

ASSURED MISSION CONTINUITY

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ABSTRACT: With four new optical imaging satellites to launch over the next three years, Astrium GEO-Information Services is gearing up to bring its customers the best that space technology has to offer, ensuring continuity of service up to 2023.

The Pléiades twins are very-high-resolution satellites delivering 50-cm ortho color products as a standard. The other two are SPOT 6 and 7, designed to extend SPOT 5's success to the 1.5-m product family. Phased on the same orbit, the constellation will enjoy unprecedented reactivity, with intra-day revisit capacity anywhere on the Earth. Multiple tasking plans per day result in an unrivalled optimization of data collection: unforeseen weather changes, as well as last-minute requests, can be taken into account for a first-class level of service.

Furthermore, the upcoming constellation enjoys an unheard-of commercial availability. SPOT 6 and 7 are perfectly suited for any kind of application requiring broad coverage (60-km swath at nadir), whereas Pléiades affords the largest swath in the sub-metric market (20 km at nadir), ensuring all users maximized coverage as well as easier data processing and handling. All satellites are equipped with CMGs for state-of-the-art agility, enabling more simultaneous requests to be satisfied on the same pass. With an effective acquisition capacity reaching more than 6 million square kilometers per day for the four-satellite constellation, Astrium GEO-Information Services is more than ever committed to delivering data.

The consecutive launches of Pléiades 1 & 2 and SPOT 6 & 7 signal a paradigm shift for Astrium GEO-Information Services. Ready to enter the very-high-resolution market, the company is enhancing its role as a multisensor distributor operating a coherent, optimized multi-resolution constellation to serve applications such as defense, civil protection, hazard management, urban or national mapping, agriculture, and network and infrastructure management.

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With four new satellites - Pléiades 1 & 2 and SPOT 6 & 7 - set to launch over the next three years, Astrium GEO-Information Services is gearing up to bring its customers the very best that space technology has to offer. Ensuring continuity of Earth optical imaging service up to 2023, these satellites will operate as a true constellation, combining a twice-daily revisit capability with an ingenious range of resolutions.

1. Ideal match of detail and coverage

The images taken from the SPOT 5 optical satellite have the benefit of combining a wide swath (60 kilometers) with a spatial resolution of 2.5 meters. This characteristic has made SPOT 5's mission a huge success, providing users and customers an excellent trade-off between coverage and resolution, for a right balance between the level of information obtained and the cost to the user. As the end of SPOT 5 is now scheduled for mid-2015, the question was raised about how to continue delivering the service our users have come to expect. This was the brief underpinning the design of SPOT 6 and SPOT 7. An in-depth market survey and careful canvassing to ascertain users' expectations were conducted. Conclusions led to keep the best features of SPOT 5, retaining a 60-kilometre swath, while improving agility and product resolution (1.5 meters).

However, the needs of commercial and military users have progressively widened. They now also require images with increased resolution. Designed by the French Space Agency (CNES), the twin Pléiades satellites tie into this vision, adding local detail to the synoptic picture from SPOT. The system will deliver imagery products with a resolution of 50 centimeters combined with a 20-kilometre swath, the widest in their class of optical sub-metric satellites.

Images from both Pléiades 1 and 2 and SPOT 6 and 7 will be orthorectified automatically on Astrium GEO-Information Services' global orthorectification database, called Reference3D (a package including a DTED-2 DEM, an ortho image and quality layers). The registration of Pléiades and SPOT images on Reference3D ortho image

enables a perfect overlay in a GIS for projects implying multi-source or multi-date data, easing data post-processing or map edition.

Mixing and matching dates and resolutions will also open the gate to new products such as a multilayer version of SPOTMaps. This will mean nationwide mosaics available off-the-shelf in two-meter orthorectified color, with additional VHR mosaics where finer detail is required (such as over cities or densest areas). This combination is ideal to view an entire territory, simulate new infrastructure planning, perform impact studies, produce or update zoning plans and maps, share information with partners.

As for digital elevation models, the four satellites' stereo and tri-stereo viewing capability obviously promises to boost performance levels. SPOT 6 and SPOT 7 will extend the more than one hundred and twenty million square kilometers of stereo-pair coverage already acquired by SPOT 5. And the two Pléiades, operating with TanDEM-X and TerraSAR-X radar satellites, offer very interesting prospects for 3D products to serve a wide range of applications spanning high-accuracy orthorectified imagery to flight simulation or flooding mitigation.

The addition of these four satellites will also benefit users with regular monitoring needs. The SPOTMonitoring product line, dedicated to alert its subscribers in case of changes happening over an area of interest, will afford more frequent revisits, more sites monitored and finer details.

2. The right information at the right time

The four satellites will be phased 90 degrees apart in the same orbit (see figure 1).

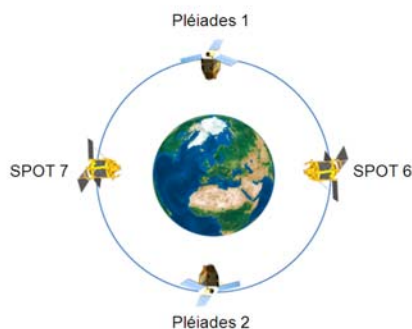


Figure 1: Pléiades 1&2 and SPOT 6&7 in phased orbit
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This feature, coupled with the ability to view off track up to 30 or even 45 degrees, offers a twice-daily revisit capability to commercial and government customers. To make the most of this repeat imaging potential, the constellation tasking will be updated and uploaded several times a day (6 for SPOT 6 & 7, 3 for Pléiades, see figure 2). As a result, it will be possible to schedule requests up to two hours before each satellite pass, and to fully leverage updated weather forecasts for improved data collection success rate.

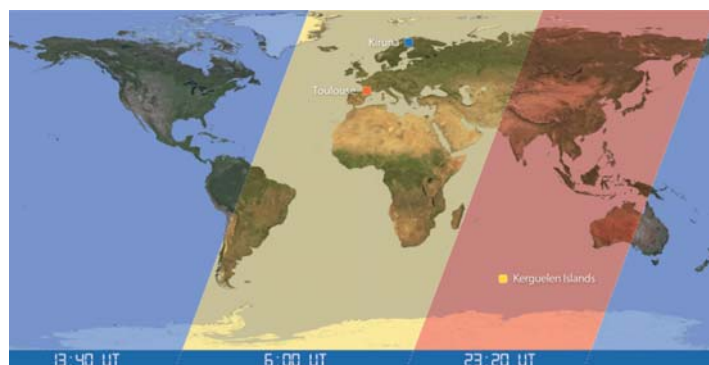


Figure 2: 3 Pléiades uplink stations have been chosen according to the 3 tasking periods. They will be located in the **Kerguelen Islands** for morning passes, the best time to upload tasking commands for Europe, Africa and the Middle East; in **Sweden** for midday orbits and coverage of North and South America; in **Toulouse** for evening passes over Asia and Oceania. For SPOT 6/7 there will be 6 tasking areas on the same principle, from **Inuvik** and **Kiruna**, two North pole stations allowing covering all orbits.

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Astrium GEO-Information Services has also built up a worldwide network of partners. Today, more than 40 receiving stations are distributing SPOT 4 and SPOT 5 products, as well as data from FORMOSAT-2, Envisat-ASAR and TerraSAR-X. This decentralized organization guarantees exceptional responsiveness and local support around the globe. These advantages will obviously benefit future customers of Pléiades 1 & 2 and SPOT 6 & 7. Pléiades is also featured to allow Direct Tasking to some Direct Receiving Stations. Direct Tasking offers the best reactivity from collection planning to mission ready data (less than one hour), to support ultimate near-real time applications such as disaster support or tactical intelligence. It provides a dedicated and guaranteed access to the satellite resource with the maximum reactivity and the highest confidentiality (all information is encrypted).

The *Instant Tasking* web service is an alternative to collect urgent fresh imagery. Users are free to post tasking requests and take full advantage of the responsiveness offered by several work plans uploaded each day to the four satellites. They simply log on and then key in their area of interest. The system indicates which satellite - Pléiades 1, Pléiades 2, SPOT 6 or SPOT 7 - will be the first in position to image the area. They then task the satellite of their choice with a maximum priority attached to their request, the imagery is acquired, validated by the user and the product is generated and delivered. This gives users real access to multisatellite tasking, leaving them free to choose between resolution and speed of acquisition depending on their needs.

Once downlinked to receiving stations, data from all four systems will be available through a single e-Business portal currently in development that will provide 24/7 access to the full range of Astrium GEO-Information Services products and services, including the archive catalogue, tasking and subscription services, as well as online geo-information for an immediate access to the appropriate geospatial data solutions.

3. Flexibility, agility and availability

Equipped with Control Moment Gyros, the four satellites will benefit of exceptional performances in terms of agility. Time to slew over 200 kilometers will be reduced to 11 seconds including stabilization time, when satellites not equipped with CMGs will do it approximately in 20 seconds (see figure 3). Consequently, the number of acquired images over an area will be maximized (typically 15 targets over 1,000 km within a corridor of +/-30 degrees for Pléiades and SPOT 6/7, see figure 4), which will increase acquisition opportunities and success probability, even more so since the constellation is also enjoying a massive acquisition capacity. The effective capacity of the constellation will reach 6 million square kilometers per day, the maximum theoretical acquisition capacity over passing 9 millions square kilometers daily.

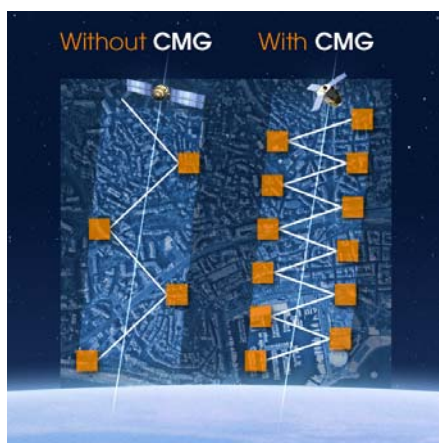


Figure 3: benefits of CMGs

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Figure 4: Multiple acquisition during the same pass

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This agility also paves the way to various acquisition scenarios, to match different applications. The strip mapping mode will entail possibility to acquire easily 40-per-40 or 60-per-60-kilometer areas with Pléiades, 120 per 120 with SPOT 6/7 for mapping applications over large areas. All four satellites are able to acquire stereo or tristereo images, for 3D applications. Last, the nominal acquisition scheme for the satellites is north to south, but they may also turn to follow linear targets such as roads, pipeline, borders or coasts.

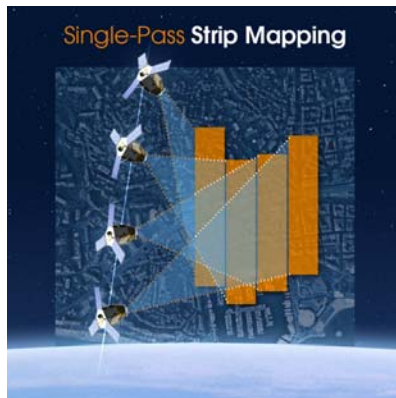


Figure 5: strip mapping over large areas

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Figure 6: stereo and tristereo acquisitions

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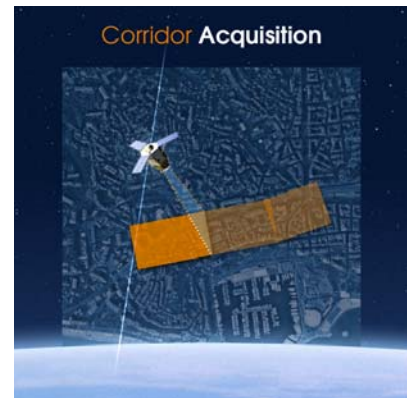


Figure 7: corridor acquisition over linear targets

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Poised for launch

Astrium Services CEO Eric Beranger officially announced funding for the SPOT 6 & 7 program in June 2009. This is the first time in the remote-sensing industry that a satellite has been built with entirely private funds, proving Astrium GEO-Information Services' confidence in this market.

The two satellites are currently in development: the SPOT 6 optical instrument is now coupled with the satellite platform. After a phase of mechanical and environmental testing, SPOT 6 launch is scheduled in September 2012. SPOT 7 integration has also started and will be ready for a launch in the fourth quarter of 2013.

The decision to go ahead with the Pléiades program was taken after an in-depth survey of users' evolving requirements. Drawing on the vast experience of the French space agency CNES in Earth observation, a cooperation program was set up between France and Italy to develop ORFEO, a dual-use system of which the French Pléiades is the optical component.

Pléiades 1 has been completed and delivered to CNES, the prime contractor, by Astrium Satellite. It is currently in storage at Astrium, where it is waiting to be transported to the Kourou spaceport this fall in readiness for launch by the end of this year. Pléiades 2 is being integrated at Astrium and has already completed all tests. It should be put into orbit one year later. Astrium GEO-Information Services is the civil operator and exclusive distributor for Pléiades in France and worldwide.

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