacity

Two have 55,000-pound capacities and one has a 47,000 pound capacity to 100-nautical mile easterly orbits from Kennedy Space Center.[1]

16,300 pounds to 100-nautical mile polar orbit from Vandenberg (facilities mothballed).

DOD Cost Per Launch

$115 million (based on agreement with NASA).[2]

Launch Schedule

	Fiscal years										
	90	91	92	93	94	95	96	97	98	99	00
	(Number of launches)										
NASA launches:											
DOD payloads only	3	3									
Shared flights[a]	1	0	0	2	2	2	1	1	1	1	1
No DOD payloads	5	7	11	11	11	11					

[a]Flights have both DOD and non-DOD payloads. The fiscal year 1990 shared flight includes a LEASAT launch considered to be a commercial payload by NASA because the launch contract is with the satellite manufacturer. DOD has requested partial flights equaling the equivalent of one-third of a flight a year after 1995.

[1]A launch vehicle's lift capacity varies with the altitude and inclination of the orbit to which it is launching a satellite. For vehicle comparison purposes, DOD describes vehicle lift capacities to theoretical 100-nautical mile circular orbits achieved from due east launches from Cape Canaveral or due south launches from Vandenberg Air Force Base.

[2]Fiscal year 1986 dollars for a full shuttle flight.

2004 are listed in table II.1 by class. They are described in the remaining pages of this appendix in the order they are presented in the table, followed by a description of the NASP program. In addition, the Delta I, a NASA and commercial launch vehicle formerly referred to as the Delta and used in the past by DOD through NASA, is also described. Figures II.1 through II.12 accompanying the descriptions identify the vehicles' satellites and launch facilities. Appendix IV contains a summary schedule of unclassified vehicle launch plans.

Table II.1: DOD Launch Vehicles for Fiscal Years 1990-2004

Vehicle	Type	Ownership
Large capacity:		
ALS	Unmanned[a]	DOD
Space shuttle	Manned	NASA
Titan III	ELV	Commercial
Titan IV	ELV	DOD
Medium capacity:		
Atlas E	ELV	DOD
Atlas I[b]	ELV	Commercial
Atlas II	ELV	DOD and commercial
Delta II	ELV	DOD and commercial
Titan II	ELV	DOD
Small capacity:		
Pegasus	ELV	DOD and commercial
Scout	ELV	NASA and commercial
Taurus	ELV	DOD and commercial
To be determined[c]	ELV	To be determined

[a]May be at least partially recoverable.

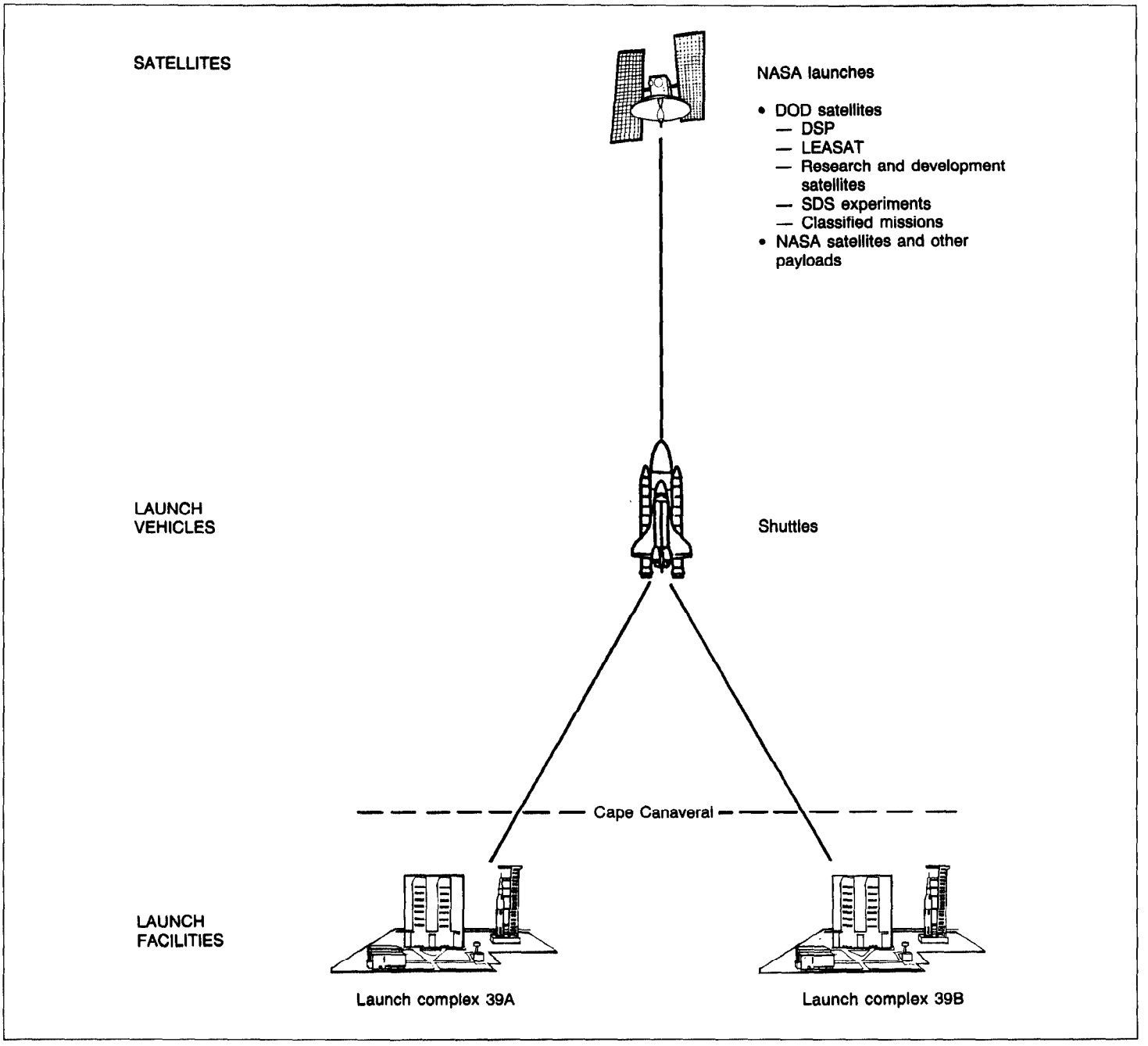
[b]Formerly referred to as Atlas-Centaur and no longer in government inventory.

[c]DOD plans to recompete the contract for a standard small launch vehicle when the current Taurus contract expires.

Advanced Launch System

Manufacturer	To be determined.
Objectives	Build a new generation of unmanned launch vehicles that can lift payloads into space at a significantly reduced cost than current systems—less than $300 per pound lifted (in 1987 dollars) at a launch rate of 5 million pounds a year to low earth orbit. Near term objective to develop the technology for a heavy-lift capacity vehicle. Longer term objectives to adapt the new technology to current generation vehicles and develop a family of new-technology vehicles to serve the spectrum of national space launch needs.
Program Manager	Air Force (joint program with NASA).
Status	In a technology development phase.
Launch Capacity	To be determined. DOD targets for the initial heavy-lift capacity vehicle have ranged between 90,000 and 360,000 pounds to low earth orbit.
DOD Cost Per Launch	To be determined.
Launch Facilities	To be determined.
Launch Schedule	To be determined.

Figure II.1: Space Shuttle Satellites and Launch Facilities

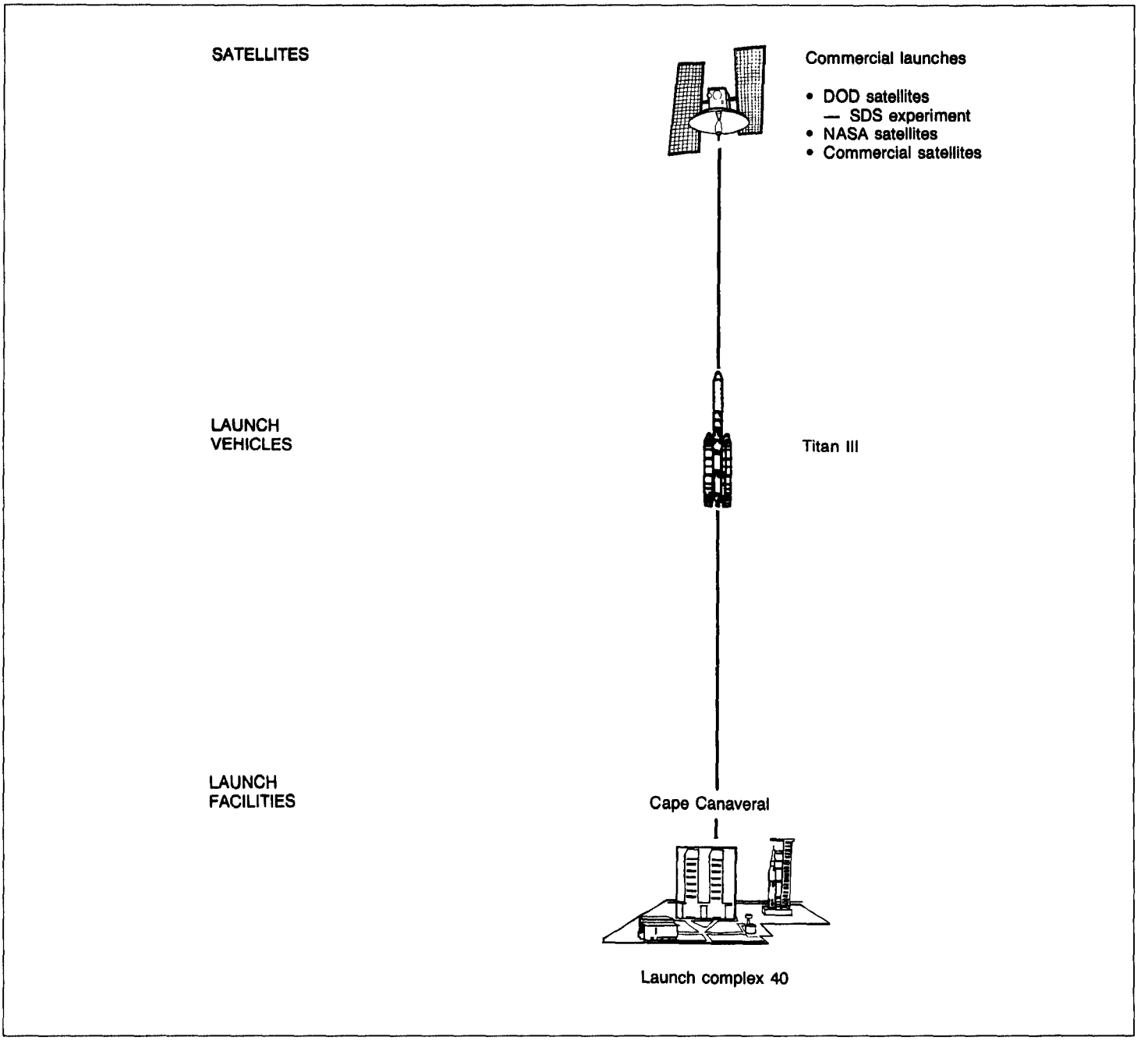


Titan III

Manufacturer	Martin Marietta.
Program Manager	None (commercial vehicle).
Status	Large capacity commercial version of former DOD-owned and launched Titan 34D. The Titan 34D is no longer in government inventory. Currently planned to be used by DOD only through commercial launch contracts.
Launch Capacity	30,300 pounds to 100-nautical mile easterly orbit.
DOD Cost Per Launch	No launches on contract yet. The Strategic Defense Initiative Organization estimates the launch services for the planned 1996 launch will cost $120 million to $130 million.
Launch Schedule	

	Fiscal years										
	90	91	92	93	94	95	96	97	98	99	00
	(Number of launches)										
Commercial launches:											
DOD satellites							1				
NASA satellites			1								
Commercial satellites	3										

Figure II.2: Titan III Satellites and Launch Facilities



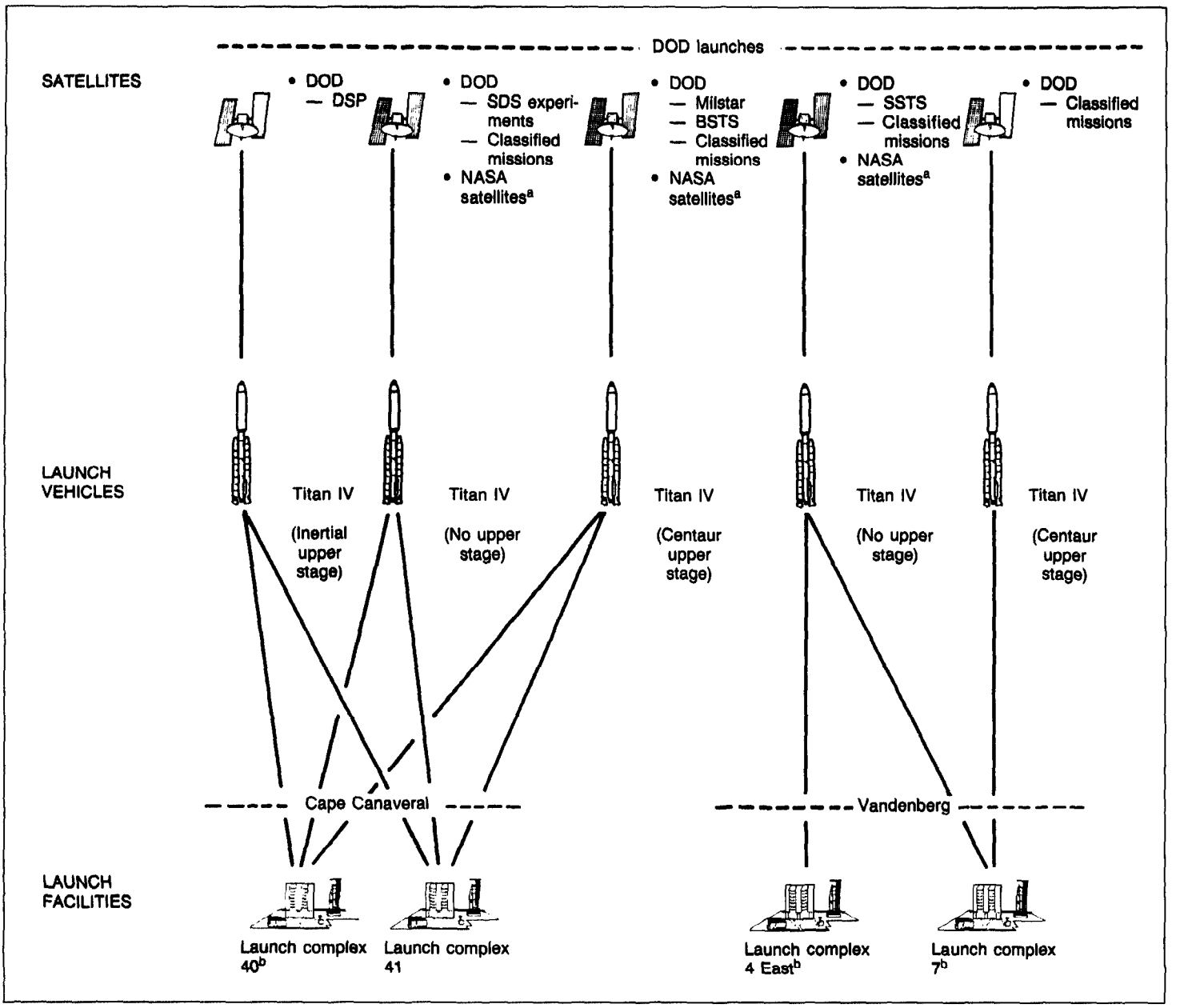
Titan IV

Manufacturer	Martin Marietta.
Program Manager	Air Force.
Status	New large capacity ELV. First launched with Inertial upper stage in June 1989. In multiyear contract for 13 vehicles. Follow-on contract planned for 18 vehicles.
Launch Capacity	39,100 pounds to 100-nautical mile easterly orbit using no upper stage. 31,100 pounds to 100-nautical mile polar orbit using no upper stage. 5,290 pounds to 22,300-nautical mile geosynchronous equatorial orbit using Inertial upper stage. 10,200 pounds to 22,300-nautical mile geosynchronous equatorial orbit using Centaur upper stage.
DOD Cost Per Launch[4]	$142 million, including vehicle cost with no upper stage. $191 million, including vehicle cost with Inertial upper stage. $211 million, including vehicle cost with Centaur upper stage.
Launch Schedule	

	Fiscal years										
	90	91	92	93	94	95	96	97	98	99	00
	(Number of launches)										
DOD launches:											
DOD satellites	(Information deleted)										
NASA requests						1	2	1	2	1	

[4]Fiscal Year 1986 dollars.

Figure II.3: Titan IV Satellites and Launch Facilities



[a]Requested by NASA. DOD has not yet determined which launches it can accommodate.

[b]Initial Titan IV operational capability planned for fiscal year 1992 for complex 40, fiscal year 1990 for complex 4 East, and fiscal year 1996 for complex 7.

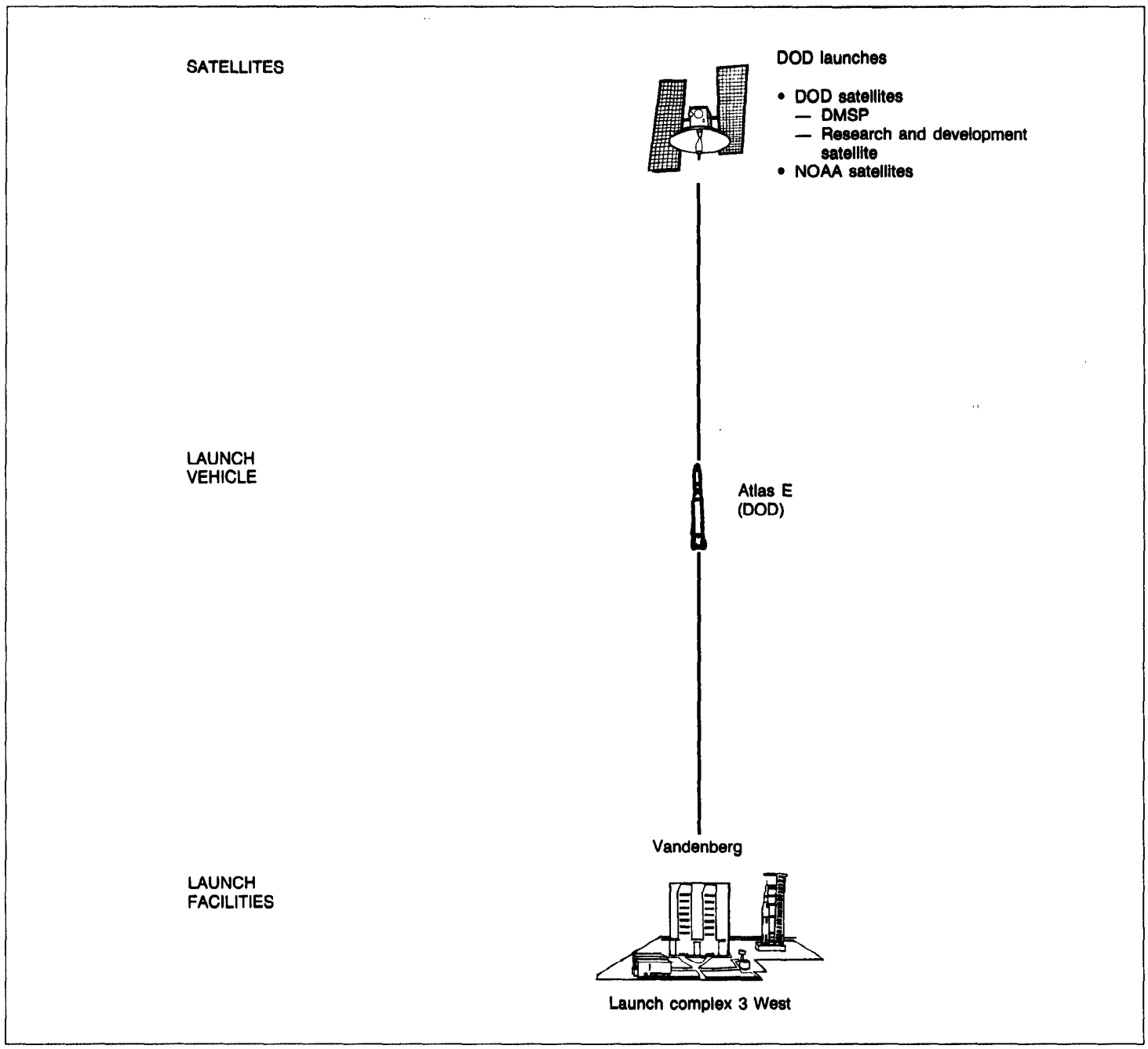
Atlas E

Manufacturer	General Dynamics.
Program Manager	Air Force.
Status	Medium capacity ELV (converted intercontinental ballistic missile) owned and launched by DOD only but being phased out of inventory and use. Not available commercially and no longer in production. Eight vehicles remaining in DOD inventory—three scheduled for DOD satellite launches, three scheduled for NOAA satellite launches by Air Force, and two unscheduled. Planned to be used for high inclination or polar orbit launches only.
Launch Capacity	1,750 pounds to 100-nautical mile polar orbit.
DOD Cost Per Launch	$45 million, including vehicle cost.[5]
Launch Schedule	

	Fiscal years										
	90	91	92	93	94	95	96	97	98	99	00
	(Number of launches)										
DOD launches:											
DOD satellites	2	1									
NOAA satellites	1	1	1								

[5]Fiscal year 1986 dollars.

Figure II.4: Atlas E Satellites and Launch Facilities

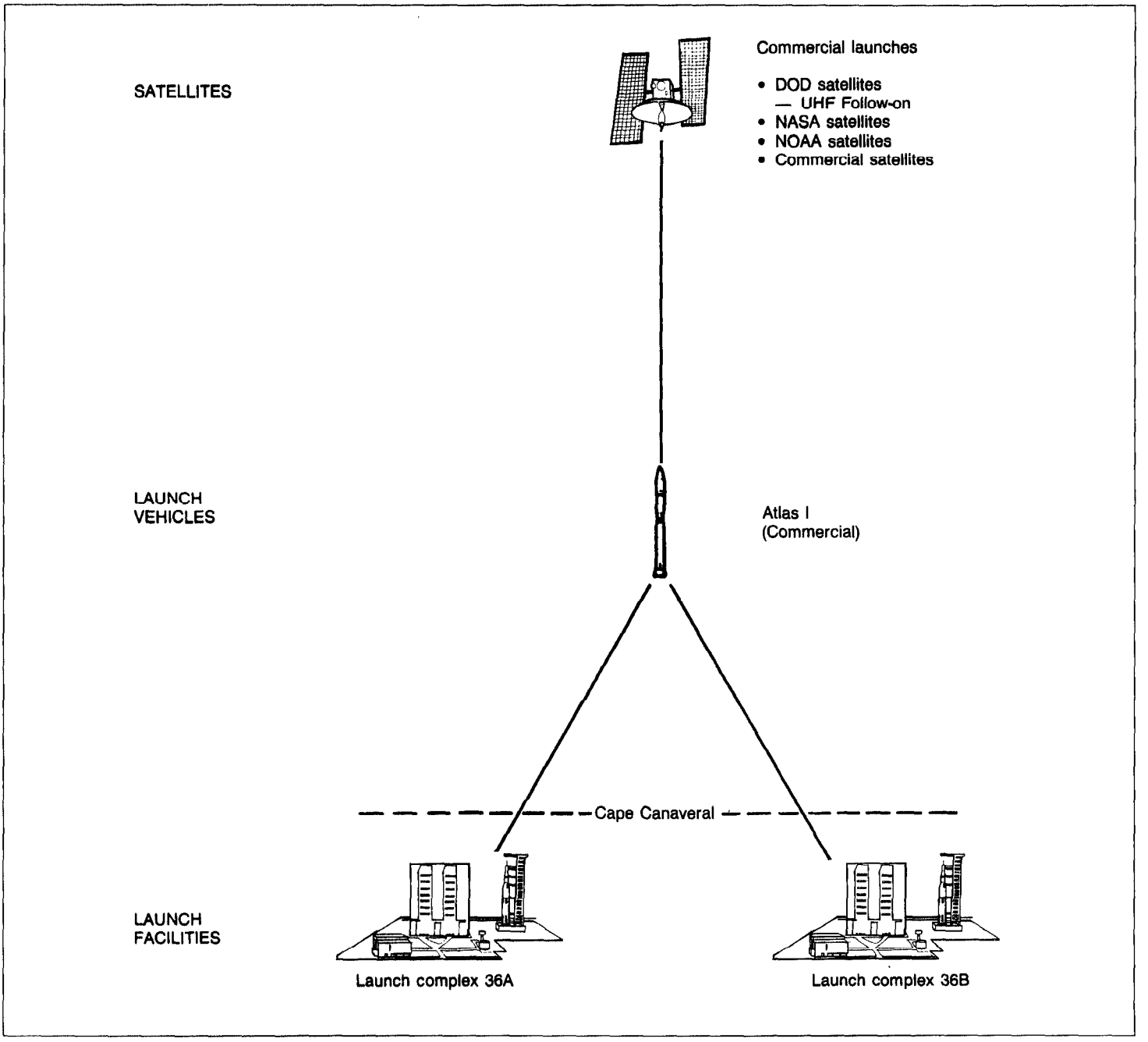


Atlas I

Manufacturer	General Dynamics.
Program Manager	None (commercial vehicle).
Status	Medium capacity ELV formerly owned and launched by NASA but discontinued from NASA acquisition and inventory in 1989. Formerly called Atlas-Centaur and used by DOD through NASA. Still commercially available. Scheduled to be used for the Navy's UHF Follow-on satellite launches through a commercial launch contract between General Dynamics and the satellite manufacturer. Vehicle includes a Centaur stage.
Launch Capacity	1,750 pounds to 22,300-nautical mile geosynchronous equatorial orbit.
DOD Cost Per Launch	Included in UHF Follow-on acquisition cost.
Launch Schedule	

	Fiscal years										
	90	91	92	93	94	95	96	97	98	99	00
	(Number of launches)										
Commercial launches:											
DOD satellites			1		2	3	3	1			
NASA satellites	1										
NOAA satellites		1	1			1					
Commercial satellites		1		1							

Figure II.5: Atlas I Satellites and Launch Facilities



Atlas II

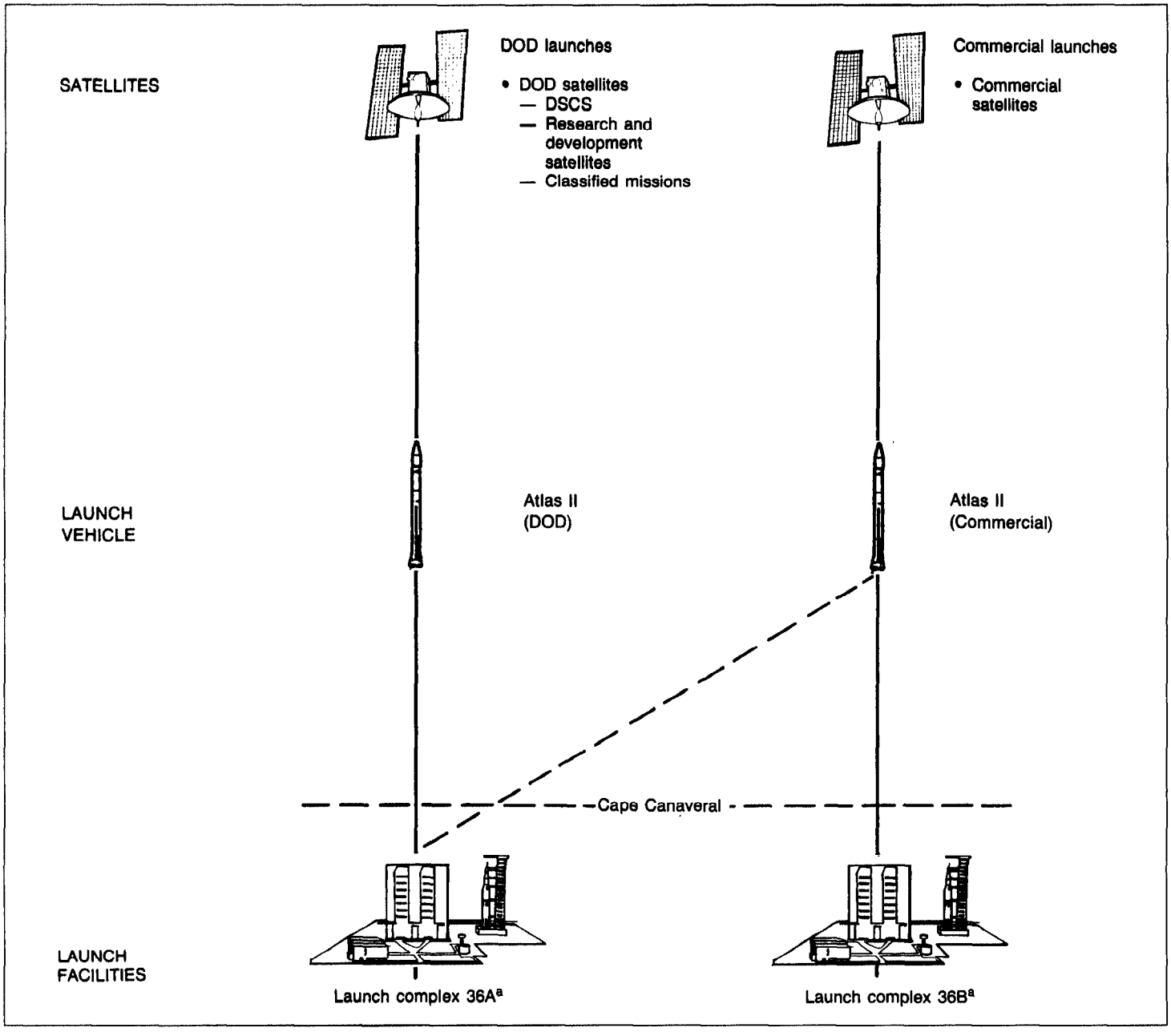
Manufacturer	General Dynamics.
Program Manager	Air Force.
Status	New medium capacity ELV that will be owned and launched by DOD and will also be available in commercial versions for commercial launches. Vehicle includes a Centaur stage. First launch scheduled for fiscal year 1991. Current Air Force contract for 10 vehicles.
Launch Capacity	14,500 pounds to 100-nautical mile easterly orbit. 6,100 pounds to geosynchronous transfer orbit.
DOD Cost Per Launch	$45 million projected, including vehicle cost.[6]

Launch Schedule

	Fiscal years										
	90	91	92	93	94	95	96	97	98	99	00
	(Number of launches)										
DOD launches:											
DOD satellites	(Information deleted)										
Commercial launches:											
Commercial satellites		1	2	2							

[6]Fiscal year 1986 dollars.

Figure II.6: Atlas II Satellites and Launch Facilities



[a]Initial operational capability projected to be in fiscal year 1991. Commercial launches will be permitted from complex 36A when it is not being used for DOD launches.

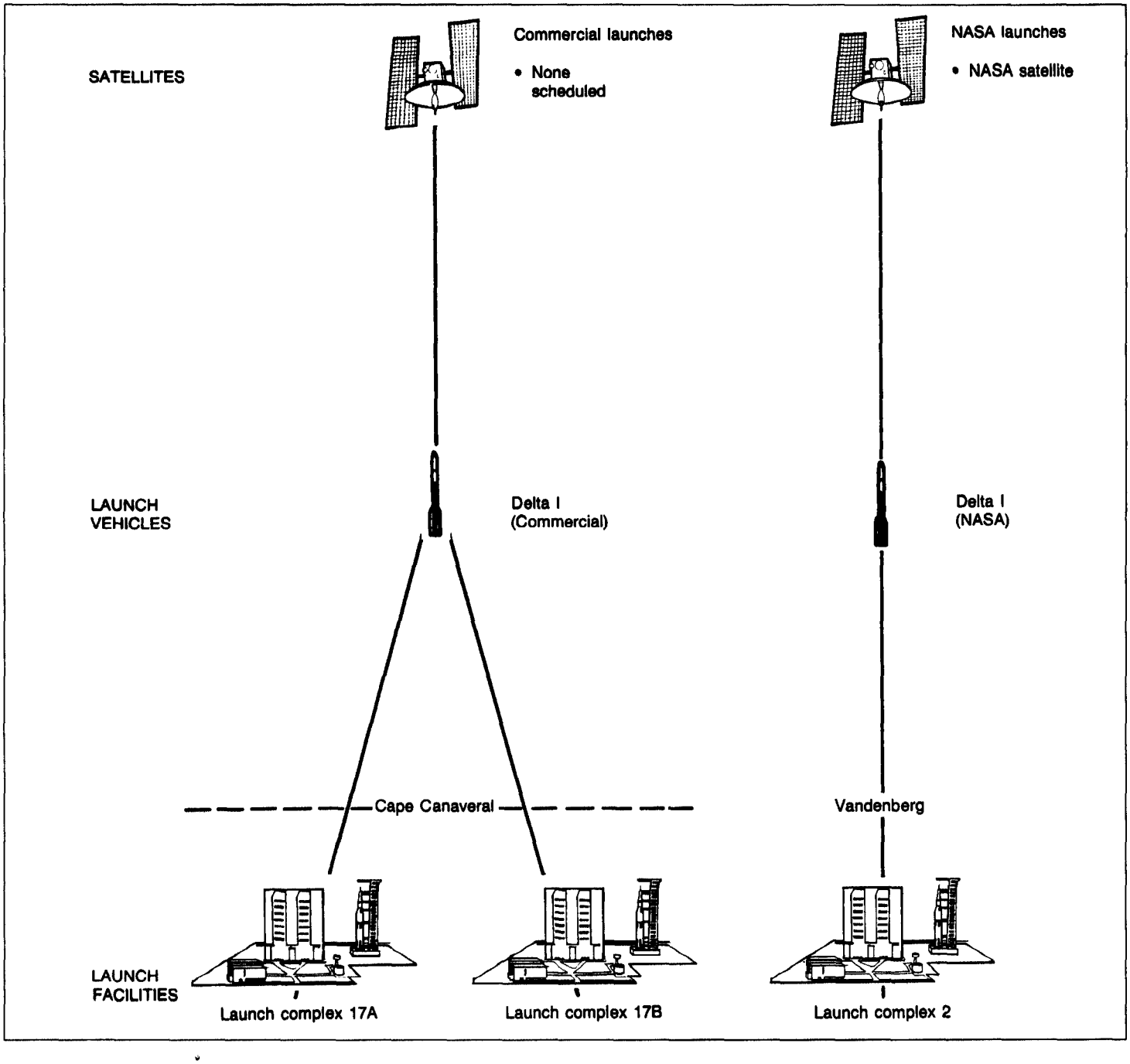
Delta I

Manufacturer	McDonnell Douglas.
Program Manager	NASA.
Status	Medium capacity ELV owned and launched by NASA but being phased out of NASA inventory and will no longer be acquired by NASA. One vehicle left in NASA inventory. Formerly used by DOD through NASA. Commercial versions available.
Launch Capacity	7,600 pounds to 100-nautical mile easterly orbit. 5,500 pounds to 100-nautical mile polar orbit.
DOD Cost Per Launch	$33 million, including vehicle cost.[7]
Launch Schedule	

	Fiscal years										
	90	91	92	93	94	95	96	97	98	99	00
	(Number of launches)										
NASA launches:											
NASA satellites	1										

[7]Fiscal year 1986 dollars.

Figure II.7: Delta I Satellites and Launch Facilities



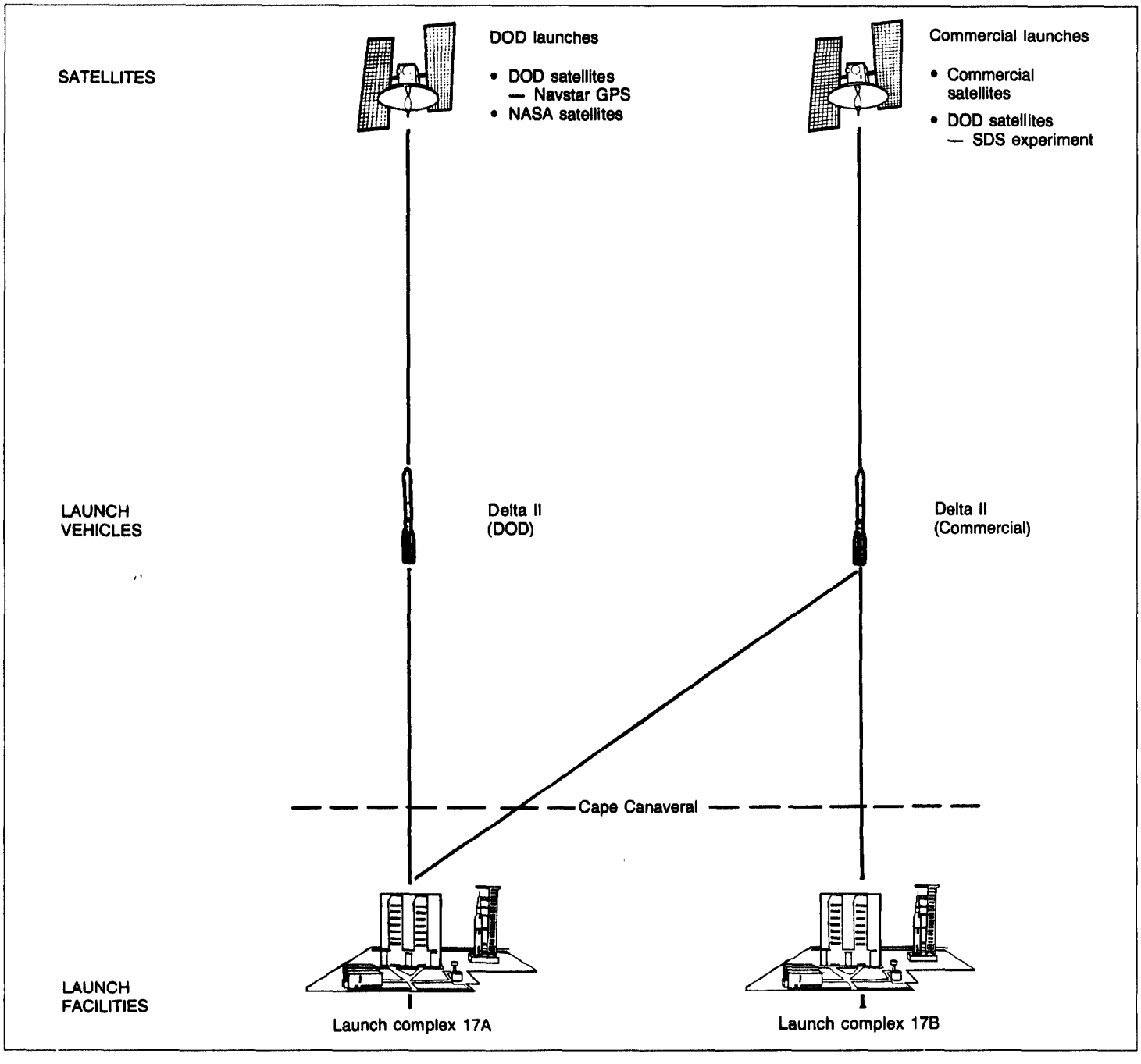
Delta II

Manufacturer	McDonnell Douglas.
Program Manager	Air Force.
Status	New medium capacity ELV owned and launched by DOD. First launched in February 1989. In multiyear contract awarded in fiscal year 1987 for 20 vehicles in support of Navstar GPS launches. Follow-on contract with open-ended options planned for award in fiscal year 1990. Vehicle includes PAM D stage. Commercial version will be available.
Launch Capacity	11,100 pounds to 100-nautical mile easterly orbit. 1,850 pounds to Navstar GPS transfer orbit (10,900-nautical miles altitude at 55-degrees inclination).
DOD Cost Per Launch	$37 million, including vehicle cost.[8]
Launch Schedule	

	Fiscal years										
	90	91	92	93	94	95	96	97	98	99	00
	(Number of launches)										
DOD launches:											
DOD satellites	6	5	5	5	3	1	4	4	4	4	4
NASA satellites	1	1									
Commercial launches:											
Commercial satellites	4	4									
DOD satellite	1										

[8]Fiscal year 1986 dollars.

Figure II.8: Delta II Satellites and Launch Facilities



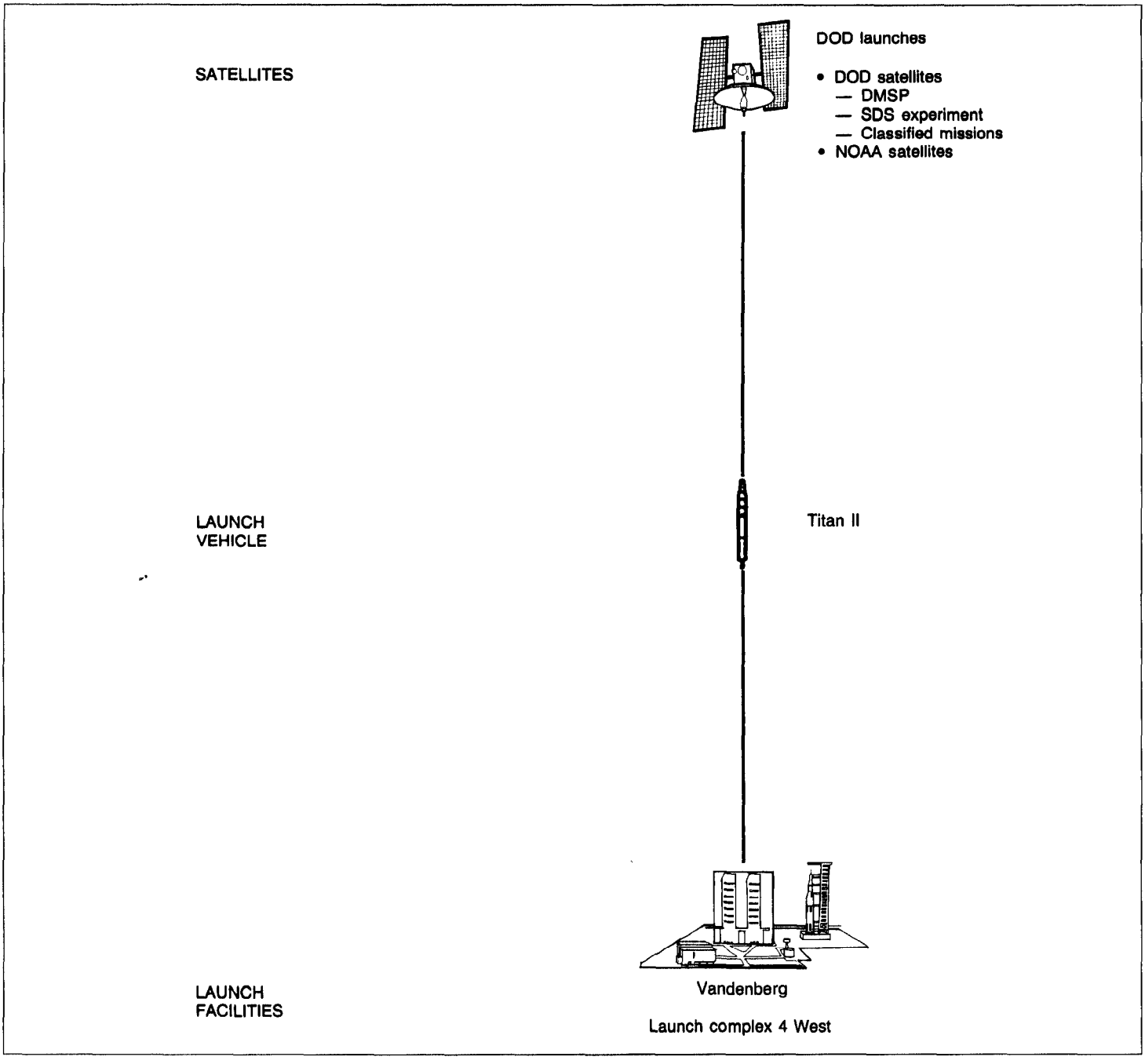
Titan II

Manufacturer	Martin Marietta.
Program Manager	Air Force.
Status	"New" (refurbished intercontinental ballistic missile) medium capacity ELV owned and launched by DOD only. First launched in fiscal year 1988. Current contract is for 14 vehicles. Planned to be used for polar or high-inclination orbits only. Not available commercially.
Launch Capacity	4,200 pounds to 100-nautical mile polar orbit.
Average Cost Per Launch	$43 million, including vehicle costs.[9]
Launch Schedule	

	Fiscal years										
	90	91	92	93	94	95	96	97	98	99	00
	(Number of launches)										
DOD launches:											
DOD satellites	(Information deleted)										
NOAA satellites		1			1	1		1			

[9]Fiscal year 1986 dollars.

Figure II.9: Titan II Satellites and Launch Facilities



Pegasus

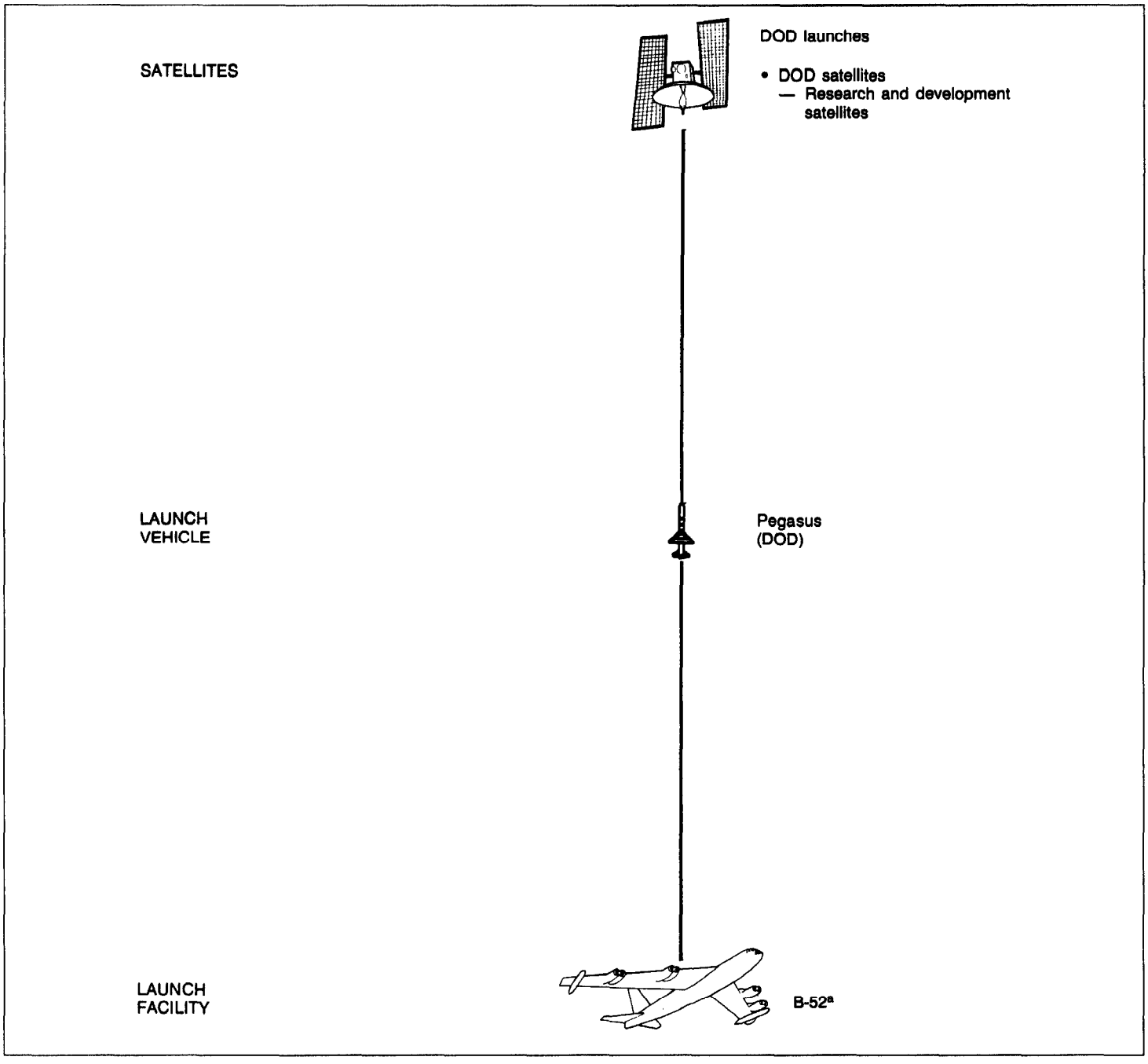
Manufacturer	Orbital Sciences Corporation and Hercules Aerospace Company (joint venture).
Program Manager	DARPA.
Status	New small capacity, air-launched, solid propellant, three-stage ELV. Developed with private funding but DARPA is funding test and evaluation. First launch a demonstration and test launch from a NASA B-52 scheduled in fiscal year 1990 under contract to DARPA to launch a LIGHTSAT. Contract includes two additional launches and options for three more. B-52 for scheduled launches to take off from Edwards Air Force Base and launch while over Vandenberg test range. Will be available for commercial launch services.
Launch Capacity	350 pounds to 400-nautical mile polar orbit.
DOD Cost Per Launch	$6 million, not including B-52 and range costs.[10]
Launch Schedule	

	Fiscal years										
	90	91	92	93	94	95	96	97	98	99	00
	(Number of launches)										
DOD launches:											
DOD satellites	8[a]	1									

[a]Seven of these are microsatellites to be launched on a single vehicle.

[10]Fiscal year 1989 dollars.

Figure II.10: Pegasus Satellites and Launch Facilities



[a]Takes off from Edwards Air Force Base and launches the Pegasus over Vandenberg's test range.

Scout

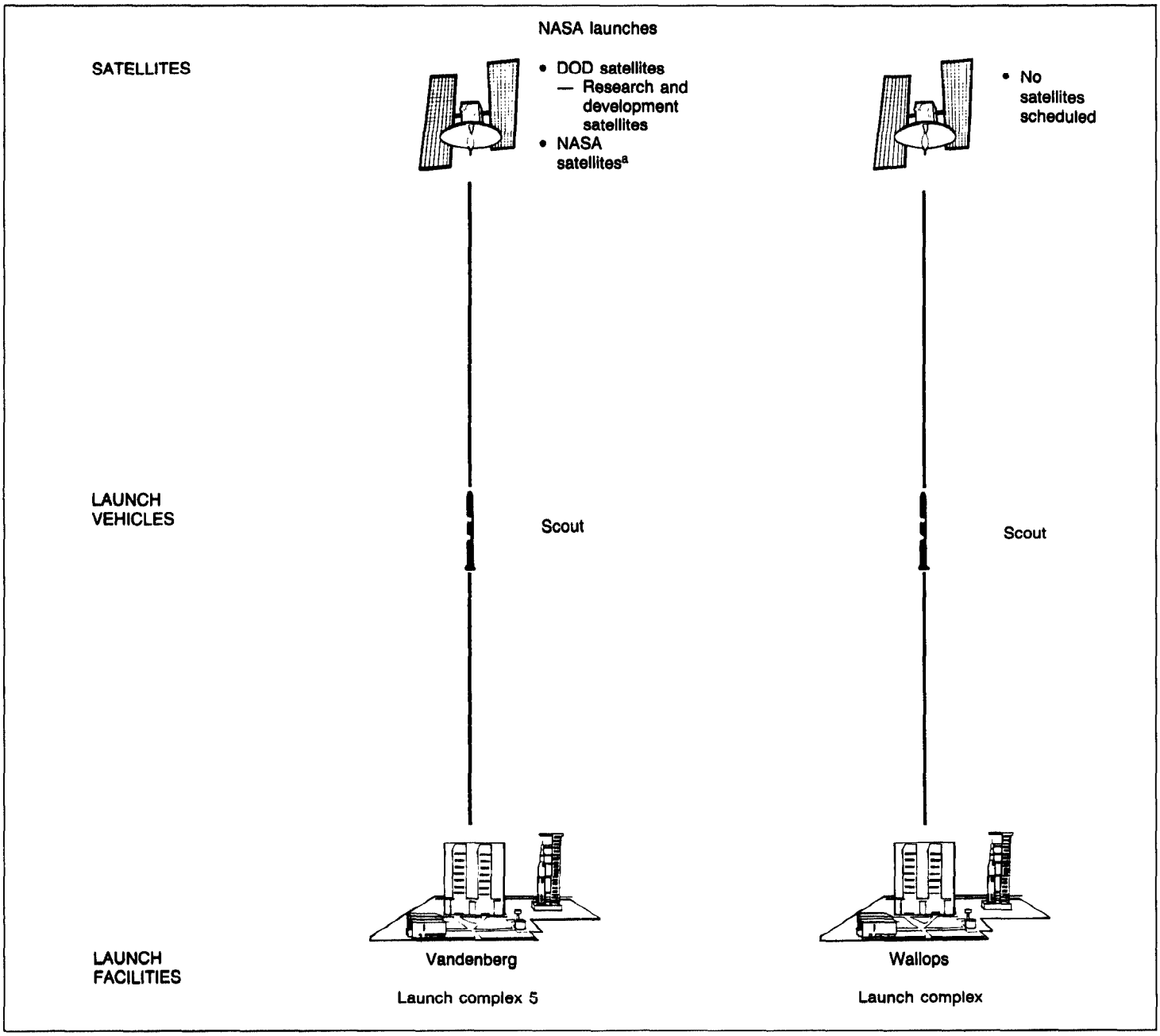
Manufacturer	LTV Aerospace and Defense Company.
Program Manager	NASA.
Status	Small capacity ELV being phased out of government inventory. Six vehicles left in government inventory owned by NASA. Three vehicles scheduled for DOD satellite launches by NASA. Will be available commercially.
Launch Capacity	570 pounds to 100-nautical mile easterly orbit. 460 pounds to 100-nautical mile polar orbit.
DOD Cost Per Launch	$9 million, including vehicle cost.[12]
Launch Schedule	

	Fiscal years										
	90	91	92	93	94	95	96	97	98	99	00
	(Number of launches)										
NASA launches:											
DOD satellites	2[a]	1	1								
NASA satellites			1	2							

[a]The two satellites will be launched on one vehicle.

[12]Fiscal year 1986 dollars.

Figure II.11: Scout Satellites and Launch Facilities



[a]NASA also plans to launch a NASA satellite from an Italian launch facility at San Marco, Kenya.

Taurus

Manufacturer

Orbital Sciences Corporation.

Program Manager

DARPA.

Status

Newly developed small capacity ELV. Vehicle is a combination of Peacekeeper missile and Pegasus. Will have flexible launch siting because it will have transportable launch assembly and launch stand equipment that will not require prepared permanent launch pads. According to DARPA, future arms control treaty limitations that may be imposed could restrict launch site options.

Developed with private funding but DARPA is funding test and evaluation. Current contract to fund one demonstration launch of two DOD experimental satellites. Contract has options for four additional vehicles to be either purchased or launched through a commercial launch service contract. Contract awarded through DARPA's program to develop a standard small launch vehicle. DOD plans a new competition for small launch vehicle when this contract expires and projects one small vehicle launch a year for fiscal years 1993 through 2004. Will be commercially available.

Launch Capacity

1,000 pounds to 400-nautical mile polar orbit.

Potentially could be increased to 2,300 pounds to 400-nautical mile polar orbit.

DOD Cost Per Launch

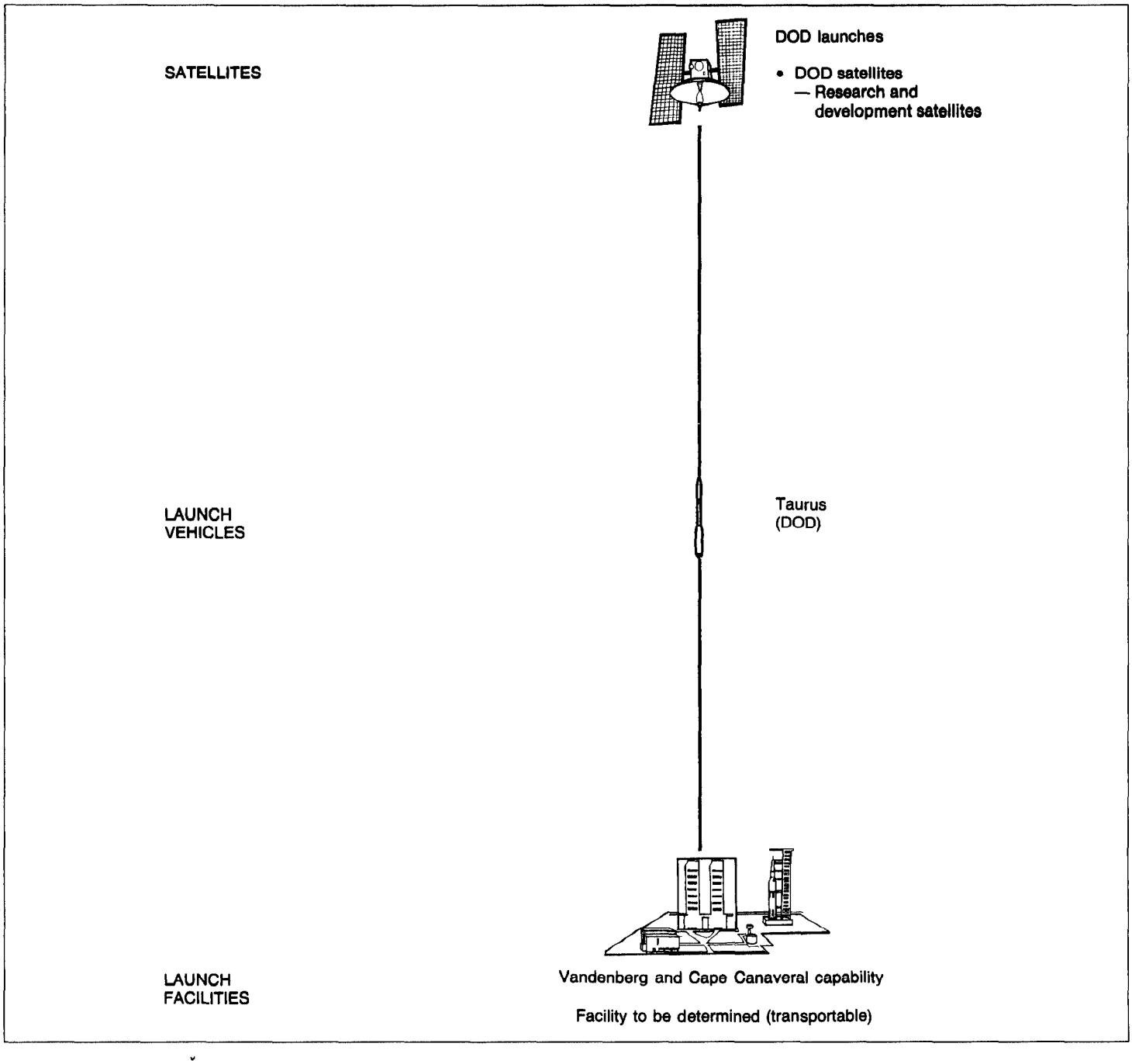
$10.9 million for first launch, including vehicle. $14 million to $15 million per launch for optional launches. Costs do not include range support.

Launch Schedule

	Fiscal years										
	90	91	92	93	94	95	96	97	98	99	00
	(Number of launches)										
DOD launches:											
DOD satellites			2[a]								

[a]Will be launched on a single vehicle.

Figure II.12: Taurus Satellites and Launch Facilities



National Aerospace Plane Program

Manufacturer	Not applicable.
Program Manager	Air Force (joint program with NASA).
Status	In research and development.
Objectives	Develop and demonstrate hypersonic flight technologies with the ultimate goal of deploying a manned or unmanned, hypersonic flight vehicle capable of delivering payloads to orbit with single-stage-to-orbit launches. Decision whether to proceed with a flight vehicle program scheduled for 1993. First flight of an experimental aircraft to demonstrate technology (the X-30) in the mid-to-late 1990s. Initial operational capability for a NASP vehicle between fiscal years 2005 and 2010.
Launch Capacity	Not yet determined. Ultimate payload lift capacities being studied by DOD range from 10,000 pounds to 65,000 pounds to low earth orbits.
DOD Cost Per Launch	Not yet available.
Launch Facilities	Not yet determined.
Launch Schedule	No launches scheduled yet.
Satellites	None yet scheduled for launch by the NASP.

Launch Facilities

DOD's primary satellite launch facilities are located at Cape Canaveral Air Force Station and NASA's Kennedy Space Center, Florida, and at Vandenberg Air Force Base, California. DOD also launches satellites, through NASA, on the shuttle from the Kennedy Center and on Scout vehicles from NASA's Wallops Flight Facility in Virginia. In addition, the air launch and transportable launch techniques of the Pegasus and Taurus, respectively, permit flexibility to launch these vehicles from nearly any location where safety considerations allow.[1] This appendix identifies, as of October 1, 1989, the launch pads available and planned at the Cape Canaveral, Kennedy, Vandenberg, and Wallops facilities and the vehicles and satellites that are currently planned to be launched from them through the year 2004.

The Cape Canaveral Station and Kennedy Center are geographically adjacent and are owned and operated, respectively, by the Air Force and NASA. The Kennedy Center contains NASA's shuttle launch complex and one of the Air Force's Titan IV complexes (complex 41) and the Cape Canaveral station contains the remaining east coast ELV complexes. DOD permitted NASA to operate and use the Atlas-Centaur (now Atlas I) and Delta I complexes at Cape Canaveral until NASA ceased launching these vehicles from the east coast in 1989 and 1988, respectively.

The Vandenberg base is owned and operated by the Air Force. Vandenberg contains all of the west coast ELV complexes and a mothballed shuttle complex. The Air Force permits NASA to operate and use the Delta I and Scout launch complexes at Vandenberg.

In addition, in keeping with national space policy to encourage and support the nation's commercial launch industry, DOD permits commercial launches from several of its pads on an as available and cost-reimbursable basis. Currently, the three manufacturers of DOD's major families of ELVs—General Dynamics (Atlas), Martin Marietta (Titan), and McDonnell-Douglas (Delta)—are the principal launch service companies scheduled to use DOD's satellite launch facilities for commercial launches.

Launches from the Cape Canaveral/Kennedy and Wallops facilities are restricted to orbits from zero to 57-degrees inclination to avoid flights over populated areas and foreign air space. For the same reasons, launches from Vandenberg facilities are limited to southerly launches to high-inclination orbits. However, these limitations may be avoided with

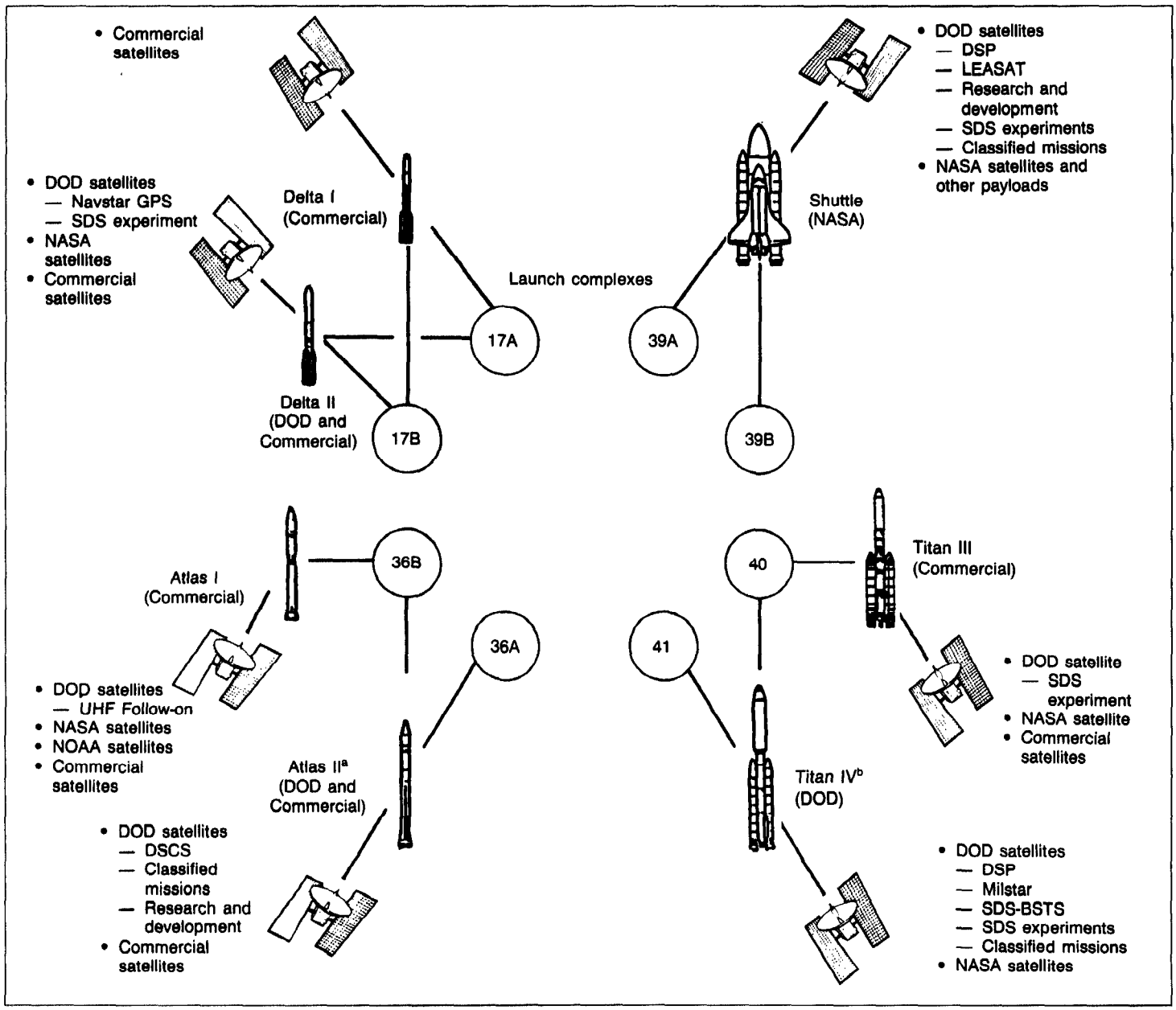
[1]Except possibly as limited by future arms control treaty provisions, according to DOD officials.

the Pegasus which is an air-launched vehicle that can be launched sufficiently offshore to avoid overflying populated areas.

Figures III.1 through III.3 show the launch complexes at each of the facilities, including which vehicles and satellites are planned to be launched from them. The Pegasus and Taurus vehicles are not illustrated in the figures because they are not linked to specific launch pads.

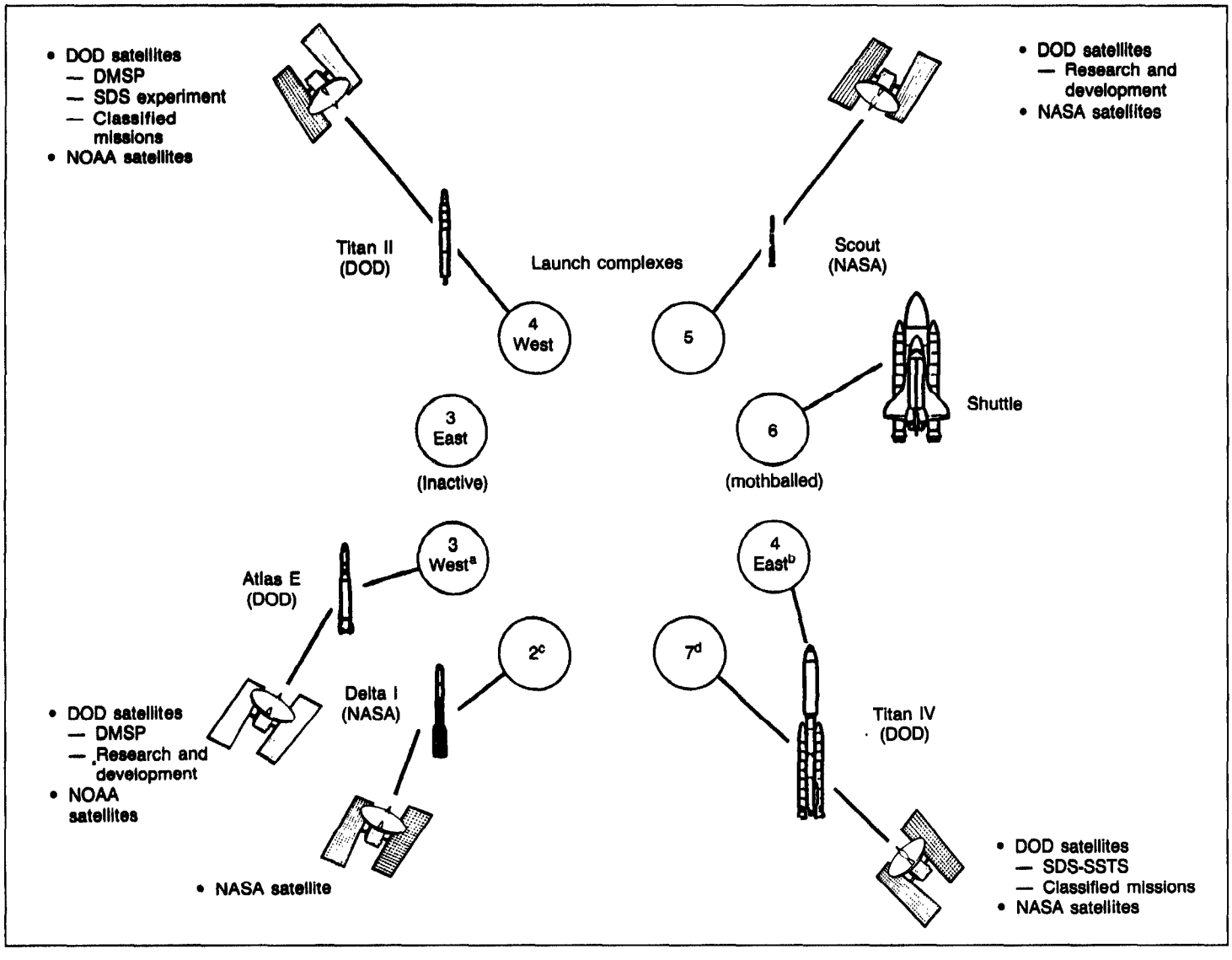
DOD plans projected the construction at Vandenberg of space launch complex 7, an additional Titan IV pad as shown in figure III.2. However, the National Defense Authorization Act for Fiscal Years 1990 and 1991 prohibited DOD from expending fiscal year 1990 funds on its construction. Instead, it permitted DOD to expend 1990 funds to convert complex 6 to a Titan IV pad. In commenting on our report, DOD said it had not decided whether to proceed with converting complex 6 or to request funds again in the fiscal year 1991 budget request for constructing complex 7, as it had originally planned. Because the issue has not been resolved, we continued to show complex 7 in figure III.2 as the second Titan IV pad at Vandenberg. It should be noted that the launches scheduled on it may be executed from complex 6 instead.

Figure III.1: Cape Canaveral Air Force Station/Kennedy Space Center Launch Complexes, Launch Vehicles, and Satellites



[a]Scheduled to become operational in fiscal year 1991. Commercial launches only from complex 36B.
Scheduled to become operational from complex 40 in fiscal year 1992.

Figure III.2: Vandenberg Air Force Base Launch Complexes, Launch Vehicles, and Satellites



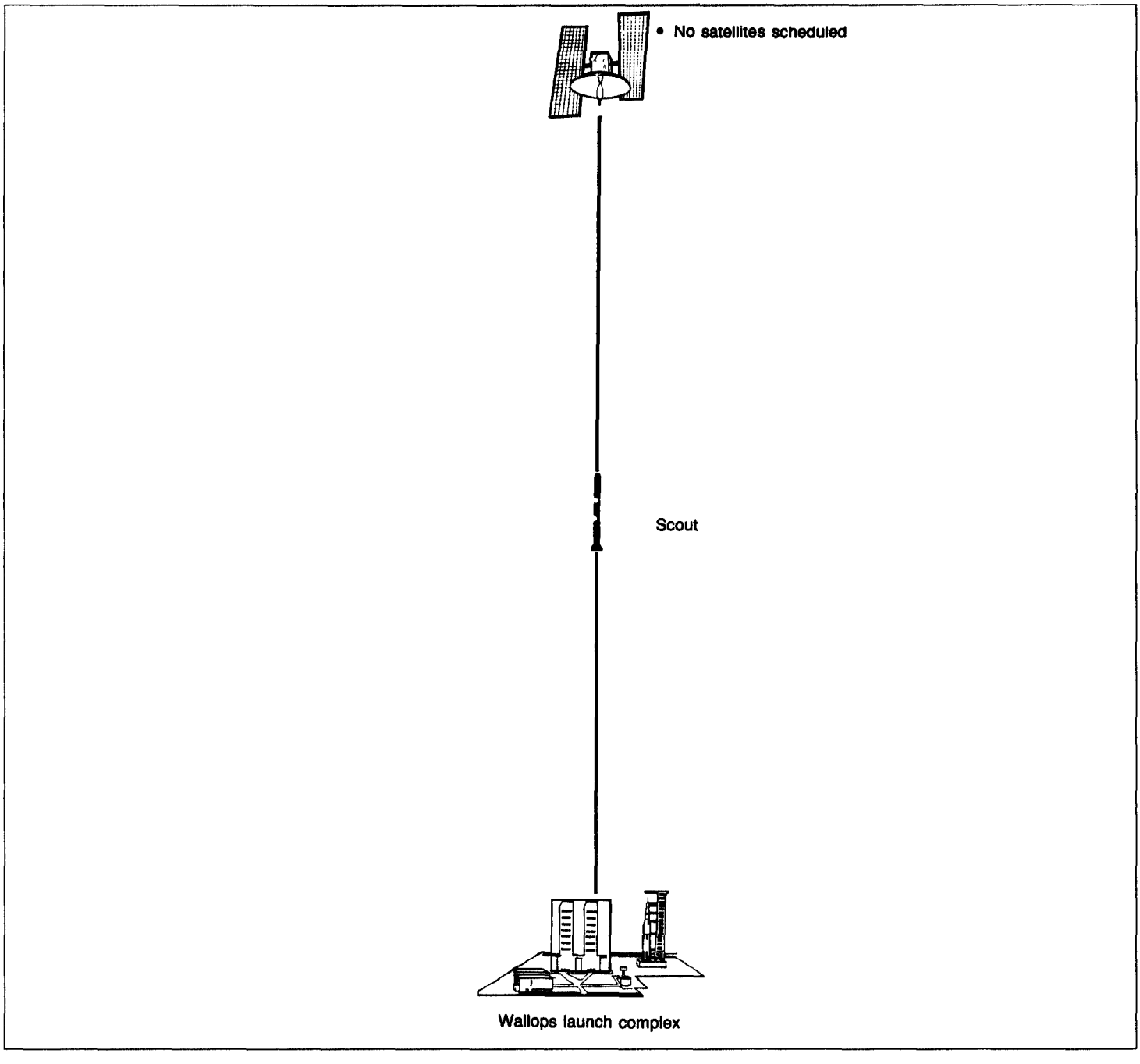
[a]The Air Force plans to either deactivate this complex or convert it to an Atlas II or other medium vehicle complex after the last Atlas E launch.

[b]Scheduled to become operational in fiscal year 1990.

[c]Due to proximity of off-shore oil wells, the Air Force plans to deactivate this complex after one more NASA launch. However, the Air Force may make it available to commercial launch companies if a demand evolves.

[d]Scheduled to become operational in fiscal year 1996. However, DOD may not construct this pad and may convert complex 6 for Titan IV operations instead.

Figure III.3: Wallops Flight Facility Launch Complex, Launch Vehicles, and Satellites



Launch Plans

This appendix describes unclassified DOD launch plans organized by satellites, launch vehicles, and launch facilities, as shown in tables IV.1 through IV.3. It also describes the normal launch rate capability of the facilities, as shown in table IV.5. The launch plans described are the unclassified DOD plans for fiscal years 1990 through 2004 as of October 1, 1989. They include launches that DOD plans to make for NASA and NOAA and launches that DOD plans to have done by NASA and commercial launch companies.

Since NASA and commercial ELV launches of non-DOD satellites are made from DOD launch facilities, we have also included available launch plans for non-DOD satellites launched by NASA and commercial companies. Available NASA plans projected launches for fiscal years 1990 through 1995 and available Department of Transportation launch schedules for commercial launches also projected launches through 1995.[1] The NASA and commercial launch plans for non-DOD satellites are described in table IV.4.

It should be noted that launch plans for future years are tentative and subject to frequent changes. Moreover, DOD launch projections were not made for the entire period through the year 2004 for some satellite programs. Also, commercial launch projections may not be complete through 1995 because the Department of Transportation's schedule lists only those launches which it has licensed, for which it has received license applications, and for which it anticipates receiving a license application.

[1]The Department of Transportation regulates and licenses commercial space launches and publishes quarterly launch schedules for commercial launches.

Table IV.1: Planned DOD Launches by Satellite

Satellite	Launch vehicle	Upper stage	Launch complex[a]	Fiscal years 90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	Total
				(Number of satellites to be launched)															
Communications:																			
DSCS	Atlas II		Cape-36	Information deleted															
FLTSATCOM																			
LEASAT	Shuttle		Cape-39	1															1
UHF Follow-on	Atlas I[b]		Cape-36			1		2	3	3	1								10
Milstar	Titan IV	Centaur	Cape-40 or 41	Information deleted															
Total				**1**		**1**		**2**	**3**	**3**	**1**								**11**
Meteorology:																			
DMSP	Atlas E		VAFB-3 West	1	1														2
	Titan II		VAFB-4 West			1	1	1		1	1		1	1		1	1		9
Total				**1**	**1**	**1**	**1**	**1**		**1**	**1**		**1**	**1**		**1**	**1**		**11**
Navigation:																			
Navstar GPS	Delta II		Cape-17	6	5	5	5	3	1	4	4	4	4	4	4	4	4	4	61
Total				**6**	**5**	**5**	**5**	**3**	**1**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**61**
Research and development	Atlas E		VAFB-3 West	1															1
	Atlas II		Cape-36					1											1
	Pegasus		Not applicable	8[c]	1														9
	Scout		VAFB-5	2[c]	1	1													4
	Shuttle[d]		Cape-39		1[c]		2	2	2	1	1	1	1	1	1	1	1	1	16
	Small ELV to be determined		To be determined				1	1	1	1	1	1	1	1	1	1	1	1	12
	Taurus		To be determined		2[c]														2
Total				**11**	**5**	**1**	**3**	**4**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**45**
SDS systems:				Information deleted															
BSTS	Titan IV	Centaur	Cape-40 or 41	Information deleted															
SBI	To be determined	To be determined	To be determined	To be determined															
SSTS	Titan IV[e]	VAFB-4 West		Information deleted															
SDS experiments:																			
	Delta II[b]		Cape-17	1															1
	Shuttle		Cape-39		3[c]														3
	Titan II		VAFB-4 West			1													1
	Titan III[b]		Cape-40							1									1
	Titan IV		Cape-40 or 41								2								2

(continued)

Satellite	Launch vehicle	Upper stage	Launch complex[a]	Fiscal years 90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	Total
				(Number of satellites to be launched)															
Total				**1**	**3**	**1**				**1**	**2**								**8**
Tactical warning and attack assessment:																			
DSP	Shuttle	Inertial	Cape-39						Information deleted										
	Titan IV	Inertial	Cape-40 or 41						Information deleted										
NDS	See Navstar GPS schedule																		
NOAA and NASA:																			
NASA	Delta II		Cape 17	1	1														**2**
NASA[f]	Titan IV		To be determined						To be determined										**0**
NOAA	Atlas E		VAFB-3 West	1	1	1													**3**
NOAA	Titan II		VAFB-4 West		1		1	1		1									**4**
Total NOAA and NASA satellites				**2**	**3**	**1**	**1**	**1**		**1**									**9**
Total DOD satellites (unclassified launches)				**20**	**14**	**9**	**9**	**10**	**7**	**11**	**10**	**6**	**7**	**7**	**6**	**7**	**7**	**6**	**136**
Total				**22**	**17**	**10**	**10**	**11**	**7**	**12**	**10**	**6**	**7**	**7**	**6**	**7**	**7**	**6**	**145**

[a]Cape refers to Cape Canaveral Air Force Station and Kennedy Space Center. VAFB refers to Vandenberg Air Force Base.

[b]Commercial ELV to be launched through commercial launch contracts.

[c]Numbers include multiple satellite launches on single vehicles as follows: seven on a single Pegasus in 1990 for a total of two launches, two on a single Taurus in 1991 for a total of one launch, two on a single Scout in 1990 for a total of one launch, and one research and development satellite and two of the three SDS experiments in 1991 on a single shuttle flight.

[d]DOD has requested the equivalent of one-third of a shuttle flight (i.e., shared flights) a year from NASA after 1995 and plans at least one research and development satellite launch a year on the shuttle after 1995. More than one DOD satellite could be launched on a single flight within the one-third of a flight allocation.

[e]The Air Force may launch these satellites instead of Atlas II ELVs.

[f]NASA has requested DOD to make a total of nine Titan IV launches of NASA satellites and outer space probes through 2004 from both coasts. The Air Force has not yet determined which launches it can accommodate.

Table IV.2: Planned DOD Launches by Launch Vehicle

Launch vehicle	Upper stage	Satellite	Launch facility[a]	Fiscal years															Total
				90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	
				(Number of satellites to be launched)															
ALS		To be determined	To be determined	To be determined															
Atlas E		DOD:																	
		DMSP	VAFB-3 West	1	1														**2**
		Research and development	VAFB-3 West	1															**1**
		NOAA	VAFB-3 West	1	1	1													**3**
Total				**3**	**2**	**1**													**6**
Atlas I[b]		DOD:																	
		UHF Follow-on	Cape-36			1		2	3	3	1								**10**
Total						**1**		**2**	**3**	**3**	**1**								**10**
Atlas II		DOD:																	
		Classified missions	Cape-36	Information deleted															
		DSCS	Cape-36	Information deleted															
		Research and development	Cape-36					1											**1**
Total								**1**											**1**
Delta II		DOD:																	
		Navstar GPS	Cape-17	6	5	5	5	3	1	4	4	4	4	4	4	4	4	4	**61**
		SDS experiment	Cape-17	1															**1**
		NASA	Cape-17	1	1														**2**
Total				**8**	**6**	**5**	**5**	**3**	**1**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**64**
Pegasus		DOD:																	
		Research and development	Not applicable	8[c]	1														**9**
Total				**8**	**1**														**9**
Scout[d]		DOD:																	
		Research and development	VAFB-5	2[e]	1	1													**4**
Total				**2**	**1**	**1**													**4**
Shuttle[d]		DOD:																	
		Classified missions	Cape-39	Information deleted															
	Inertial	DSP	Cape-39	Information deleted															
		LEASAT	Cape-39	1															**1**

(continued)

Launch vehicle	Upper stage	Satellite	Launch facility[a]	Fiscal years															
				90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	Total
				(Number of satellites to be launched)															
		Research and development	Cape-39		1[f]		2	2	2	1	1	1	1	1	1	1	1	1	**16**
		SDS-experiments	Cape-39		3[f]														**3**
Total				**1**	**4**		**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**20**
Small ELV to be determined		DOD:																	
		Research and development	To be determined				1	1	1	1	1	1	1	1	1	1	1	1	**12**
Total							**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**12**
Taurus		DOD:																	
		Research and development	To be determined		2[g]														**2**
Total					**2**														**2**
Titan II		DOD:																	
		Classified missions	VAFB-4 West						Information deleted										
		DMSP	VAFB-4 West			1	1	1		1	1		1	1		1	1		**9**
		SDS experiment	VAFB-4 West			1													**1**
		NOAA	VAFB-4 West		1		1	1		1									**4**
Total					**1**	**2**	**2**	**2**		**2**	**1**	**1**	**2**	**1**		**1**	**1**		**14**
Titan III[b]		DOD:																	
		SDS experiment	Cape-40							1									**1**
Total										**1**									**1**
Titan IV		DOD:																	
		Classified missions	Cape-40 or 41						Information deleted										
		Classified missions	VAFB-4 East or 7						Information deleted										
	Inertial	DSP	Cape-40 or 41						Information deleted										
	Centaur	Milstar	Cape-40 or 41						Information deleted										
	Centaur	SDS-BSTS	Cape-40 or 41						Information deleted										
		SDS experiments	Cape-40 or 41								2								**2**
		SDS-SSTS	VAFB-4 East or 7						Information deleted										
		NASA[h]	To be determined						To be determined										
Total											**2**								**2**

(continued)

Launch vehicle	Upper stage	Satellite	Launch facility[a]	Fiscal years 90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	Total
				(Number of satellites to be launched)															
Total DOD satellites (unclassified launches)				20	14	9	9	10	7	11	10	6	7	7	6	7	7	6	**136**
Total NASA and NOAA satellites				2	3	1	1	1		1									**9**
Total				**22**	**17**	**10**	**10**	**11**	**7**	**12**	**10**	**6**	**7**	**7**	**6**	**7**	**7**	**6**	**145**

[a]Cape refers to Cape Canaveral Air Force Station and Kennedy Space Center. VAFB refers to Vandenberg Air Force Base.

[b]Commercial ELV to be launched through commercial launch contracts.

[c]Seven of the eight satellites are microsatellites that will be launched simultaneously on a single vehicle, for a total of two vehicle launches in 1990.

[d]Vehicle owned and launched by NASA.

[e]Both satellites will be launched simultaneously on a single vehicle for a total of one launch in 1990.

[f]The research and development satellite and two SDS experiment satellites are scheduled to be launched together on a single shuttle flight. DOD has requested the equivalent of one-third of a shuttle flight (i.e., shared flights) a year from NASA after 1995 and plans at least one satellite launch a year on the shuttle after 1995. More than one DOD satellite could be launched on a single flight within the one-third of a flight allocation.

[g]Both satellites are scheduled to be launched simultaneously on a single vehicle.

[h]NASA has requested DOD to make a total of nine Titan IV launches of NASA satellites and outer space probes through 2004 from both coasts. The Air Force has not yet determined which launches it can accommodate.

Table IV.3: Planned DOD Launches by Launch Facility

Launch facility[a]	Launch vehicle	Upper stage	Satellite	Fiscal years															
				90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	Total
				(Number of satellites to be launched)															
Cape Canaveral:[a]																			
Complex 17			DOD:																
	Delta II[b]		SDS experiment	1															**1**
(2 pads)	Delta II		Navstar GPS	6	5	5	5	3	1	4	4	4	4	4	4	4	4	4	**61**
	Delta II		NASA	1	1														**2**
Total				**8**	**6**	**5**	**5**	**3**	**1**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**64**
Complex 36			DOD:																
	Atlas I[b]		UHF Follow-on			1		2	3	3	1								**10**
(2 pads)	Atlas II		Classified missions						Information deleted										
	Atlas II		DSCS						Information deleted										
	Atlas II		Research and development					1											**1**
Total						**1**		**3**	**3**	**3**	**1**								**11**
Complex 39			DOD:																
	Shuttle[c]		Classified missions						Information deleted										
	Shuttle[c]	Inertial	DSP						Information deleted										
(2 pads)	Shuttle[c]		LEASAT	1															**1**
	Shuttle[c]		Research and development[d]		1		2	2	2	1	1	1	1	1	1	1	1	1	**16**
	Shuttle[c]		SDS experiments[d]		3														**3**
Total				**1**	**4**		**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**20**
Complexes 40 and 41[e]			DOD:																
	Titan III[b]		SDS experiment							1									**1**
(2 pads)	Titan IV		Classified missions						Information deleted										
	Titan IV	Inertial	DSP						Information deleted										
	Titan IV	Centaur	Milstar						Information deleted										
	Titan IV	Centaur	SDS-BSTS						Information deleted										
	Titan IV		SDS experiments								2								**2**
	Titan IV[f]		NASA						To be determined										
Total										**1**	**2**								**3**

(continued)

Launch facility[a]	Launch vehicle	Upper stage	Satellite	Fiscal years 90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	Total
				(Number of satellites to be launched)															
Vandenberg:																			
Complex 3 West			DOD:																
	Atlas E		DMSP	1	1														2
(1 pad)	Atlas E		Research and development	1															1
	Atlas E		NOAA	1	1	1													3
Total				**3**	**2**	**1**													**6**
Complex 4 West			DOD:																
(1 pad)	Titan II		Classified missions						Information deleted										
	Titan II		DMSP			1	1	1		1	1		1	1		1	1		9
	Titan II		SDS experiment			1													1
	Titan II		NOAA		1		1	1		1									4
Total					**1**	**2**	**2**	**2**		**2**	**1**		**1**	**1**		**1**	**1**		**14**
Complex 4 East and 7[g]			DOD:																
	Titan IV		Classified missions						Information deleted										
(2 pads)	Titan IV		SDS-SSTS						Information deleted										
	Titan IV[f]		NASA						To be determined										
Complex 5			DOD:																
(1 pad)	Scout[e]		Research and development	2[h]	1	1													4
Total				**2**	**1**	**1**													**4**
No launch pad[i]			DOD:																
	Pegasus		Research and development	8[h]	1														9
Total				**8**	**1**														**9**
Facilities to be determined			DOD:																
	ALS		To be determined						To be determined										
	Small ELV to be determine		Research and development				1	1	1	1	1	1	1	1	1	1	1	1	12
	Taurus		Research and development		2[h]														2
Total					**2**		**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**14**

(continued)

Launch facility[a]	Launch vehicle	Upper stage	Satellite	Fiscal years 90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	Total
				(Number of satellites to be launched)															
Total DOD satellites (unclassified launches)				20	14	9	9	10	7	11	10	6	7	7	6	7	7	6	**136**
Total NASA and NOAA satellites				2	3	1	1	1		1									**9**
Total				**22**	**17**	**10**	**10**	**11**	**7**	**12**	**10**	**6**	**7**	**7**	**6**	**7**	**7**	**6**	**145**

[a]Refers to Cape Canaveral Air Force Station and Kennedy Space Center.

[b]Commercial ELV to be launched through commercial launch contracts.

[c]Vehicle owned and launched by NASA.

[d]The research and development satellite and two SDS experiment satellites scheduled for launch in fiscal year 1991 are scheduled to be launched together on a single shuttle flight. DOD has requested the equivalent of one-third of a shuttle flight (i.e., shared flights) a year from NASA after 1995 and plans at least one satellite launch a year on the shuttle after 1995. More than one DOD satellite could be launched on a single flight within the one-third of a flight allocation.

[e]Complex 40 is not scheduled to have Titan IV capability until fiscal year 1992.

[f]NASA has requested DOD to make a total of nine Titan IV launches of NASA satellites and outer space probes through 2004 from both coasts. The Air Force has not yet determined which launches it can accommodate.

[g]The Air Force has planned to construct complex 7 to be operational in fiscal year 1996 but on the basis of congressional direction may convert complex 6 for Titan IV launches instead.

[h]Numbers include multiple satellite launches on single vehicles as follows; two on a single Scout in 1990 for a total of one launch, two on a single Taurus in 1991 for a total of one launch, and seven on a single Pegasus in 1990 for a total of two launches.

[i]To be launched from a B-52 aircraft over the Vandenberg test range.

Table IV.4: Planned NASA and Commercial Launches of Non-DOD Satellites Through 1995

Launch agent/ satellite[a]	Launch vehicle	Upper stage	Launch facility[b]	Fiscal years 90	91	92	93	94	95	Total
				(Number of satellites to be launched)						
NASA:										
NASA satellite	Delta I		VAFB-2	1						**1**
NASA satellites	Scout		VAFB-5			1	1			**2**
NASA satellites	Scout		San Marco[c]				1			**1**
NASA satellites and other payloads	Shuttle[d]		Cape-39	5	7	11	11	11	11	**56**
Total				**6**	**7**	**12**	**13**	**11**	**11**	**60**
General Dynamics:										
NASA satellites	Atlas I		Cape-36	1						**1**
NOAA satellites	Atlas I		Cape-36		1	1			1	**3**
Commercial satellites	Atlas I		Cape-36		1		1			**2**
Commercial satellites	Atlas II[e]		Cape-36		1	2	2			**5**
Total				**1**	**3**	**3**	**3**		**1**	**11**
Martin Marietta:										
NASA satellite	Titan III		Cape-40			1				**1**
Commercial satellites	Titan III		Cape-40	4[f]						**4**
Total				**4**		**1**				**5**
McDonnell Douglas:										
Commercial satellites	Delta II		Cape-17	4	4					**8**
Total				**4**	**4**					**8**
To be determined										
NASA satellites	Medium ELV TBD[g]		TBD			1	3	1	1	**6**
NASA satellites	Small ELV TBD[g]		TBD					2	1	**3**
Total						**1**	**3**	**3**	**2**	**9**
Total				**15**	**14**	**17**	**19**	**14**	**14**	**93**

[a]The commercial satellite category includes foreign government, international consortium, and North Atlantic Treaty Organization (NATO) satellites.

[b]Cape refers to Cape Canaveral Air Force Station and Kennedy Space Center. VAFB refers to Vandenberg Air Force Base.

[c]An Italian offshore platform launch facility at San Marco, Kenya.

[d]Additional non-DOD payloads are scheduled to be launched on flights carrying partial loads of DOD payloads.

[e]Category includes commercial variations designated Atlas IIA and Atlas IIAS.

[f]Two of the satellites are scheduled to be launched simultaneously on a single vehicle.

[g]NASA intends to contract with commercial launch companies for these launches. Vehicles are yet to be determined (TBD).

Table IV.5: Normal Yearly Launch Rate Capabilities

Launch facility	Number of launch pads	Vehicles launched	Normal yearly launch rate capability
Cape Canaveral/ Kennedy:			
Complex 17	2	Delta I Delta II	12
Complex 36	2	Atlas I Atlas II	8
Complex 39	2	Shuttle	14[a]
Complexes 40 and 41	2	Titan IV Titan III	6
Vandenberg:			
Complex 2	1	Delta	1[b]
Complex 3	1	Atlas E	3–4
Complex 4 West	1	Titan II	1–3[c]
Complexes 4 East and 7[d]	2	Titan IV	4–5
Complex 5	1	Scout	6
Complex 6[d]	1	Shuttle	Mothballed

[a]Currently less. NASA's goal is to achieve this rate by 1994.

[b]The Air Force plans to deactivate this pad after one more launch.

[c]Because of the pad's close proximity to launch complex 4 East, safety considerations while launch activities are occurring on 4 East restrict launch rates to this level.

[d]DOD may convert complex 6 for Titan IV launches rather than construct a new complex 7.

DOD Space Program Cost Estimates

In March 1989, we reported on DOD estimates of total space-related funding, including funding for all support costs such as satellite control networks and operations and maintenance of facilities.[1] We obtained updated DOD estimates for fiscal years 1985 through 1994. These estimates are shown in table V.1.

DOD estimates as of October 1, 1989, show a funding increase from $12.8 billion in fiscal year 1985 to a projected $18.0 billion for fiscal year 1990 (41-percent increase). They show continued increases to $23.6 billion in fiscal year 1993 (84-percent increase from 1985 and 31-percent increase from 1990) followed by a slight decrease to $23.3 billion in fiscal year 1994.

[1]Space Funding: NASA and DOD Activities for Fiscal Years 1981 Through 1989 (GAO/NSIAD-89-102FS, March 23, 1989).

Table V.1: DOD's Space-Related Funding Estimates for Fiscal Years 1985 Through 1994[a]

Dollars in millions

	Fiscal years									
Category	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992[b]**	**1993[b]**	**1994[b]**
Navigation	$564	$442	$447	$431	$449	$553	$590			
Communication	1,575	1,308	1,760	1,366	1,538	1,931	2,097			
Mapping, charting, and geodesy	62	22	15	12	13	16	19			
Tactical warning and attack assessment	581	745	1,080	936	859	1,050	1,162			
Meteorology and oceanography	293	203	155	198	457	515	588			
Launch vehicle acquisition and development	1,466	1,570	1,700	1,727	1,627	1,544	1,280			
Ground support	1,114	1,130	1,430	1,386	1,096	1,102	1,155			
Supporting research and development	1,118	3,110	2,750	2,583	2,975	3,486	4,171			
General support	5,995	6,470	6,380	5,865	7,291	7,755	8,180			
Total	**$12,768**	**$15,000**	**$15,717**	**$14,504**	**$16,305**	**$17,952**	**$19,242**	**$21,600**	**$23,600**	**$23,300**

[a]As of October 1, 1989.

[b]DOD provided only totals for fiscal years 1992 through 1994.

Category definitions:

Navigation consists mainly of the Navstar GPS and TRANSIT satellite programs.

Communication consists of communications satellites and related equipment, including AFSATCOM, DSCS, FLTSATCOM and UHF Follow-on, and Milstar.

Mapping, charting, and geodesy includes efforts to obtain more accurate data for maps and charts and provide geophysical information to strategic and tactical weapon systems, such as knowledge of the size, shape, and gravity field of the earth for supporting ballistic missile forces.

Tactical warning and attack assessment consists of various satellite and ground programs, such as DSP, that together provide attack warning information.

Meteorology and oceanography consists mainly of the DMSP and other environmental programs that supply timely weather information to help DOD effectively employ forces.

Launch vehicle acquisition and development consists of programs for space launch vehicles and space launch and shuttle support, including the ALS program, shuttle operations, and the Vandenberg shuttle launch complex.

Ground support consists mainly of operations and maintenance funding necessary to support launch facilities, satellite control, and spacetrack networks.

Supporting research and development consists mainly of support for research, development, test, and evaluation projects, including the development and testing of launch systems, the Space Test Program, LIGHTSAT/SPINSAT, SDI, and NASP programs.

General support covers various functions such as technical and mission support for space-related activities and classified Air Force and Navy programs.

Source: DOD.

Objective, Scope, and Methodology

Our objective was to develop an information baseline on DOD satellites, launch vehicles, launch facilities, and their related costs. We also included information on DOD's projected satellite launch schedules to show how these key elements of DOD's space programs interrelate. The Chairman, House Armed Services Committee, requested this information to assist the Committee in its assessment of the implications and affordability of various DOD space program changes.

We interviewed officials and reviewed documents pertaining to DOD space programs at the Washington, D.C., headquarters of the Office of the Secretary of Defense; Defense Communications Agency; Strategic Defense Initiative Organization; Joint Chiefs of Staff; Departments of the Air Force, Navy, and Army; Air Force Systems Command; National Security Council; at the El Segundo, California, headquarters of the Air Force Space Division; and at the Air Force Space Command's Consolidated Space Operations Center at Falcon Air Force Station, Colorado. We also performed similar work at NASA and the Department of Transportation in Washington, D.C., to obtain information on how space launches controlled by these agencies affect DOD space program planning.

Our review was performed between July 1988 and March 1989. Follow-up activity to clarify program information was performed through September 1989 and information presented in this fact sheet was updated to reflect DOD, NASA, and commercial launch plans as of October 1, 1989. We did not independently verify information provided by DOD on satellite program status, acquisition schedules, launch schedules, unit satellite and launch costs, and space-related program cost estimates. Also, our review did not include nonsatellite space activities.

The information in this fact sheet reflects unclassified DOD space program plans to the extent they existed for activities through the year 2004. However, DOD space program plans are dynamic and subject to frequent changes. Because of this, the information presented in this fact sheet is a snapshot in time of DOD's space program plans that is subject to change.

We obtained DOD and NASA official comments on a draft of the classified version of this report. In addition, program level officials from each agency reviewed the draft and suggested minor technical changes to more accurately reflect current program status. These changes were also incorporated into the final report where appropriate and are also reflected in this unclassified version.

Comments From DOD

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

THE UNDER SECRETARY OF DEFENSE

WASHINGTON, DC 20301

27 DEC 1989

ACQUISITION

Mr. Frank C. Conahan
Assistant Comptroller General
United States General Accounting Office
Washington, DC 20548

Dear Mr. Conahan:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) Draft Report, "MILITARY SPACE PROGRAMS: An Overview of Defense Space Activities," dated October 31, 1989 (GAO Code 395102), OSD Case 8169.

See comment 1.

The DoD military space programs are continually reviewed and adjusted to reflect budgetary actions, and information included in the report may not always be current. It is the DoD position, however, that the report should include only approved programs. Those efforts that are not approved programs, such as Space-Based Wide Area Surveillance, should either be removed from the report or addressed separately. In addition, the report should indicate that the described space activities are limited to "orbital" programs. For completeness in describing the total DoD space effort sub-orbital activities should be included. The exclusion of the sub-orbital activities is a report limitation.

See comment 2.

Proposed technical and clarifying changes to the report were separately provided to the GAO staff at the November 27 meeting to discuss the draft. The DoD appreciates the opportunity to review and comment on the draft report.

Sincerely,

Robert C. McCormack

Robert C. McCormack
Deputy Under Secretary

The following are GAO's comments on the Under Secretary of Defense's letter dated December 27, 1989.

GAO Comments

1. DOD suggested that the report emphasize more strongly the continually changing nature of DOD space activities due to various program and budgetary actions. DOD also asked that because the Space-Based Wide Area Surveillance satellite program is not an approved program, that we not include it in our report. We understand DOD's concern on both of these matters and have revised the report accordingly.

2. DOD suggested that for completeness in describing the total DOD space effort, DOD suborbital or nonsatellite programs should be included in the report. The Chairman's letter and subsequent discussions with committee staff confirm, however, that the requester's interest relates only to the satellite programs. However, to accommodate DOD's concern we have further clarified the objectives concerning the scope of our review.

Major Contributors to This Report

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Glossary

Geosynchronous Equatorial Orbit	A geosynchronous orbit that is concentric with the earth's equator. Such an orbit for earth satellites normally occurs at about 22,300-nautical miles altitude and the satellite appears to an earth observer as being stationary overhead. The orbit is also referred to as a geostationary orbit.
Geosynchronous Orbit	A circular orbit such that the period of one revolution of a satellite in the orbit is equal to the period of one rotation of the earth, or 24 hours.
Geosynchronous Transfer Orbit	An elliptical orbit used in the process of launching a satellite to a geosynchronous orbit. Satellites launched to geosynchronous orbits usually are launched initially to a circular low earth orbit and propelled by an upper stage rocket to geosynchronous altitude via the elliptical transfer orbit.
Extremely High Frequency	Frequencies in the electromagnetic wave spectrum from 30 to 300 gigahertz.
Gigahertz	A unit of frequency equal to 1 billion cycles per second.
Inclination	Inclination is the angle made by the intersection of the plane of a satellite's orbit with the plane of the equator. The angle is measured from the equator to the orbital path projected onto the earth as the satellite crosses over the equator from the southern to northern hemisphere. Thus, when a satellite's projected path on the earth crosses the equator in a northerly direction at an angle of 67 degrees, for example, the satellite would have an inclination of 67 degrees. An equatorial orbit has a zero-degree inclination because a satellite in such an orbit travels in a path concentric with the equator and the path does not cross the equator. A true polar orbit has a 90-degree inclination because the path for a satellite in such an orbit is perpendicular to the equatorial plane. Orbits with inclinations above 45 degrees are considered by the Air Force to be high-inclination orbits.
Low Earth Orbit	An orbit relatively near the earth. Low earth orbits are typically within several hundred miles high but have undefined limits in altitude and

	may be as high as several thousand miles. The term can refer to equatorial, low-inclination, high-inclination, or polar orbits.
Megahertz	A unit of frequency equal to 1 million cycles per second.
Polar Orbit	An orbit passing over the vicinity of the earth's poles. The Air Force considers orbits with inclinations between 80 and 100 degrees to be polar orbits.
Semisynchronous Orbit	An orbit such that a satellite in the orbit revolves about the earth every 12 hours, or twice a day.
Sun-Synchronous Orbit	An orbit such that its orbital plane makes a full revolution about the earth once each year. This results in the satellite passing over the equator at the same local time throughout the year.
Superhigh Frequency	Frequencies in the electromagnetic wave spectrum from 3 to 30 gigahertz.
UHF	Frequencies in the electromagnetic wave spectrum from 300 to 3,000 megahertz.

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