

## Satellites launched for Europe and India

Arianespace will be orbiting two payloads on its sixth flight of the year: the INSAT 4A communications satellite for ISRO, the Indian Space Research Organization, and the MSG-2 weather satellite for Eumetsat, the European Meteorological Satellite Organization.

INSAT 4A will be the 12th ISRO satellite to be launched by Europe's Ariane booster. Since the launch of the Apple experimental satellite on Flight L03 in 1981, Arianespace has orbited 11 Indian satellites. Another ISRO satellite, INSAT 4B, is still to be launched by Arianespace.

Weighing about 3,100 kg at launch, INSAT 4A was designed, assembled and integrated by ISRO in Bangalore, India. INSAT 4A is a dedicated telecommunications satellite, with 12 Ku-band transponders and 12 C-band transponders. Its footprint will primarily cover all of the Indian sub-continent.

MSG-2, the second Meteosat Second Generation satellite, is part of a European program comprising four geostationary meteorological observation and forecasting satellites. It is the eighth Eumetsat satellite to be launched by Arianespace. The first second-generation satellite was launched on August 28, 2002 by Arianespace. The third in the series, and the ninth to be launched by Arianespace, is scheduled for a 2009 liftoff.

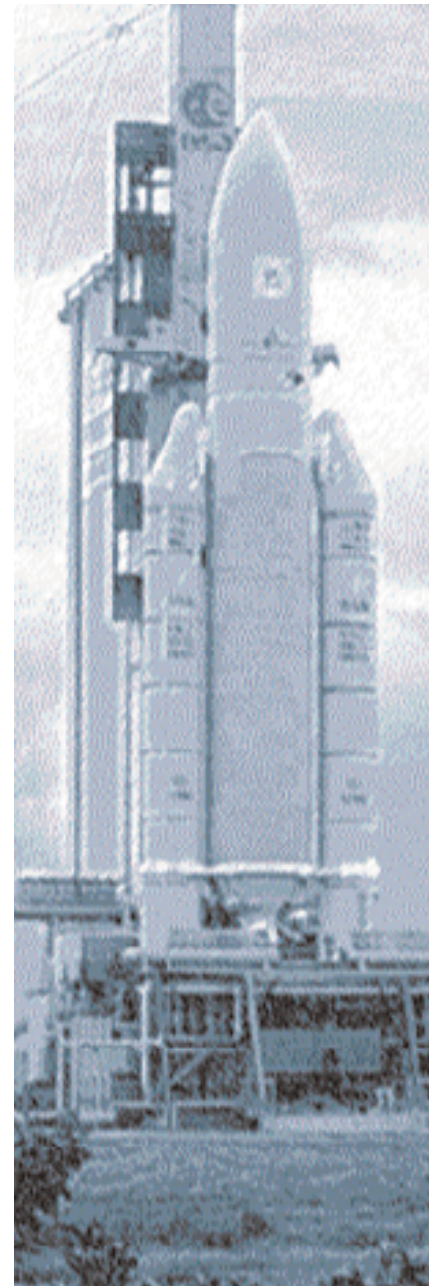
MSG-2 was built by prime contractor Alcatel Alenia Space, and will weigh about 2,000 kg at launch. Its main instrument is fitted with 12 separate observation channels, three in the visible wavelength, and nine infrared. It will transmit images every 15 minutes.

The MSG-2 satellite will ensure service continuity, giving meteorologists a powerful weather observation and forecasting tool covering Europe and neighboring regions.

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## 1. Arianespace Flight mission

The 169th Ariane launch will orbit two satellites: the INSAT 4A communications satellite for ISRO, the Indian Space Research Organization, and the MSG-2 weather satellite for the European Meteorological Satellite Organization, Eumetsat.

This will be the 25th Ariane 5 launch.

The launcher will be carrying a total payload of 6,390 kg, including 5,110 kg for the INSAT 4A and MSG-2 satellites. The mission will be carried out from Ariane Launch Complex No. 3 (ELA 3) in Kourou, French Guiana.

### Injection orbit

<i>Perigee altitude</i>	<b>620 km</b>
<i>Apogee altitude</i>	<b>36,026 km at injection</b>
<i>Inclination</i>	<b>4° degrees</b>

The lift-off is scheduled on the night of december 21 to 22, 2005 as soon as possible within the following launch window:

### Launch opportunity

	<i>Universal time (GMT)</i>	<i>Paris time</i>	<i>Washington time</i>	<i>Bangalore time</i>	<i>Kourou time</i>
<i>Between</i>	<b>10:33 pm</b>	<b>11:33 am</b>	<b>05:33 pm</b>	<b>04:03 am</b>	<b>07:33 pm</b>
<i>and</i>	<b>11:01 pm</b>	<b>00:01 am</b>	<b>06:01 pm</b>	<b>04:31 am</b>	<b>08:01 pm</b>
<i>on</i>	<b>Dec. 21, 2005</b>	<b>Dec. 21/22, 2005</b>	<b>Dec. 21, 2005</b>	<b>Dec. 22, 2005</b>	<b>Dec. 21, 2005</b>

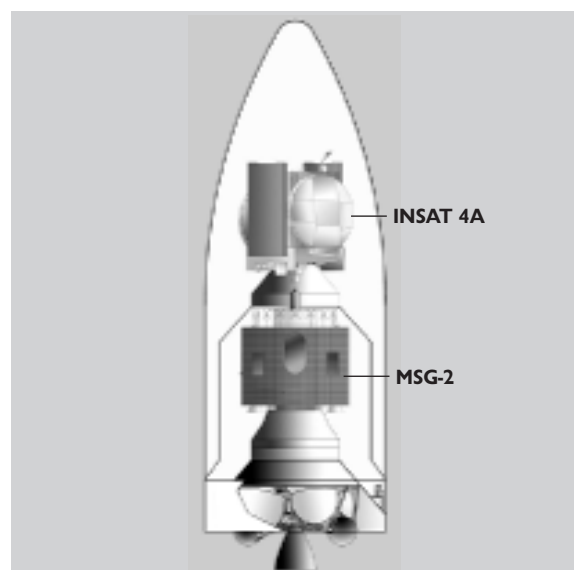
## Ariane payload configuration

**The INSAT 4A satellite** was designed, assembled and integrated by the Indian Space Research Organization in Bangalore (India).

*Orbital position: 83 degrees East, over the Indian Ocean.*

**The MSG-2 satellite** was manufactured by Alcatel Alenia Space in Cannes (southern France), with the European Space Agency acting as project manager on behalf of Eumetsat.

*Orbital position: 0 degrees longitude, over the Gulf of Guinea.*



## 2. Range operations campaign: ARIANE 5 - INSAT 4A/MSG-2

### Satellites and launch vehicle campaign calendar

Ariane activities	Dates	Satellites activities
	June 21, 2005	Arrival in Kourou and beginning of MSG-2 preparation campaign in building S5C
	Oct. 25, 2005	Arrival in Kourou and beginning of INSAT 4A preparation campaign in building S1B
Campaign start review	Nov. 17, 2005	
EPC Erection	Nov. 17, 2005	
	Nov. 18, 2005	Transfer of INSAT 4A to S5B
EAP transfer and positioning	Nov. 18-19, 2005	
Integration EPC/EAP	Nov. 21, 2005	
EPS Erection	Nov. 23, 2005	
Integration equipment bay	Nov. 23, 2005	
	Nov. 24, 2005	Transfer of MSG-2 from S5C to S5A
	Nov. 22-24, 2005	INSAT 4A filling operations in S5B building
	Nov. 29-1 <sup>st</sup> Dec., 2005	MSG-2 filling operations in S5A building
Roll-out from BIL to BAF	Dec. 7, 2005	

### Satellites and launch vehicle campaign final calendar

J-10	Thursday, Dec. 8	INSAT 4A integration on adaptor
J-9	Friday, Dec. 9	INSAT 4A transfer to Final Assembly Building (BAF)
J-8	Saturday, Dec. 10	INSAT 4A integration on Sylida
J-7	Monday, Dec. 12	Fairing integration on Sylida - MSG-2 integration on adaptor and transfer to Final Assembly Building (BAF)
J-6	Tuesday, Dec. 13	MSG-2 integration on launcher
J-5	Wednesday, Dec. 14	Upper composite integration with INSAT 4A on launcher
J-4	Thursday, Dec. 15	Filling of SCA with N <sub>2</sub> H <sub>4</sub> - Filling of EPS with MMH
J-3	Friday, Dec. 16	Launch rehearsal - Filling of EPS with N <sub>2</sub> O <sub>4</sub>
J-2	Monday, Dec. 19	Launch readiness review (RAL). Arming of launch vehicle and final preparation of launcher
J-1	Tuesday, Dec. 20	Roll-out from BAF to Launch Area (ZL), launch vehicle connections and filling of the EPC liquid Helium sphere
J-0	Wednesday, Dec. 21	Launch countdown including EPC filling with liquid oxygen and liquid hydrogen

### 3. Launch countdown and flight events

The countdown comprises all final preparation steps for the launcher, the satellites and the launch site. If it proceeds as planned, the countdown leads to the ignition of the main stage engine, then the two boosters, for a liftoff at the targeted time, as early as possible in the satellites launch window.

The countdown culminates in a synchronized sequence (see appendix 3), which is managed by the control station and onboard computers starting at T-7 minutes.

If an interruption in the countdown means that T-0 falls outside the launch window, then the launch will be delayed by one, two or more days, depending on the problem involved, and the solution developed.

Time	Events
- 11 h 30 mn	Start of final countdown
- 7 h 30 mn	Check of electrical systems
- 5 h 50 mn	Start of filling of main cryogenic stage with liquid oxygen and hydrogen
- 3 h 20 mn	Chilldown of Vulcain main stage engine
- 1 h 10 mn	Check of connections between launcher and telemetry, tracking and command systems
- 16 mn 00 s	"All systems go" report, allowing start of synchronized sequence
- 4 mn 00 s	Tanks pressurized for flight
- 1 mn 00 s	Switch to onboard power mode
- 04 s	Onboard systems take over
- 03 s	Unlocking of guidance systems to flight mode

HO	Ignition of the cryogenic main stage engine (EPC)	ALT (km)	V. rel. (m/s)
+ 7,0 s	Ignition of solid boosters	0	0
+ 7,3 s	Liftoff	0	0
+ 13 s	End of vertical climb and beginning of pitch rotation (10 seconds duration)	0.09	39.3
+ 17 s	Beginning of roll manoeuvre	0.36	79.6
+ 2 mn 20 s	Jettisoning of solid boosters	65	2125
+ 3 mn 22 s	Jettisoning of fairing	107	2416
+ 8 mn 08 s	Acquisition by Natal tracking station	133	5634
+ 9 mn 41 s	Shut-down of main cryogenic stage	145	7708
+ 9 mn 47 s	Separation of main cryogenic stage	148	7726
+ 9 mn 54 s	Ignition of the storable propellant stage (EPS)	151	7723
+ 12 mn 20 s	Acquisition by Ascension tracking station	228	7869
+ 21 mn 43 s	Acquisition by Malindi tracking station	879	8374
+ 26 mn 45 s	Shut-down of EPS / Injection	1576	8623
+ 29 mn 05 s	Separation of INSAT 4A satellite	2011	8321
+ 32 mn 15 s	Separation of Sylva 5	2669	7898
+ 36 mn 44 s	Separation of MSG-2 satellite	3705	7307
+ 56 mn 48 s	End of Arianespace Flight mission	8608	5305



## 4. Flight trajectory

The launcher's attitude and trajectory are totally controlled by the two onboard computers, located in the Ariane 5 vehicle equipment bay (VEB).

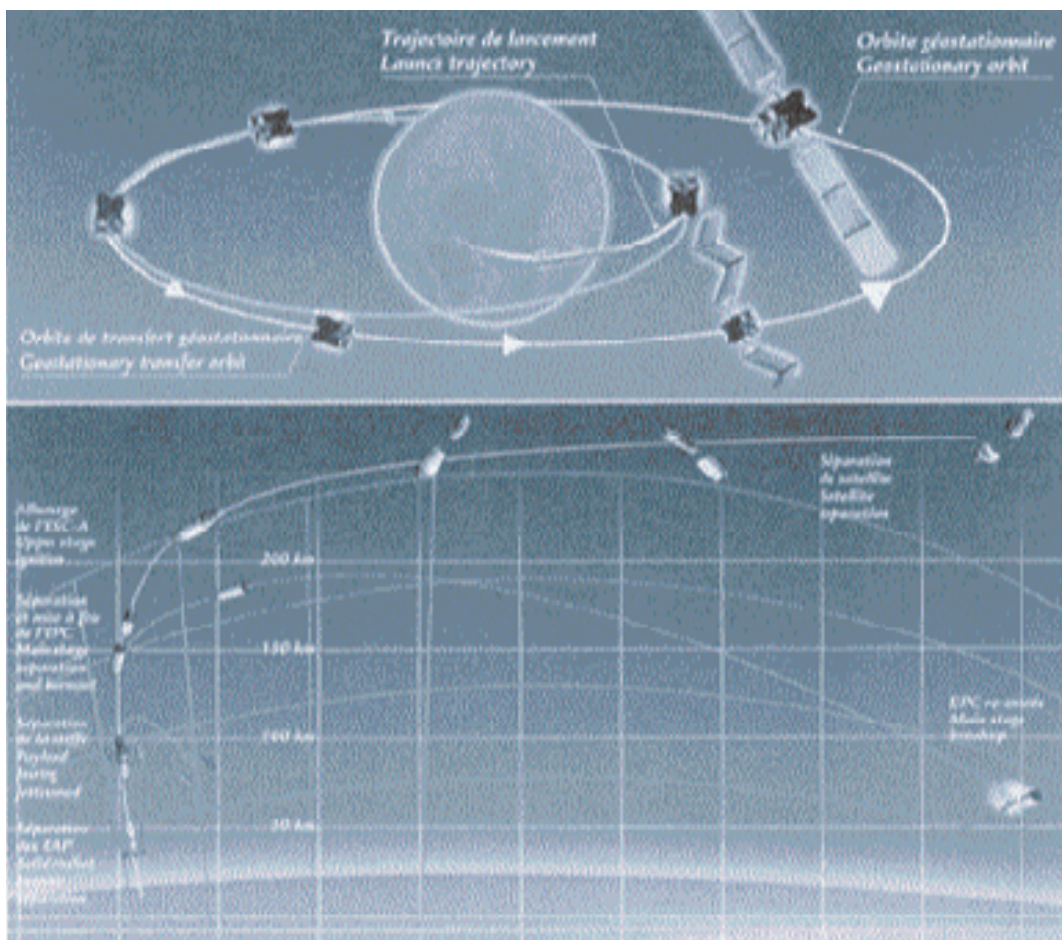
7.05 seconds after ignition of the main stage cryogenic engine at T-0, the two solid-propellant boosters are ignited, enabling liftoff. The launcher first climbs vertically for 6 seconds, then rotates towards the East. It maintains an attitude that ensures the axis of the launcher remains parallel to its velocity vector, in order to minimize aerodynamic loads throughout the entire atmospheric phase, until the solid boosters are jettisoned.

Once this first part of the flight is completed, the onboard computers optimize the trajectory in real time, minimizing propellant consumption to bring the launcher first to the intermediate orbit targeted at the end of the main stage propulsion phase, and then the final orbit at the end of the flight of the storable propellant stage. The main stage falls back off the coast of Africa in the Atlantic Ocean (in the Gulf of Guinea).

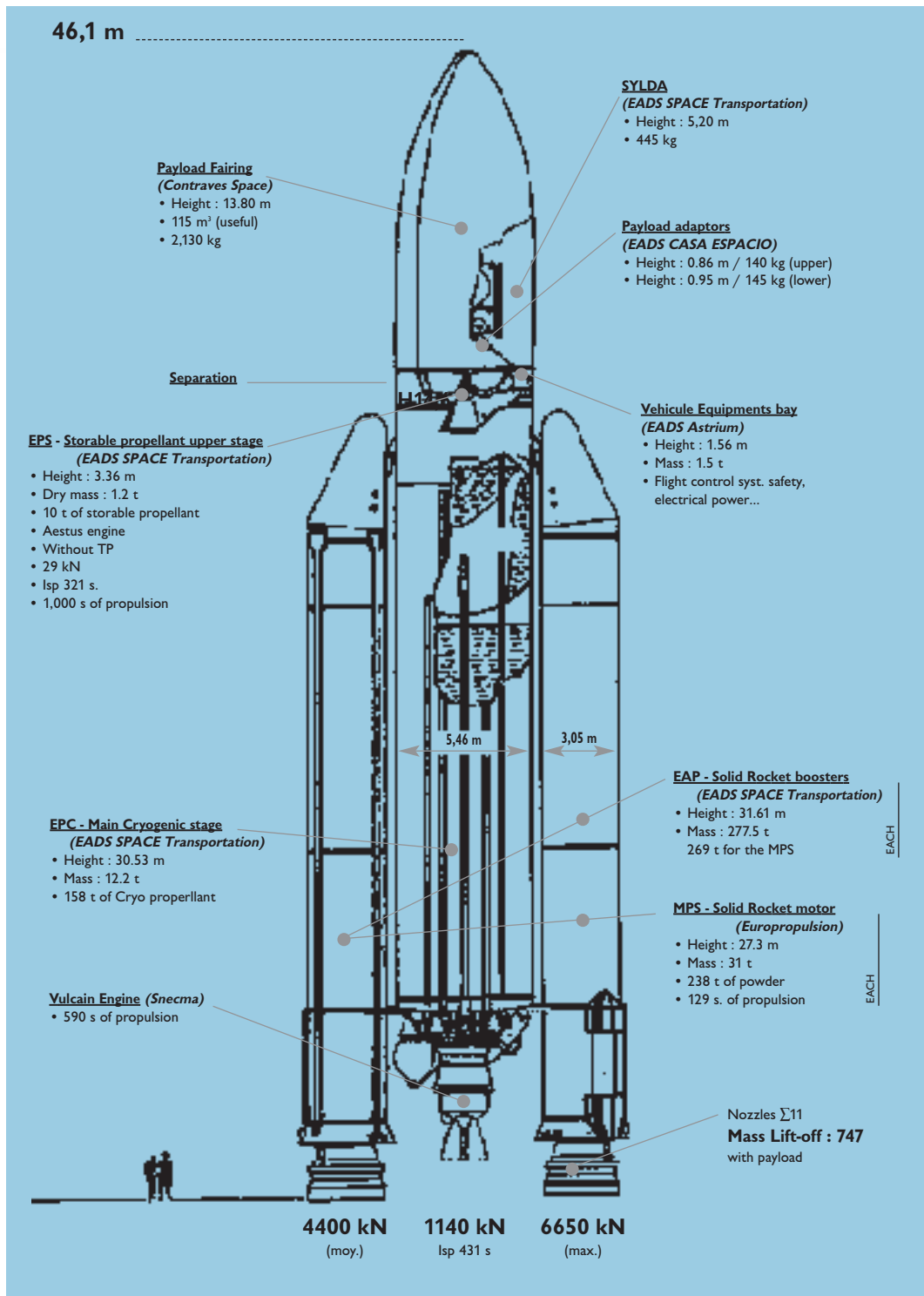
On orbital injection, the launcher will have attained a velocity of approximately 8,623 meters/second, and will be at an altitude of about 1,576 kilometers.

The fairing protecting the INSAT 4A/MSG-2 spacecraft is jettisoned shortly after the boosters are jettisoned at about T+202 seconds.

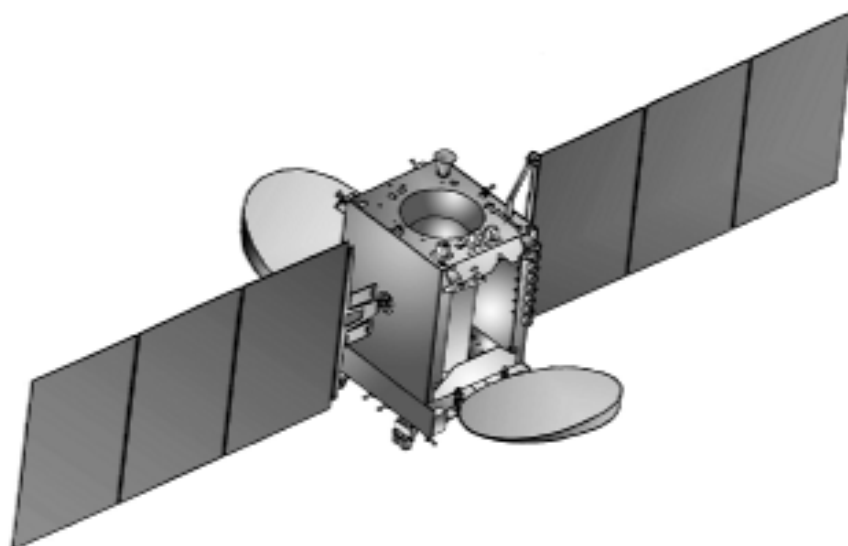
### Standard Ariane 5 trajectory for geostationary transfer orbit



## 5. The Ariane 5G (Industrial architect: EADS SPACE Transportation)



## 6. The INSAT 4A satellite

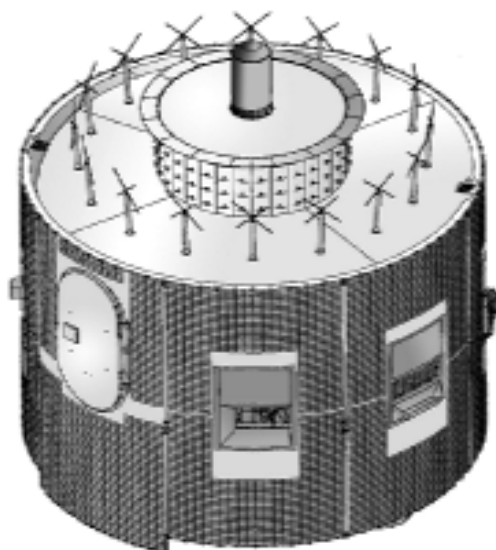


<b>Customer</b>	<b>Indian Space Research Organisation (ISRO)</b>	
<i>Prime contractor</i>	<i>ISRO/ISAC</i>	
<i>Mission</i>	<i>Telecommunications satellite</i>	
<i>Mass</i>	<i>Total mass at lift-off</i>	<i>3.081 kg</i>
	<i>Dry mass</i>	<i>1.386 kg</i>
<i>Stabilization</i>	<i>3 axis stabilized</i>	
<i>Dimensions</i>	<i>2.8 x 1.77 x 2.0 m</i>	
<i>Span in orbit</i>	<i>15.4 m</i>	
<i>Payload</i>	<i>12 C band transponders and 12 Ku band transponders</i>	
<i>On-board power</i>	<i>5200 W (end of life)</i>	
<i>Life time</i>	<i>12 years minimum</i>	
<i>Orbital position</i>	<i>83° East over the Indian Ocean</i>	
<i>Coverage area</i>	<i>India</i>	

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## 7. The MSG-2 satellite



<b>Customer</b>	<b>EUMETSAT</b>	
<i>Prime contractor</i>	<i>Alcatel Alenia Space</i>	
<i>Mission</i>	<i>Meteorological satellite</i>	
<i>Mass</i>	<i>Total mass at lift-off</i>	<i>2034 kg</i>
<i>Stabilization</i>	<i>Spinned</i>	
<i>Dimensions</i>	<i>at launch</i>	<i>ø 3.2 x 2.3 m</i>
<i>Platform</i>	<i>MSG FM 2</i>	
<i>Payload</i>	<i>12 channel radiometer</i>	
<i>On-board power</i>	<i>700 kW (end of life)</i>	
<i>Life time</i>	<i>7 years</i>	
<i>Orbital position</i>	<i>0° North, 0° East</i>	
<i>Coverage area</i>	<i>Europe, Africa, The Atlantic Ocean, East of South America</i>	

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## Appendix 1. Arianespace INSAT 4A/MSG-2 launch key personnel

### In charge of the launch campaign

<i>Mission Director</i>	<i>(CM)</i>	<i>Jean-Marc DURAND</i>	<i>ARIANESPACE</i>
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### In charge of the launch service contract

<i>Ariane Payload Manager</i>	<i>(RCUA)</i>	<i>Christophe BARDOU</i>	<i>ARIANESPACE</i>
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<i>Ariane Deputy Mission Manager</i>	<i>(RCUA/A)</i>	<i>Alexandre MADEMBA-SY</i>	<i>ARIANESPACE</i>
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### In charge of INSAT 4A satellite

<i>INSAT Program Director</i>	<i>(DP)</i>	<i>V. R. KATTI</i>	<i>ISRO</i>
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<i>Satellite Mission Director &amp; Program Manager</i>	<i>(DMS)</i>	<i>Y. K. SINGHAL</i>	<i>ISRO</i>
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<i>Satellite Preparation Manager</i>	<i>(CPS)</i>	<i>B. VANKATA RAO</i>	<i>ISRO</i>
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### In charge of MSG-2 satellite

<i>Satellite Mission Director</i>	<i>(DMS)</i>	<i>Sergio ROTA</i>	<i>EUMETSAT</i>
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<i>Satellite Program Manager</i>	<i>(CPS)</i>	<i>Wolfgang SCHUMAN</i>	<i>ESA</i>
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<i>Satellite Preparation Manager</i>	<i>(RPS)</i>	<i>Alain GUEDJ</i>	<i>Alcatel Alenia Space</i>
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### In charge of the launch vehicle

<i>Launch Site Operations Manager</i>	<i>(COEL)</i>	<i>Christian LARDOT</i>	<i>ARIANESPACE</i>
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<i>Ariane Production Project Manager</i>	<i>(CPAP)</i>	<i>Roland LAGIER</i>	<i>ARIANESPACE</i>
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### In charge of the Guiana Space Center (CSG)

<i>Range Operations Manager</i>	<i>(DDO)</i>	<i>Pierre RIBARDIERE</i>	<i>CNES/CSG</i>
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<i>Flight Safety Officer</i>	<i>(RSV)</i>	<i>Stéphane LOUVEL</i>	<i>CNES/CSG</i>
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## Appendix 2. Launch environment conditions

Acceptable wind speed limits at lift-off range from between 7.5 m/s to 9.5 m/s according to the wind direction. The most critical is a northerly wind. For safety reasons, the wind's speed on the ground (Kourou), and at a high altitude (between 10,000 and 20,000 m) is also taken into account.

## Appendix 3. The synchronized sequence

The synchronized sequence starts 7 mn before ignition (T-0), it is primarily designed to perform the final operations on the launcher prior to launch, along with the ultimate checks needed following switchover to flight configuration. As its name indicates, it is fully automatic, and is performed concurrently by the onboard computer and by two redundant computers at the ELA 3 launch complex until T-4 seconds.

The computers command the final electrical operations (startup of the flight program, servocontrols, switching from ground power supply to onboard batteries, etc.) and associated checks. They also place the propellant and fluid systems in flight configuration and perform associated checks. In addition, it handles the final ground system configurations, namely:

- Startup of water injection in the flame trenches and jet guide (T-30 sec).
- Hydrogen aspiration for chilldown of the Vulcain engine in the jet guide (T-18 sec).
- Burnoff of hydrogen used for chilldown (T-5.5 sec).

At T-4 seconds, the onboard computer takes over control of final engine startup and lift-off operations:

- It starts the ignition sequence for the Vulcain main stage engine (T-0).
- It checks engine operation (from T+4.5 to T+7.3 sec).
- It commands ignition of the solid boosters for immediate lift-off at T+7.3 seconds.

Any shutdown of the synchronized sequence after T-7 mn automatically places the launcher back in its T-7 min configuration.



## Appendix 4. Arianespace, its relations with ESA and CNES

**From a production base in Europe, Arianespace, a private company, serves customers all over the world.**

Arianespace is the world's first commercial space transportation company, created in 1980 by 36 leading European aerospace and electronics corporations, 13 major banks and the French space agency CNES (Centre National d'Etudes Spatiales).

The shareholder partners in Arianespace represent the scientific, technical, financial and political capabilities of 12 countries: Belgium, Denmark, Germany, France, Great Britain, Ireland, Italy, Netherlands, Norway, Spain, Switzerland and Sweden.

In order to meet the market needs, Arianespace is present throughout the world: in Europe, with its head office located near Paris, France at Evry, in North America with its subsidiary in Washington D.C. and in the Pacific Region, with its representative offices in Tokyo, Japan, and in Singapore.

Arianespace employs a staff of 250. Share capital totals 395,010 €.

Arianespace is in charge of these main areas:

- markets launch services to customers throughout the world ;
- finances and supervises the construction of Ariane expendable launch vehicle ;
- conducts launches from Europe's Spaceport of Kourou in French Guiana ;
- insures customers for launch risks.

Personalized reliable service forms an integral part of Arianespace launch package. It includes the assignment of a permanent team of experts to each mission for the full launch campaign.

Today, Arianespace's offer is mainly based on Ariane 5. With its proven experience, demonstrated business model and unquestioned credibility, Arianespace has been committed for more than 24 years to providing its customers - satellite operators around the world - a technically and economically reliable means offer to place their satellites on the targeted orbit at the right moment. This offer is strengthened by the flexibility provided by the three launcher fleet - Ariane 5, Soyuz and Vega - and by the Launch Services Alliance, which gives customers mission back-up aboard alternative launch systems.

### Relations between ESA, CNES and ARIANESPACE

Development of the Ariane launcher was undertaken by the European Space Agency in 1973. ESA assumed overall direction of the ARIANE 1 development program, delegating the technical direction and financial management to CNES. The ARIANE 1 launcher was declared qualified and operational in January 1982. At the end of the development phase which included four launchers, ESA started the production of five further ARIANE 1 launchers. This program, known as the "promotion series", was carried out with a management arrangement similar to that for the ARIANE 1 development program.

In January 1980 ESA decided to entrust the commercialization, production and launching of operational launchers to a private-law industrial structure, in the form of ARIANESPACE company, placing at its disposal the facilities, equipment and tooling needed of producing and launching the ARIANE launchers. ARIANE follow-on development programs have been undertaken by ESA since 1980. They include a program for developing uprated versions of the launcher: Ariane 2 and Ariane 3 (qualified in August 1984) ; the program for building a second ARIANE launch site (ELA 2) (validated in August 1985) ; the Ariane 4 launcher development program (qualified on June 15th, 1988) ; and the preparatory and development program of the Ariane 5 launcher and its new launch facilities: ELA 3 (qualified on November, 1997). All these programs are run under the overall direction of ESA, which has appointed CNES as prime contractor. In general, as soon as an uprated version of the launcher has been qualified 5 oct, 1998, ESA makes the results of the development program together with the corresponding production and launch facilities available to ARIANESPACE.

ESA is responsible (as design authority) for development work on the Ariane launchers. The Agency owns all the assets produced under these development programs. It entrusts technical direction and financial management of the development work to CNES, which writes the program specifications and places the industrial contracts on its behalf. The Agency retains the role of monitoring the work and reporting to the participating States.

Since Flight 9 Arianespace has been responsible for building and launching the operational Ariane launchers (as production authority), and for industrial production management, for placing the launcher manufacturing contracts, initiating procurements, marketing and providing Ariane launch services, and directing launch operations.

### The Guiana Space Center: Europe's Spaceport

For over 30 years, the Guiana Space Center (CSG), Europe's Spaceport in French Guiana, has offered a complete array of facilities for rocket launches.

It mainly comprises the following:

- CNES/CSG technical center, including various resources and facilities that are critical to launch bas operation, such as radars, telecom network, weather station, receiving sites for launcher telemetry, etc.
- Payload processing facilities (EPCU), in particular the new S5 facility.
- Ariane launch complexes (ELA), comprising the launch zone and launcher integration buildings.
- Various industrial facilities, including those operated by Regulus, Europropulsion, Air Liquide Spacial Guyane and EADS, which contribute to the production of Ariane 5 elements. A total of 40 European manufacturers and local companies are involved in operations.

Europe's commitment to independent access to space is based on actions by three key players: the European sapce Agency (ESA), French space agency CNES and Arianespace.

ESA has helped change the role of the Guiana Space Center, in particular by funding the construction of the launch complexes, payload processing buildings and associated facilities. Initially used for the French space program, the Guiana Space Center has gradually become Europe's own spaceport, according to the terms of an agreement between ESA and the french government.

To ensure that the Spaceport is available for its programs, ESA takes charge of the lion's share of CNES/CSG fixed expenses, and also helps finance the fixed costs for the ELA launch complexes.

French space agency CNES plays several roles at the Space Center.

- It designs all infrastructures and, on behalf of the French government, is responsible for safety and security.
- It provides the resources needed to prepare the satellites and launcher for missions.

Whether during tests or actual launches, CNES is also responsible for overall coordination of operations. It collects and processes all data transmitted from the launcher via a network of receiving stations, to track Ariane rockets throughout their trajectory.

In French Guiana, Arianespace is in charge of launcher integration in the Launcher Integration Building (BIL), coordinates satellite preparation in the payload processing facility (EPCU), and integrates them on the launcher in the Final Assembly Building (BAF). It is also responsible for launch operations, from the CDL 3 Launch Center.

Arianespace has created a top-flight team and array of technical resources to get launchers and satellites ready for their missions. Building on tihs unrivalled expertise and outstanding local facilities, Arianespace is now the undisputed benchmark in the global launch services market.