Alphasat I-XL – a quantum leap for satellite communications

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Everyday life is dominated by information. Constantly growing volumes of data have to be transported around the globe. Satellite telecommunications play an important role in ensuring that such data reaches its destination reliably. Advanced German technology is playing its part in this on board Alphasat I-XL, the largest European Space Agency (ESA) telecommunications satellite to date, which lifted off on an Ariane 5 launcher from Europe's Spaceport in French Guiana on 25 July 2013 at 21:54 (CEST). From an altitude of about 36,000 kilometres above the Earth, the giant satellite is expected to revolutionise broadband communication over the next 15 years, offering over 750 L-Band channels in the mobile communications spectrum.

Alphasat I-XL is a Public-Private Partnership (PPP) between ESA and Inmarsat, a global operating company for mobile satellite communication services. It is because of this PPP that the satellite has the 'I' in its name. 'XL' refers to the fact that Alphasat is the largest telecommunications satellite ever built in Europe. Several goals are being pursued simultaneously with the Alphasat development programme, under ESA's ARTES 8 satellite programme. Through the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) Space Administration, Germany is the second largest contributor to this project, with a 14 percent share.

German technology in geostationary orbit

The newly developed 'Alphabus' satellite platform introduces a promising European product line for the market in large satellites – with a launch mass of up to 8.8 tons. Alphabus was developed in Toulouse under French leadership by prime contractors EADS Astrium and Thales Alenia Space. German suppliers also made significant contributions to the construction of the satellite platform, making Germany the second largest financial contributor to the Alphabus development programme as well. "The German elements ensure that Alphasat I-XL will be transferred into geostationary orbit, are responsible for aspects of attitude and orbit control and provide electrical power to the satellite," says Gerd Gruppe, DLR Executive Board Member responsible for the German Space Administration.

The solar generator was developed and built by EADS Astrium in Ottobrunn, and provides 12 kilowatts of power for Alphasat I-XL. With four panels on both the north and south sides of the satellite, its span of almost 40 metres is longer than the wingspan of the Airbus A320. "To generate this amount of power, new, larger panels were needed; these were developed in Ottobrunn, with contributions from Munich-based company GKN Aerospace. The solar generator was designed from the outset so that it could supply even larger versions of the Alphabus, with a maximum capacity of 22 kilowatts," says Anke Pagels-Kerp from the DLR Space Administration.

The propulsion system for the transfer to geostationary orbit and engines for attitude and orbit control were manufactured by EADS Astrium in Lampoldshausen. As is standard practice with telecommunication satellites, Alphasat was delivered into a geostationary transfer orbit by the launcher. To reach its target position in geostationary orbit at an altitude of around 36,000 kilometres, the satellite needs an onboard chemical propulsion system.

The fuel tanks for the chemical propulsion system, which have a capacity of around 2000 litres, are also of German design. Augsburg company MT Aerospace succeeded in manufacturing the largest tanks ever built for a telecommunications satellite. The reaction wheels that control the orientation of the satellite were built by Rockwell Collins in Heidelberg.

Alphasat – a platform for testing new technologies

In addition to the commercial payload from Inmarsat, Alphasat I-XL has additional space for innovative technologies that will be tested under the conditions found in geostationary orbit for the first time. Of the four payloads flying on Alphasat for demonstration purposes, two come from Germany. One is an innovative star sensor built by Jena Optronik, which provides extremely accurate orbit and attitude information for the satellite; as it does so, it supports the precise orientation of the laser communication terminal, the second demonstration payload from Germany. The optical Laser Communication Terminal (LCT) was developed under the leadership of Tesat, from Backnang, under contract to DLR, as part of the preparation for a new data highway in space – the European Data Relay System (EDRS).

Light instead of radio waves - laser enables faster data transfer

Transferring the massively increasing volumes of data between satellites and Earth is presenting ever-greater challenges to engineers. So far, they have been able to continually increase data transfer speeds by using higher radio frequencies and new electronic systems. Radio technology has its limitations; only a certain number of frequencies are available, and many of these are already being used. However, by switching from radio waves to much higher frequency laser light, these restrictions can be avoided; this will enable data streams to be transported much faster in the future. "The development in laser data transfer is a quantum leap in satellite communication. Germany saw the significance of this technology early on and has been encouraging it from the start. This is now bearing fruit; Tesat, a German company, is now the global market leader in this segment," explains Gruppe. This development did not just happen. Laser transfer systems have been tested on satellites for a number of years. In 2007, the German Earth observation satellite TerraSAR-X succeeded in using a LCT to exchange data with the American NFIRE satellite at a rate of 5.6 gigabits per second over a distance of 5000 kilometres – this corresponds to transferring a data volume equivalent to 400 DVDs per hour.

Preparing for a new data highway

A modified LCT is being used on Alphasat; it is capable of transporting a reduced data volume of 1.8 gigabits per second – corresponding to 130 DVDs per hour – but over a much greater distance of 45,000 kilometres. This makes it possible to transfer data between satellites in low Earth orbit, at an altitude of 200 to 2000 kilometres, and those in geostationary orbit, at an altitude of around 36,000 kilometres. The LCT on Alphasat I-XL will be used to test data transfer between geostationary and low Earth orbits.

Europe's largest telecommunication satellite will receive data from the two European Earth observation satellites Sentinel 1A and Sentinel 2A in this way. "With demonstration technology 'made in Germany', Alphasat I-XL is the gateway to the EDRS – an information highway in space along which data can be exchanged between satellites around the clock," explains Gruppe. A company called Tesat-Spacecom is taking a leading role in the development of this new transfer method. It built the LCT for Alphasat I-XL, in collaboration with DLR and Swiss company RUAG. The development of the LCT was supported by the DLR Space Administration.

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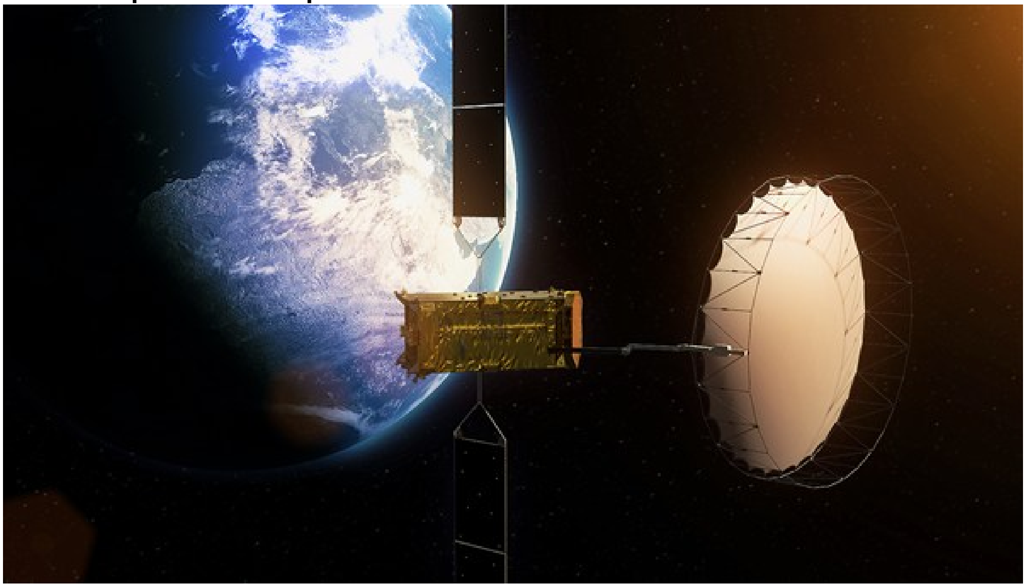
Alphasat I-XL lifts off on an Ariane 5 launcher

Europe's largest telecommunications satellite, Alphasat I-XL, lifted off from Europe's Spaceport in French Guiana at 21:54 CEST on 25 July 2013 on board an Ariane 5 launcher. Twenty-eight minutes later, it was injected into geostationary transfer orbit.

Credit: Arianespace.

Artist's impression of Alphasat I-XL



The European telecommunications satellite Alphasat I-XL was launched on 25 July 2013 with the intention of revolutionising mobile telecommunications. From geostationary orbit at an altitude of about 36,000 kilometres, it will be testing new technologies such as the German Laser Communication Terminal (LCT).

Credit: Corvaja/ESA.

Alphasat on its way into the vacuum chamber

Alphasat was tested in the vacuum chamber to ensure that the 6.6-ton satellite will be able to withstand the harsh conditions it will encounter in space.

Credit: EADS Astrium.

Solar arrays with the wingspan of an Airbus A320

The solar generator for Alphasat I-XL was developed and built by EADS Astrium in Ottobrunn. It provides 12 kilowatts of power and, with four panels on both the north and south sides of the satellite, its span of almost 40 metres is longer than the wingspan of the Airbus A320.

Credit: EADS Astrium.

LCT – Light instead of radio waves

Transferring the massively increasing volumes of data between satellites and Earth is presenting ever-greater challenges to engineers. Switching from radio waves to much higher frequency laser light allows restrictions to be avoided; this will enable data streams to be transported much faster in the future. The development of laser data transfer is a quantum leap in satellite communication.

Credit: ESA.

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