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STARSEM

OneWeb

OneWeb Satellites

ARIANESPACE AT THE ONEWEB CONSTELLATION'S SERVICE FOR THE THIRD TIME

For its fourth mission of the year — and the second flight in 2020 with the Soyuz medium-lift launcher — Arianespace will perform the third launch for the OneWeb constellation, orbiting 34 satellites.

This 51st Soyuz mission conducted by Arianespace and its Starsem affiliate will be operated from the Baikonur Cosmodrome. It will pave the way for the constellation's deployment phase – for which Arianespace is planned to perform 18 more medium-lift Soyuz launches from three spaceports (Kourou, Baikonur and Vostochny) during 2020 and 2021, without mentioning the Ariane 62 maiden flight.

By operating this third flight on behalf of the global satellite operator OneWeb, Arianespace participates in the fulfilment of its customer's ultimate ambition: providing internet access for everyone, everywhere.

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The OneWeb satellites

In June 2015, Arianespace and OneWeb signed an agreement for the deployment of Phase 1 of the eponymous constellation, covering 21 launches with the medium-lift Soyuz from three spaceports (Kourou in French Guiana; the Baikonur Cosmodrome in Kazakhstan; and Vostochny Cosmodrome in Russia) through 2020 and 2021.

On March 2019, Arianespace and OneWeb signed a new launch contract. The launch service agreement specifies the use of:

- the qualification launch of the Ariane 62 version, scheduled by the end of 2020;
- plus two Ariane 6 options (either in its Ariane 62 version, accommodating up to 36 OneWeb satellites, or in the Ariane 64 version with up to 78 OneWeb satellites) to be utilized, starting in 2023.

Flight ST28, the 28th Soyuz commercial mission from the Baikonur Cosmodrome performed by Arianespace and its Starsem affiliate, will put **34 OneWeb satellites** into a near polar orbit at an altitude of 450 kilometers. After separation, the satellites will raise themselves to their operational orbit.

The initial six OneWeb satellites were successfully orbited by Arianespace on Soyuz Flight VS21 from French Guiana on February 27, 2019. On February 7, 2020, Arianespace and its Starsem affiliate launched successfully from Baikonour 34 OneWeb satellites on Soyuz Flight ST27.

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 wide range of customers in sectors that include aeronautics, maritime, backhaul services, community Wi-Fi, emergency response services and more. Central to its mission, OneWeb also will focus on connecting schools and bridging the digital divide for people everywhere.

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

OneWeb's initial constellation is based on approximately 650 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 constellation's prime contractor. The OneWeb spacecraft for Flight ST28 were built in OneWeb Satellites' Florida-based series production line dedicated to the assembly, integration, and test of the OneWeb satellites. They will be the 41st to 74th OneWeb satellites to be launched by Arianespace.

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With the launch of 34 OneWeb satellites on Flight ST28, Arianespace will have orbited a total of 201 spacecraft from Airbus Defence and Space. The Arianespace backlog of payloads still to be launched for Airbus Defence and Space (excluding the remaining OneWeb satellites) counts 21 additional payloads.

RUAG Space AB (Linköping, Sweden) is the prime contractor in charge of development and production of the dispenser system used on Flight ST28. It will carry the satellites during their flight to low Earth orbit and then release them into space.
This dedicated dispenser is designed to accommodate up to 36 spacecraft per launch, allowing Arianespace to timely deliver the lion's share of the initial OneWeb constellation.

Arianespace, Starsem and satellite constellations

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

Indeed, since the late 1990s, Arianespace has launched a total of 121 commercial constellation satellites, including 56 for Globalstar, 20 for O3b, four for Planet and one for Orbcomm; along with 26 institutional satellites for ESA and the European Commission as part of the Galileo constellation project.

Arianespace's backlog, apart from the OneWeb constellation's payloads, currently consists in 45 more constellation satellites to orbit in particular on behalf of Spire (eight), Airbus Defence and Space (four), as well as for ESA and the European Commission (four).

MISSION DESCRIPTION

Arianespace's second launch of 2020 will place its satellite passengers into low Earth orbit, at an altitude of 450 km.

The Soyuz 2-1b launcher will be carrying a total payload of 5,689 kg.

The launch will be performed from the Soyuz Launch Complex in Baikonur, Kazakhstan.

DATE AND TIME

Liftoff is **scheduled for Saturday, March 21, 2020** at exactly:

- **01:06 p.m.,** in Washington, D.C. on March 21,
- **17:06** Universal Time (UTC) on March 21,
- **06:06 p.m.,** in Paris on March 21,
- **08:06 p.m.,** in Moscow on March 21,
- **10:06 p.m.,** in Baikonur on March 21,
- **02:06 a.m.,** in Tokyo on March 22.

MISSION DURATION

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

3 hours, 45 minutes.

TARGETED ORBIT

Orbit	Altitude at separation	Inclination
LEO (Low Earth orbit)	Approx. 450 km.	87.4 degrees

THE LAUNCH AT A GLANCE

Following lift-off from the Baikonur Cosmodrome, 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 satellites. The three lower Soyuz stages and the payload fairing will fall back to Earth.

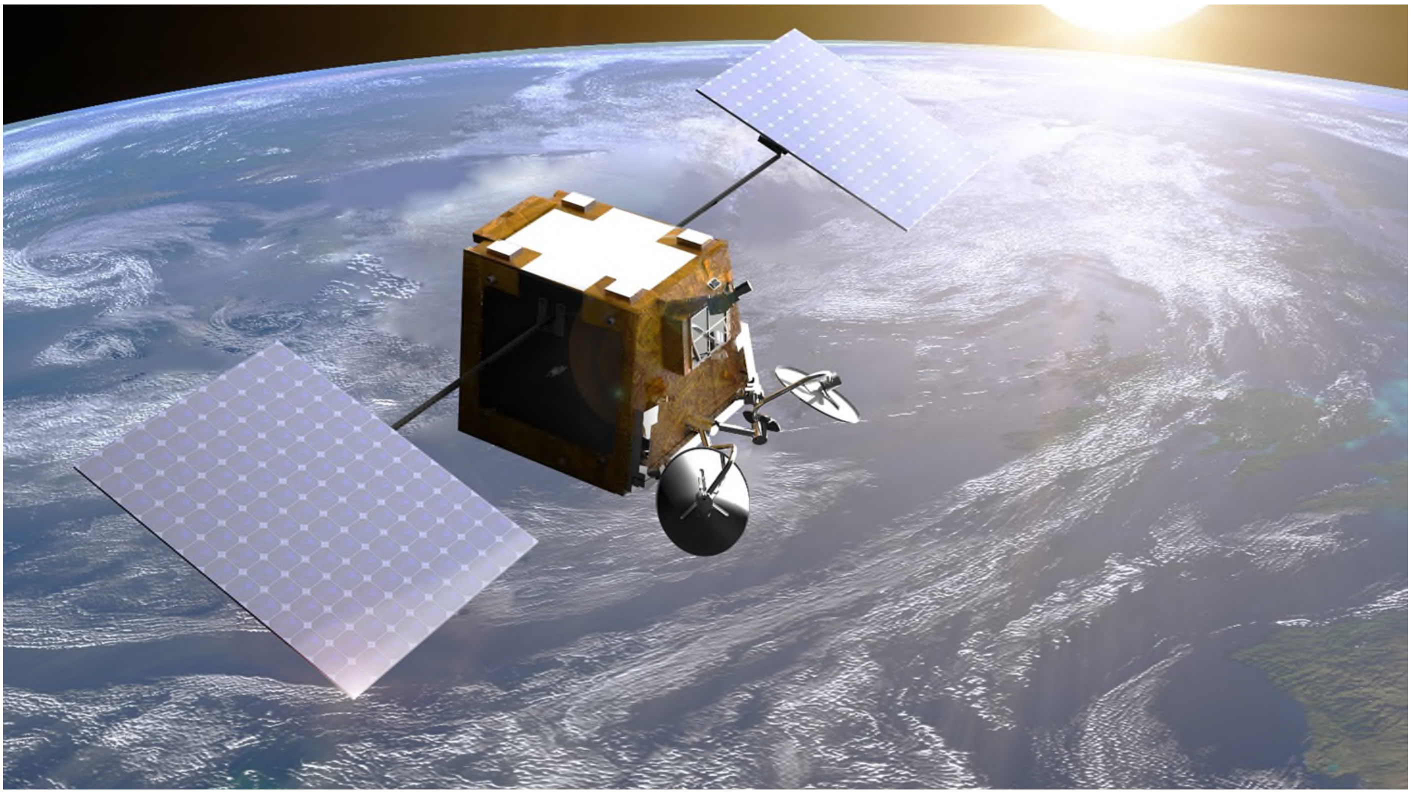
Prior to release of the satellites, Fregat will carry out several main powered phases.
The 34 satellites will be then separated during nine separation sequences.

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

SOYUZ PAYLOAD CONFIGURATION

- **Payload:** **34 OneWeb satellites**
- **Mass at liftoff:** 5,015 kg. (147.5 kg. maximum for each satellite)
- **ST Fairing**
- **OneWeb Dispenser System**

OneWeb Satellites



CUSTOMER	OneWeb
MANUFACTURER	OneWeb Satellites (Florida factory)
MISSION	Telecommunications
OPERATIONAL ORBIT	Low Earth orbit, at 1,200 km. altitude and 87.4° inclination
PLATFORM	Specific
MASS AT LAUNCH	5,015 kg. (147.5 kg. for each satellite)
PROPULSION	Plasmic propulsion system
BATTERY	Li-ion
ANTENNAS	Two TTC omni antennas ; two Ku-band antennas ; two Ka-band 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 some 1,915 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.

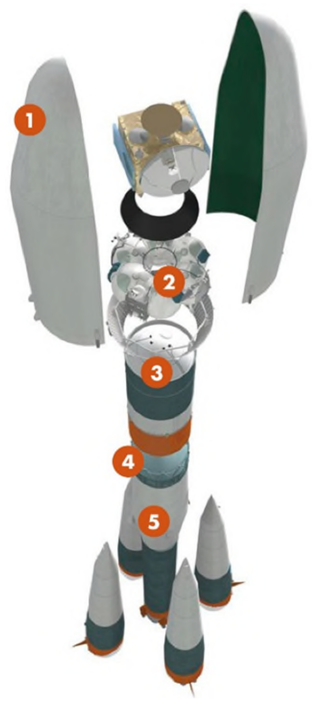
The decision of the European Space Agency to introduce Soyuz launch capability at the Guiana Space Center (CSG) in French Guiana marked a major step forward in expanding the range of missions. With the introduction of Soyuz at CSG, this famed medium-lift Russian launch vehicle is now an integral part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




After the completion of the pre-launch assembly, integration and testing at OneWeb Satellites' manufacturing facility in Florida, USA, the OneWeb satellites arrived at the Baikonur airport and the launch campaign began. Activities in Baikonur during the first several weeks of the launch campaign included preparation of the satellites in the PPF followed by filling and mounting to the dispenser in the HPF. The satellites/dispenser combination was then mated to the Fregat upper stage, and together were encapsulated under the fairing, thereby comprising the Upper Composite. The key events of the OneWeb Launch Campaign in the final days and moments prior to launch proceed as follows (L = lift-off):

L-7 days (or in the night from L-7 to L-6):
Upper composite (satellites + dispenser + Fregat with intermediate bay + fairing) is transferred to the launch vehicle assembly facility ("MIK-40") at Site 31 near launch pad n°6

L-6 to L-4 days:
The Upper Composite is mated to the launch vehicle's third stage, completing the full assembly of the launcher, enabling connections to be verified

L-4 days:
The Transfer Readiness Review ensures the Soyuz launch vehicle and its payload are ready for final launch pad activity and for the launch itself

L-3 days:
The fully assembled launch vehicle is transferred to the pad and erected in the vertical position. Check out of the launch vehicle's three lower stages takes place

L-2 days:
Countdown rehearsal for the customer's spacecraft, along with the Fregat upper stage and the launcher's three stages, as well as verification of the guidance system

L-10 hours:
Final countdown begins. System checks begin on the Soyuz launcher's three stages

L-5 hours 10min:
System checks begin on the Fregat upper stage

L-4 h20m:
Launch vehicle fueling authorization review

L-4 hours:
Launch vehicle fueling begins

L-30 minutes:
Opening of service platform

L-2m25s:
Pressurization of propellant tanks

L-40 seconds:
Transfer to on-board power supply

L-20 seconds:
Ignition of booster and core engines at intermediate thrust level

L:
Lift-off!

COUNTDOWN AND FLIGHT SEQUENCE

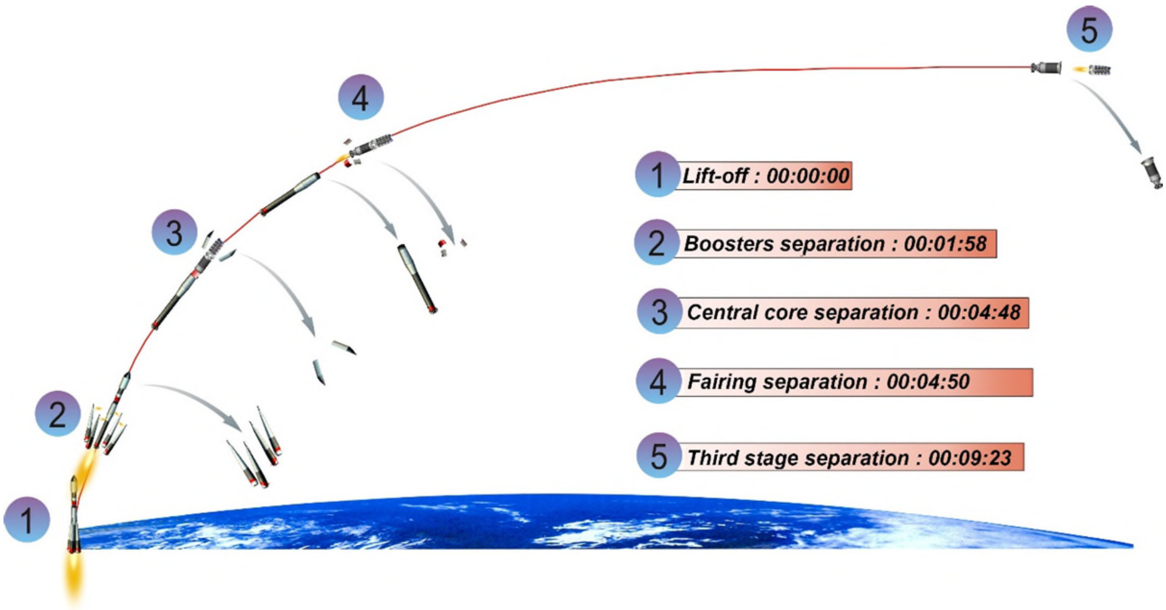
The countdown comprises all final preparation steps for the launcher, the satellites and the launch site. If it proceeds as planned, the countdown leads to the ignition of the core stage engine and the four boosters.

TIME			EVENTs
- 5 h			Meeting for launcher fueling authorization (BTR)
- 4 h	30 min.		Launch vehicle fueling begins
- 1 h	35 min.		End of fueling operations
	- 30 min.		Test bars and 1 kHz tone
	- 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
		- 19 s	Ignition
		- 14 s	Preliminary thrust level
HO		**00 s**	**Liftoff**
	+ 1 min.	58 s	Jettisoning of boosters
	+ 4 min.	48 s	Separation of central core (second stage)
	+4 min.	50 s	Jettisoning of fairing
	+ 9 min.	23 s	Separation of 3rd stage
	+ 10 min.	23 s	First Fregat burn
	+ 14 min.	34 s	First Fregat burn cut-off
+1 h	06 min.	45 s	Second Fregat burn
+1 h	07 min.	19 s	Second Fregat burn cut-off
+ 1 h	11 min.	40 s	1st separation of 2 OneWeb satellites
+ 1 h	27 min.	30 s	Fregat ACS ignition
+ 1 h	27 min.	45 s	Fregat ACS extinction
+ 1 h	30 min.	50 s	2nd separation of 4 OneWeb satellites
+ 1 h	46 min.	40 s	Fregat ACS ignition
+ 1 h	46 min.	54 s	Fregat ACS extinction
+ 1 h	50 min.	00 s	3rd separation of 4 OneWeb satellites
+ 2 h	05 min.	50 s	Fregat ACS ignition
+ 2 h	06 min.	03 s	Fregat ACS extinction
+ 2 h	09 min.	10 s	4th separation of 4 OneWeb satellites
+2 h	25 min.	00 s	Fregat ACS ignition
+ 2 h	25 min.	11 s	Fregat ACS extinction
+ 2 h	28 min.	20 s	5th separation of 4 OneWeb satellites
+ 2 h	44 min.	10 s	Fregat ACS ignition
+ 2 h	44 min.	20 s	Fregat ACS extinction
+ 2 h	47min.	30 s	6th separation of 4 OneWeb satellites
+ 3 h	03 min.	20 s	Fregat ACS ignition

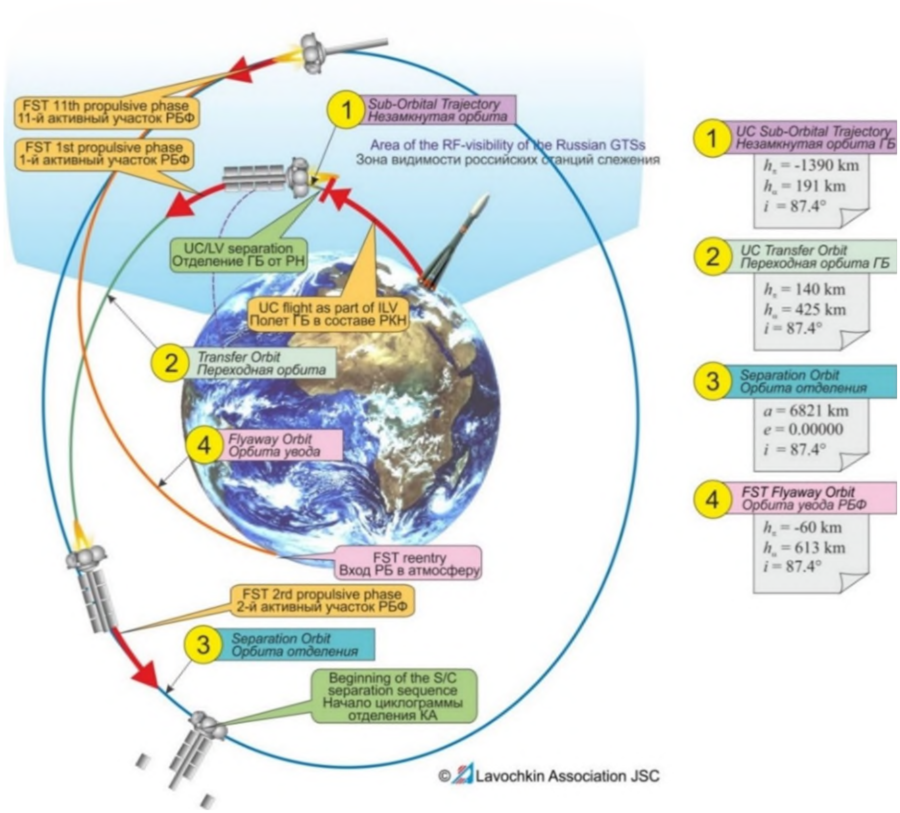
+ 3 h	03 min.	29 s	Fregat ACS extinction
+ 3 h	06 min.	40 s	**7th separation of 4 OneWeb satellites**
+ 3 h	22 min.	30 s	Fregat ACS ignition
+ 3 h	22 min.	37 s	Fregat ACS extinction
+ 3 h	25 min.	50 s	**8th separation of 4 OneWeb satellites**
+ 3 h	41 min.	40 s	Fregat ACS ignition
+ 3 h	41 min.	46 s	Fregat ACS extinction
+ 3 h	45 min.	00 s	**9th separation of 4 OneWeb satellites**
+ 5 h	05 min.	55 s	Third Fregat burn (for deorbiting)
+ 5 h	06 min.	41 s	Third Fregat burn cut-off
+ 5 h	52 min.	20 s	End of the Arianespace mission

ST28 MISSION PROFILE

MISSION PROFILE FOR THE THREE SOYUZ STAGES



THE FREGAT MISSION PROFILE

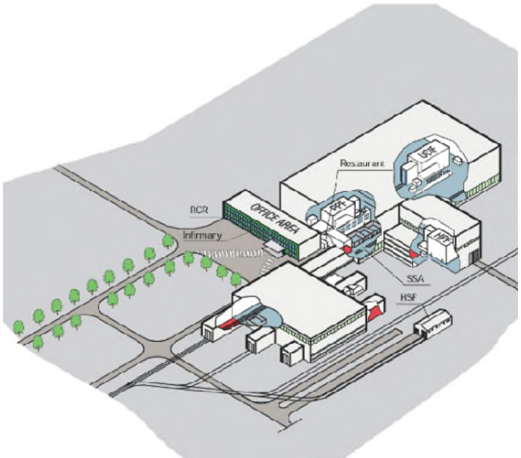


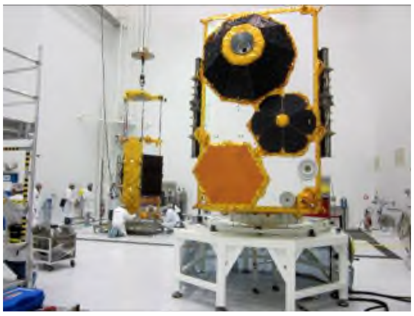
ARIANESPACE AND THE BAIKONUR COSMODROME FACILITIES

Arianespace's Starsem affiliate has adapted, modified, developed, and built dedicated facilities at the Baikonur Cosmodrome, which allow its customers to access to state-of-the-art facilities for their launch campaign. Central to these facilities are the three Class 100,000 clean rooms used for the complete integration checkout, test, and fueling of customer's spacecraft.

SITE 112

Starsem's facilities are located primarily in two areas of the Cosmodrome: Site 112 and Site 31. Site 112 is the location of the assembly and integration facility for the former Energia launch vehicle. This facility (MIK 112) houses Starsem's dedicated clean rooms and is the location where customer's spacecraft are prepared, fueled, and eventually mated to the Fregat upper stage and encapsulated in the fairing. Offices for the mission's customer also are located in this facility. Built in 1998, Starsem's 1,158-sq. meters of Class 100,000 clean rooms ensure customers have access to international-standard facilities for the preparation of their spacecraft. This allows customers to have their spacecraft in a controlled environment – from unpacking through encapsulation. Portable and fixed ventilation systems ensure the thermal conditions of the spacecraft until launch. Fail-safe backup power supplies are available in all clean rooms to protect sensitive hardware during processing activities. Dedicated networks allow voice and data exchange between the clean rooms and other facilities. An independent, redundant satellite communications system provides high data rate connections between customers and their home base.





THE PAYLOAD PROCESSING FACILITY (PPF)

The PPF features a 286 sq. meter high bay for the processing of customer spacecraft. This facility has two independent 70 sq. meter control rooms to permit parallel operations with personnel and equipment airlocks to ensure the integrity of conditions in the processing area.

THE HAZARDOUS PROCESSING FACILITY (HPF)

The HPF high bay covers a surface of 285 sq. meters, and is designed for spacecraft fueling activities and pressurization of tanks. The HPF is designed to accommodate bipropellant spacecraft (e.g.: MMH/N2O4). The facility has airlocks and an on-site control room. A remote control room in the customer office area with a dedicated data transmission system, intercoms, and video monitors ensures maximum safety for customer's launch teams. Spacecraft propellants are stored in the controlled and monitored Hazardous Storage Facility, located next to MIK 112.

THE UPPER COMPOSITE INTEGRATION FACILITY (UCIF)

Spacecraft mating with the Fregat upper stage is performed in this 587 sq. meter high bay, along with fairing encapsulation. The facility has equipment and personnel airlocks and an on-site control room. The remote control room in the customer office area can also be used to monitor activities in the UCIF. The data network allows the customer to carry out spacecraft testing via direct links with EGSE installed in the PPF control room.

SITE 31

Site 31 includes the launch pad, assembly and integration facility for the launch vehicle (MIK 40), and administrative buildings. After encapsulation, customer spacecraft are transported to MIK 40 under a controlled environment to be mated to the rest of the launch vehicle. Following integration, the vehicle is rolled out to the launch pad.