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CENTRE NATIONAL D'ÉTUDES SPATIALES

ARIANESPACE TO ORBIT THE FIRST SIX SATELLITES IN THE ONEWEB CONSTELLATION

For its second mission of the year — and the initial flight in 2019 with the Soyuz medium launcher — Arianespace will perform the first launch for the OneWeb constellation and orbit six satellites.

By operating this maiden flight, out of 21 launches on behalf of the global satellite operator, Arianespace participates in the fulfilment of its customer's ultimate ambition: providing Internet access for everyone, everywhere.

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The OneWeb F6 satellites

Flight VS21, the 21st Soyuz mission from the Guiana Space Center, will put the first six OneWeb satellites into a circular low Earth orbit at 1,000 km. (close to their operational orbit), along with four Mass Flight Simulators (MFS) that will not be separated from the launcher's dispenser system.

The first to sixth OneWeb satellites to be launched by Arianespace on Flight VS21 are designated OneWeb F6.

In June 2015, Arianespace and OneWeb signed an agreement for the deployment of Phase no.1 of the eponymous constellation, covering 21 launches with the medium-lift Soyuz to orbit the initial constellation satellites from three spaceports (Kourou in French Guiana; the Baikonur Cosmodrome in Kazakhstan; and Vostochny, Russia) through 2020.

OneWeb's mission is to deliver global communications through a next-generation satellite constellation that will bring seamless connectivity to everyone, everywhere.

To achieve its purpose, OneWeb is building a network composed of Low Earth Orbit satellites that will provide high-speed, low latency services to a range of markets including aeronautics, maritime, backhaul services, community Wi-Fi, emergency response services and more. Central to its mission, OneWeb will also be focused on connecting unconnected schools and working to bridge the digital divide for people everywhere.

With its system deployed, the OneWeb constellation will enable user terminals capable of offering 3G, LTE, 5G and Wi-Fi coverage, giving high-speed access around the world – by air, sea and land.

OneWeb's initial constellation will be compromised of approximately 650 satellites and will scale to more than 900 satellites as it grows to meet demand around the world. OneWeb will begin customer demos in 2020 and provide global, 24-hour coverage to customers in 2021.

OneWeb Satellites – a joint-venture between OneWeb and Airbus Defence and Space – is the prime contractor of the constellation. The OneWeb F6 spacecraft were built in its Toulouse-based serial production line dedicated to the assembly, integration, and test of the first satellites.

OneWeb F6 will be the 1st to 6th OneWeb satellites to be launched by Arianespace, which has the next satellites of the initial constellation left in its order book.

They will also be the 124th to 129th Airbus Defence and Space spacecraft launched by Arianespace, whose backlog (excluding the OneWeb satellites) consists of 21 additional satellites.

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APCO Technologies, is responsible for designing and building the four Mass Flight Simulators that are carried on Flight VS21.

RUAG Space AB (Linköping, Sweden) is the prime contractor in charge of development and production of the dispenser system. It will first secure the satellites during their flight to low Earth orbit and then release them into space.
This dedicated dispenser is also designed to accommodate up to 32 spacecraft per launch, allowing Arianespace to timely deliver the lion's share of the initial OneWeb constellation.

Arianespace and satellite constellations

With its current family of launchers (Ariane 5, Soyuz and Vega) and the future family (Ariane 6 and Vega C), Arianespace enjoys an excellent position in the growth market of satellite constellations – whether for navigation, telecommunications or Earth observation.

Indeed, since the early 1990s, Arianespace has launched a total of 77 commercial constellation satellites for U.S customers; including 56 satellites for Globalstar, 16 for O3b, 4 for Planet and 1 for Orbcomm; as well as 26 institutional constellation satellites for the European Space Agency ESA and the European Commission as part of the Galileo constellation program.

As for OneWeb F6, they will be the 104th to 109th constellation satellites launched by Arianespace whose backlog, apart from the OneWeb constellation, currently consists in 20 more constellation satellites to orbit on behalf of Spire (x8), Airbus Defence and Space (x4), ESA and the European Commission (x4), and O3b (x4).

MISSION DESCRIPTION

The 21st Soyuz launch from the Guiana Space Center (CSG) will place its satellite passengers into a low Earth orbit, at an altitude of 1,000 km.
The Soyuz ST-B launcher will be carrying a total payload of 1,945.2 kg.

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

DATE AND TIME

Liftoff is scheduled for **Tuesday, February 26, 2019** at exactly:

> **04:37 p.m.,** in Washington, D.C.
> **06:37 p.m.,** in Kourou, French Guiana
> **21h37** Universal Time (UTC)
> **10:37 p.m.,** in Paris
> **00:37 a.m.,** in Moscow on February 27, 2019
> **06:37 a.m.,** in Tokyo on February 27, 2019.

MISSION DURATION

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

1 hour, 22 minutes and 30 seconds.

TARGETED ORBIT

Orbit
LEO
(Low Earth orbit)

Altitude at separation
Approx. 1,000 km.

Inclination
87.77 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. The launcher's third stage will then be separated from the upper composite, which comprises the Fregat upper stage and the OneWeb F6 satellites. The three lower Soyuz stages and the payload fairing will fall into the sea.

Prior to the separation of the satellite, Fregat will carry out two main powered phases:

- Its 1st burn, lasting about 4 minutes, to be followed by a ballistic phase lasting about 43 minutes.
- Its 2nd burn, lasting approximately 2 minutes, followed by a second ballistic phase, lasting 4 minutes and a half.

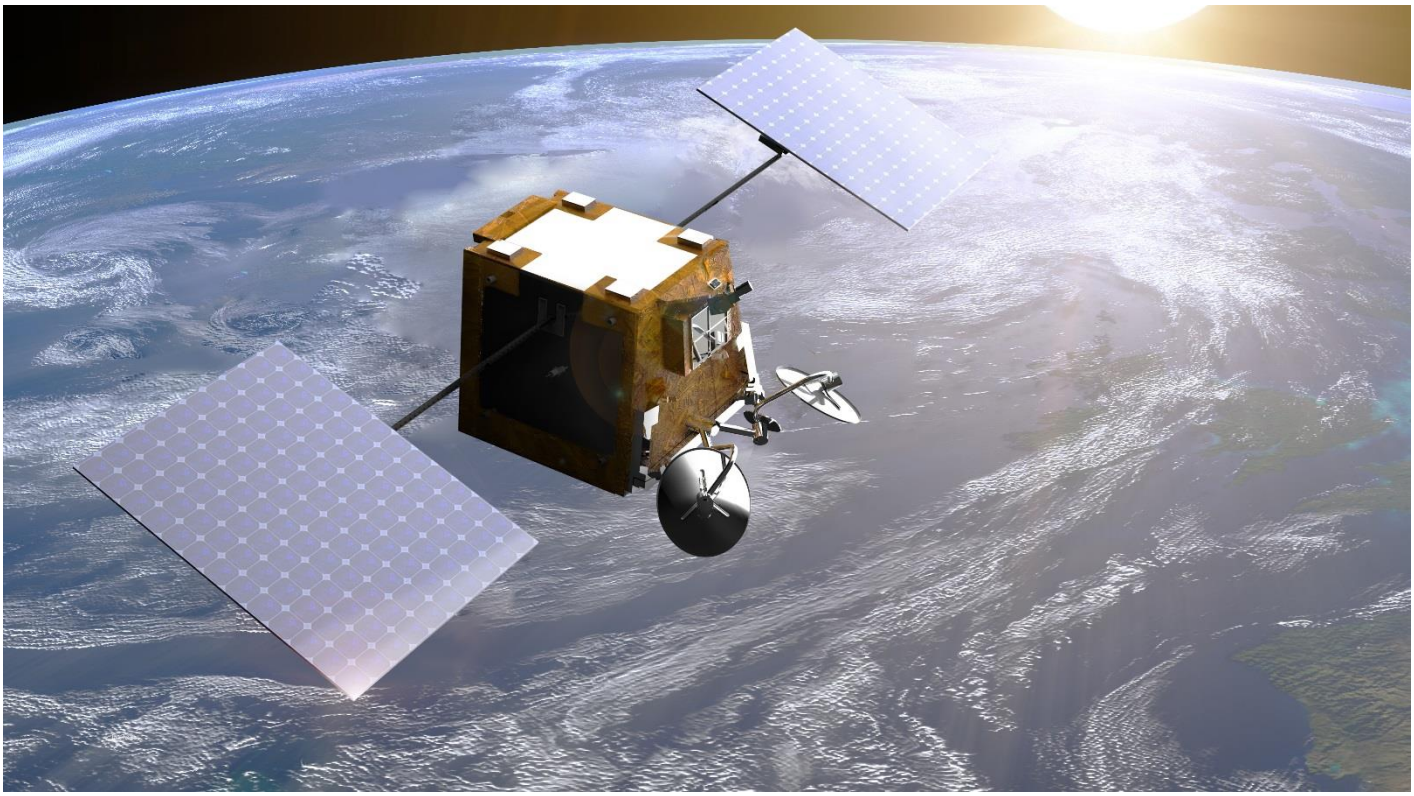
Then, the six satellites will be released on their dedicated orbit in 2 separation events.

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

SOYUZ PAYLOAD CONFIGURATION

> **Payload:** OneWeb F6
> **Mass at liftoff:** 886 kg. (147.7 kg. for each satellite)
> **ST Fairing**
> **OneWeb Dispenser System**

OneWeb F6 satellites



CUSTOMER	OneWeb
MANUFACTURER	OneWeb Satellites, a joint-venture between OneWeb and Airbus Defence and Space
MISSION	Telecommunications
OPERATIONAL ORBIT	Low Earth orbit, at 1,200 km. altitude and 87.9°
PLATFORM	Specific
MASS AT LAUNCH	886 kg. (147.7 kg. for each satellite)
PROPULSION	Plasmic propulsion system
BATTERY	1x Li-Ion
ANTENNAS	2x TTC omni antennas ; 2x Ku antennas ; 2x Ka antennas
STABILIZATION MODE	3-axis stabilized
COVERAGE	Global

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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.

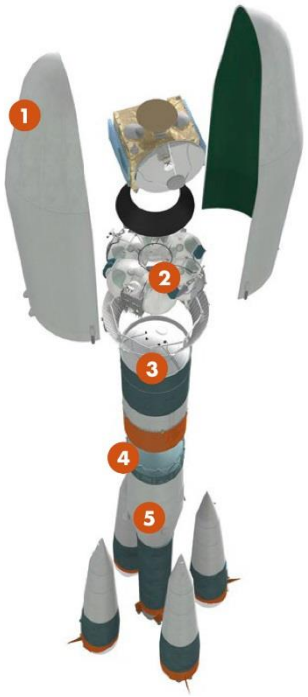
The decision of the European Space Agency to introduce Soyuz launch capability at the Guiana Space Center (CSG) in French Guiana marked a major step forward in expanding the range of missions. With the introduction of Soyuz at CSG, this famed medium-lift Russian launch vehicle is now an integral part 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: ONEWEB F6

CAMPAIGN CALENDAR FOR THE SATELLITES AND LAUNCH VEHICLE

DATE	ACTIVITIES WITH THE SATELLITES	LAUNCH VEHICLE ACTIVITIES
September 3, 2018		Campaign start review - Integration and control of the three Soyuz stages at the Soyuz launcher preparation building (MIK)
September 5 to December 19, 2018		Fregat upper stage preparation at the Soyuz MIK
November 20, to December 15, 2018		Pneumatic and propulsion system tests on the lower three Soyuz stages in the MIK
December 20, 2018		Transfer of the Fregat upper stage to the FCube building for fueling operations
January 22, 2019	Arrival of the OneWeb F6 satellites	
January 23, 2019 to February 7, 2019	Integration of OneWeb F6 Satellites and MFS on the Dispenser	
January 23, 2019 to February 15, 2019		Fregat N204 and UDMH fueling operations in the FCube building
February 7 to 8, 2019		Electrical tests on the lower three Soyuz stages in the MIK
February 18, 2019		Fregat N2H4 fueling operations in the FCube building
February 18, 2019		Fregat upper stage transfer to the S3B building
February 19, 2019	OneWeb F6 and dispenser integration on the Fregat upper stage	Fregat upper stage final preparation; Encapsulation in the payload fairing

FINAL CAMPAIGN CALENDAR FOR THE SATELLITES AND LAUNCH VEHICLE

DATE	ACTIVITIES WITH THE SATELLITES	LAUNCH VEHICLE ACTIVITIES
Thursday, February 21, 2019	Payload checks	Final preparations of the lower three Soyuz stages in the MIK Final launcher checks
Friday, February 22, 2019	Roll-out of the payload upper composite from S3B to the launch zone;	Rollout from MIK to the launch zone;
Saturday, February 23, 2019	Payload checks	Launch rehearsal at the Spaceport facilities
Monday, February 25, 2019		Final launcher checks; Fregat rehearsal; Preparation for fueling operations; Launch readiness review (RAL)
Tuesday, February 26, 2018		Launcher final preparations; Launch countdown; Launch vehicle fueling operations

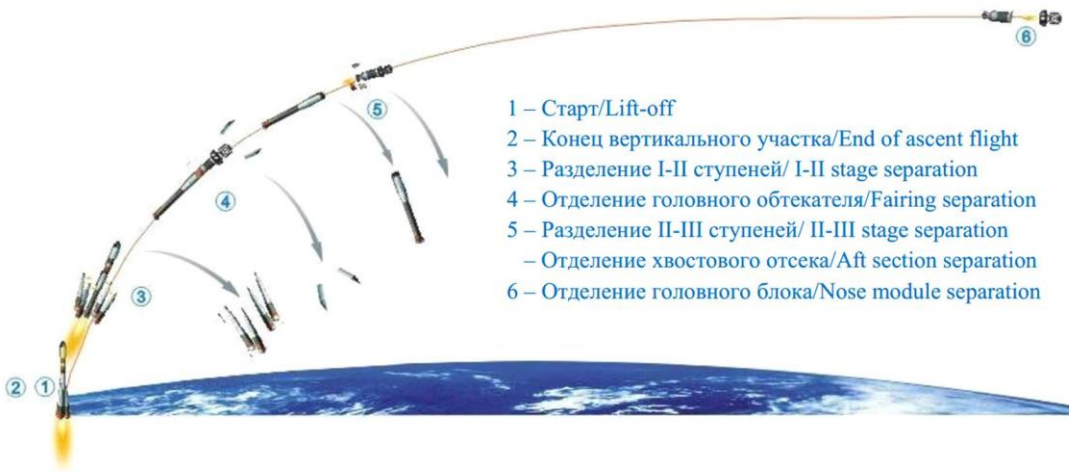
COUNTDOWN AND FLIGHT SEQUENCE

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**
+ 1 min. 58 s	Jettisoning of boosters
+ 3 min. 50 s	Jettisoning of fairing
+ 4 min. 47 s	Separation of central core (second stage)
+ 8 min. 49 s	Separation of 3rd stage
+ 10 min. 23 s	First Fregat burn
+ 14 min. 29 s	First Fregat burn cut-off
+ 56 min. 45 s	Second Fregat burn
+ 58 min. 36 s	Second Fregat burn cut-off
+ 1 h 03 min. 20 s	Separation of 2x OneWeb F6 satellites
+ 1 h 19 min. 10 s	ACS boost ignition
+ 1 h 22 min. 30 s	Separation of 4x OneWeb F6 satellites
+ 3 h 36 min. 35 s	Third Fregat burn (for deorbiting)
+ 3 h 43 min. 36 s	Third Fregat burn cut-off
+ 4 h 23 min. 17 s	End of the Arianespace mission

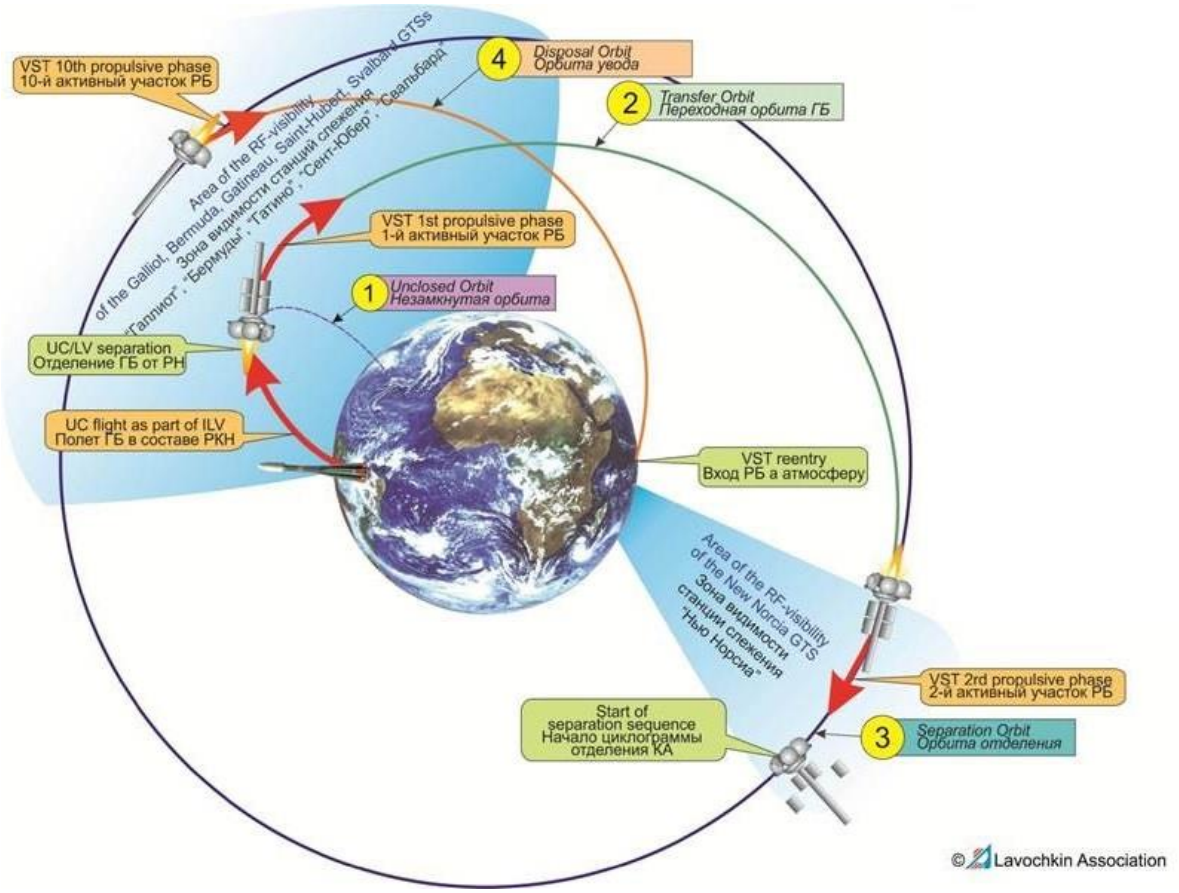
VS21 MISSION PROFILE

MISSION PROFILE FOR THE THREE SOYUZ STAGES



1 –	Старт/Lift-off	0,00 c/s
2 –	Конец вертикального участка/End of ascent flight	8,00 c/s
3 –	Разделение I-II ступеней/ I-II stage separation	117, 83 c/s
4 –	Отделение головного обтекателя/Fairing separation	230,36 c/s
5 –	Разделение II-III ступеней/ II-III stage separation	287,36 c/s
–	Отделение хвостового отсека/Aft section separation	292,04 c/s
6 –	Отделение головного блока/Nose module separation	561,60 c/s

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 launc hed 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, 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 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, 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.