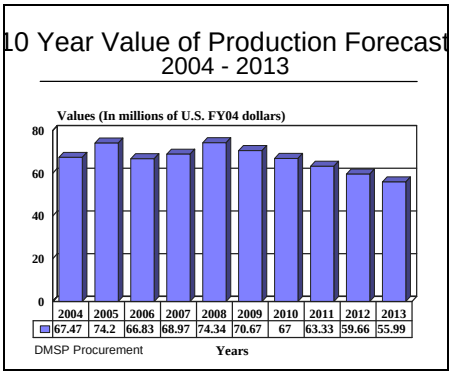
Defense Meteorological Satellite Program - Archived 11/2005

Outlook

- Forecast International projects the U.S. Air Force will spend US$668.46 million over the next decade on DMSP procurement
- In 2008, look for Lockheed Martin to complete Miniature Inertial Measurement Unit retrofit onto DMSP S-16 and S-19 spacecraft



Orientation

Description. The Defense Meteorological Satellite Program (DMSP) is a United States Department of Defense program run by the Air Force Space and Missile Systems Center. The DMSP covers the design, building, launch, and maintenance of several near-polar-orbiting, sun-synchronous satellites that monitor the meteorological, oceanographic, and solar-terrestrial physics environments.

Sponsor

U.S. Air Force
Space & Missile System Center
Los Angeles, CA

Status. Ongoing operation, maintenance, and procurement.

Total Produced. Through 2003, approximately 39 DMSP satellites (all types and models) had been manufactured.

Application. DMSP satellites provide meteorological, terrestrial, oceanographic, and solar-geophysical data to civilian and military users.

Price Range. Unit cost of a DMSP satellite is approximately US$108 million (in FY92 dollars).

Contractors

Lockheed Martin Space Systems Company, Division HQ, http://www.lockheedmartin.com/ssc, 12257 South Wadsworth Blvd, Littleton, CO 80125-8500 United States, Tel: + 1 (303) 977-3000, Prime

Technical Data

The following data relate only to DMSP satellites.

	Metric	U.S.
Dimensions		
Height (5D-1)	5.18 m	17 ft
Height (5D-2)	6.0 m	19.6 ft
Height (5D-3)	6.1 m	20 ft

	Metric	**U.S.**
Diameter (5C)	1.1 m	3.6 ft
Diameter (5D-1)	1.07 m	3.5 ft
Weight		
Weight, in orbit (5D-1)	516 kg	1,135 lb
Weight (5D-2)	823 kg	1,811 lb
Weight (5D-3)	1,125 kg	2,474 lb
Performance		
Onboard Power (5D-1)	Solar	
Onboard Power (5D-2)	Solar	
Onboard Power (5D-3)	Solar	
Orbital Lifetime (5D-1)	1-2 years[(a)]	
Orbital Lifetime (5D-2)	3-4 years	
Orbital Lifetime (5D-3)	4+ years	
Launch Vehicle (5D-1)	Thor (LV-2F)	
Launch Vehicle (5D-2)	Atlas-E	
Launch Vehicle (5D-3)	Titan II	

[(a)]The first Block 5A satellite failed after three months; one of the most recent satellites lasted 50 months.

Design Features. At least two DMSP satellites are required to be in sun-synchronous, near-polar orbits at all times. (Sun-synchronous means that the satellite crosses the equator going north at the same local time on each of its 14 orbits per day.) One satellite provides data in the early morning and early evening, the other during midday and mid-evening.

The satellites operate in two data modes: stored and real-time. The satellites can distinguish clouds as small as 610 meters in diameter, with resolution up to one-third of a mile. In the stored mode, data is recorded worldwide, then transmitted from the satellite to the Air Force Global Weather Central at Offutt AFB, Nebraska, and to the Navy's Fleet Numerical Oceanographic Center at Monterey, California.

DMSP Instrumentation. The following instruments have been or are currently on the DMSP satellites:

Operational Linescan System (OLS). The primary Block 5D-2 and 5D-3 sensor is the Operational Linescan System (OLS). The OLS instrument consists of two telescopes and a photo multiplier tube (PMT).

Visible and infrared imagery from the OLS instruments is used to monitor the global distribution of clouds and cloud top temperatures twice daily. The archive data set consists of low-resolution global coverage, high-resolution regional coverage, imagery recorded along a 3,000 kilometer scan, satellite ephemeris, and solar and lunar data. IR pixel values vary from 190 to 310 Kelvins in 256 equally spaced steps. Onboard calibration is performed during each scan. Visible pixels are currently relative values ranging from 0 to 63 rather than absolute values in watts per m2. Instrumental gain levels are adjusted to maintain constant cloud reference values under varying conditions of solar and lunar illumination. Telescope pixel values are replaced by photo multiplier tube (PMT) values at night. A telescope pixel is 0.55 kilometer at high resolution and 2.7 kilometers at low resolution. Low-resolution values are the mean of the appropriate 25 high-resolution values, while a PMT pixel is 2.7 kilometers at nadir.

Special Sensor Microwave/Imager (SSM/I). The SSM/I is a seven-channel, four-frequency, linearly polarized, passive microwave radiometric system that measures atmospheric, ocean, and terrain microwave brightness temperatures at 19.35, 22.235, 37.0, and 85.5 GHz. The data are used to obtain synoptic maps of critical atmospheric, oceanographic, and selected land parameters on a global scale. The SSM/I archive data set consists of antenna temperatures recorded across a 1,400 kilometer conical scan, satellite ephemeris, Earth surface positions for each pixel, and instrument calibration. Electromagnetic radiation is polarized by the ambient electric field, scattered by the atmosphere and the Earth's surface, and scattered and absorbed by atmospheric water vapor, oxygen, water, and ice.

Special Sensor Microwave/Temperature Sounder (SSM/T). The SSM/T is a seven-channel microwave sounder that measures atmospheric emission in the 50- to 60-GHz oxygen (O^2) band. The system is designed to provide temperature soundings over previously inaccessible regions and at higher altitudes than those attainable with IR sounders.

Special Sensor Microwave/Water Vapor Profiler (SSM/T-2). The SSM/T-2 is a cross-track scanning,

five-channel, passive total power microwave radiometer system that consists of a single, self-contained module with a step-scan motion in the cross-track direction of +/-40.5 degrees. The SSM/T-2 scan mechanism is synchronized with the SSM/T-1 so that the beam cell patterns of the two sensors coincide. The SSM/T-2 observation rate is 7.5 scans per minute. There are 28 observations (beam positions) per scan for each of the five channels, and each observation has a spatial resolution of approximately 48 kilometers. All five channels have coincident centers. The total swath width for the SSM/T-2 is approximately 1,500 kilometers.

Precipitating Electron and Ion Spectrometer (SSJ/4). The SSJ/4 instrument was designed to measure the flux of charged particles as they enter the Earth's upper atmosphere from the near-Earth space environment. It consists of four electrostatic analyzers that record electrons and ions between 30 eV and 30 KeV as they flow past the spacecraft toward the Earth. The instruments "look" toward the satellite zenith. The curved plate detectors allow precipitating electrons and ions to enter through an aperture of about 20 by 100 FWHM (full-width half-maximum). Electrons and ions of the selected energy are deflected toward the target by an imposed electrical field applied across the two plates. The two low-energy detectors consist of 10 channels centered at 34, 49, 71, 101, 150, 218, 320, 460, 670, and 960 eV. The high-energy detector measures particles in 10 channels centered at 1.0, 1.4, 2.1, 3.0, 4.4, 6.5, 9.5, 14.0, 20.5, and 29.5 KeV. Each detector dwells at each channel for 0.09 seconds from high-energy channel to low. A complete cycle is sampled each second. The nominal response efficiency is 50 percent at a value of 10 percent of the central energy for that channel.

Special Sensor for Ions and Electrons (SSI/E) Series. The SSI/ES is an improved version of the Special Sensor for Ions and Electrons (SSI/E). The SSI/E instruments measure the ambient electron density and temperatures, the ambient ion density, and the average ion temperature and molecular weight at the DMSP orbital altitude. An upgraded version of the SSI/ES is known as the SSI/ES-2.

Special Sensor Magnetic (SSM). The SSM measures geomagnetic fluctuations associated with geophysical phenomena (i.e., ionospheric currents flowing at high latitudes). In combination with the SSI/ES (or SSI/ES-2) and the SSJ/4, the SSM provides heating and electron density profiles in the high-latitude ionosphere.

SSM data are currently available only from the F-12 and F-13 satellites.

Variants/Upgrades

5D-1. Follow-on to earlier DMSP system; development began in 1972.

5D-2. Follow-on to 5D-1 satellites; first launch occurred in 1982.

5D-3. Most recent DMSP version, first launched in 1999.

Program Review

Background. The Defense Meteorological Satellite Program was established in 1965 to provide weather information in support of military activities. Data on cloud coverings or formation was found to be useful in such areas as photo reconnaissance and locating troop.

Between 1966 and 1980, the program achieved 22 successful launches in 25 attempts, using refurbished surplus Thor boosters. In 1972, the Air Force began development of a more reliable system, designated the Block 5D integrated spacecraft. This effort continued from FY73 through FY77, and the first Block 5D satellite was launched in September 1976.

Efforts to extend the on-orbit life of DMSP satellites from two to three years were completed in 1978. In 1982, the U.S. Air Force launched a Block 5D-2 satellite. The Air Force launched another Block 5D-2 satellite in 1983.

In June 1987, the Air Force launched a DMSP satellite into polar orbit from Vandenberg AFB aboard a General Dynamics Atlas-E to replace the first Block 5D-2 satellite launched in October 1982. The spacecraft became operational within a few weeks.

At the height of Operation Desert Shield in December 1990, the U.S. Air Force Space Command launched a DMSP satellite from Vandenberg Air Force Base. On November 28, 1991, the Air Force launched DMSP F-11 to replace the F-8 (its OLS sensor failed after 50 months in operation). After 19 days of on-orbit testing and evaluation, the Air Force Systems Command turned over the satellite to the Air Force Command for routine operations.

In June 2002, Lockheed Martin received a substantial contract to maintain, test, store, and launch all remaining Defense Meteorological Satellite Program

spacecraft. Lockheed Martin will also provide on-orbit support services under the agreement.

Recent Activity. In October 2003, a Titan II launch vehicle successfully placed a DMSP Block 5D-3 satellite into orbit from Vandenburg Air Force Base in California. Over the next 30 days, the DMSP Early-Orbit Team at the National Oceanic and Atmospheric Administration (NOAA) Space Operations Control Center successfully completed an on-orbit checkout of the satellite and its instruments.

In April 2004, the U.S. Air Force awarded Lockheed Martin a contract modification to provide for the analysis and design work for the integration of DMSP Flight 18 onto an Atlas V launch vehicle. Forecast International expects Lockheed to complete work under this contract modification by year-end 2012.

Funding

U.S. FUNDING

	FY03		FY04		FY05(Req)		FY06(Req)	
	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
Procurement (U.S. Air Force)								
DMSP	-	69.37	-	67.47	-	74.20	-	66.83

	FY07(Req)		FY08(Req)		FY09(Req)	
	QTY	AMT	QTY	AMT	QTY	AMT
Procurement (U.S. Air Force)						
DMSP	-	68.97	-	74.34	-	70.67

All US$ are in millions.

Source: U.S. Air Force FY 2005 Procurement Summary

Recent Contracts

Contractor	Award (US$ millions)	Date/Description
Lockheed Martin	251.3	Jun 2002 – Lockheed Martin Space Systems Company was awarded a contract modification to provide for DMSP spacecraft integration and testing. Work includes maintenance, integration, testing, storage, launch services, and on-orbit support for all remaining DMSP spacecraft. Work is expected to be completed by December 2012. The Space and Missile Systems Center, Los Angeles Air Force Base, is the contracting agency. (F04701-02-C-0003)
Lockheed Martin	11.0	Nov 2002 – Lockheed Martin Space Systems Company was awarded a contract modification to provide personnel, material, and facilities in support of all phases of the Miniature Inertial Measurement Unit (spacecraft gyros) retrofit onto the Defense Meteorological Satellite Program S-16 and S-19 spacecraft, including development, design, procurement, fabrication, integration and testing. Work will be completed by December 2008. The Space and Missile Systems Center, Los Angeles Air Force Base, is the contracting agency. (F04701-02-C-0003, P00008)

Contractor	Award (US$ millions)	Date/Description
Lockheed Martin	16.7	Jun 2003 – Lockheed Martin Space Systems Company was awarded a contract modification to provide all personnel, material and facilities required to accommodate a ninth-month launch slip to the Defense Meteorological Satellite Program F-16 schedule and to support all phases of the Miniature Inertial Measurement Unit retrofit onto the DMSP F-17, including development, design, procurement, fabrication, integration, and testing. This work will be completed by April 2011. The Space and Missile Systems Center, Los Angeles Air Force Base, is the contracting agency. (F04701-02-C-0003, P00015)
Lockheed Martin	9.3	Apr 2004 – Lockheed Martin Corporation receives a contract modification to provide for the analysis and design work for the integration of DMSP Flight 18 onto an Atlas V launch vehicle. This work will be complete by 2012. The Headquarters Space and Missile Systems Center, Los Angeles Air Force Base, California, is the contracting agency. (F04701-02-C-0003, P00029)

Timetable

Month	Year	Major Development
	1966	First Defense Meteorological Satellite Program Block 4 satellite launch
Feb	1970	DMSP operational
Feb	1972	Contract award for Block 5D satellite
Sep	1976	First Block 5D launched
Jun	1977	Second Block 5D launched
Apr	1978	Third Block 5D launched
	1979	Fourth Block 5D launched
Dec	1982	First extended life 5D-2 launched
Nov	1983	Second 5D-2 launched
Jun	1987	Launch of DMSP satellite aboard Atlas E
Feb	1988	DMSP 5D-2 (DMSP 27) launched
Jul	1989	GE Astro-Space picked for Block 5D-3
Dec	1990	Another DMSP 5D-2 launched
Nov	1991	Another DMSP 5D-2 launched
Apr	1997	Last Block 5D-2 placed into orbit
Feb	2001	Lockheed Martin receives contract to integrate the Special Microwave Imager Sounder onto the DMSP S-18 spacecraft
Jun	2002	Lockheed Martin receives contract to maintain, test, store, and launch all remaining DMSP spacecraft
Oct	2003	A Titan II launch vehicle successfully places a DMSP Block 5D-3 satellite into orbit
Apr	2004	Lockheed Martin receives a contract modification to provide analysis and design work for the integration of DMSP Flight 18 onto an Atlas V launch vehicle
	2008	Lockheed Martin to complete Miniature Inertial Measurement Unit retrofit onto DMSP S-16 and S-19 spacecraft

Worldwide Distribution

DMSP is solely a **U.S. Department of Defense** program.

Forecast Rationale

The Defense Meteorological Satellite Program (DMSP) is a United States Department of Defense program managed by the U.S. Air Force Space and Missile Systems Center. The DMSP covers the design, building, launch, and maintenance of several near-polar orbiting, sun-synchronous satellites that monitor the meteorological, oceanographic, and solar-terrestrial environments.

As indicated in the outlook chart, Forecast International projects the U.S. Air Force will spend US$668.46 million over the next decade on DMSP procurement. The U.S. Department of Defense's need to provide the U.S. armed forces with accurate weather data is driving DMSP procurement funding.

DMSP satellites are used for strategic and tactical weather prediction to aid the U.S. military in planning operations at sea, on land, and in the air. Equipped with a sophisticated sensor suite that creates visible and infrared images of cloud cover, each DMSP satellite collects specialized meteorological, oceanographic, and solar-geophysical information in all weather conditions.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR FUNDING (US$ in millions)

				High Confidence Level				Good Confidence Level			Speculative			
Designation	**Application**	**Thru 03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**Total 04-13**
DMSP	DMSP PROCUREMENT (U.S. AIR FORCE)	2107.35	67.47	74.20	66.83	68.97	74.34	70.67	67.00	63.33	59.66	55.99	668.46