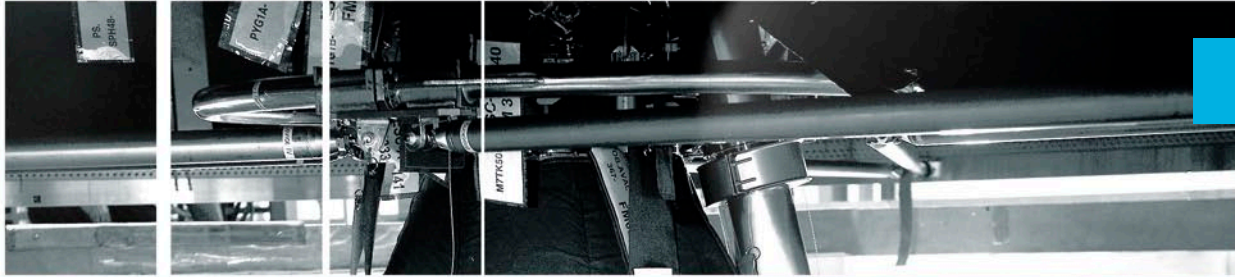
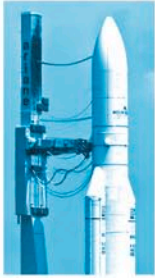


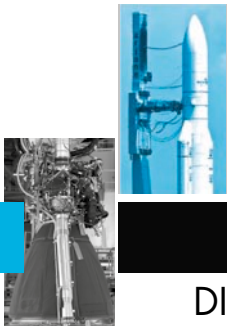
May  
2015



**VA 223**

DIRECTV 15  
SKYM-1





# VA 223

## DIRECTV-15 - SKYM-1



## A DEDICATED LAUNCH FOR HIGH DEFINITION DIRECT TO HOME BROADCAST SATELLITES

On its fourth launch of the year and second with the Ariane 5 heavy launcher, Arianespace will orbit two direct-to-home (DTH) TV broadcast satellites: DIRECTV 15, the most powerful direct TV broadcast satellite in the United States For DIRECTV, one of the world's leading providers of television entertainment services. SKYM-1 for SKY Mexico, the leading company in the Mexican pay TV market.

The second Ariane 5 mission of the year clearly demonstrates operators' sustained confidence in the reliability and performance of Ariane 5, the heavy lifter in Arianespace's family of European launch vehicles. It also reflects the top-flight relationship that Arianespace has established with its customer DIRECTV, and the adaptability of its launch services, which allow for both a 3-ton and a 6-ton class satellite on the same mission.

### DIRECTV-15

DIRECTV-15 will be the eighth satellite orbited by Arianespace for the private operator DIRECTV, after its latest launch of DIRECTV-14 in December 2014.

Built by Airbus Defence and Space in Toulouse, southwest France, using a Eurostar-3000 platform, DIRECTV-15 will weigh about 6,200 kg at launch. It is fitted with 150 travelling wave tubes (TWTs) to provide 28 active Ku-band and 25 active Ka-band/Rev-band transponders, and will offer new HD and 4K UHD direct TV broadcast services in the continental United States, Alaska, Hawaii and Puerto Rico.

It will be able to operate from up to five different orbital positions: 99.2° or 102.8° West in Ka-band, 17 GHz Reverse Band and at 101°, 110° or 119° in Ku-band.

DIRECTV-15 offers a design life of 15 years.

DIRECTV-15 is the 111<sup>th</sup> payload built by Airbus Defence and Space to be launched by Arianespace.

### SKYM-1

SKYM-1 will be launched by Arianespace for the private operator SKY Mexico.

It was built by Orbital ATK using a GEOStar-2.4E platform, and will weigh about 3,000 kg at launch.

SKYM-1 is fitted with 32 travelling wave tubes (TWTs) to provide 24 active Ku-band and two active Rev-band transponders. Offering a design life of 15 years, it will be positioned at 78.8° West, and will provide high-definition (HD) direct TV broadcast services for Mexico, Central America and the Caribbean.

SKYM-1 is the 26<sup>th</sup> satellite built by Orbital ATK to be launched by Arianespace.



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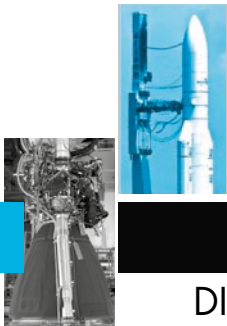
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# VA 223

## DIRECTV-15 - SKYM-1



## MISSION DESCRIPTION

The 223<sup>rd</sup> Arianespace launch will orbit two telecommunications satellites for operators DIRECTV and SKY Mexico.

This will be the 79<sup>th</sup> launch of an Ariane 5.

The launcher will be carrying a total payload of 9,960 kg, including 9,200 kg for the DIRECTV-15 and SKYM-1 satellites, which will be released into their targeted orbits.

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

### Targeted orbit

**Perigee altitude** : 250 km  
**Apogee altitude** : 35,786 km  
**Inclination** : 6 degrees

Liftoff is planned on **Wednesday, Mai 27, 2015**  
as soon as possible within the following launch windows:

- Between 06:16 pm and 07:40 pm, Kourou,
- Between 02:16 pm and 03:40 pm, Los Angeles time,
- Between 04:16 pm and 05:40 pm, Mexico time,
- Between 05:16 pm and 06:40 pm, New York time,
- Between 09:16 pm and 10:40 pm, Universal Time (GMT),
- Between 11:16 pm and 00:40 am, Paris time, May 28, 2015

## The launch at a glance

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

7.05 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 6 seconds, then rotates towards the East. It maintains an attitude that ensures the axis of the launcher remains parallel to its velocity vector, in order to minimize aerodynamic loads throughout the entire atmospheric phase, until the solid boosters are jettisoned.

The fairing protecting the DIRECTV-15 and SKYM-1 spacecraft is jettisoned at T+200 seconds (once the Ariane 5 has climbed through the Earth's dense atmospheric layers), and comes after the launcher's boosters are jettisoned at approximately at T+142 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 falls back off the coast of Africa in the Atlantic Ocean (in the Gulf of Guinea).

On orbital injection, the launcher will have attained a velocity of approximately 9,365 meters/second, and will be at an altitude of about 643.2 kilometers.

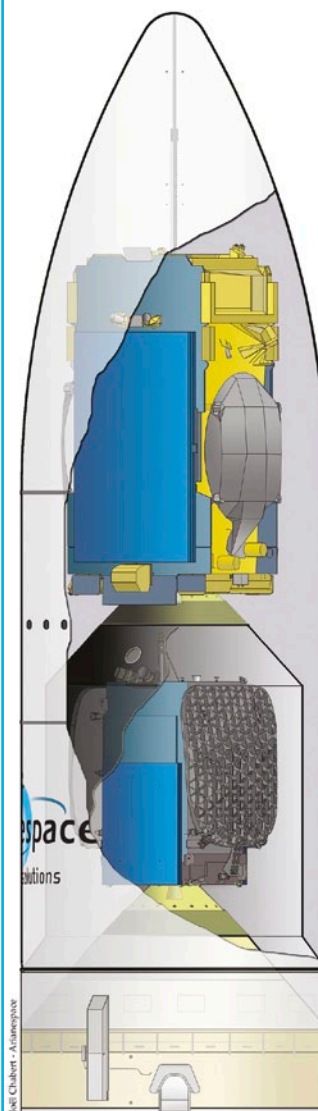
## Payload configuration

DIRECTV-15 satellite was built for the operator DIRECTV by Airbus Defence and Space (ADS) in Toulouse (France).

Orbital position: 99° to 119° West

The SKYM-1 satellite was built for the operator SKY Mexico by Orbital ATK in Dulles (Virginia, USA)

Orbital position: 78,8° West



## Mission length

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

**37 minutes  
and 59 seconds.**





# VA 223

DIRECTV-15 - SKYM-1

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## THE DIRECTV-15 SATELLITE



<b>Customer</b>	<b>DIRECTV</b>
<b>Prime contractor</b>	<b>Airbus Defence And Space - ADS (Toulouse)</b>
<b>Mission</b>	<b>Direct-to-home television broadcast services</b>
<b>Mass</b>	<b>Total mass at lift-off approx. 6,200 kg</b>
<b>Stabilization</b>	<b>3 axis</b>
<b>Dimensions</b>	<b>2.9 x 2.3 x 5.9 m</b>
<b>Span in orbit</b>	<b>42 m</b>
<b>Platform</b>	<b>Eurostar - E3000</b>
<b>Payload</b>	<b>28 Ku-band transponders and 25 Ka-band/Rev-band active transponders</b>
<b>On-board power</b>	<b>18 kW (end of life)</b>
<b>Life time</b>	<b>15 years</b>
<b>Orbital position</b>	<b>99° to 119° west - 5 different positions</b>
<b>Coverage area</b>	<b>Continental United States, Alaska, Hawaii and Puerto Rico</b>

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# VA 223

DIRECTV-15 - SKYM-1

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## THE SKYM-1 SATELLITE



<b>Customer</b>	<b>SKY Mexico</b>
<b>Prime contractor</b>	<b>Orbital ATK</b>
<b>Mission</b>	<b>Direct TV</b>
<b>Mass</b>	<b>Total mass at lift-off 3,000 kg</b>
<b>Stabilization</b>	<b>3 axis</b>
<b>Dimensions</b>	<b>4.7 m x 3 m x 2.5 m</b>
<b>Platform</b>	<b>GEOSTAR-2.4E</b>
<b>Payload</b>	<b>24 Ku-band transponders and 2 Rev-band active transponders</b>
<b>On-board power</b>	<b>6 kW (end of life)</b>
<b>Life time</b>	<b>15 year</b>
<b>Orbital position</b>	<b>78.8° west</b>
<b>Coverage area</b>	<b>Mexico, Central America and the Caribbean</b>

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# VA 223

DIRECTV-15 - SKYM-1

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## ARIANE 5-ECA LAUNCH VEHICLE

54.8 m

### Fairing

(RUAG Space)  
▼ 17 m  
▼ Mass: 2.4 t

### DIRECTV-15

(DIRECTV)  
▼ Mass: 6.2 t

### SKYM-1

((SKY Mexico))  
▼ Mass: 3.0 t

### Vehicle Equipment Bay

(Airbus Defence and Space)  
▼ Height: 1.13 m  
▼ Mass: 970 kg

### ESC-A - Cryogenic upper stage

(Airbus Defence and Space)  
▼ Height: 4.71 m  
▼ Mass: 19 t

### EPC - Main Cryogenic stage

(Airbus Defence and Space)  
▼ Height: 31 m  
▼ Mass: 188 t

### EAP - Solid Rocket Boosters

(Airbus Defence and Space)  
▼ Height: 31.6 m  
▼ Mass: 277 t approx.

### Vulcain 2 Engine

(Snecma)  
▼ Thrust: 1,390 kN (in vacuum)  
▼ 540 sec of propulsion

**780 tons**

(total mass at liftoff)

### ACU - Payload adaptor (2)

(RUAG Space or Airbus Defence and Space)  
▼ Mass: 140 kg each approx.

### SYLDA - Internal structure

(Airbus Defence and Space)  
▼ 7 versions (Height: 4.9 to 6.4 m)  
▼ Mass: 400 to 530 kg

### M-7B Engine

(Snecma)  
▼ Thrust: 67 kN (in vacuum)  
▼ 945 sec of propulsion

### Propellants (in tons) at T-O

**H** : Cryogenic  
**P** : Solid

### MPS - Solid Propellant Motor

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

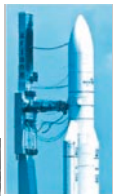
**13,000 kN at Lift-off**  
(at T-O + 7.3 sec)



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# VA 223

## DIRECTV-15 - SKYM-1



## RANGE OPERATIONS CAMPAIGN: ARIANE 5 - DIRECTV-15 - SKYM-1

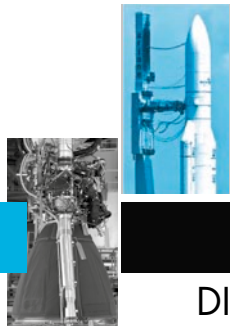
### DIRECTV-15 - SKYM-1 and launch vehicle campaign calendar

Dates	Satellite activities	Launch vehicle activities
February 7, 2015		Campaign start review
February 9, 2015		EPC erection
February 10, 2015		EAP transfer and positioning
February 11, 2015		EPC/EAP integration
March 6, 2015		ESC-A Erection and equipment bay integration
March 31, 2015	Arrival of DIRECTV-15 and beginning of preparation campaign in building S5C	
April 8, 2015	DIRECTV-15 transfer to S5A	
April 17, 2015	Arrival in Kourou of SKYM-1, beginning of preparation campaign in building S1B and DIRECTV-15 filling operations	
April 24 - 6, 2015	DIRECTV-15 integration on adaptor ACU and functional test	
April 25, 2015	DIRECTV-15 transfer to Final Assembly Building (BAF)	
April 27, 2015	DIRECTV-15 integration on SYLDA and SKYM-1 transfer to S3B	
April 28, 2015	Fairing integration on SYLDA	
April 29, 2015	SKYM-1 filling operations	
May 5, 2015		Transfer BIL-BAF
May 6, 2015	SKYM-1 integration on ACU	

### DIRECTV-15 - SKYM-1 launch vehicle campaign final calendar

Dates	Satellite activities	Launch vehicle activities
Monday, May 11, 2015	SKYM-1 transfer to Final Assembly Building (BAF)	
Tuesday, May 12, 2015	SKYM-1 integration on launcher	
Wednesday, May 13, 2015	Composite integration with DIRECTV-15 on launcher	
Tuesday, May 19, 2015		Completion of composite integration on launcher
Wednesday, May 20, 2015		ESC-A final preparations and Launch rehearsal
Thursday, May 21, 2015		Arming of launch vehicle
Friday, May 22, 2015		Launch readiness review (RAL) and final preparation of launcher
Tuesday, May 26, 2015		Rollout from BAF to Launch Zone, launch vehicle connections and filling of the EPC liquid helium tank
Wednesday, May 27, 2015		Start of final countdown and launch countdown, including EPC filling with liquid oxygen and liquid hydrogen





# VA 223

## DIRECTV-15 - SKYM-1



## COUNTDOWN AND FLIGHT

The countdown comprises all final preparation steps for the launcher, the satellites/spacecraft and the launch site. If it proceeds as planned, the countdown leads to the ignition of the main stage engine, then the two boosters, for a liftoff at the targeted time.

The countdown culminates in a synchronized sequence (see appendix 3), which is managed by the control station and onboard computers starting at T-7 minutes.

If an interruption in the countdown means that T-0 falls outside the nominal liftoff 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 30 mn	Start of final countdown
- 07 h 30 mn	Check of electrical systems
- 04 h 50 mn	Start of filling of main cryogenic stage with liquid oxygen and hydrogen
- 03 h 20 mn	Chilldown of Vulcain main stage engine
- 01 h 10 mn	Check of connections between launcher and telemetry, tracking and command systems
- 07 mn 00.0 s	"All systems go" report, allowing start of synchronized sequence
- 04 mn 00.0 s	Tanks pressurized for flight
- 01 mn 00.0 s	Switch to onboard power mode
- 05.5 s	Cryogenic arm opening command
- 04.0 s	Onboard systems take over
- 03.0 s	Two inertial reference systems switch to flight mode

T-O	Ignition of the cryogenic main stage engine (EPC)
+ 07.0 s	Ignition of solid boosters (EAP)
+ 07.3 s	Liftoff
+ 12.6 s	End of vertical climb, beginning of pitch motion (10 seconds duration)
+ 17.0 s	Beginning of roll maneuver
+ 2 mn 23.2 s	EAP separation
+ 3 mn 26.7 s	Fairing jettisoned
+ 7 mn 52.6 s	Acquisition by Natal tracking station
+ 8 mn 51.1 s	End of EPC thrust phase
+ 8 mn 58.1 s	EPC separation
+ 9 mn 2.3 s	Beginning of first ESC-A thrust phase
+ 13 mn 40.0 s	Acquisition by Ascension tracking station
+ 18 mn 25.4 s	Acquisition by Libreville tracking station
+ 23 mn 9.4 s	Acquisition by Malindi tracking station
+ 25 mn 11.2 s	End of first ESC-A thrust phase / Injection
+ 27 mn 47.2 s	<b>DIRECTV-15 satellite separation</b>
+ 29 mn 47.6 s	Sylta 5 separation
+ 37 mn 58.9 s	<b>SKYM-1 satellite separation</b>
+ 01 h + 44 mn 30.6 s	End of Arianespace mission





# VA 223

## DIRECTV-15 - SKYM-1



## ▼ DIRECTV-15 - SKYM-1 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 7 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:

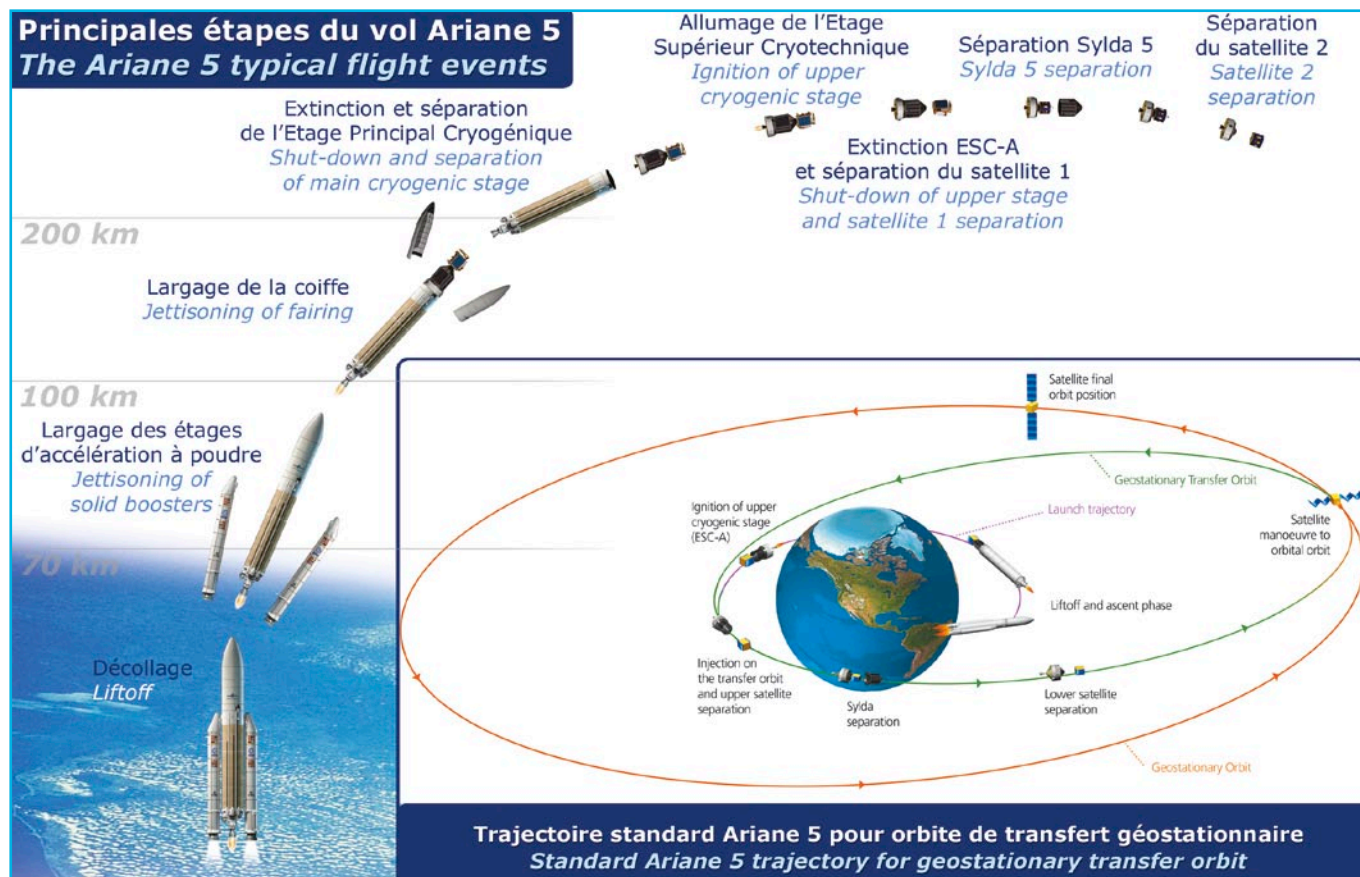
- Startup of water injection in the flame trenches and jet guide (T-30 sec).
- Hydrogen aspiration for chilldown of the Vulcain engine in the jet guide (T-18 sec).
- Burnoff of hydrogen used for chilldown (T-5.5 sec).

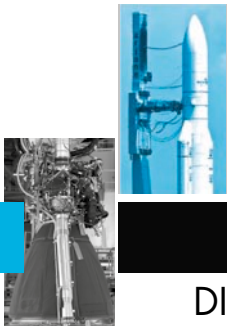
At T-4 seconds, the onboard computer takes over control of final engine startup and liftoff operations. It:

- Starts the ignition sequence for the Vulcain main stage engine (T-0).
- Checks engine operation (from T+4.5 to T+7.3 sec).
- Commands ignition of the solid boosters for immediate liftoff at T+7.3 seconds.

**Any shutdown of the synchronized sequence after T-7 mn automatically places the launcher back in its T-7 min configuration.**

## Ariane 5-ECA - DIRECTV-15 - SKYM-1 trajectory





VA 223  
DIRECTV-15 - SKYM-1



## ARIANESPACE AND THE GUIANA SPACE CENTER

### Arianespace, the first launch service company in the world

Arianespace was founded in 1980 as the world's first launch Service & Solutions company. Arianespace now has 21 shareholders from ten European countries (including Airbus Safran Launchers 40.99 % , CNES 34 % and all European companies participating in the production of Ariane launchers). Since the outset, Arianespace has signed more than 400 launch contracts and launched 502 satellites. More than two-thirds of the commercial satellites now in service worldwide were launched by Arianespace. The company posted sales of 1,399 million euros in 2014.

As of March 1, 2015, Arianespace had 322 employees, working at the company's headquarters in Evry (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 launcher, operated from the Guiana Space Center in French Guiana.
- The Soyuz medium launcher, currently in operation at the Guiana Space Center and the Baikonur Cosmodrome in Kazakhstan.
- The Vega light 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 45 satellites to be launched.

### The Guiana Space Center: Europe's Spaceport

For 40 years, the Guiana Space Center (CSG), Europe's Spaceport in French Guiana, has offered a complete array of facilities for rocket launches. It mainly comprises the following:

- 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 (EPCU), 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 Airbus Defence and Space, all involved in the production of Ariane 5 components. A total of 40 European manufacturers and local companies are involved in operations.

Europe's commitment to independent access to space is based on actions by three key players: the European Space Agency (ESA), French space agency CNES and Arianespace. ESA is responsible for the Ariane, Soyuz and Vega development programs. Once these launch systems are qualified, ESA transfers responsibility to the operator Arianespace. 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 French space program, the Guiana Space Center has gradually become 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 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 launcher for missions. Whether during tests or actual launches, CNES is also responsible for overall coordination of operations, 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 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 functional checks of the Ariane launcher, built by Airbus Defence and Space as production prime contractor, in the Launcher Integration Building (BIL). It then carries out acceptance tests of the launcher at the same time as satellite preparations in the Payload Preparation Complex (EPCU), operated by the Guiana Space Center (CSG). Arianespace next oversees final assembly of the launcher and integration of satellites in the Final Assembly Building (BAF), followed by transfer of the launcher to Launch Zone No. 3 (ZL3), and then final countdown and liftoff from Launch Complex No. 3 (CDL3).

Arianespace deploys a top-flight team and technical facilities to ensure the launchers and their satellites 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.

