arianespace
arianeGROUP

LAUNCH KIT

April 2019

VS22

O3b Satellites

esa

SES

cnes
CENTRE NATIONAL D'ÉTUDES SPATIALES

ARIANESPACE FLIGHT VS22: A FIFTH LAUNCH FOR THE OPERATOR SES AND ITS O3b CONSTELLATION

For its fourth mission of 2019 — and the second this year with the Soyuz medium launcher from the Guiana Space Center (CSG) in French Guiana, Arianespace will be launching four more O3b satellites for SES.

By performing the 22nd Soyuz flight from the CSG, Arianespace is supporting — for the fifth time — SES in the expansion of its successful Non-Geostationary Satellite Orbit (NGSO) satellite constellation.

Operational since 2014, the O3b medium Earth orbit (MEO) satellite constellation delivers fiber-equivalent connectivity, and is part of SES's bold vision of connecting people and empowering them with opportunities.

CONTENTS

O3b satellites

The **O3b satellites** lofted by Arianespace on Flight VS22 are the 58th, 59th, 60th and 61th satellites to be launched by Arianespace for the global satellite operator SES.

SES is the world-leading satellite-enabled service operator and is the first to deliver a differentiated and scalable GEO-MEO offering worldwide, with more than 50 satellites in Geostationary Earth Orbit (GEO) and 16 in Medium Earth Orbit (MEO).

SES provides a diverse range of customers with global video distribution and data connectivity services through two business units: SES Video and SES Networks.
SES Video reaches over 351 million TV homes through Direct-to-Home (DTH) platforms and cable, terrestrial, and IPTV networks globally.
The SES Video portfolio includes MX1, a leading media service provider offering a full suite of innovative services for both linear and digital distribution; and the ASTRA satellite system, which has the largest DTH television reach in Europe.

SES Networks provides global managed data services, connecting people in a variety of sectors including telecommunications, maritime, aeronautical, and energy, as well as governments and institutions across the world.
The SES Networks portfolio includes GovSat, a 50/50 public-private partnership between SES and the Luxembourg government, and O3b, the only non-geostationary system delivering fiber-like broadband services today.

The four new Ka-band satellites will join SES's existing constellation of O3b MEO satellites, orbiting at approximately 8,000 km. from Earth and serving customers based in almost 50 countries. They will improve connectivity capabilities, increase performance, and serve to seamlessly scale the existing O3b constellation. By increasing the size of the constellation from 16 to 20 satellites, SES Networks will offer enhanced coverage while providing greater service availability and reliability to cater for the increasing demand for bandwidth in government and in the telecommunication, cloud, maritime and energy markets.

The current O3b MEO constellation, in commercial service since September 2014, was orbited by Arianespace, utilizing its medium-lift Soyuz workhorse to carry four spacecraft each on launches that began in June 2013, and was followed by missions in July and December 2014 and more recently in March 2018.

In addition, Arianespace also has one SES geostationary satellite in its order book backlog.

The four O3b satellites will be the 156th to 159th satellites manufactured by Thales Alenia Space and its predecessors to be orbited by Arianespace, following the previously-launched 79 dedicated satellites and 72 constellation satellites, along with four auxiliary payloads.

Seven additional Thales Alenia Space satellites are in Arianespace's order book backlog.

PRESS CONTACT
Claudia Euzet-Hoyau
c.hoyau@arianespace.com
+33 (0)1.60.87.55.11

Arianespace and constellations

Since 1999, 83 commercial constellation satellites and 26 institutional constellation satellites have been orbited by Arianespace - with O3b satellites being the 110th to 113th spacecraft dedicated to such applications.

By providing a wide range of launch service and solutions, Arianespace has the ability to launch any mass, to any orbit, any time, and is thus able to achieve the innovative space ambitions of global satellite operators.

With NGEO constellations for example, the objective is to have launchers capable of deploying a huge quantity of satellites in a short period of time, as well as replenish portions of the constellation occasionally.

The European family of launch vehicles comprises all these solutions with the capability of deploying constellations on Soyuz and Vega.

Ariane 6 and Vega C, Europe's next-generation launchers, also will be well-suited to meet these needs with new multi-launch adapters: SSMS on Vega/Vega C and MLS on Ariane 6.

MISSION DESCRIPTION

The 22nd Soyuz launch from the Guiana Space Center (CSG) will place its satellite passengers into a circular orbit, at an altitude of approximately 7,830 km.

The Soyuz ST-B launcher will be carrying a total payload of 3,198 kg.

The launch will be performed from the Soyuz Launch Complex (ELS) in Sinnamary, French Guiana.

DATE AND TIME

Liftoff is scheduled for **Thursday, April 4, 2019** at exactly:

> **12:30:37 p.m.,** in Washington, D.C.
> **01:30:37 p.m.,** in Kourou, French Guiana
> **16:30:37** Universal Time (UTC)
> **06:30:37 p.m.,** in Luxembourg and Paris
> **07:30:37 p.m.,** in Moscow
> **01:30:37 a.m.,** in Tokyo on April 5, 2019.

MISSION DURATION

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

2 hours, 23 minutes and 51 seconds.

TARGETED ORBIT

Circular Orbit
MEO
(Medium Earth orbit)

Altitude at separation
Approx. 7,830 km.

Inclination
0.04 degrees

THE LAUNCH AT A GLANCE

Following liftoff from the Guiana Space Center, the powered phase of the lower three Soyuz stages will last approximately nine minutes and 23 seconds. The launcher's third stage will then be separated from the upper composite, which comprises the Fregat upper stage and the four O3b satellites. The three lower Soyuz stages and the payload fairing will then fall into the sea.

Fregat will carry out three main powered phases:
• Its 1st burn, lasting about 5 minutes, to be followed by a ballistic phase lasting about 8 minutes and 27 seconds.
• Its 2nd burn, lasting approximately 8 minutes and 36 seconds, followed by a second ballistic phase, lasting one hour and 21 minutes.

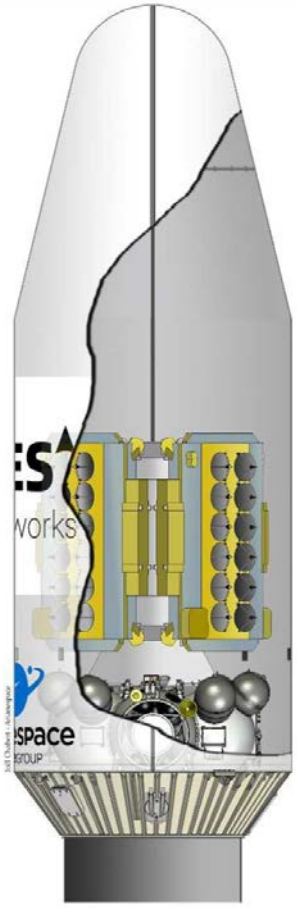
• Its 3rd burn, lasting about 5 minutes and 6 seconds, to be followed by a third ballistic phase, lasting 3 minutes and 20 seconds.

The four satellites will then be released on their dedicated orbits in two separation events.

At the end of the mission, one firing of the Fregat engine will place Fregat into a re-entry orbit.

SOYUZ PAYLOAD CONFIGURATION

> **Payload:** O3b satellites
> **Mass at liftoff:** **2,800 kg**. (approx. 700 kg. for each satellite)
> **ST fairing**



O3b satellites

CUSTOMER	**SES**
MANUFACTURER	Thales Alenia Space
MISSION	Internet network
PAYLOAD	Ka-band transponders – Steerable antennas
MASS AT LIFTOFF	2,800 kg. (700 kg. per satellite)
DIMENSIONS	7.72 m. x 3.2 m. x 1.7 m.
PROPULSION	Chemical
BATTERIES	Li-Ion
STABILIZATION	3 axis
AVAILABLE POWER	2,535 W
COVERAGE	Global
LIFETIME	10 years

PRESS CONTACTS

SES
Markus Payer
Corporate Communications & PR
Tel:+352 710 725 500
E-mail: Markus.Payer@ses.com
Website: www.ses.com

THALES ALENIA SPACE
Cinzia Marcanio
Media Relation
Tel:+39 06 4151 2685
Mobile: + 39 366 56 04 053
E-mail: Cinzia.marcanio@thalesaleniaspace.com
Website: www.thalesaleniaspace.com

SOYUZ LAUNCH VEHICLE

The Soyuz launch vehicle family has provided reliable and efficient launch services since the start of space exploration. Soyuz rockets, which launched both the first artificial satellite and the first human into space, have performed more than 1,890 launches to date. Today, Soyuz is used for manned and unmanned flights to the International Space Station, as well as Russian government launches and commercial launches.

Introduced in 1966, Soyuz has been the workhorse of the Soviet/Russian space program. As the only manned launch vehicle in Russia and the former Soviet Union, Soyuz meets very high standards of reliability and robustness.

The first launch of the Soyuz 2-1a version on November 8, 2004 from the Plesetsk Cosmodrome represented a major step in the Soyuz launch vehicle's development program. This modernized version, also used to successfully launch MetOp-A on October 19, 2006 from the Baikonur Cosmodrome, features a digital control system providing additional mission flexibility; it also enables control of the launch vehicle fitted with the 4.1-meter ST payload fairing. This was a necessary step towards the next-generation Soyuz 2-1b launcher, the culmination of a joint European/Russian upgrade program. It adds a more powerful third stage engine, significantly increasing the launcher's overall performance.

The upgraded Soyuz 2-1b launch vehicle's inaugural flight was successfully performed from Baikonur Cosmodrome on December 27, 2006, orbiting the Corot scientific spacecraft for the French CNES space agency.

The decision of the European Space Agency to introduce Soyuz launch capability at the Guiana Space Center (CSG) in French Guiana marked a major step forward in expanding the range of missions. With the introduction of Soyuz at CSG, this famed medium-lift Russian launch vehicle is now an integral part of the European launcher fleet, together with the heavy-lift Ariane 5 and the lightweight Vega. Offered exclusively by Arianespace to the commercial market for launches from CSG, Soyuz becomes Europe's standard medium launcher for both government and commercial missions.

In October 2011, Arianespace successfully launched the first Soyuz rocket from the Guiana Space Center, orbiting the initial two satellites in the Galileo constellation.

The Samara Space Center in Russia continues to produce Soyuz launchers. Because of sustained demand from the Russian government, International Space Station requirements and Arianespace's commercial orders, Soyuz is being produced at an average rate of 15 to 20 launchers per year. The manufacturer also can rapidly scale up to accommodate market demand. In fact, annual Soyuz production peaked in the early 1980s at 60 vehicles per year.

Soyuz is a reliable, efficient, and cost-effective solution for a full range of missions, from LEO (Low Earth Orbit) to interplanetary trajectories to Mars or Venus. Offering an unrivaled heritage, Soyuz already has performed almost every type of mission, from launching telecommunications, Earth observation, weather and scientific satellites to manned spacecraft. It is a very scalable and flexible launch vehicle.

The Soyuz version currently offered by Arianespace is a four-stage launch vehicle composed of: four boosters (first stage), a central core (second stage), a third stage, and the restartable Fregat upper stage (fourth stage). It also includes a payload adapter/dispenser and fairing.

SOYUZ

1 - Fairing
2 - Fregat upper stage
3 - Third stage
4 - Central core (2nd stage)
5 - Boosters (1st stage)

BOOSTERS (FIRST STAGE)

The four cylindrical-conical boosters are assembled around the central core. The booster's RD-107A engines are powered by liquid oxygen and kerosene, which are the same propellants used on each of the lower three stages. The kerosene tanks are located in the cylindrical part and the liquid oxygen tanks in the conical section. Each engine has four combustion chambers and four nozzles. Three-axis flight control is provided by aerofins (one per booster) and steerable vernier thrusters (two per booster). Following liftoff, the boosters burn for approximately 118 seconds and are then jettisoned. Thrust is transferred to the vehicle through a ball joint located at the top of the conical structure of the booster, which is attached to the central core by two rear struts.

CENTRAL CORE (SECOND STAGE)

The central core is similar in construction to the four boosters, with a special shape to accommodate the boosters. A stiffening ring is located at the interface between the boosters and the core. This stage is fitted with an RD-108A engine, also comprising four combustion chambers and four nozzles. It also has four vernier thrusters, used for three-axis flight control once the boosters have separated. The core stage has a nominal burn time of 286 seconds. The core and boosters are ignited simultaneously on the launch pad, 20 seconds before liftoff. Thrust is first adjusted to an intermediate level to check engine readings. The engines are then gradually throttled up, until the launcher develops sufficient thrust for liftoff.

THIRD STAGE

The third stage is linked to the central core by a latticework structure. Ignition of the third stage's engine occurs approximately two seconds before shutdown of the central core engine. The third stage engine's thrust enables the stage to separate directly from the central core. Between the oxidizer and fuel tanks is a dry section where the launcher's avionics systems are located. The third stage uses either a RD-0110 engine in the Soyuz ST-A (2-1a) version, or a RD-0124 engine in the ST-B (2-1b) version.

FREGAT UPPER STAGE (FOURTH STAGE)

Flight qualified in 2000, the Fregat upper stage is an autonomous and flexible stage that is designed to operate as an orbital vehicle. It extends the Soyuz launcher's capability, now covering a full range of orbits (LEO, SSO, MEO, GTO, GEO and Earth escape). To ensure high reliability for the Fregat stage from the outset, various flight-proven subsystems and components from previous spacecraft and rockets are used. The upper stage consists of six spherical tanks (four for propellants, two for avionics) arranged in a circle and welded together. A set of eight struts through the tanks provide an attachment point for the payload, and also transfer thrust loads to the launcher. The upper stage is independent from the lower three stages, as Fregat has its own guidance, navigation, attitude control, tracking, and telemetry systems. The stage's engine uses storable propellants – UDMH (unsymmetrical dimethyl hydrazine) and NTO (nitrogen tetroxide) – and can be restarted up to 20 times in flight, thus enabling it to carry out complex missions. It can provide the customer with three-axis or spin stabilization of their spacecraft.

The Fregat upper stage is encapsulated in a fairing with the payload and a payload adapter/dispenser

THE FAIRING

Soyuz launchers operated by Arianespace at the Guiana Space Center use the ST fairing with an external diameter of 4.1 meters and a length of 11.4 meters.

ROSCOSMOS AND THE RUSSIAN LAUNCHER INDUSTRY

The Roscosmos State Corporation for space activities is responsible for license allocations and intergovernmental relations. It is the launch authority in charge of range operations. RKTs-Progress (the Samara Space Center) is responsible for the design, development, and manufacture of launch vehicles, including the Soyuz launch vehicle's first, second, third stages and fairing. It also integrates vehicle stages and handles flight operations. NPO Lavochkin manufactures and integrates the Fregat upper stage, and is responsible for its launch operations. TsENKI is in charge of launch planning and the provision of associated services, including systems engineering, the design, and technical and operational management of the launch pad and associated facilities dedicated to the Soyuz launcher.

LAUNCH CAMPAIGN: O3b SATELLITES

CAMPAIGN CALENDAR FOR THE SATELLITES AND LAUNCH VEHICLE

DATE	ACTIVITIES WITH THE SATELLITES	LAUNCH VEHICLE ACTIVITIES
December 2018		Campaign start review - Integration and control of the three Soyuz stages at the Soyuz launcher preparation building (MIK)
February 2, 2019	Arrival of the O3b satellites at "Félix Eboué " airport in Cayenne	
February 6, 2019		Fregat upper stage preparation at the Soyuz MIK
February 23, 2019 to February 27, 2019	Integration of three O3b satellites on the dispenser in S5 building	
February 26, 2019		Transfer of the Fregat upper stage to the FCube building for fueling operations
February 28, 2019 to March 18, 2019		Fregat preparation and filling GHe, N204, UDMH and N2H4 activities in the FCube building
March 7 to 14, 2019		Pneumatic and propulsion system tests on the lower three Soyuz stages in the MIK
March 13, 2019	Final O3b satellite mating on the dispenser in S5 building	
March 14, 2019	Finalization of the the spacecraft stack (O3b satellites and dispenser)	
March 15 to 20, 2019		Electrical and functional verifications on the lower three Soyuz stages in the MIK
March 18 to 24, 2019	Stand-by in the S5B integration hall	Stand-by in the MIK
March 25, 2019	Arrival of the spacecraft stack (O3b satellites and dispenser) at the S3B building	
March 26 to 29, 2019	Spacecraft stack (O3b satellites and dispenser) integration on the Fregat upper stage; Fairing installation	Fregat upper stage final preparation

FINAL CAMPAIGN CALENDAR FOR THE SATELLITES AND LAUNCH VEHICLE

DATE	ACTIVITIES WITH THE SATELLITES	LAUNCH VEHICLE ACTIVITIES
Monday, April 1, 2019	Payload upper composite arrival in the launch zone; integration on the launcher	Final preparation for installation on the transporter/erector; Roll-out of the three-stage Soyuz launcher and erection in the ZLS
Tuesday, April 2, 2019		Final verifications of the lower three Soyuz stages; Preparation for fueling operations
Wednesday, April 3, 2019		Final launcher checks; Fregat countdown rehearsal; Spacecraft rehearsal; Fueling operations for the three Soyuz stages; Launch readiness review (RAL)
Thursday, April 4, 2019		Launch vehicle final preparations; Fueling operations for the three Soyuz stages; Final countdown

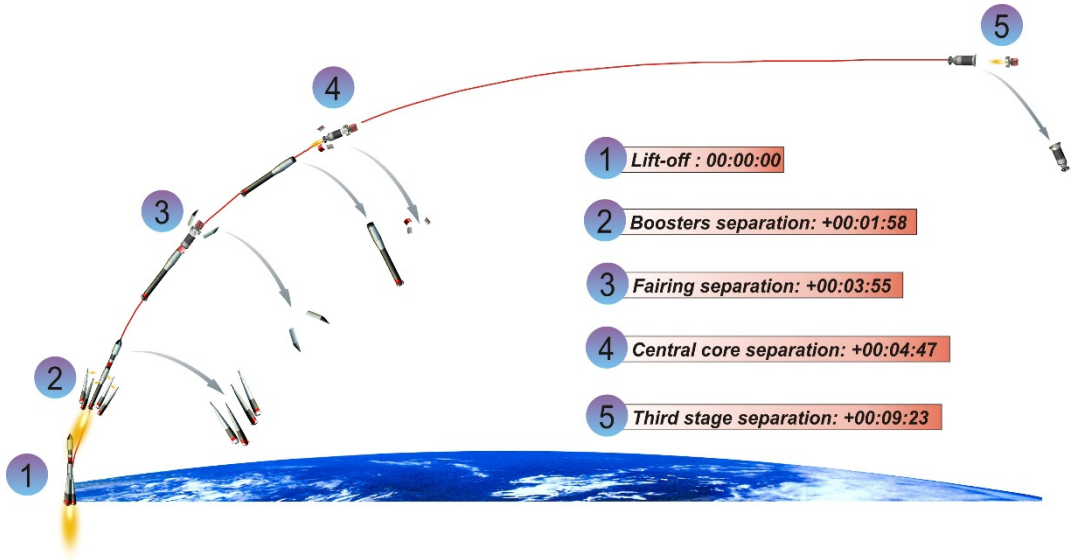
COUNTDOWN AND FLIGHT SEQUENCE

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 core stage engine and the four boosters.

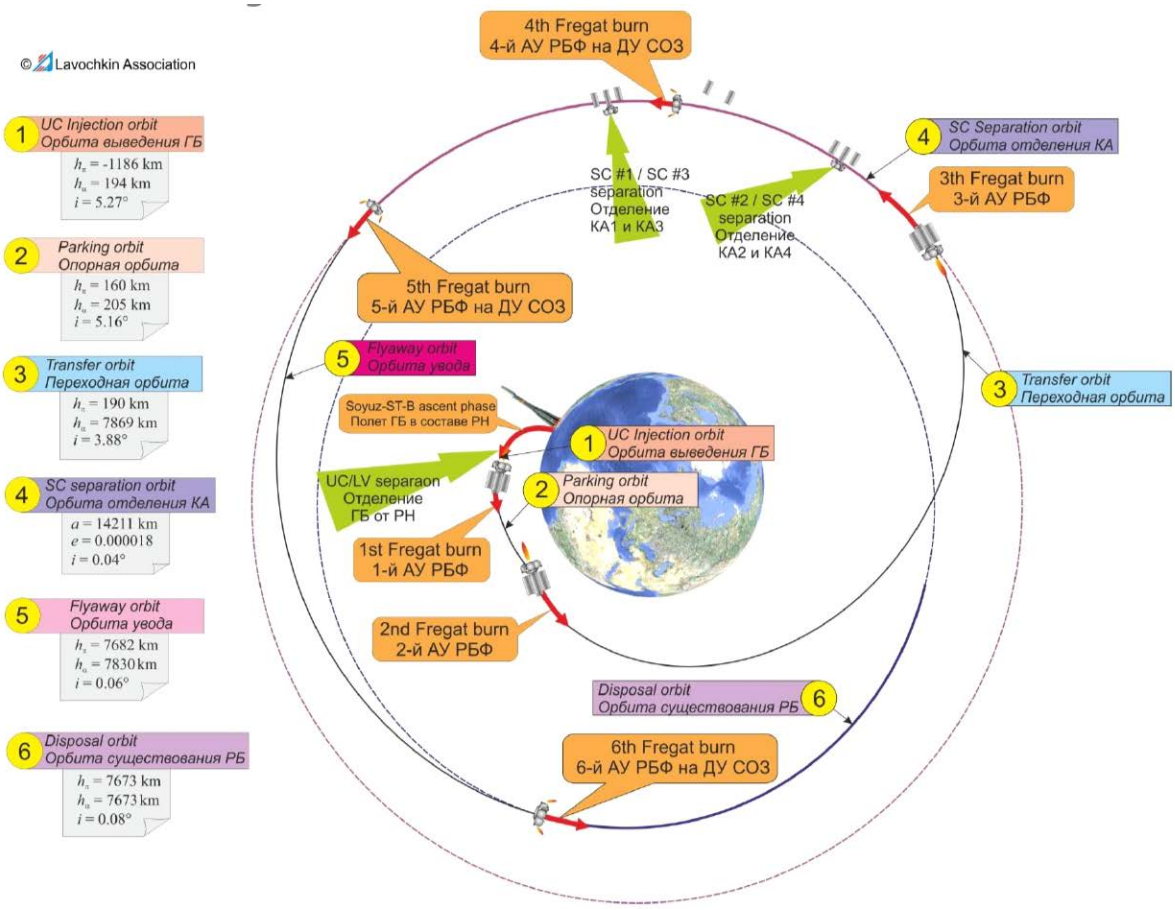
TIME	EVENTS
- 5 hrs.	Meeting for launcher fueling authorization (BTR)
- 4 hrs. 30 min.	Launch vehicle fueling begins
- 1 hr. 35 min.	End of fueling operations
- 1 hr. 10 min.	Mobile gantry removal
- 5 min. 09 s	Key on start
- 5 min.	Fregat transfer to onboard power supply
-2 min. 25 s	Upper composite umbilical drop-off command
- 40 s	Ground-onboard power transfer
- 28 s	Lower stage umbilical mast retraction
- 16 s	Ignition
- 14 s	Preliminary thrust level
- 01 s	Full thrust level
H0 00 s	**Liftoff**
+ 2 min. 00 s	Jettisoning of boosters
+ 3 min. 55 s	Jettisoning of fairing
+ 4 min. 47 s	Separation of central core (second stage)
+ 9 min. 23 s	Separation of 3rd stage
+ 10 min. 23 s	First Fregat burn
+ 14 min. 23 s	First Fregat burn cut-off
+ 22 min. 50 s	Second Fregat burn
+ 31 min. 26 s	Second Fregat burn cut-off
+ 1 h 52 min. 45 s	Third Fregat burn
+ 1 h 57 min. 51 s	Third Fregat burn cut-off
+ 2 h 01 min. 11 s	**Separation of the first two O3b satellites**
+ 2 h 16 min. 11 s	Beginning of Fregat burn with ACS thrusters
+ 2 h 16 min. 28 s	End of Fregat burn with ACS thrusters
+ 2 h 22 min. 51 s	**Separation of the second two O3b satellites**
+ 4 h 46 min. 00 s	ACS boost ignition
+ 4 h 57 min. 08 s	End of the Arianespace mission

VS22 MISSION PROFILE

MISSION PROFILE FOR THE THREE SOYUZ STAGES



THE FREGAT MISSION PROFILE



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 more than 600 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, at the Baikonur Cosmodrome in Kazakhstan, and shortly at the Vostochny Cosmodrome in Russia.

> 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 50 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, Soyuz and Vega 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 5, Soyuz and Vega.

For Soyuz, Arianespace supervises the launcher's integration and functional checks in the MIK facility, carried out by RKTs-Progress for the three lower stages, and by NPO-Lavochkin for the Fregat upper stage. It also coordinates Fregat propellant loading operations in the Fregat Fueling Facility (FCube), and satellite preparations in the EPCU payload preparation facility operated by CNES/CSG. Arianespace then integrates the satellite(s) on the Fregat stage in the S3B building, transfers the launcher and upper composite to the Soyuz launch zone and, along with the Russian entities in charge of the launcher, conducts the final countdown and liftoff operations from the Soyuz Launch Center (CDLS). Arianespace deploys a top-flight team and technical facilities to prepare launchers and satellites for their missions.

Building on this unrivalled expertise and outstanding local facilities, Arianespace is now the undisputed benchmark in the global launch services market.