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ESA Polar Platform

Outlook

- Production of Metop replacements may not begin production until late in the forecast period with deliveries taking place after the end of the 2010-2019 forecast period
- Metop-A launched in October 2006, currently operational
- Metop-B will launch in 2012
- Metop-C was put into storage in 2009 until needed for launch in 2016
- With no production forecast for the next 10 years, this report will be archived in 2012.

Orientation

Description. The European Space Agency (ESA) Polar Platform program produces a series of Earth resources satellites based on Astrium's SPOT platform.

Sponsor. The ESA has primary responsibility for development of the Polar Platform series. The European Meteorological Satellite Organization (Eumetsat) is cooperating with the ESA on the development of Metop spacecraft.

Status. Envisat was launched aboard an Ariane 5 booster in March 2002, while Metop-A was launched in 2006. Metop-B and -C will launch in 2012 and 2016, respectively.

Total Produced. Four (one Envisat, three Metop). The Metop-A, Metop-B, and Metop-C are complete.

Application. The Polar Platform is designed for continuous Earth observations, including monitoring of the terrestrial environment for cartographic, resource prospecting, and meteorological and hazard identification purposes. Secondary operations include space science disciplines research.

Price Range. Total development cost for the Envisat is approximately $2.5 billion, including the satellite's construction, launch, and ground facilities, and the first five years of operation. The Envisat platform structure cost about $871 million.

The Metop program, including three satellites and their launch and ground operations, is expected to cost about $2.3 billion. Each Metop spacecraft is expected to cost an average of $550 million.

Contractors

Prime

Astrium	http://www.astrium.eads.net/en, Gunnels Wood Rd, Stevenage, SG1 2AS United Kingdom, Tel: + 44 1438 313 456, Fax: + 44 1438 773 637, Prime (METOP Spacecraft; Metop Payload Module; Metop ASCAT Radar)

Subcontractor

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BAE Systems, Electronic Solutions	http://www.baesystems.com/Businesses/ElectronicSolutions/, 130 Daniel Webster Hwy, Merrimack, NH 03054 United States, Tel: + 1 (603) 885-9500 (Envisat High-Capacity Tape Recorders)
RUAG Space AB	http://www.ruag.com/Space/, Solhusgatan 11, Göteborg, 405 15 Sweden, Tel: + 46 31 735 00 00, Fax: + 46 31 735 40 00 (Metop GRAS Radiometer)
Thales Alenia Space	http://www.thaleson-line.com/space, 26 ave JF Champollion, BP 1187, Toulouse, 31037 France, Tel: + 33 05 34 35 36 37, Fax: + 33 05 61 44 49 90 (Radar Antenna Panels)
Thales Alenia Space Italia	http://www.thalesgroup.com/Markets/Space/Home/, Via Saccomuro, 24, Rome, 00131 Italy, Tel: + 39 06 41511, Fax: + 39 06 4190675 (Envisat Microwave Radiometer)

Technical Data

Design Features. The Polar Platform, on which the Envisat and Metop satellites are based, consists of two modules: the service module and the payload module, the latter of which carries the instruments for sensing Earth and the atmosphere. Because of the platform's modular structure, these two elements can be developed and built in parallel. Modularity is also omnipresent inside the two modules, thereby accommodating individually tailored dimensions and capabilities. The only limiting factors in the design are the overall dimensions, which had to be compatible with the Ariane 5 launcher.

The service module reuses many items of equipment already developed for the French SPOT 4 Earth observation satellite. However, the structure that carries the various subsystems had to be enlarged, as did the base plate, on which eight batteries can now be mounted. The four propulsion unit tanks together hold 300 kilograms of hydrazine fuel for attitude and orbit control, sufficient to keep the module in service for at least five years. The service module also accommodates an S-band terminal for command and control by way of the ESA's new Artemis Data Relay Satellite system.

The modular concept of the Polar Platform is demonstrated by its solar array, which uses technology derived from the ESA's Eureca retrievable platform. This is an entirely new development, made up of rigid panels fitted with solar cell elements. These panels are folded during launch and deployed once in orbit. A mission's power requirement dictates how many solar panels are actually used – in the case of Envisat, 14 panels provide 6.6 kW of power.

The payload module comprises, in a similarly flexible way, two to five segments, each measuring 1.6 meters in length. Envisat has four such segments. When assembled, the payload and service modules stand 11 meters high inside the Ariane 5 fairing.

The core of the payload module, the payload equipment bay, has been designed to provide maximum capabilities for the payload. It is, for example, possible to vary the number of data recorders, the data storage capacity, and the number of communications channels to Earth. Payload data can be transmitted (using two 100-Mbits/s channels simultaneously) in the X-band to ground receiving stations within direct view of the satellite, or by way of the Data Relay System, directly over Europe.

Envisat. This satellite is dedicated to monitoring the environment and providing radar data as a complement to the data provided by the ERS-1 and ERS-2 synthetic aperture radar.

Four Envisat instruments are geared toward studies of the Earth's surface and oceans, as follows:

- ASAR (Advanced Synthetic Aperture Radar) is a C-band system built on the experience gained from the ERS-1/2 satellite program. It features dual polarization, a 400-kilometer-wide swath, and a set of viewing angles.
- The MERIS (Medium Resolution Imaging Spectrometer) addresses the needs of three disciplines, primarily oceanographic and secondarily atmospheric and land observations. Its 1,150 kilometer-wide swath is divided into five segments covered by five identical cameras having corresponding fields of view, with a slight overlap between adjacent cameras.
- AATSR (Advanced Along Track Scanning Radiometer) provides continuity of the ATSR-1 and ATSR-2 data sets from the ERS-1/2 spacecraft. Its 500-kilometer-swath radiometer (in infrared and

visible wavelengths) precisely measures sea surface temperatures and observes land characteristics.

- The advanced Radar Altimeter (RA-2) is an instrument for determining wave heights, and the heights of sea ice, polar ice sheets, and most land surfaces, with high precision. It also measures wind speeds globally and provides information on ocean circulation.

Envisat also carries instruments to address atmospheric dynamics. They include the following:

- MIPAS (Michelson Interferometer for Passive Atmospheric Sounding) is a Fourier transform spectrometer for the measurement of high-resolution gaseous emission spectra at the Earth's limb. It operates in the mid-infrared spectrum.
- GOMOS (Global Ozone Monitoring by Occultation of Stars) is a limb-viewing spectrometer observing ozone and other trace gases in the stratosphere, at high vertical resolution. An advanced follow-on to the Global Ozone Measuring Experiment (GOME) used on the ERS-1 satellite, GOMOS takes measurements both day and night, with more than 600 profile measures taken each day.
- SCIAMACHY (Scanning Imaging Absorption Spectrometer for Atmospheric Cartography) provides global measurements of trace gases in the troposphere and stratosphere using a limb- and nadir-viewing imaging spectrometer.
- MWR (Microwave Radiometer) measures the integrated atmospheric water content in clouds and rain. It has evolved from the instruments previously flown on ERS-1 and ERS-2.
- DORIS (Doppler Orbitography and Radio positioning Integrated by Satellite) is a tracking system providing the Envisat's satellite orbit with an accuracy on the order of centimeters.

	Metric	U.S.
Dimensions		
Envisat length	8 m	26.2 ft
Envisat width	3 m	9.8 ft
Envisat solar array length	14 m	45.9 ft
Envisat solar array width	5 m	16.4 ft
Weight		
Envisat weight	8,200 kg	18,040 lb
Envisat payload capacity	2,000 kg	4,409 lb
Power, average	1.9 kW	
Power, peak	6.6 kW	
Earth direct link	X-band	
DRS link	Ka-band	
Polar orbit altitude	800 km	497 mi
Orbit duration	100 m	
Earth observation cycle time	35 days	
Design life	4-5 years	

Metop-1. Developed in cooperation with Eumetsat, Metop-1 is a remote-sensing satellite that will provide operational meteorological observations. With Europe and the U.S. sharing weather information from polar orbit since 2005, Eumetsat takes responsibility for the 9:30 a.m. orbit, the local time at which the satellite passes over the Earth's equator, with NOAA covering the afternoon orbit.

Also based on the Polar Platform, the 4,500-kilogram Metop features subsystems adapted to the Metop mission requirement. Metop-1 (Metop-B) and Metop-2 (Metop-A) payloads are nearly identical, but the payload will likely evolve for Metop-C. Metop-A carries the following instruments:

- AVHRR/3 – Advanced Very High Resolution Radiometer. A six-channel radiometer operating in the visible and near-IR wavelength with a 1-kilometer resolution. AVHRR/3 provides global imagery of clouds, the ocean, and land surfaces.
- HIRS/4 – High Resolution Infrared Radiation Sounder, a 20-channel sounding unit operating predominately in IR wavelength. The HIRS/4 can detect the temperature and humidity of the global atmosphere in cloud-free conditions. The instrument is provided by NOAA.
- AMSU-A1 & A2 – Advanced Microwave Sounding Units 1 & 2. The third instrument developed by NOAA, the AMSU-A is able to detect the temperature of the global atmosphere in all weather conditions.
- MHS – Microwave Humidity Sounder. Provided by Eumetsat, the MHS is a five-channel scanning

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radiometer that measures the humidity of the global atmosphere.

- IASI – Infrared Atmospheric Sounding Interferometer. This instrument provides enhanced atmospheric soundings. It was developed as a joint effort by CNES (Centre National d'Etudes Spatiales) and Eumetsat.
- GRAS – Global Navigation Satellite System Receiver for Atmospheric Sounding. By providing the temperature of the upper troposphere and stratosphere with high vertical resolution, GRAS aids Numerical Weather Prediction (NWP) systems, weather services, climate change centers, and atmospheric and ionospheric researchers. The instrument was developed by ESA/Eumetsat.
- ASCAT – Advanced Scatterometer. This ESA instrument measures near-surface wind speeds over the global oceans.
- GOME-2 – Global Ozone Experiment-2. GOME-2 is used to monitor profiles of ozone and other atmospheric constituents.

	Metric	U.S.
Weight		
Metop launch mass	4,813 kg	10,588 lb
Payload mass	919 kg	2,021 lb
Performance		
Altitude	840 km	521 mi
Power	4 kW	
Orbit	Sun-synchronous, near polar	
Equator descending crossing time	9:30 a.m.	
Design life	5 years	
Repeat cycle	5 days	

Artist's Impression of a Metop at Work

Source: EADS Astrium

Variants/Upgrades

Metop-B (Metop-1). Metop-B will be identical to Metop-A. Launch planned for 2012.

Metop-C (Metop-3). While the overall spacecraft design will be the same as that of its predecessors, upgrades of the AVHRR/3, AMSU-A, and GOME-2 instruments are being considered for Metop-C. Launch planned for 2016.

Program Review

Background. The Polar Orbit Earth Observation Mission (POEM-1) was first proposed in the mid-1980s to the European Space Agency (ESA), which, at the time, was committed to developing three major programs: Hermes, the International Space Station, and the Data Relay System (DRS). The ESA Polar Platform that would serve as the basis of POEM-1 was also to provide the basis for the ISS Columbus Space Station module.

POEM Split in Two

In 1992, the ESA agreed to include POEM-1 and -2 as part of its Earth Observation Program. Later that year, the POEM program was split into two parts: Envisat and Metop. Envisat is geared toward observations of the Earth's surface and atmosphere, as well as serving as a follow-on to the radar remote-sensing capacity aboard ERS-1 and ERS-2. Meanwhile, the Metop program is producing Europe's first polar-orbiting weather satellites and complements Meteosat spacecraft operated by Eumetsat.

Eumetsat gave official approval in 1998 for the Eumetsat Polar System (EPS) program to begin. The Polar Platform is a development of Astrium's highly successful SPOT satellite platform, on which many of the ESA's Earth observation satellites, including the ERS series, have been based. The Astrium company began leading the industrial development of this modular platform in 1989, coordinating the involvement of about 50 companies from 12 countries.

Joint Operation Agreed Upon

Later that year, the U.S. National Oceanic and Atmospheric Administration (NOAA) and the ESA agreed to produce the Initial Joint Polar System (IJPS), in which both parties would operate their polar-orbiting satellite as an integrated system. The agreement was also to ensure complete global data coverage at intervals of no more than six hours. The IJPS commenced with the deployment of Metop-A in 2006.

Envisat, originally scheduled for an October 2001 flight, was finally launched atop an Ariane 5 rocket in March 2002. After a few verification snags, the satellite was declared fully operational at the end of the year. Envisat is expected to continue transmitting unprecedented Earth observation imagery and data through at least 2008.

Metop. Metop is a series of three satellites to be launched sequentially over 14 years. It forms the space segment of Eumetsat's Polar System. The Metop-A is Europe's first polar-orbiting satellite dedicated to operational meteorology. As previously mentioned, it also represents the European contribution to the cooperative venture with the United States, the Initial Joint Polar System (IJPS), in which Eumetsat and the U.S. NOAA jointly provide data for climate and environmental monitoring and improved weather forecasting. Metop-1 will serve alongside the POES/NOAA series of polar-orbiting weather satellites managed by NOAA. It will be responsible for the "morning" (local time) orbit, while the NOAA polar-orbiting spacecraft will continue with the "afternoon" coverage.

Launch of the first Metop spacecraft was originally planned for 2003 but was delayed until 2006 due to problems with the ground station's retrieval capabilities and a delay in Eumetsat's approval of the program.

While the ESA Polar Platform was specifically designed for launch on an Ariane 5, the disastrous failure of the debut Ariane 5-ECA heavy-lift variant in December 2002 scuttled many plans to use the rocket. Eumetsat awarded Starsem a $120 million contract to launch two Metop spacecraft, with an option for a third mission. The spacecraft will be launched separately aboard Soyuz ST rockets from Baikonur Cosmodrome in Kazakhstan.

Metop Program Restructured

Due to a change in schedule, the Metop-1 satellite is not planned for flight until 2012, and will be stored until needed. The satellite was renamed Metop-B, while Metop-2 was renamed Metop-A, and launched in 2006. Metop-3 will be known as Metop-C, and is currently scheduled to fly in 2016.

Data Denial Agreement Signed

The U.S. NOAA and the European Organization for the Exploitation of Meteorological Satellites have reached a deal on the controversial Data Denial Implementation Plan (DDIP), which secures the continued flow of real-time meteorological satellite data from NOAA-provided instruments on board Eumetsat's Metop spacecraft to public duty users in the United States and Eumetsat member states during episodes that might otherwise require data denial. Data denial means real-time data from U.S. environmental instruments can be denied during periods of crisis or war. The agreement provides the necessary steps for data denial if NOAA makes the request. One important feature of the DDIP is that it contains lists of public duty users in the United States and in Eumetsat Member and Cooperating States who will be allowed to continue receiving real-time access to U.S. instrument data during episodes of data denial. No restriction will apply to the availability of data more than three hours old.

Quid Pro Quo

NOAA and Eumetsat agreed to allow for Eumetsat's repair of a sounding instrument that was damaged in a 2003 incident involving NOAA's N-Prime satellite. In exchange, NOAA will extend pre-launch support of an imager instrument designated for integration on Eumetsat's Metop-3 satellite.

Successful Launch and Handover of First Metop

The first Metop was launched in October 2006 on a Soyuz ST from the Baikonur Cosmodrome. Following launch, the handover of Metop-A to Eumetsat was performed by the European Space Operations Center (ESOC). The Metop-A Satellite In-Orbit Verification (SIOV) phase started October 23, 2006, and was completed in March 2007.

Slovenia Becomes Eumetsat's 21st Member State

Eumetsat was officially notified by the Depositary of the Eumetsat Convention that Slovenia had deposited its instrument of accession to the convention in February 2008, thus becoming the European weather satellite organization's 21st member state. The Slovenian Hydrometeorological Institute will use Eumetsat satellite data for operational and research activities in meteorology and hydrology.

Metop-B. Metop-B began a de-storage campaign in 2009. In June 2010, the Metop-B payload was placed in the Large Space Simulator (LSS), a vacuum chamber designed to test spacecraft payloads. The payload was removed in August 2010, having successfully passed its tests. Metop-B is planned to launch in 2012.

Timetable

Month	Year	Major Development
Nov	1992	ESA ministers approve funding for Envisat and Metop-1
Mar	1993	ESA ministers endorse Polar Platform development plan
Sep	1994	Envisat and Polar Platform development contracts awarded
Mar	2002	Envisat-1 launched on Ariane 5
Oct	2006	Metop-A (Metop-2) launched on Soyuz ST
	2012	Scheduled launch of Metop-B (Metop-1) on Soyuz ST
	2016	Scheduled launch of Metop-C (Metop-3)

Forecast Rationale

Metop satellites have completed production. One satellite is currently operational, while the other two will be launched in the future. ESA originally planned to keep each satellite in service for about five years, but with Metop-B scheduled to launch in 2012, it would appear that Metop-A, which launched in 2006, will stay operational for six years.

There has been some discussion within ESA and EUMETSAT (European Organisation for the Exploitation of Meteorological Satellites) about a follow-on to Metop. In fact, ESA and EUMETSAT have begun feasibility studies to begin planning this follow-on mission, which is known as Metop Second Generation, or EPS Second Generation. However, deliveries will likely not begin until after the forecast period.

With manufacturing complete on the first three Metop satellites, ESA and EUMETSAT have turned their attention to developing a next-generation system. Satellites will not be needed until after the forecast period, but the agencies want to avoid any risk of a gap. ESA and EUMETSAT will also work on launching Metop-B and Metop-C, which were built at the same time as Metop-A, but not launched. With no production forecast for the next 10 years, this report will be archived in 2012.

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