arianespace
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LAUNCH KIT

December 2018

VA246

GSAT-11

GEO-KOMPSAT-2A

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KARI 한국항공우주연구원 Korea Aerospace Research Institute

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FLIGHT VA246: ARIANESPACE TO ORBIT GSAT-11 FOR ISRO AND GEO-KOMPSAT-2A FOR KARI, TWO MAJOR ASIAN SPACE AGENCIES

For its 10th launch of 2018, and the sixth of the year using an Ariane 5 vehicle, Arianespace will serve the national ambitions of two major Asian space agencies by orbiting GSAT-11 for the Indian Space Research Organisation (ISRO) and GEO-KOMPSAT-2A for the Korea Aerospace Research Institute (KARI).

With this mission dedicated to space applications for telecommunications, weather and climate studies, Arianespace once again contributes to the improvement of life on Earth, especially in its most remote and isolated areas.

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GSAT-11

To be installed as Ariane 5's upper passenger, GSAT-11 is an operational telecommunication satellite designed and manufactured by ISRO. By operating GSAT-11, ISRO will 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 harness space technology for national development while pursuing space science research and planetary exploration.

To be positioned at 74° East, GSAT-11 – ISRO's largest and heaviest communication satellite ever – is configured on its next-generation I-6K structure to provide communications services from geostationary orbit in Ku- and Ka-bands in both forward and return links. Offering a multi-spot beam coverage over the Indian mainland and nearby islands, GSAT-11 will bring significant advantages to users when compared with existing INSAT/GSAT satellite systems. Its designed lifetime is more than 15 years.

Since the launch of India's APPLE experimental satellite on Ariane Flight L03 in 1981, Arianespace have orbited 21 satellites and signed 24 launch contracts with the Indian space agency. It has also won almost 90% of the geostationary orbit launch contracts opened to non-Indian launch vehicles.

With two additional satellites remaining in Arianespace's order book, the launch of GSAT-11 is to be another vivid demonstration of the strong bond uniting Europe and India in space cooperation.

GEO-KOMPSAT-2A

The GEO-KOMPSAT-2 program is a national program of the Korean Government to develop and operate two civilian geostationary satellites: GEO-KOMPSAT-2A and -2B.

Positioned on Ariane 5 as Flight VA246's lower passenger, GEO-KOMPSAT-2A is designed to conduct meteorological and space weather monitoring missions (whereas GEO-KOMPSAT-2B is to carry out Earth environment monitoring and ocean monitoring missions).

Covering the Asia-Pacific region, the satellite will be stationed at the 128.2° East orbital location for a 10-year nominal life in service.
Developed by KARI at its facility in Daejeon, South-Korea, this weather satellite will be the 68th Earth observation satellite launched by Arianespace. Such missions represent 10% of the total number of satellites orbited by the launch service company.

For nearly 30 years, Arianespace and Korea's satellite technology research centers have developed a sound relationship, with the launch of scientific microsatellites (KITSAT A & B, in 1992 et 1993) as well as the multi-mission COMS satellite (in 2010).

GEO-KOMPSAT-2A will be KARI's second's satellite, and the seventh for South-Korea to be lofted by Arianespace.
By entrusting Arianespace with the launch of its KOMPSAT-7 satellite, KARI confirmed the relevance of its services and solutions toward the dynamic Earth observation market as well as its capacities to help Korea fulfil its ambitions in Space.

Prior to Flight VA246, Arianespace has orbited 588th satellites, out of which 115 were launched for eight space agencies around the world (Europe, France, Italy, Sweden, U.S., India, Korea and Japan).

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MISSION DESCRIPTION

Arianespace' six Ariane 5 ECA launch of the year will place its satellite passengers into geostationary orbit.

The launcher will be carrying a total payload of approximately 10,298 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, December 4, 2018** as early as possible within the following launch window:

> **Between 3:37 p.m. and 4:53 p.m.** Washington DC time
> **Between 5:37 p.m. and 6:53 p.m.** Kourou, French Guiana time
> **Between 20:37 and 21:53** Universal Time (UTC)
> **Between 9:37 p.m. and 10:53 p.m.** Paris time
> **Between 2:07 a.m and 3:23 a.m** Bangalore time, on Wednesday, December 5, 2018
> **Between 5:37 a.m. and 6:53 a.m** Seoul and Tokyo time on Wednesday, December 5, 2018

MISSION DURATION

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

33 minutes, 38 seconds.

TARGETED GEOSTATIONARY ORBIT

Perigee altitude
250 km.

Apogee altitude
35,726 km.

Inclination
3.5 degrees

THE LAUNCH AT A GLANCE

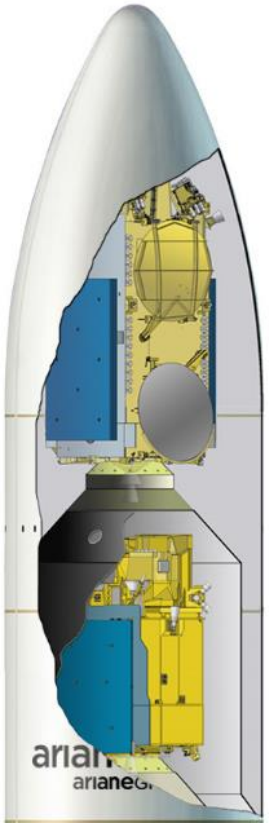
The launcher's attitude and trajectory are controlled by the two onboard computers located in the Ariane 5 vehicle equipment bay (VEB).

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+193 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

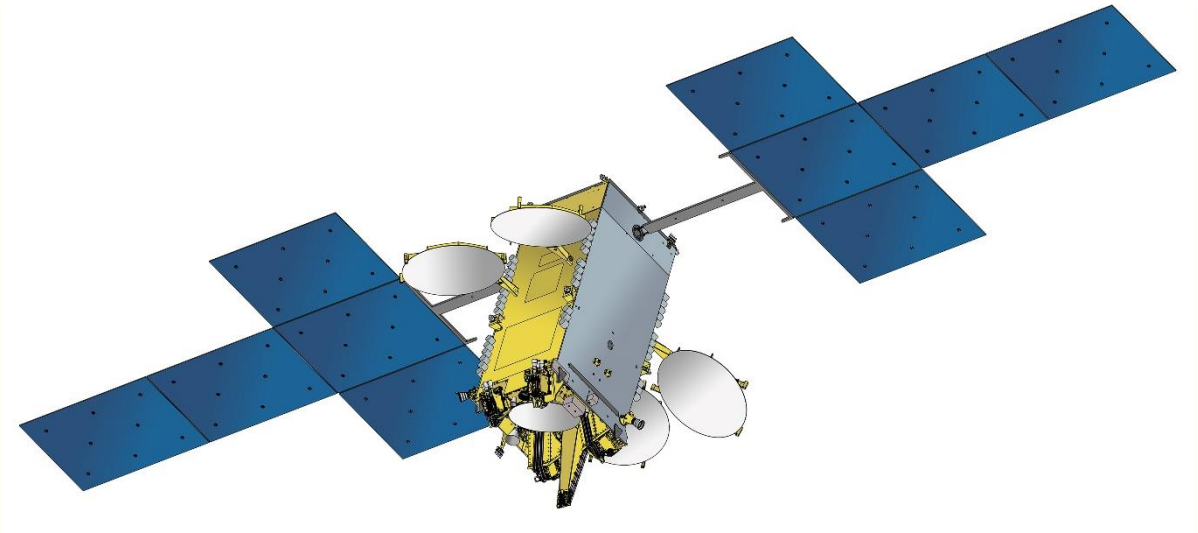
> **Upper payload (CUH): GSAT-11**
Mass at liftoff: 5,854.5 kg.

> **Lower payload (CUB): GEO-KOMPSAT-2A**
Mass at liftoff: 3,507.2 kg.

> **Long version of the payload fairing**

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

GSAT-11 SATELLITE



CUSTOMER/MANUFACTURER	**ISRO (Indian Space Research Organisation)**
MISSION	Communications
MASS AT LAUNCH	5,854.5 kg.
PLATFORM	I-6K bus (first model)
ORBITAL POSITION	74° East longitude
STABILIZATION	3 axis
BATTERIES	2x Li-Ion
PAYLOAD	Ku- and Ka-band transponders
DESIGN LIFE	15 years

PRESS CONTACT

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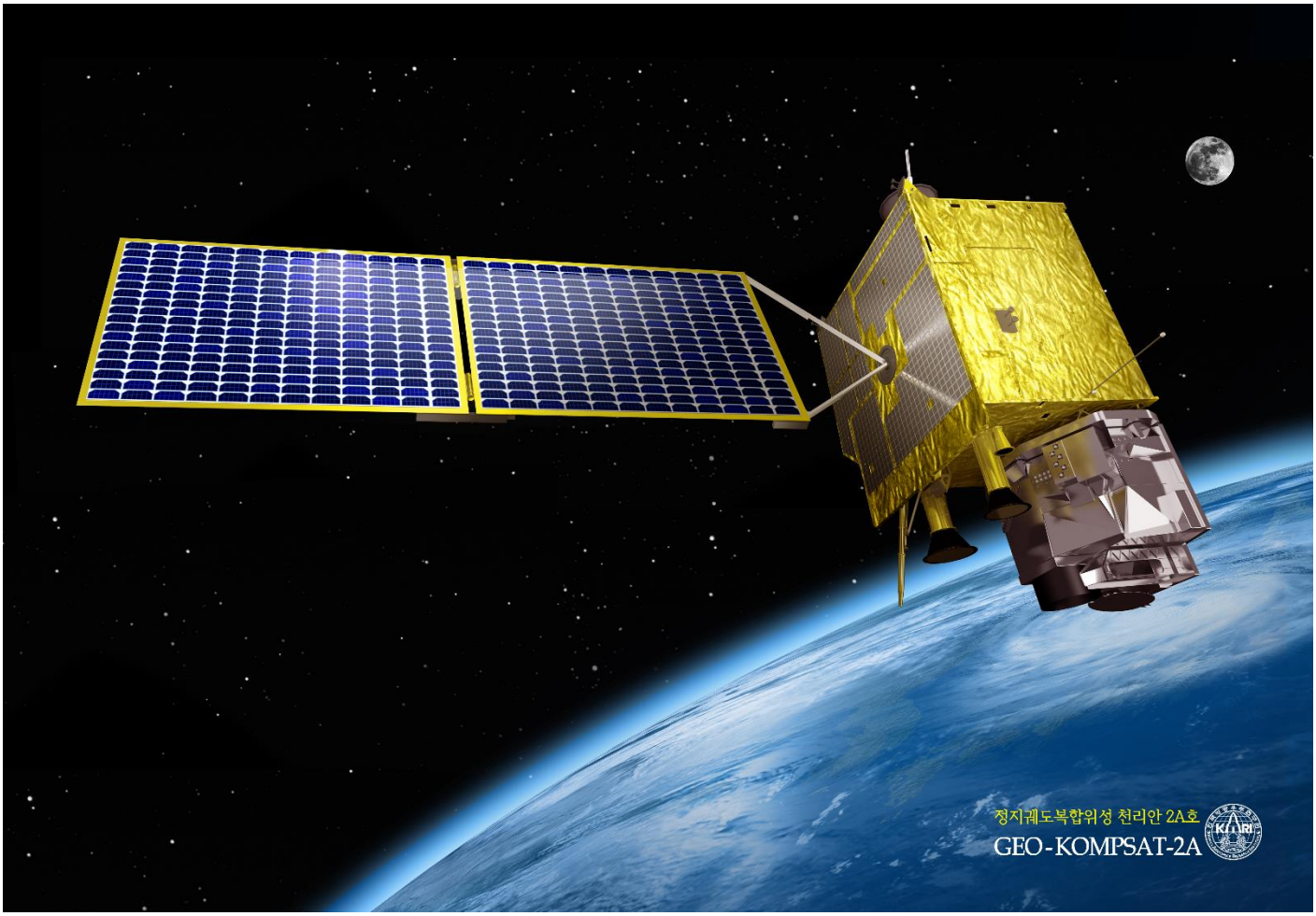
GEO-KOMPSAT-2A SATELLITE



CUSTOMER/MANUFACTURER	**KARI (Korea Aerospace Research Institute)**
MISSION	Meteorology
MASS AT LAUNCH	3,507.2 kg.
PLATFORM	Specific (heritage from COMS-V195
INSTRUMENT	AMI (Advanced Meteorological Imager)
ORBITAL POSITION	128.2° East
STABILIZATION	3 axis
BATTERIES	1x Li-Ion (225 Ah)
DESIGN LIFE	More than 10 years

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ARIANE 5 ECA LAUNCH VEHICLE

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

54.8 m.

Fairing

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

GSAT-11

ISRO
Mass: 5,854.5 kg.

GEO-KOMPSAT-2A

KARI
Mass: 3,507.2 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

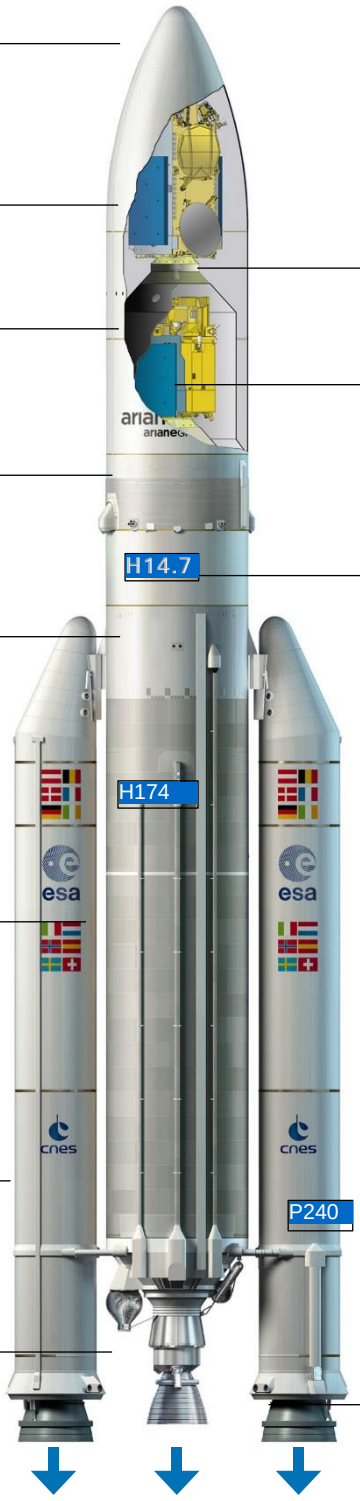
Height: 31 m.
Mass: 188 t.

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



780 metric tons
(total mass at liftoff)

PA - Payload adaptor (2)

(RUAG Space or Airbus)
Mass: approx. 300 kg. (approx. 150 kg. each)

SYLDA - Internal structure

Mass: 500 to 530 kg.

ESC-A - Cryogenic upper stage

Height: 4.71 m.
Mass: 19 t.

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

MPS - Solid Rocket Motor (SRM)

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

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

LAUNCH CAMPAIGN - ARIANE 5
GSAT-11
GEO-KOMPSAT-2A

SATELLITE AND LAUNCH VEHICLE CAMPAIGN CALENDAR

DATE	SATELLITES ACTIVITIES	LAUNCH VEHICLE ACTIVITIES
October 20, 2018	Arrival of GEO-KOMPSAT-2A in French Guiana and transfer by road to the Spaceport's S5C payload preparation facility	
October 22, 2018		Campaign start review EPC unpacking and erection
October 23, 2018		EAP 1 & 2 transfer to the BIL (Launcher Integration Building)
October 24, 2018		EPC/EAP integration
October 26, 2018	GSAT-11 arrival in French Guiana and transfer by road to the Spaceport's S5 payload preparation facility	
October 29, 2018		Erection of ESC-A and vehicle equipment bay installation
November 10 to 14, 2018	GSAT-11 fueling operations	
November 13 to 16, 2018	GEO-KOMPSAT-2A fueling operations	
November 15, 2018		Transfer from BIL to BAF (Final Integration Building)
November 17, 2018	GSAT-11 integration on payload adaptor	
November 19, 2018	GSAT-11 transfer to the BAF	
November 20, 2018	GSAT-11 integration on SYLDA	
November 21, 2018	GEO-KOMPSAT-2A integration on payload adaptor	

SATELLITE AND LAUNCH VEHICLE CAMPAIGN FINAL CALENDAR

DATE	SATELLITES ACTIVITIES	LAUNCH VEHICLE ACTIVITIES
Wednesday, November 21, 2018, 2018	GSAT-11 final preparation before fairing encapsulation	
Thursday, November 22, 2018	Fairing encapsulation on SYLDA/GSAT-11 GEO-KOMPSAT-2A final preparation and transfer to the BAF	
Friday, November 23, 2018	GEO-KOMPSAT-2A integration on launch vehicle	HM7B engine final inspection
Saturday, November 24, 2018	Payload checks after composite integration on launcher	Composite integration on launcher and payload checks
Monday and Tuesday, November 26-27, 2018		Finalization of the composite/launcher integration
Wednesday, November 28, 2018		Launch rehearsal
Thursday and Friday, November 29-30, 2018		Arming of launch vehicle
Friday, November 30, 2018		Launch readiness review (LRR), final preparation of launcher and BAF for chronology
Monday, December 3, 2018		Roll-out from BAF to Launch Zone, launch vehicle connections and filling of the EPC liquid helium tank
Tuesday, December 4, 2018		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 site. If it proceeds as planned, the countdown leads to ignition of the main stage engine, then the two boosters, for a liftoff at the targeted time.

The countdown culminates in a synchronized sequence, which is managed by the control station and onboard computers starting at T-7 minutes.

If an interruption in the countdown 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
+ 12.4 s	End of vertical climb, beginning of pitch motion
+ 17.1 s	Beginning of roll maneuver
+ 32.1 s	End of roll maneuver
+ 2 min 21 s	EAP separation
+ 3 min 13 s	Fairing jettisoned
+ 6 min 26 s	Acquisition by Natal tracking station
+ 8 min 50 s	End of EPC thrust phase
+ 9 min 00 s	EPC separation
+ 9 min 08 s	Ignition of ESC-A stage
+ 13 min 22 s	Acquisition by Ascension tracking station
+ 17 min 46 s	Acquisition by Libreville tracking station
+ 21 min 59 s	Acquisition by Malindi tracking station
+ 25 min 04 s	Extinction of ESC-A stage
+ 25 min 06 s	Injection
+ 29 min 07 s	**GSAT-11 satellite separation**
+ 31 min 47 s	SYLDA separation
+ 33 min 38 s	**GEO-KOMPSAT-2A 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).

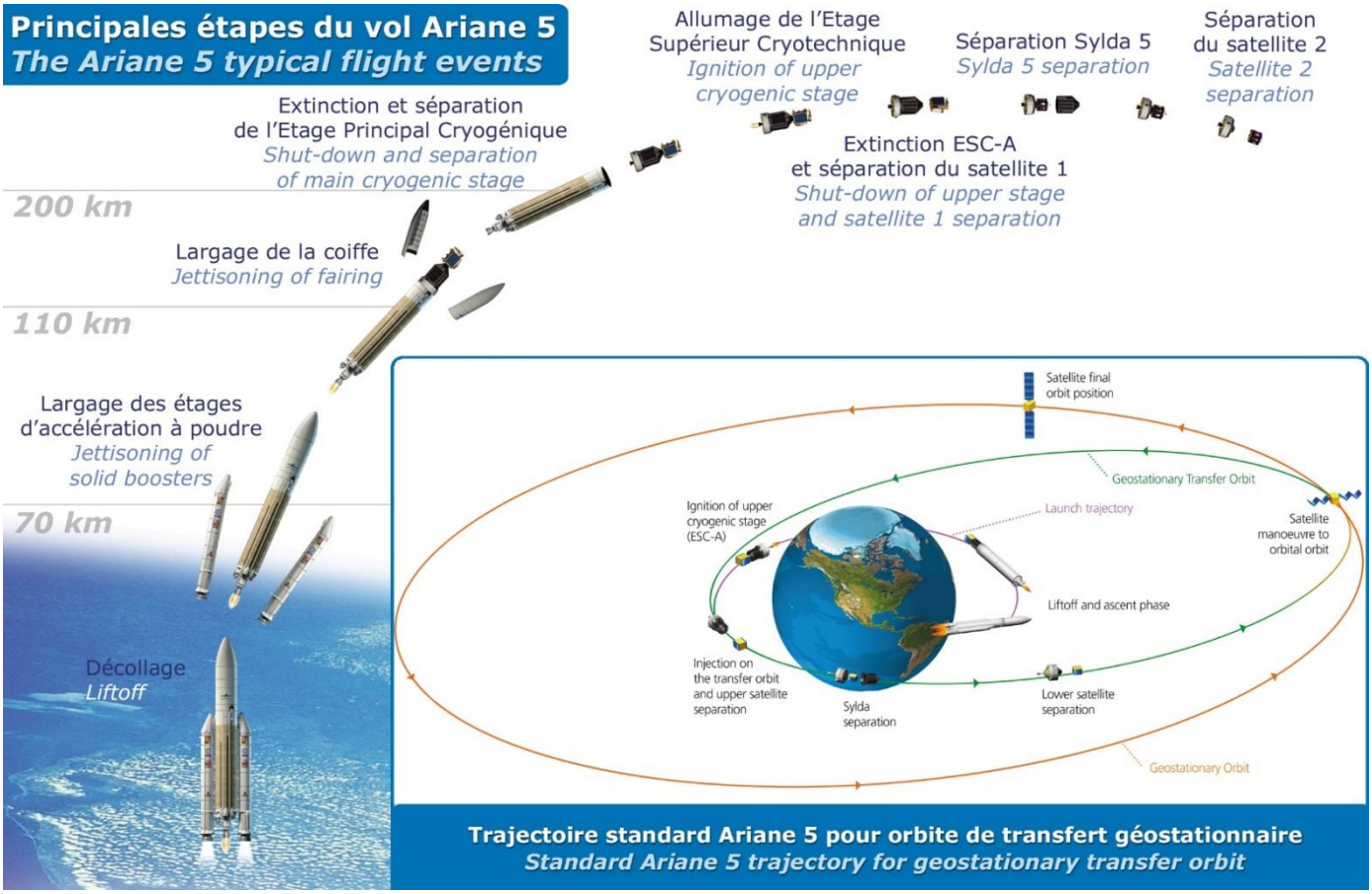
The synchronized sequence starts seven minutes before ignition (T-0). It is primarily designed to perform the final operations on the launcher prior to launch, along with the ultimate checks needed following switchover to flight configuration. As its name indicates, the sequence is fully automatic, and 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 530 launch contracts and launched 580-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 1.3 billion euros in 2017.

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.