LAUNCH KIT

February 2019

VA247

Saudi Geostationary Satellite 1/Hellas Sat 4

GSAT-31

FOR ITS FIRST MISSION OF 2019, ARIANESPACE TO LAUNCH TWO TELECOMMUNICATIONS SATELLITES WITH ARIANE 5

For its first launch of 2019, Arianespace will orbit two telecommunications satellites using an Ariane 5 from the Guiana Space Center: Saudi Geostationary Satellite 1/Hellas Sat 4, a condosat for KACST (and Hellas Sat; along with GSAT-31 for the Indian Space Research Organisation (ISRO).

Through this 103rd Ariane 5 mission - the 70th with an Ariane 5 ECA version – Arianespace confirms its leadership in the geostationary launch services market segment.

Saudi Geostationary Satellite 1/Hellas Sat 4 (HS-4/SGS-1)

Composed of two payloads, **Saudi Geostationary Satellite 1/Hellas Sat 4**, also called HS- 4/SGS-1, is a geostationary condosat for KACST (King Abdulaziz City for Science and Technology – Saudi Arabia) and Hellas Sat (Greece – Cyprus). To be installed as Flight VA247's upper passenger, HS-4/SGS-1 will provide telecommunications capabilities, including television, Internet, telephone and secure communications in the Middle East, South Africa and Europe.

The **Saudi Geostationary Satellite 1** communications payload will provide advanced Ka-band spot beam communications services for the Kingdom of Saudi Arabia's KACST, including secure communications for the Gulf Cooperative Council region. KACST is an independent scientific organization of the government of Saudi Arabia that is responsible for the promotion of science and technology in the Kingdom.

The **Hellas Sat 4** communications payload, on the other hand, will offer advanced Ku-band regional beam communications services for Arabsat's subsidiary Hellas Sat, a Greek-Cypriot satellite operator which provides services to leading Direct-to-Home (DTH) operators by delivering contents to more than 3 million households.

With a design life of more than 15 years with orbital maneuver up to 23 years, HS-4/SGS-1 will be positioned at 39° East and will join Hellas Sat 3, launched by Arianespace on June 28, 2017 from the Guiana Space Center (on Flight VA238).

Since the launch of Arabsat-1A in 1985, Arianespace has expanded its services to the Middle East, and since then, has developed a trust-based relationship with historical telecommunications operations such as Arabsat. As such, HS-4/SGS-1 will be the 22nd satellites orbited for the Middle East region, accompanying the development of middle-eastern space programs.

Headquartered in Bethesda, Maryland, USA, Lockheed Martin Space designed, assembled and integrated the HS-4/SGS-1 satellite in its Denver, Colorado and Sunnyvale, California facilities. HS-4/SGS-1 will be the 46th Lockheed Martin satellite to be launched by Arianespace, whose backlog comprises one additional satellite built by the American manufacturer.

GSAT-31

Following the launch of GSAT-11 for the Indian Space Research Organisation (ISRO) using the year-ending Ariane 5 of 2018, Arianespace will orbit **GSAT-31** utilizing the initial Ariane 5 in 2019.

To be installed as Flight VA247's lower passenger, GSAT-31 is a telecommunications satellite designed and manufactured by the Indian space agency. To be positioned at a longitude of 48° East, GSAT-31 is configured on ISRO's enhanced I-2K bus structure to provide communications services from geostationary orbit in Ku-band for a lifetime greater than 15 years.

By operating GSAT-31, ISRO will – once again – foster the use of space to help bridge the digital divide in the Indian subcontinent as part of its ambitious space program, whose objectives are to develop India while pursuing science research and planetary exploration.

Since the launch of India's APPLE experimental satellite on Ariane Flight L03 in 1981, Arianespace has orbited 22 satellites and signed 24 launch contracts with the Indian space agency. It has also won 89% of the geostationary orbit launch contracts opened to non-Indian launch vehicles.

The orbiting of GSAT-31 – along with GSAT-30, which is an additional geostationary satellite to be lofted soon by the European launch services provider, Arianespace – marks another vivid demonstration of the strong bond uniting Europe and India in space cooperation.

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MISSION DESCRIPTION

Arianespace's first Ariane 5 ECA launch of 2019 will place its satellite passengers into geostationary orbit.

The launcher will be carrying a total payload of approximately 10,052 kg.

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

DATE AND TIME

Liftoff is planned on **Tuesday, February 5, 2019** as early as possible within the following launch window:

> **Between 4:01 p.m. and 5:02 p.m.** Washington DC time
> **Between 6:01 p.m. and 7:02 p.m.** Kourou, French Guiana time
> **Between 21:01 and 22:02** Universal Time (UTC)
> **Between 10:01 p.m. and 11:02 p.m.** Paris time
> **Between 11:01 p.m. and 0:02 a.m.** Athens time, during the night of February 5 to 6, 2019
> **Between 0:01 a.m. and 1:02 a.m.** Riyadh time, on Wednesday, February 6, 2019
> **Between 2:31 a.m. and 3:32 a.m.** Bangalore time, on Wednesday, February 6, 2019

MISSION DURATION

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

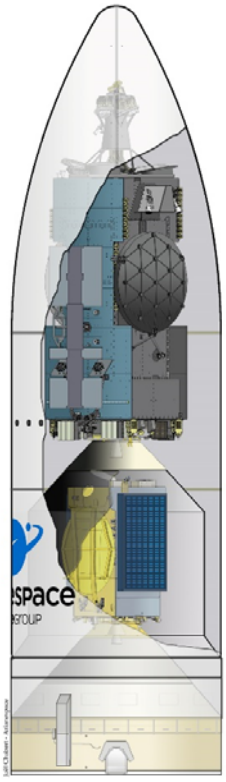
42 minutes, 27 seconds.

TARGETED GEOSTATIONARY ORBIT

Perigee altitude
250 km.

Apogee altitude
35,786 km.

Inclination
3 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 13 seconds, then rotates towards the East. It maintains an attitude that ensures the axis of the launcher remains parallel to its velocity vector to minimize aerodynamic loads throughout the entire atmospheric phase until the solid boosters are jettisoned.

The fairing protecting the payload is jettisoned at T+201.7 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).

PAYLOAD CONFIGURATION

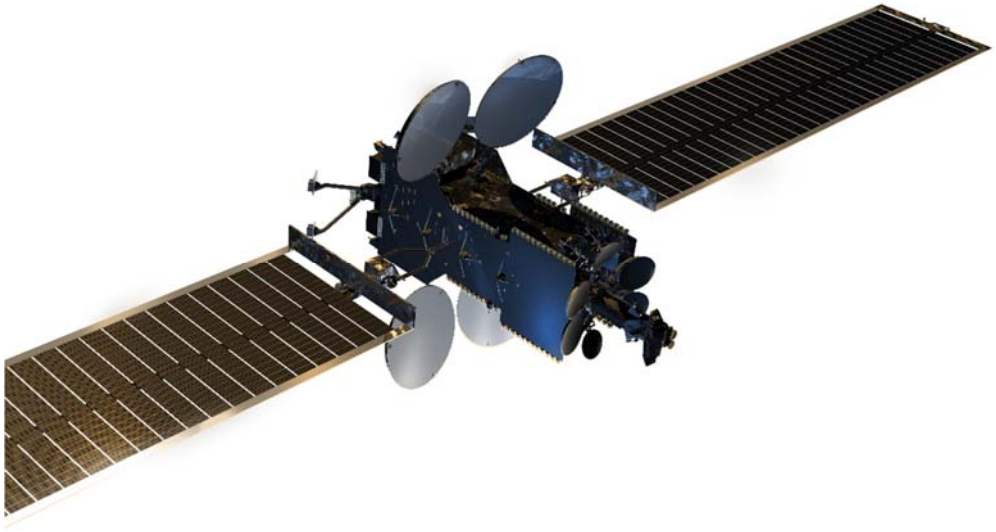
> **Upper payload (CUH): HS-4/SGS-1**
Mass at liftoff: 6,495 kg.

> **Lower payload (CUB): GSAT-31**
Mass at liftoff: 2,536 kg.

> **Long version of the payload fairing**

> **SYLDA (SYstème de Lancement Double Ariane)**

Saudi Geostationary Satellite 1/Hellas Sat 4



CUSTOMERS	**KACST (King Abdulaziz City for Science and Technology) and Hellas Sat (Arabsat)**
MANUFACTURER	Lockheed Martin Space
MISSIONS	**Telecommunications**
MASS AT LAUNCH	6,495 kg.
PLATFORM	Modernized A2100
ORBITAL POSITION	39° East
BATTERIES	2x Li-Ion
PAYLOAD	Ku and Ka-band
COVERAGE AREA	Europe, South Africa, Middle East
DESIGN LIFE	More than 15 years (up to 23 years orbital maneuver)

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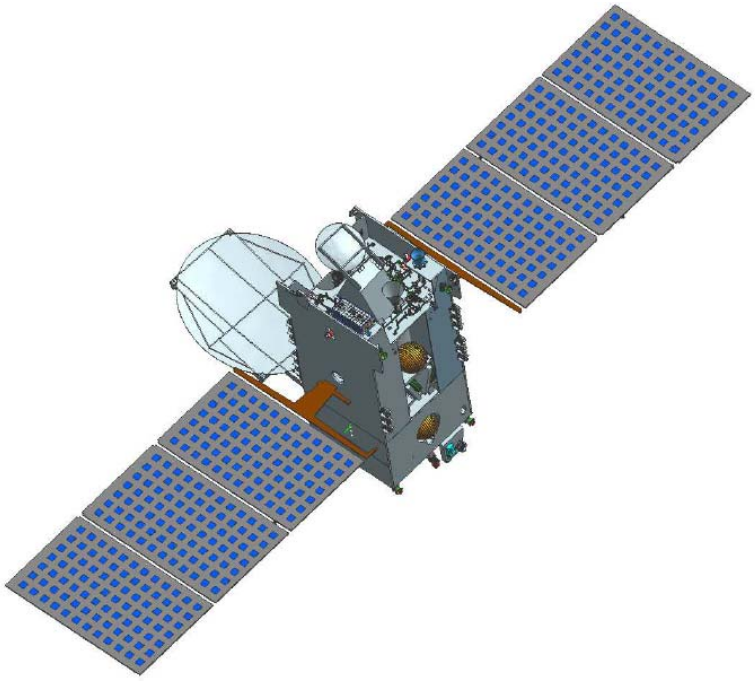
GSAT-31 SATELLITE



CUSTOMER/MANUFACTURER	**ISRO (Indian Space Research Organisation)**
MISSION	**Telecommunications**
MASS AT LAUNCH	2,536 kg.
ORBITAL POSITION	48° East
PLATFORM	I-2K
STABILIZATION	3 axis
BATTERIES	2x Li-Ion
PAYLOAD	Ku-band transponders
DESIGN LIFE	More than 15 years

PRESS CONTACT

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ARIANE 5 ECA LAUNCH VEHICLE

The launcher is delivered to Arianespace by ArianeGroup as production prime contractor.

51.03 m.

Fairing

(RUAG Space): 17 m.
Mass: 2.4 t.

HS-4/SGS-1

KACST/Hellas Sat
Mass: 6,495 kg.

GSAT-31

ISRO
Mass: 2,536 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

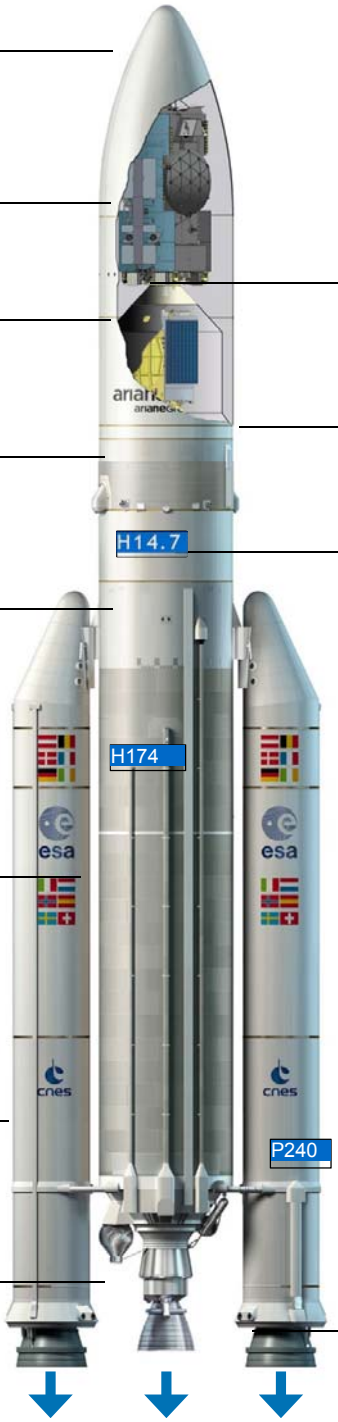
Height: 31 m.
Mass: 188 t.

EAP - Solid rocket boosters

Height: 31.6 m.
Mass: 277 t. approx.

Vulcain 2 engine

Thrust: 1,410 kN (in vacuum)
540 sec. of propulsion



13,000 kN at liftoff
(at T+7.3 sec.)

780 metric tons
(total mass at liftoff)

PA - Payload adaptor (2)

(*Airbus Defence and Space - SAU*)
Mass: approx. 220 kg.

SYLDA - Internal structure

Mass: 440 kg.

ESC-A - Cryogenic upper stage

Height: 4.71 m.
Mass: 19 t.

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

MPS - Solid Rocket Motor (SRM)

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

LAUNCH CAMPAIGN - ARIANE 5
HS-4/SGS-1
GSAT-31

SATELLITE AND LAUNCH VEHICLE CAMPAIGN CALENDAR

DATE	SATELLITES ACTIVITIES	LAUNCH VEHICLE ACTIVITIES
From November 23 to 26, 2018		Campaign start review EPC unpacking and erection
November 26, 2018		EAP 1 & 2 transfer to the BIL (Launcher Integration Building)
November 27 , 2018		EPC/EAP integration
November 30, 2018		Erection of ESC-A and vehicle equipment bay installation
January 4, 2019	Arrival of HS-4/SGS-1 in French Guiana and transfer by road to the Spaceport's S5C payload preparation facility	
January 8, 2019	Arrival of GSAT-31 in French Guiana and transfer by road to the Spaceport's S5C payload preparation facility	
January 14 to 16, 2019	HS-4/SGS-1 fueling operations	
January 19 and 22, 2019	GSAT-31 fueling operations	
January 17, 2019		Transfer from BIL to BAF (Final Integration Building)
January 21, 2019	HS-4/SGS-1 integration on payload adaptor	
January 22, 2019	HS-4/SGS-1 transfer to the BAF	
January 23, 2019	HS-4/SGS-1 integration on SYLDA	

SATELLITE AND LAUNCH VEHICLE CAMPAIGN FINAL CALENDAR

DATE	SATELLITES ACTIVITIES	LAUNCH VEHICLE ACTIVITIES
Thursday, January 24, 2019	GSAT-31 integration on payload adaptor, Payload fairing encapsulation on SYLDA (with HS-4/SGS-1 inside)	
Friday, January 25, 2019	GSAT-31 transfer to the BAF	
Saturday, January 26, 2019	GSAT-31 integration on launch vehicle and final preparation before fairing encapsulation	
Monday, January 28, 2019	Composite (HS-4/SGS-1 under fairing) integration on launch vehicle	HM7B engine final inspection
Tuesday, January 29, 2019		Finalization of the composite/launcher integration
Wednesday, January 30, 2019		Dress rehearsal
Thursday, January 31 to Friday, February 1, 2019		Arming of launch vehicle
Friday, February 1, 2019		Launch readiness review (LRR), final preparation of launcher and BAF for chronology
Monday, February 4, 2019		Roll-out from BAF to the Launch Pad, launch vehicle connections and filling of the EPC liquid helium tank
Tuesday, February 5, 2019		Start of launch countdown, EPC and ESC-A filling with liquid oxygen and liquid hydrogen

COUNTDOWN AND FLIGHT SEQUENCE

The countdown comprises all final preparation steps for the launcher, the satellites and the launch pad. 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 results in the T-0 moving 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 23 min	Start of final countdown
- 10 h 33 min	Check of electrical systems
- 04 h 38 min	Start of filling of EPC with liquid oxygen and liquid hydrogen
- 03 h 28 min	Start of filling of ESC-A with liquid oxygen and liquid hydrogen
- 03 h 18 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	Reference time
+ 01 s	Ignition of the cryogenic main stage (EPC)
+ 07.05 s	Ignition of solid boosters (EAP)
+ 07.3 s	Liftoff
+ 12.7 s	End of vertical climb, beginning of pitch motion
+ 17.05 s	Beginning of roll maneuver
+ 32.05 s	End of roll maneuver
+ 2 min 24 s	EAP separation
+ 3 min 21 s	Fairing jettisoned
+ 7 min 47 s	Acquisition by Natal tracking station
+ 8 min 41 s	End of EPC thrust phase
+ 8 min 47 s	EPC separation
+ 8 min 51 s	Ignition of ESC-A stage
+ 13 min 37 s	Acquisition by Ascension tracking station
+ 18 min 17 s	Acquisition by Libreville tracking station
+ 23 min 00 s	Acquisition by Malindi tracking station
+ 25 min 9 s	Extinction of ESC-A stage
+ 25 min 11 s	Injection
+ 27 min 21 s	**HS-4/SGS-1 satellite separation**
+ 29 min 35 s	SYLDA separation
+ 42 min 27 s	**GSAT-31 satellite separation**

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).

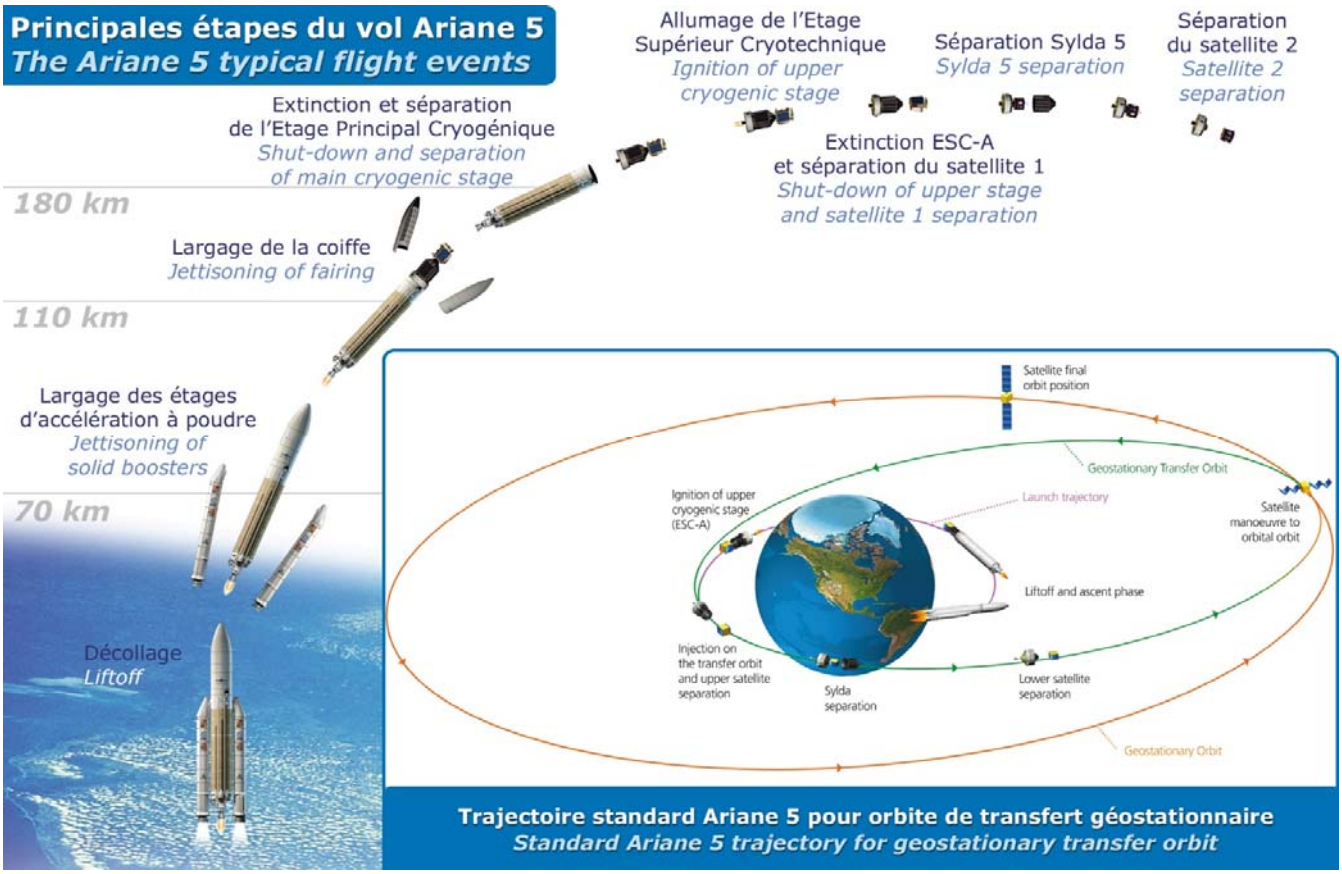
The synchronized sequence starts seven minutes before ignition (T-0). It is primarily designed to perform the final operations on the launcher prior to launch, along with the ultimate checks needed following switchover to flight configuration. As its name indicates, the sequence is fully automatic, and 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).
> Burn-off 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.



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 is a subsidiary of ArianeGroup, which holds 74% of its share capital; the balance is held by 15 other shareholders from the European launcher industry.

Since the outset, Arianespace has signed over 540 launch contracts and launched 590-plus satellites. More than half of the commercial satellites now in service around the globe were launched by Arianespace. The company posted sales of approximately 1.4 billion euros in 2018.

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 700 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 (ECPU), 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 Regulus, Europropulsion, Air Liquide Spatial Guyane and ArianeGroup – all participate 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 checks of the Ariane launcher – which is built under ArianeGroup responsibility as the production prime contractor; coordinates the satellite preparations that are performed in parallel inside the Payload Preparation Complex (EPCU) [which is operated by the Guiana Space Center - CNES/CSG], followed by the payload's integration on the launcher in the Final Assembly Building (BAF); and also works with ArianeGroup teams in charge of the launcher to conduct the final countdown and launch from 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.