



LAUNCH KIT

October 2016

VA231

Sky Muster™ II

GSAT-18





VA231

Sky Muster™ II GSAT-18



WITH ARIANE 5, ARIANESPACE TO LAUNCH FOR AUSTRALIA AND INDIA

For its eighth mission of 2016, and the year's fifth Ariane 5 launch from the Guiana Space Center in French Guiana, Arianespace will orbit two satellites: Sky Muster™ II for the Australian operator nbn (National Broadband Network), and GSAT-18 for the Indian space agency ISRO (Indian Space Research Organization).

Sky Muster™ II and GSAT-18 are the 542nd and 543rd satellites to be launched by Arianespace.

This Ariane 5 flight will be the 280th mission by the Arianespace launcher family.

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Sky Muster™ II

Sky Muster™ II will be the second satellite launched by Arianespace for the Australian operator nbn owned by the Commonwealth of Australia, after the first Sky Muster™ spacecraft orbited in September 2015.

Sky Muster™ II reflects the country's political commitment to bridging the digital divide, especially in the rural and isolated regions of Australia. This new satellite will help extend high-speed internet to the entire country, including the Norfolk, Christmas, Macquarie and Cocos islands, in conjunction with the services already delivered by Sky Muster™ I.

Sky Muster™ II will be the eighth satellite that Arianespace has launched for Australia, following Aussat 3, Optus C1/D1/D2/D3 and 10, and Sky Muster™ I.

Built by SSL (Space Systems Loral) in Palo Alto, California using a 1300 platform, Sky Muster™ II will be the 59th SSL satellite to be orbited by Arianespace - which has four more satellites from this manufacturer in its order book.

GSAT-18

GSAT-18 will be the 20th satellite from ISRO to be launched by Arianespace. Since the launch of the Apple experimental satellite on Flight L03 in 1981, Arianespace has won 86% of the geostationary orbit launch contracts that the country has opened to non-Indian launch systems.

Built by ISRO, GSAT-18 will provide telecommunications services for India, strengthening ISRO's current fleet of 14 operational telecom satellites.

ISRO fosters the use of space to help develop the Indian subcontinent. It focuses on all types of space applications, including Earth observation, telecommunications, broadcasts of educational programs, science and navigation.

The long-standing strategic partnership between ISRO and Arianespace reflects the strong relationship between India and France in the space sector.

After choosing Arianespace to launch its GSAT-17 and GSAT-18 satellites in 2015, ISRO selected Arianespace most recently to launch its GSAT-11 satellite. GSAT-17 and GSAT-11 will be orbited by 2017.

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Sky Muster™ II GSAT-18

MISSION DESCRIPTION

The fifth Arianespace Ariane 5 launch of the year will place both satellites into geostationary transfer orbit.

The launcher will be carrying a total payload of approximately 10,663 kg.

The launch will be from Ariane Launch Complex No. 3 (ELA 3) in Kourou, French Guiana.

DATE AND TIME



Liftoff is planned on **Tuesday, October 4, 2016**

as early as possible within the following launch window:

- > Between **05:30 p.m. and 06:45 p.m.**, Kourou time
- > Between **04:30 p.m. and 05:45 p.m.**, Washington D.C. time
- > Between **20:30. and 21:45**, Universal Time (UTC)
- > Between **10:30 p.m. and 11:45 p.m.**, Paris time
- > Between **2:00 a.m. and 3:15 a.m.**, Bangalore, India time on October 5
- > Between **7.30 a.m. and 8:45 a.m.**, Sydney, Australia time on October 5.

MISSION DURATION



The nominal duration of the mission (from liftoff to separation of the satellites) is:

32 minutes and 33 seconds.

TARGETED ORBIT



Perigee altitude
250 km.



Apogee altitude
35,786 km.



Inclination
6 degrees

THE LAUNCH AT A GLANCE

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

About seven seconds after start of the 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.

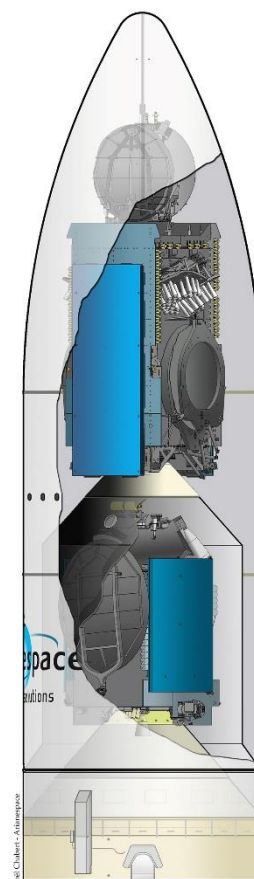
The fairing protecting the payload is jettisoned at T+200 seconds.

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 cryogenic upper stage.

The main stage splashes down off the coast of Africa in the Atlantic Ocean (in the Gulf of Guinea). At orbital injection, the launcher will have attained a velocity of approximately 9,365 meters/second, and will be at an altitude of 640 kilometers.

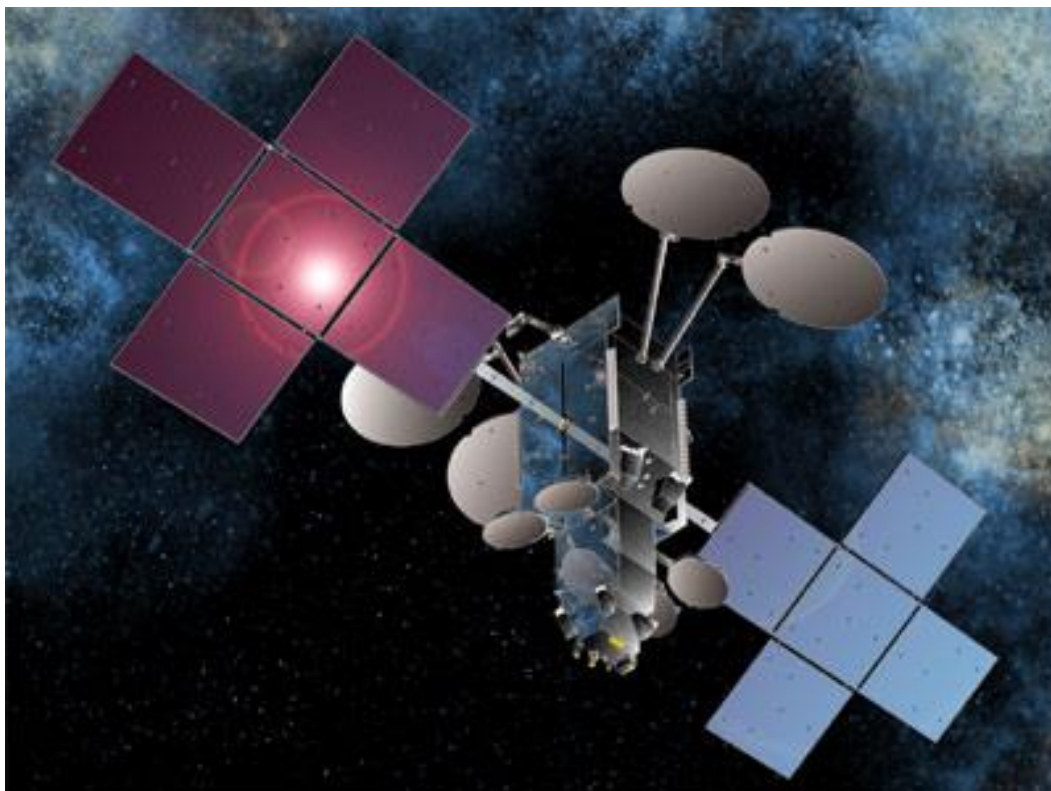
PAYLOAD CONFIGURATION

- > **Upper payload (CUH): Sky Muster™ II**
Mass at liftoff: 6,405 kg.
- > **Lower payload (CUB): GSAT-18**
Mass at liftoff: 3,404 kg.
- > **Long version of the payload fairing**
- > **SYLDA (Système de Lancement Double Ariane)**



**VA231****Sky Muster™ II
GSAT-18**

SKY MUSTER™ II SATELLITE



CUSTOMER	nbn
PRIME CONTRACTOR	SSL
MISSION	High-speed broadband services
MASS	6,405 kg. at liftoff
STABILIZATION	3 axis
DIMENSIONS	8.5 m x 3 m x 3.5 m
PLATFORM	1300
PAYLOAD	202 Ka-band transponders
ONBOARD POWER	16.4 kW (end of life)
DESIGN LIFE	More than 15 years
ORBITAL POSITION	135 to 150° East
COVERAGE AREA	Australia, including the Norfolk, Christmas, Macquarie and Cocos islands

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**VA231****Sky Muster™ II
GSAT-18**

GSAT-18 SATELLITE



CUSTOMER	ISRO
PRIME CONTRACTOR	ISRO / ISAC (ISRO satellite Centre)
MISSION	Communications
MASS	3,404 kg. at liftoff
STABILIZATION	3 axis
DIMENSIONS	3.1 m x 1.7 m x 2 m
PLATFORM	I-3K
PAYLOAD	12 transponders in Ku-Band and 24 in C-Band
ONBOARD POWER	5.600 kW (end of life)
DESIGN LIFE	More than 12 years
ORBITAL POSITION	74° East
COVERAGE AREA	India

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Sky Muster™ II
GSAT-18

ARIANE 5-ECA LAUNCH VEHICLE

The launcher is delivered to Arianespace by Airbus Safran Launchers as production prime contractor.

54.8 m

Fairing

(RUAG Space): 17 m
Mass: 2.4 t

Sky Muster™ II

(nbn)
Mass: 6,405 kg.

GSAT-18

(ISRO)
Mass: 3,404 kg.

Vehicle Equipment Bay

Height: 1.13 m
Mass: 970 kg.

HM-7B engine

Thrust: 67 kN (in vacuum)
945 sec. of propulsion

EPC - Cryogenic main stage

Height: 31 m
Mass: 188 t

EAP - Solid Rocket Boosters

Height: 31.6 m
Mass: 277 t approx.

Vulcain 2 Engine

Thrust: 1,390 kN (in vacuum)
540 sec. of propulsion

780 tons
(total mass at liftoff)

ACU - Payload adaptor (2)

(RUAG Space or Airbus Safran Launchers)
Mass: approx. 140 kg. each

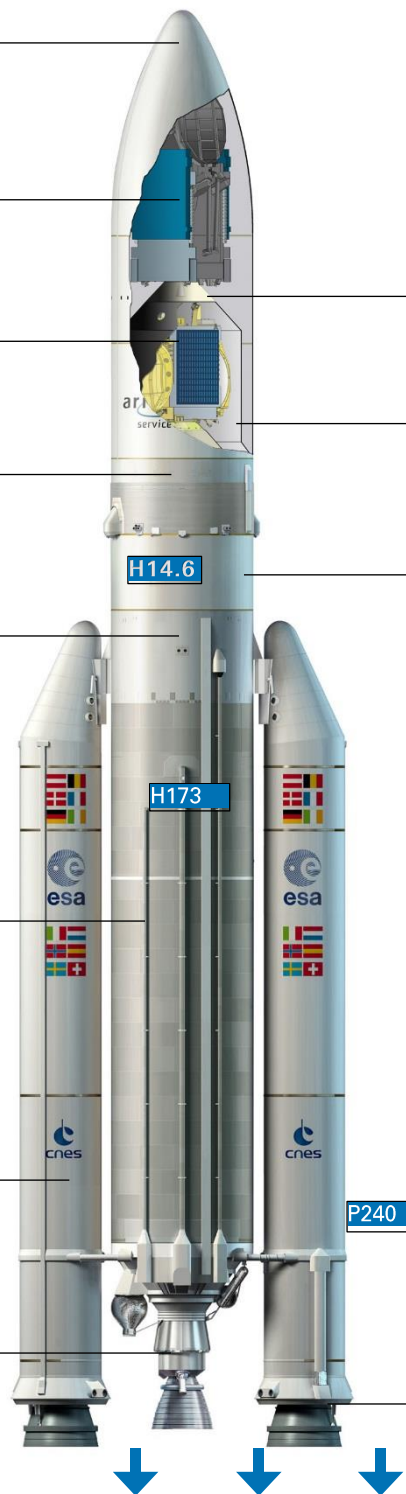
SYLDA - Internal structure

7 versions (Height: 4.9 to 6.4 m)
Mass: 400 to 530 kg.

ESC-A - Cryogenic upper stage

Height: 4.71 m
Mass: 19 t

Propellants (in metric tons)
at T-O
H: Cryogenic
P: Solid



13,000 kN at Lify-off
(at T+7.3 sec.)

MPS - Solid Rocket Motor (SRM)

Average thrust: 5,060 kN
Maximum thrust: 7,080 kN (in vacuum)
130 sec. of propulsion

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GSAT-18**

LAUNCH CAMPAIGN - ARIANE 5 - Sky Muster™ II / GSAT-18

SATELLITES AND LAUNCH VEHICLE CAMPAIGN CALENDAR

DATES	SATELLITE ACTIVITIES	LAUNCH VEHICLE ACTIVITIES
May 18, 2016		Campaign start review EPC unpacking
May 19, 2016		EPC erection – EAP2 transfer
May 20, 2016		EAP1 transfer and EAP positioning EPC/EAP integration
May 30, 2016	Arrival in French Guiana of GSAT-18; beginning of preparation in the S5C hall	
May 31, 2016		Erection of ESC-A with Vehicle Equipment Bay
June 1 st , 2016	GSAT-18 fitcheck in the S5C hall	
August 30, 2016	Arrival in French Guiana of Sky Muster™ II; beginning of preparation in the S5C hall	
August 31, 2016	Sky Muster™ II fitcheck in the S5C hall	
September 9, 2016	GSAT-18 transfer to S5A	
September 10, 2016	Sky Muster™ II transfer to S5B	
September 13, 2016		Transfer from BIL (Launcher Integration Building) to BAF (Final Assembly Building)
September 13 and 16, 2016	GSAT-18 fueling operations in the S5A hall	
September 14 and 16, 2016	Sky Muster™ II fueling operations in the S5B hall	
September 19, 2016	Sky Muster™ II integration on ACUH in the S5B	
September 20, 2016	GSAT-18 integration on ACUB in the S5A Sky Muster™ II transfer to the Final Assembly Building (BAF)	
September 21, 2016	Sky Muster™ II integration on	
September 22, 2016	Sky Muster™ II encapsulation in the payload fairing	

SATELLITES AND LAUNCH VEHICLE CAMPAIGN FINAL CALENDAR

DATES	SATELLITE ACTIVITIES	LAUNCH VEHICLE ACTIVITIES
Friday, September 23, 2016	GSAT-18 transfer to Final Assembly Building (BAF)	
Saturday, September 24, 2016	GSAT-18 integration on launcher	
Monday, September 26, and Tuesday, September 27, 2016	GSAT-18 encapsulation in the payload fairing and composite integration with Sky Muster™ II on launcher	Final inspection of the HM-7B engine Completion of composite integration on launcher and payload check
Wednesday, September 28, 2016		Launch rehearsal
Thursday, September 29, 2016		Arming of launch vehicle
Friday, September 30, 2016		Launch readiness review (RAL), final preparation of launcher and BAF for the chronology
Monday, October 3, 2016		Rollout from BAF to Launch Zone, launch vehicle connections and filling of the EPC liquid helium tank
Tuesday, October 4, 2016		Start of launch countdown, EPC filling with liquid oxygen and liquid hydrogen

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GSAT-18**

COUNTDOWN AND FLIGHT SEQUENCE

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

The countdown culminates in a synchronized sequence, 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	EVENT
- 11 h 43 min	Start of final countdown
- 10 h 53 min	Check of electrical systems
- 04 h 58 min	Start of filling of EPC with liquid oxygen and hydrogen
-03 h 28 min	Start of filling of ESC-A with liquid oxygen and hydrogen
- 03 h 38 min	Chilldown of Vulcain main stage engine
- 01 h 15 min	Check of connections between launcher and the telemetry, tracking and command systems
- 7 min	"All systems go" report, allowing start of synchronized sequence
- 4 min	Tanks pressurized for flight
-1 min	Switch to onboard power mode
- 05 s	Opening command for the cryogenic arms
- 04 s	Onboard systems take over
T-0	Ignition of the cryogenic main stage engine (EPC)
+ 07 s	Ignition of solid boosters (EAP)
+ 07 s	Liftoff
+ 13 s	End of vertical climb, beginning of pitch motion
+ 17 s	Beginning of roll maneuver
+ 2 min 23 s	EAP separation
+ 3 min 16 s	Fairing jettisoned
+ 8 min 15 s	Acquisition by Natal tracking station
+ 8 min 54 s	End of EPC thrust phase
+ 9 min 00 s	EPC separation
+ 9 min 04 s	Ignition of ESC-A stage
+ 13 min 45 s	Acquisition by Ascension tracking station
+ 18 min 13 s	Data acquisition by Libreville tracking station
+ 22 min 59 s	Acquisition by Malindi tracking station
+ 25 min 17 s	Injection
+ 28 min 26 s	Sky Muster™ II satellite separation
+ 30 min 47 s	SYLDA separation
+ 32 min 33 s	GSAT-18 satellite separation
+ 47 min 53 s	End of the Arianespace commercial mission
+1 h 22 min 06 s	End of the Arianespace mission



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Sky Muster™ II GSAT-18

ARIANE 5 ECA MISSION PROFILE

The launcher's attitude and trajectory are entirely controlled by the two onboard computers in the Ariane 5 Vehicle Equipment Bay (VEB).

The synchronized sequence starts seven minutes 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, the sequence 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, they handle the final ground system configurations, namely:

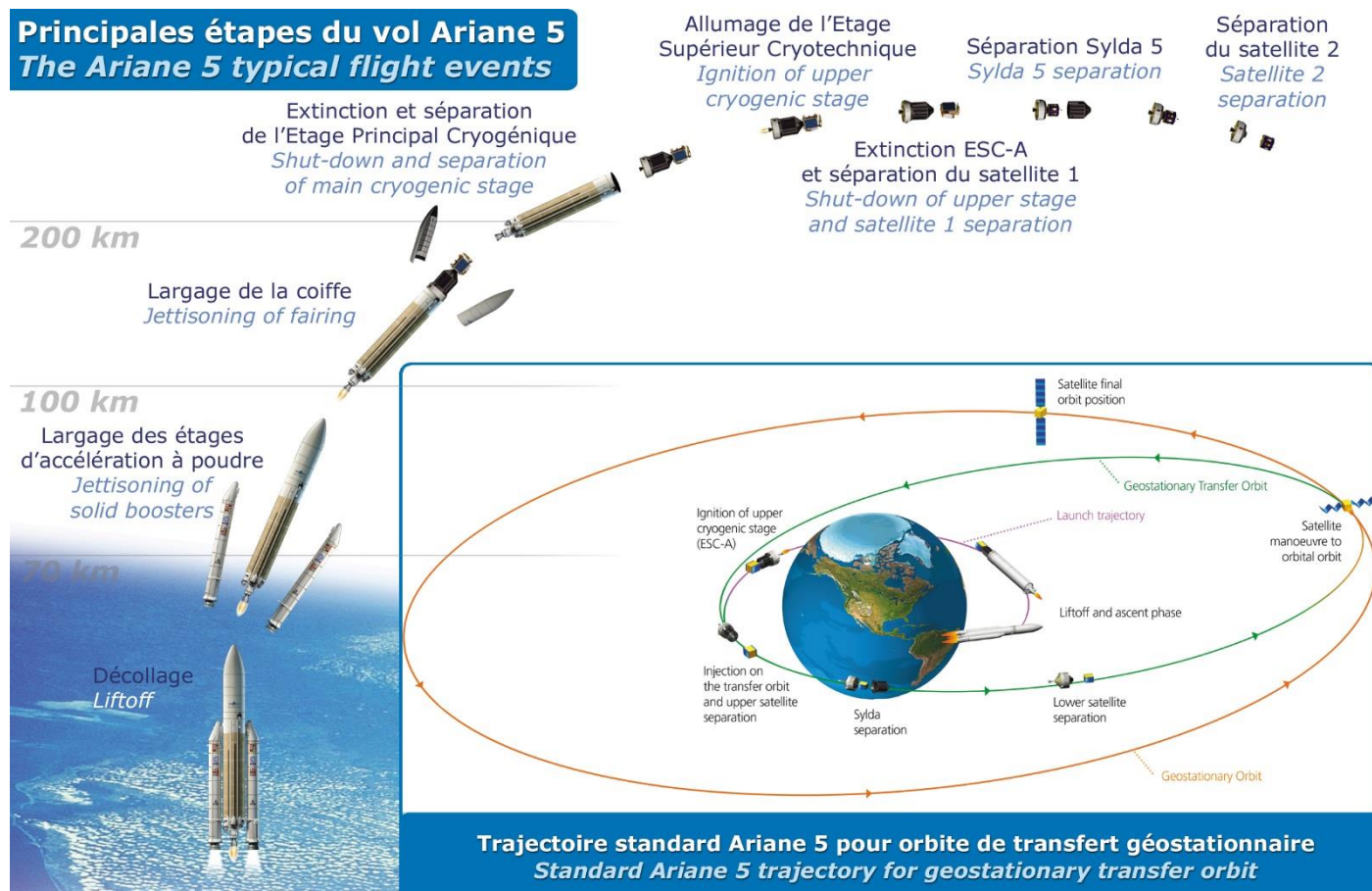
- > Startup of water injection in the flame trenches and exhaust guide (T-30 sec).
- > Hydrogen aspiration for chilldown of the Vulcain engine in the exhaust guide (T-18 sec).
- > Burnoff of hydrogen used for chilldown (T-5.5 sec).

At T-4 seconds, the onboard computer takes over control of final engine startup and liftoff operations. It:

- > Starts the ignition sequence for the Vulcain main stage engine (T-0).
- > Checks engine operation (from T+4.5 to T+6.9 sec).
- > Commands ignition for the solid boosters at T+7.05 sec for liftoff at T+7.3 seconds.

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

Principales étapes du vol Ariane 5 The Ariane 5 typical flight events





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ARIANESPACE AND THE GUIANA SPACE CENTER

ARIANESPACE, THE WORLD'S FIRST LAUNCH SERVICES COMPANY

Arianespace was founded in 1980 as the world's first launch Services & Solutions company. Arianespace now has 20 shareholders from 10 European countries (including Airbus Safran Launchers, CNES and all European companies participating in the production of Ariane launchers). Since the outset, Arianespace has signed over 530 launch contracts and launched 520-plus satellites. More than half of the commercial satellites now in service around the globe were launched by Arianespace. The company posted sales of more than 1.4 billion euros in 2015.

The company's activities are worldwide, with the headquarters in Evry, France (near Paris); the Guiana Space Center in French Guiana, where the Ariane, Soyuz and Vega launch pads are located; and offices in Washington, D.C., Tokyo and Singapore. Arianespace offers launch services to satellite operators from around the world, including private companies and government agencies. These services call on three launch vehicles:

- > The Ariane 5 heavy-lift launcher, operated from the Guiana Space Center in French Guiana.
- > The Soyuz medium-lift launcher, currently in operation at the Guiana Space Center and the Baikonur Cosmodrome in Kazakhstan.
- > The Vega light-lift launcher, also operated from the Guiana Space Center.

Building on its complete family of launchers, Arianespace has won over half of the commercial launch contracts up for bid worldwide in the past two years. Arianespace now has a backlog of more than 70 satellites to be launched.

THE GUIANA SPACE CENTER: EUROPE'S SPACEPORT

For more than 40 years, the Guiana Space Center (CSG), Europe's Spaceport in French Guiana, has offered a complete array of facilities for rocket launches. It primarily comprises the following:

- > The CNES/CSG technical center, including various resources and facilities that are critical to launch base operations, such as radars, telecom network, weather station, receiving sites for launcher telemetry, etc.
- > Payload processing facilities (EPCU), in particular the S5 facility.
- > Ariane, Soyuz and Vega launch complexes, comprising the launch zones and launcher integration buildings.
- > Various industrial facilities, including those operated by Regulux, Europropulsion, Air Liquide Spatial Guyane and Airbus Safran Launchers - all participating in the production of Ariane 5 components. A total of 40 European manufacturers and local companies are involved in the launcher operations.

Europe's commitment to independent access to space is based on actions by three key players: the European Space Agency (ESA), the French CNES space agency and Arianespace. ESA is responsible for the Ariane, Soyuz and Vega development programs. Once these launch systems are qualified, ESA transfers responsibility to Arianespace as the operator. 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 France's space program, the Guiana Space Center has evolved into 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 the CNES/CSG fixed expenses, and also helps finance the fixed costs for the ELA launch complexes.

The French CNES space agency has several main responsibilities at the Guiana Space Center. It designs all infrastructure and, on behalf of the French government, is responsible for safety and security. It provides the resources needed to prepare the satellites and launchers for missions. Whether during tests or actual launches, CNES is also responsible for overall coordination of operations and it collects and processes all data transmitted from the launcher via a network of receiving stations to track Ariane, Soyuz and Vega rockets throughout their trajectories.

ARIANESPACE IN FRENCH GUIANA

In French Guiana, Arianespace is the contracting authority in charge of operating the family of three launchers, Ariane, Soyuz and Vega.

Arianespace supervises the integration and functional checks of the Ariane launcher - built by Airbus Safran Launchers as production prime contractor - in the Launcher Integration Building (BIL). It then carries out acceptance tests of the launcher at the same time as satellite preparations in the Payload Preparation Complex (EPCU), which is operated by the Guiana Space Center (CNES/CSG). Next, Arianespace oversees final assembly of the launcher and integration of satellites in the Final Assembly Building (BAF), followed by transfer of the Ariane launcher to Launch Zone No. 3 (ZL3), and then the final countdown and liftoff - which are managed from the Launch Control Center No. 3 (CDL3).

Arianespace deploys a top-flight team and technical facilities to ensure the launchers and their satellite payloads are ready for their missions. Building on this unrivalled expertise and outstanding local facilities, Arianespace is now the undisputed benchmark in the global launch services market.