SPOT
Imagery
User Guide

AIRBUS

Organisation of the
SPOT 6 & SPOT 7 Imagery
User Guide

The SPOT 6 & SPOT 7 Imagery User Guide provides essential information to the users about all SPOT 6 products and services.

The document is divided into four main parts, followed by technical appendices.

- **Chapter 1** details the SPOT 6/7 constellation and its performance.

- **Chapter 2** explains the SPOT 6 / SPOT 7 products offer.

- **Chapter 3** details product ordering options.

- **Chapter 4** presents product delivery.

For the experienced users, Technical Appendices complete the document by covering the following points:

A. DIMAP V2 format

B. Image quality performance

C. Geometric modeling

D. Spectral modeling

We would like this document to be as useful as possible. If you feel that information is missing or unclear, or for any feedback you may have on the content and format, please send an email to: **technicalsupport@intelligence-airbusds.com**

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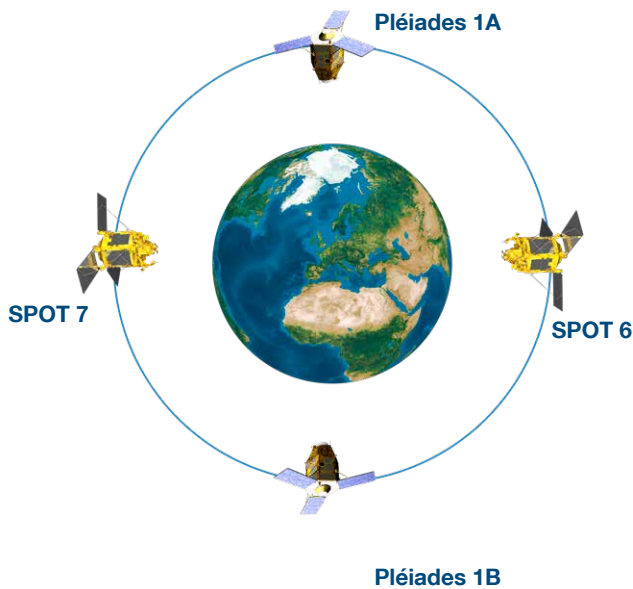
SPOT 6

Pléiades 1B

Figure 1: Pléiades 1A/1B and SPOT 6/7 constellation

With four satellites - Pléiades 1A & 1B and SPOT 6 & SPOT 7 – launched in a two-year timeframe, Airbus Defence and Space Services is offering its customers the very best of space technology.

Ensuring continuity of Earth optical imaging service up to 2024, these satellites operate in a true constellation, combining a twice-daily revisit capability with an ingenious range of resolutions.

The Pléiades twins are very high-resolution satellites delivering 50-cm Ortho products as a standard. SPOT 6 and SPOT 7 are designed to extend SPOT 5's success to the 1.5 m product family. Phased on the same orbit, the constellation enjoys unprecedented reactivity, with same-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.

SPOT 6 and SPOT 7 satellites imagery offer an affordable source of information for analysing, monitoring, forecasting and managing resources and human activity on our planet. SPOT products are true decisionsupport tools for a large range of applications such as civil and military mapping, natural and man-made disaster management, natural resource exploration, land planning, crop and forestry monitoring, environmental protection and maritime surveillance.

Following tables outline the main characteristics of the SPOT 6/7 space and ground systems.

Number of satellites	2
Launch periods	SPOT 6: September 9th, 2012 SPOT 7: June 30th, 2014
Design lifetime	Minimum of 10 years
Size	Body: ~ 1.55 x 1.75 x 2.7 m Solar array wingspan 5,4 m²
Launch mass	712 kg
Altitude	694 km
Onboard storage	1 Tbits end of life (Solid State Mass Memory)

Table 1a: Main characteristics of the Space System

SPOT 6 and SPOT 7 missions are designed to achieve efficiently both collection of large coverage and collection of individual targets that are possible thanks to the extreme agility of the satellite.

Orbit	Sun-synchronous; 10:00 AM local time at descending node, 26-day cycle, 694-km altitude
Period	98.79 minutes
Cycle	26 days
Gound sampling distance (nadir)	Panchromatic: 2m; Multispectral: 8m
Product resolution Panchromatic	1.5m; Multispectral: 6m
Swath	60 km at nadir
Viewing angle	Standard: +/- 30° in roll | Extended: +/- 45° in roll
Revisit	• 1 day with SPOT 6 and SPOT 7 operating simultaneously • Between 1 and 3 days with only one satellite in **operation**[1]
Pointing agility	Control Moment Gyroscopes allowing quick maneuvers in all directions for targeting several areas of interest on the same pass (30° in 14s, including stabilization time)
Acquisition capacity	Up to 6 million sq.km daily with SPOT 6 and SPOT 7 when operating simultaneously
Nominal imaging mode	60km-swath strips oriented along North-South axis; up to 600km length
Stereo capability	Single pass stereo and tri-stereo (Fore, nadir and aft mode)

Table 1b: Orbital characteristics and viewing capability

Optical system	**One instrument made of 2 identical Korsch telescopes, each** with a 200mm aperture, **delivering the expected swath.**
Detectors	PAN array assembly: 28,000 pixels MS array assembly: 4 x 7000 pixels
Spectral bands (specification)	Pan: 455-744nm Blue: 454-519 nm Green: 527-587 nm Red: 624-694 nm Near-IR: 756-880 nm *The 5 bands are always acquired simultaneously.*
Swath	60km at nadir
Dynamic range at acquisition	12 bits per pixel
Location accuracy specification	• 35m CE 90 without GCP within a 30° viewing angle cone • 10m CE90 for Ortho products where Reference3D is available
Instrument telemetry link rate	X-band channel - 300 Mbits/s

Table 1c: Main characteristics of the SPOT 6 and SPOT 7 optical instruments

Main receiving stations	• Toulouse (France) • Kiruna (Sweden)
S-Band uplink stations	• Kiruna (Sweden) • Inuvik (Canada)
Programming centre	Airbus Defence and Space Service – Toulouse (France) Airbus Defence and Space Service – Chantilly VA (USA)
Production centre	Airbus Defence and Space Service – Toulouse (France)
Tasking plans refresh frequency	6 times/day/satellite
Update of weather forecast	4 times/day – fully automatic process
Satellite control centre	Airbus Defence and Space Satellite – Toulouse (France)

Table 1d: Main characteristics of the SPOT 6/7 ground segment

[1] Depends on the latitude of the area of interest

1.1   Reactivity and Rapid Coverage Capacity

SPOT 6/7 constellation is composed of two twin satellites operating as a true constellation on the same orbit and phased 180° from each other. Added to their oblique viewing capability (up to 45° angle) and exceptional agility, this orbit phasing allows the satellites to revisit any point on the globe daily - ideal for anticipating risks, managing crises effectively or speed up large areas coverage.

The phased orbit of the constellation's satellites offers up to daily revisit capacity:

Viewing angle	SPOT 6 or SPOT 7 only	SPOT 6 and SPOT 7
<5 degrees	26 days	13 days
<20 degrees	7 days	4 days
<30 degrees	5 days	2 days
<45 degrees	2 days	1 day

Table 1.1: Revisit capacity
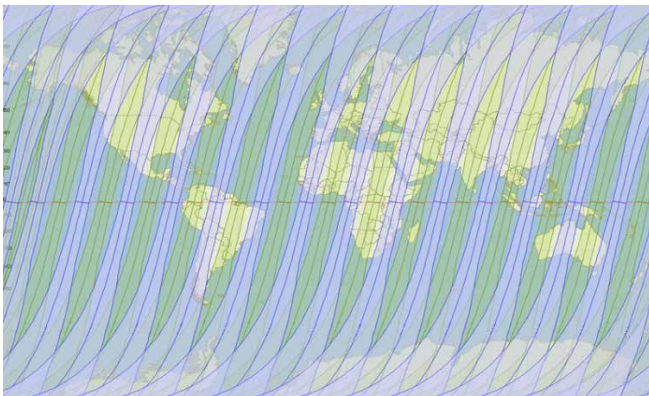
Figure 1.1a: SPOT 6 (blue) and SPOT 7 (green) combined corridor of visibility on a given day (+/- 30°)

The daily revisit capacity is backed by a reactive operational loop: mission plans are updated every 4 hours.
Two polar uplink stations are used to optimize the upload of work plans.

They are located in:

• Kiruna (Sweden) – upload of two mission plans daily
• Inuvik (Canada) – upload of four mission plans daily

These multiple mission plans per day enable handling of last-minute tasking requests as well as integration of the latest worldwide weather forecast, for an improved data collection success rate.
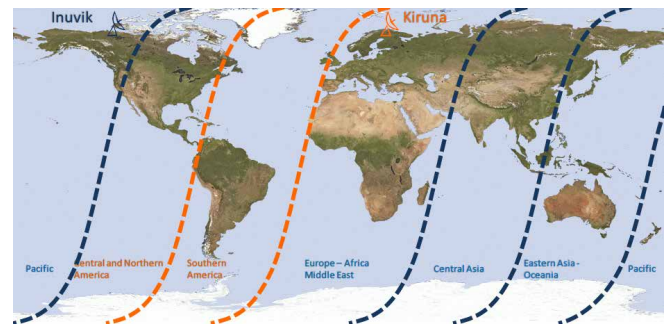
Figure 1.1b: Tasking areas

SPOT 6 and SPOT 7 satellites provide exactly the same coherent and high quality products. Tasking plans are natively optimized between the two satellites to fully leverage the synergies between the twins.

For the user, this results in:

• More images collection opportunities
• Unprecedented capacity for disaster response, regular monitoring, or change detection
• Rapid coverage of areas of interest

1.2   Acquisition Capacity

SPOT 6/7 constellation has an impressive acquisition capacity of 6 million square kilometres per day. In addition the time needed to slew from one tasking request to another is reduced thanks to the agility of the systems and the successful acquisition rate is increased with the integration of frequent updates of weather forecasts.

1.2.1 Swath and Coverage

The swath of 60 km, already available on previous SPOT missions, has been maintained on SPOT 6 and SPOT 7. SPOT 6 and SPOT 7 have been especially design to cover large areas in a shortest timeframe, therefore in nominal acquisition mode, the satellites acquired long strips, up to 600 km long.

This results in maximized information on a target and its surroundings, optimized production with diminished need for cutlines and mosaicking work over large areas, as well as easier data handling, with fewer folders and products to manipulate for a given large AOI.

1.2.2 Single Pass Collection Scenarios – Overview

SPOT 6 and SPOT 7 mission takes benefits from the high agility of the satellite to offer efficient data collection capabilities making them particularly suitable to serve cartographic and monitoring applications.

1 Standard data collection: Long strip

2 Standard data collection: Target
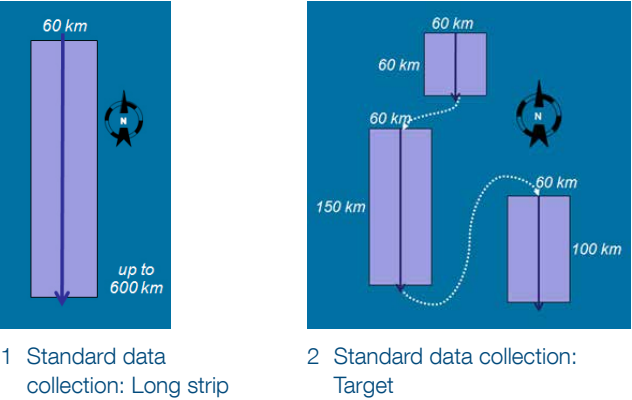
Standard data collection mode enables to acquire in one pass (a) North-South long strip of up to 600 km length. In addition, the high satellite agility allows (b) very quick moves from one scene to another along an orbit. This provides a high efficiency to complete, in the shortest time, global data coverage over a large area of interest, allow acquisition conflicts avoidance and makes possible the collection of number of distant targets in a given geographical area in a single pass.

3 Single pass Multi-strip collection

4 Single pass Corridor collection
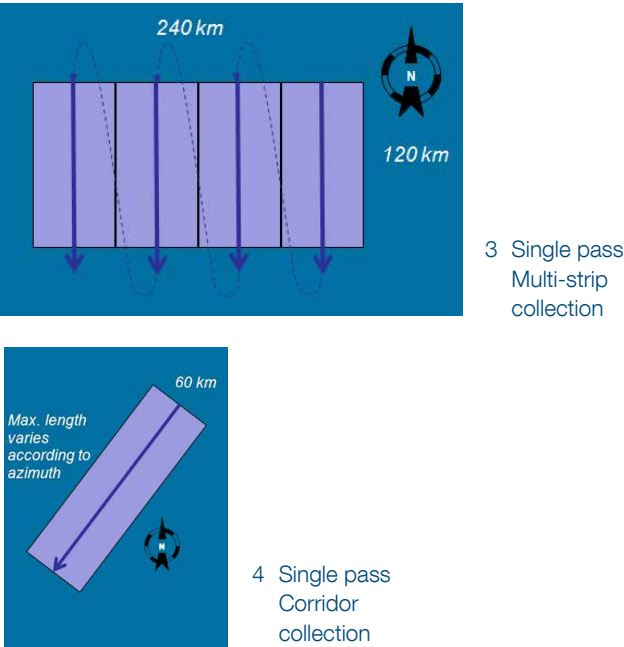
SPOT 6 and SPOT 7 are able to acquire (c) contiguous image segments collected from a single pass along one orbit. This provides capability to cover areas of more than 240 km x 120 km or 180 km x 180 km in a single pass. Corridor acquisition (non North-South oriented) allows rapid covering of certain areas in an effective way (e.g. rivers, borders…)

Figure 1.2.2: Single pass collection scenarios

1.2.3 Stereoscopic Cover Capabilities

Stereo		Tristereo	
B/H	Length	B/H	Length
0.15	35km	0.3	35km
0.2	60 km	0.4	60 km
0.3	120 km	0.5	90 km
0.4	180km	0.6	120 km
0.5	240km	0.7	150 km
0.6	300km	0.8	180 km

Table 1.2.3: Stereo / Tristereo acquisition capacities according to b/h

Tristereo images can be used to create more accurate 3D models than can be done with basic Stereo, as the near nadir acquisition minimizes the risk of missing hidden items. It is prescribed for dense urban and mountainous areas - Figure 1.2.3. Please refer to 3.2.2 (step 5) for more information about B/H.
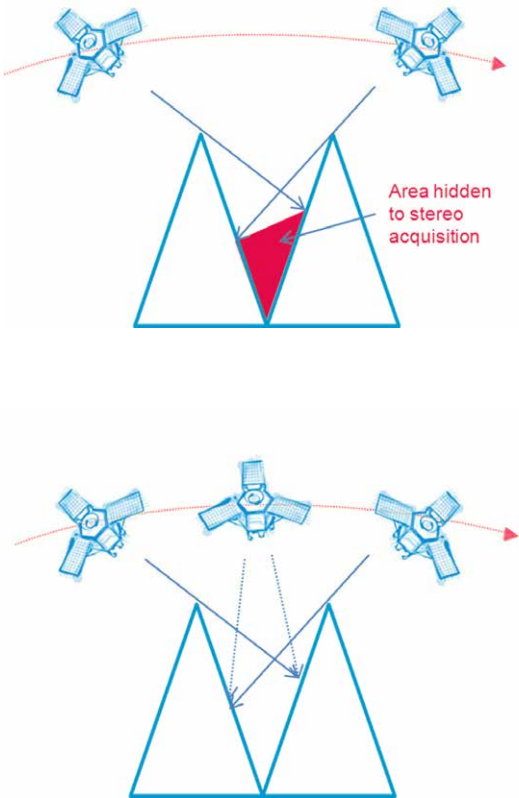
Figure 1.2.3: Stereoscopic cover capabilities over mountainous areas

2   Products, Services and Options

SPOT 6 and SPOT 7 products can be easily integrated in GIS environment or used to derive thematic geoinformation while combined with other satellite, airborne or ground information.

SPOT 6 and SPOT 7 instruments always acquire images simultaneously in both modes:

- Panchromatic: one band (black and white).
- Multispectral: four bands (colour).

Panchromatic and Multispectral bands are co-registered (completely superimposable).SPOT 6 and SPOT 7 offer a wide range of products and services, featuring different options to match as close as possible any customer's requirement.
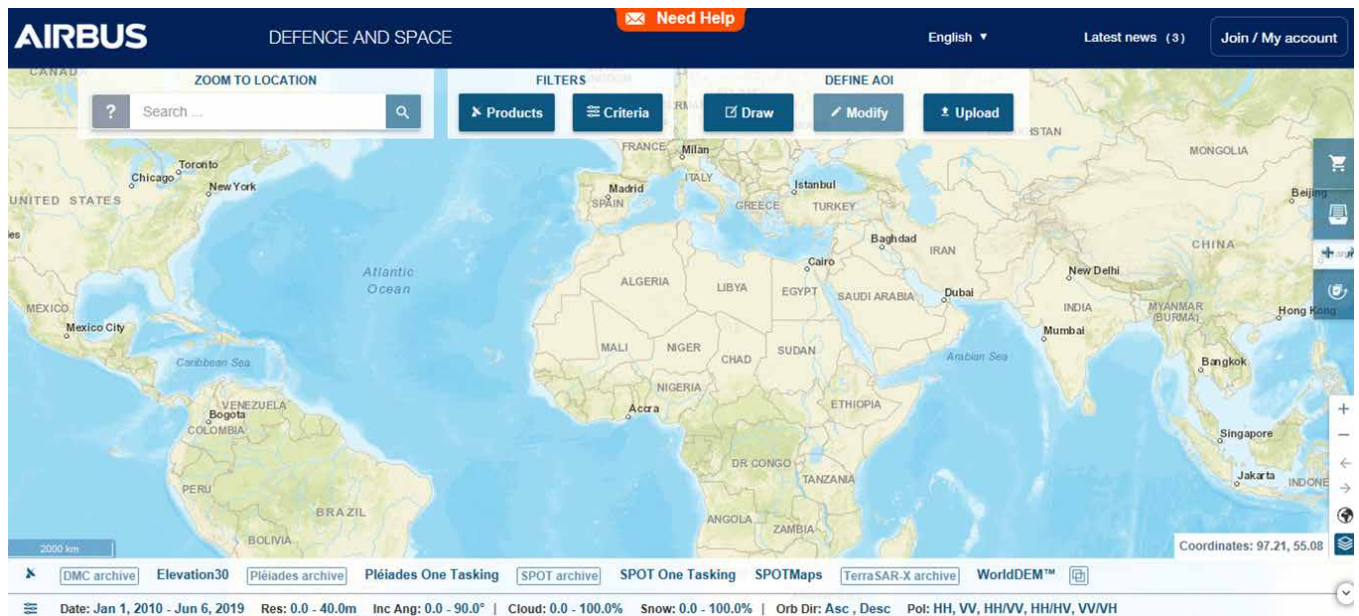
Figure 2.1: Selection of SPOT archive in GeoStore product filters

2.1   Reliable and Immediate Access: An Image When and Where You Need It

2.1.1 Get Access to Premium Archive Imagery

Since May 1986, more than 100 billion square kilometers of Earth surface have been covered by SPOT successive missions on a daily basis.

Once acquired and displayed in our catalogues, these images constitute the SPOT 6/7 archive, and are ready for immediate order. Users can search the archive via > **https://www.intelligence-airbusds.com/en/4871-geostore-ordering**

Figure 2.1.1a: GeoStore homepage to access SPOT 6 and SPOT 7 imagery
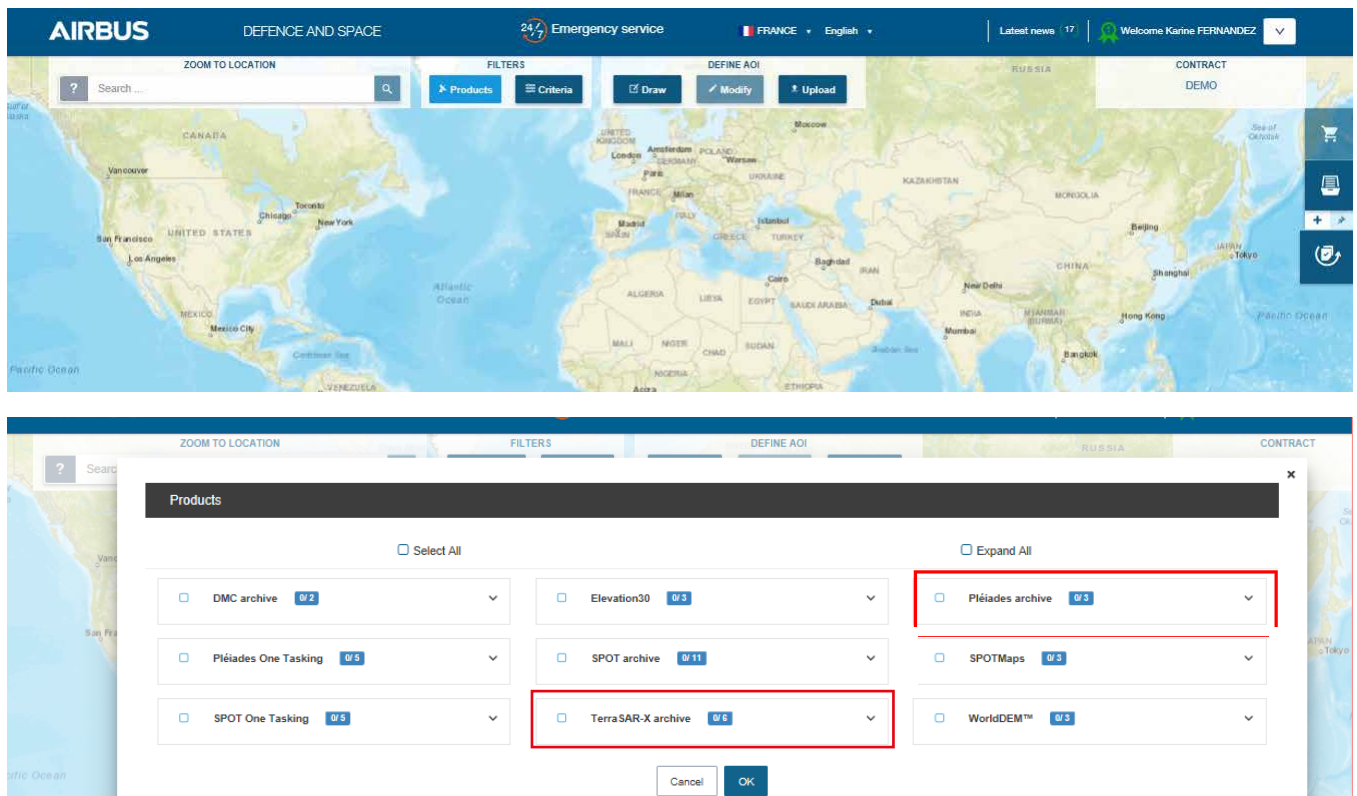
Figure 2.1.1b: Selection of SPOT 6 and SPOT 7 archive in GeoStore product filters

For any questions related to GeoStore,
please do not hesitate to contact GeoStore team:
Intelligence-geostore@airbus.com

In order to gain up-to-date information on what is currently happening on the ground, a customer can also request the acquisition of a new image.

2.1.2 One Tasking: Committed to Delivering Imagery

Commissioning a satellite and obtaining the imagery you requested – exactly when you need it – is now risk-free, fast, and incredibly easy.

30 years ago, Airbus DS Intelligence was the first to offer satellite-tasking services, revolutionising the satellite imagery market. Today, with One Tasking, the company sets the bar again, with an unprecedented commitment to deliver new imagery collections when and where its customers need them.

In a context of information overload, with One Tasking, Airbus DS Intelligence offers a unique and different offer on the market. It takes full advantage of its satellite resource availability and the true daily revisit capabilities of its satellite constellations, in order to collect and deliver – with unrivalled reliability – the image or coverage you requested, exactly when you need it.

Airbus DS Intelligence's programming offer, redesigned from the ground up, is committed to delivering the very best results, instead of the industry's typical 'best effort' approach, with a tasking service designed entirely around the customer's needs.

2.1.2.1 A Matter of Satellites, Talent and Dedication

Both genuine satellite constellations, SPOT and Pléiades, share the same orbit and tasking plan. They behave as a single flexible satellite gifted with true daily revisit capabilities – maximising collection success rate and coverage speed.

In addition, a team of world-class tasking experts ensures that your area is covered on time and on spec. Airbus DS Intelligence's team carefully conducts feasibility studies and closely follows up open tasking requests, constantly adjusting priorities. All of that fine-tuning is in Airbus DS Intelligence's DNA and, more than any technical feature, is the secret of One Tasking's reliability.

One Tasking provides you with answers and support in any situation: from the most basic map update through to emergency response, not to mention land-use analysis, mission planning, and frequent insights through reliable monitoring.

Key benefits

- Best choice for maximising the success of your collection campaign.

- Financial compensation, if (ever) we do not make it on time.

- Flexible sensors, superior availability for ultra fast delivery

- Streamlined offer, to lighten the ordering process for all satellites and sales channels.

- 24/7 access.

One Tasking offers four tasking options:

Pick the Right Product for Your Needs

ONE DAY

Choose your acquisition day

Imagery acquisition for a specific day is now risk-free. 24 hours before your acquisition date, you receive a weather forecast to let you confirm, postpone or cancel your request at no cost.

ONE NOW

Access useful information in an instant

When immediate imagery is required, our satellites can be tasked to deliver valuable insights in the shortest possible timeframe. Don't panic if it's cloudy – we keep collecting images of your area until we are successful.

ONE PLAN

Obtain qualified coverage within an agreed timeframe

You select your timeframes, dates and preferred sensor – we ensure you receive the right qualified coverage, perfectly matching your project milestones.

ONE SERIES

Get cowverage on a regular basis

Whether you are dealing with long-term changes or highly dynamic situations, OneSeries brings you the required intelligence at the frequency you choose. For highest frequencies, our cloud cover commitment ensures you pay only for the most useful results.

	◎NE DAY	**◎NE NOW**	**◎NE PLAN**	**◎NE SERIES**
Pick the Right Product for Your Needs	**Choose your acquisition day** Imagery acquisition for a specific day is now risk-free. 24 hours before your acquisition date, you receive a weather forecast to let you confirm, postpone or cancel your request at no cost.	**Access useful information in an instant** When immediate imagery is required, our satellites can be tasked to deliver valuable insights in the shortest possible timeframe. Don't panic if it's cloudy – we keep collecting images of your area until we are successful.	**Obtain qualified coverage within an agreed timeframe** You select your timeframes, dates and preferred sensor – we ensure you receive the right qualified coverage, perfectly matching your project milestones.	**Get coverage on a regular basis** Whether you are dealing with long-term changes or highly dynamic situations, OneSeries brings you the required intelligence at the frequency you choose. For highest frequencies, our cloud cover commitment ensures you pay only for the most useful results.
Timeframe	1 day	The smallest period needed to secure three acquisitions – additional acquisitions are made until cloud cover rate reaches 10% or the customer decides to end the tasking	Customer selected	Customer selected, including frequency
Cloud Cover	≤100%	≤10%. All acquisitions are delivered. A validated acquisition ends the tasking	• ≤10% or ≤ 5% with uplift • Possibility to select three small cloud-free AOIs (Pléiades 1x1 km, SPOT 3x3 km) • For OneSeries Critical, 10% or 100% in case of daily acquisition; in this case, images are invoiced when reaching at least 40% cloud free	
Min AOI	• Pléiades: 100 km² • SPOT: 500 km²	• Pléiades: 100 km² • SPOT: 500 km²	• Pléiades: 100 km² • SPOT: 500 km²	• Pléiades: 100–50 km² if five revisits or more • SPOT: 500–250 km² if five revisits or more
Max AOI	Pléiades: 20 km EW x 40 km NS SPOT: 60 km EW x 120 km NS Bigger areas are subject to feasibility study		Subject to feasibility study	
Acquisition Mode	Mono (Stereo and Tristereo subject to feasibility study)	Mono, Stereo or Tristereo	Mono (Stereo and Tristereo submitted to feasibility study)	
Incidence Angle[*]	0–52° (<30° on customer selection)	0–52° (<30° on customer selection)	• OnePlan and OneSeries Routine:0–30° or customer selected • OneSeries Critical: 0–52° or <30° on customer selection	
B/H	Customer selected for all options or per default: Stereo 0.4–0.7 /Tristereo 0.2–0.35 between each pair			
Service Level	Premium		Regular	Regular/Premium
Acquisition Failure Terms	25% voucher on the value of the missed acquisition	If one acquisition is missing from the three firsts, the other two acquisitions will be delivered at no charge. OneNow with weather forecast consideration **◎NE NOW☀**: 25% voucher of the missing acquisition value	10% voucher on the full order value	• OneSeries Routine: 10% voucher of the value of the missed acquisition • OneSeries Critical: 25% voucher of the value of the missed acquisition

Table 2.1a: Overview of One Tasking options

* The official way to display angles in Airbus DS Intelligence's offering is based on the incidence angle. This is applicable to all documents and ordering forms/tools. For customers requesting viewing angle conversion, a tool which enables dynamic conversion has been set up on our website.

2.1.2.2 Cloud Cover Warranty

Optimising SPOT 6 and SPOT 7 satellite tasking in accordance with weather forecasts three times a day ensures that all resources are used as efficiently as possible. We propose image tasking with cloud cover less than 10% or 5% over the Area Of Interest (AOI) of the order. Depending on the area of interest, we can guarantee small cloud-free zones, typically three areas of 1 x 1 km within the initial AOI. Cloud cover does not include cloud shadow or semi-transparency haze.

2.1.2.3 Vouchers

In the event of a non-successful acquisition, as defined in each offer, the customer is entitled to receive a voucher in consideration of such a failure.

A voucher is valid for three months from the end of the acquisition period. It can be redeemed against any Airbus DS Intelligence product through GeoStore only. The customer must redeem the voucher, i.e. it is not automatically deducted from the customer's next order. Once the voucher has been used, it expires. The voucher can only be spent in full; it cannot be split across several orders. If the voucher is used for an order where the amount is less than the voucher value, the unused balance of the voucher is lost. The voucher is considered as a means of payment; it should be made visible on the invoice and applied to the overall amount of the order, once potential discounts and reductions have been applied. Each voucher is linked to a customer account and the voucher notification is sent via email to the customer who placed the failed order. The overall view of vouchers attached to one customer account is not available externally. For more information on vouchers, please contact your usual point of contact: Airbus DS Intelligence Customer Care.

2.1.2.4 Feasibility Study

The feasibility study is a diagnosis performed by tasking experts in order to organise the acquisition plan and estimate the confidence in covering the area of interest within the defined acquisition period and parameters. To assess feasibility analysis, we ask the customer: **where**, **by when** and **for which application**. With this information, the Tasking Team issues a tasking proposal that includes advice and recommendations that clearly indicate:

- The feasibility study diagnosis: feasible/difficult/very difficult

- The estimated area coverage: %

- New proposed parameters when relevant.

The feasibility study proposes the best programming parameters in order to successfully collect the area on time and on specifications (basis of our commitment and philosophy of One Tasking offer). However, the customer will always have the choice to select one tasking proposal or another.

- OneNow feasibility study mainly focuses on:

  - OneNow+: the first three days when the area can be entirely collected after the desired start date

  - **☼NE NOW☼: the desired timeframe (7 days maximum), compared to the location, the size, the angle and cloud constraints.**

  In both cases, the feasibility study indicates the incidence angle.

- For OneNow orders placed through GeoStore or Customer Care, it is possible to filter access for acquisitions with an incidence angle of 30° or less – thus displaying the new acquisition days able to entirely cover the AOI with the reduced angle. No choice is given on the acquisition days.

- OnePlan and OneSeries feasibility studies mainly focus on **the desired timeframe compared to the location, the size, the angle and cloud constraints**. Depending on all requested programming parameters, the Tasking Manager issues a diagnosis (feasible, difficult, and very difficult) to the customer and proposes alternatives if the feasibility results are 'very difficult' or 'difficult'.

  - If the request is judged unachievable, the Tasking Manager sends two proposals: one for it to become 'challenging', one for it to become 'achievable' – each with the relevant quotations.

  - If the request is judged to be difficult (challenging), the Tasking Manager sends two feasibility studies, each with the relevant quotation: one with challenging parameters to match the customer's request, and another with different parameters that will make the tasking easy (achievable) to complete.

The customer will always have the choice between both tasking proposals.

Early diagnostic for tasking orders submitted online

When an order is submitted online via the web portal, the Early Diagnostic section provides customers with automated early diagnostics with regards to the desired timeframe and specified location, size, angle and cloud constraints. If the automatic diagnosis says your tasking can be easily completed (achievable), it is activated automatically and the new collection is delivered (also automatically) after acquisitions. However, if there are specific tasking parameters, the Tasking Team confirms the feasibility and issues a Tasking proposal. If a request is considered 'difficult' or even sometimes 'very difficult' to achieve, the same process as above applies, i.e. two feasibility studies: one with lightened tasking parameters and another with tighter parameters with corresponding

achievable or challenging prices, so the customer can select his preferred option. The Tasking is activated once the customer confirms their order.

2.1.2.5 Multi-AOI

Multi-polygon orders are possible. However, each AOI creates an order: a shape file featuring four polygons will be treated as four separate orders. Each order has its own service level agreement (SLA) and acquisition failure terms (i.e. if one acquisition for one polygon has failed, it has no impact on the success or failure of the other three). The polygons are also independent for the access study and the feasibility study, as well as any tracking progress service.

2.1.2.6 Regular and Premium Services

Two service levels are offered in the event of a new acquisition order.

	Premium Service Included in OneDay, OneNow and OneSeries Critical	**Regular Service** For OnePlan and OneSeries Routine
Ordering	24/7, 365 days a year	From Monday–Friday from 7:00–16:00 (UTC) through Customer Care or 24/7 through GeoStore.
Response Time	1 hour from receipt of customer request (feasibility study included dependent upon simplicity of the request)	24 hours from receipt of customer request (within normal working hours)
Customer Modification/ Cancellation After Order Confirmation	Cancellation and modifications are possible, free of charge, up to 12 hours before image acquisition. However, a 100% cancellation fee applies within 12 hours of image acquisition.	Cancellation and modifications are possible before or after the acquisition start date, with a penalty of €1000. All qualified images are invoiced. Upon acceptance of the tasking proposal, cancellation or modification shall be sent to Customer Care at least 24 hours before the image acquisition. In such a case, a penalty of €1000 will apply.
Tracked Progress	Automatic notification at each step of the tasking order: • Planned (or missing) acquisitions + expected image download time • Systematic acquisition notification + estimated delivery time (+ 2 hours) • Delivery notification	Automatic notification for: • Acquisition notification when matching the agreed cloud cover threshold + estimated delivery time[2] (+ 2 hours) • Delivery notification
Delivery Lead Time	Rush delivery: • 12 hours after the image is available in GeoStore catalogue, and 24/7/365 • Average performance: 74 minutes	Standard delivery per default (rush delivery optional) • Turnaround is 24 hours after the image is available in the GeoStore catalogue during working hours, i.e. from Monday–Friday from 7:00–16:00 (UTC) • Average performance: 12 hours

Table 2.1b: One Tasking specifications extracted from the dedicated document, One Tasking Specifications.

2.2 Spectral Band Combinations

Combining the Panchromatic and Multispectral bands, images can be visualized as either black and white (1.5-m product resolution), natural colour, false colour (6-m product resolution) or as a merged product (Pansharpened colour image) with the resolution of the Panchromatic image.

2.2.1 Panchromatic

The Panchromatic product includes only one black and white band. It covers wavelengths between 0.450μm and 0.745 μm of the visible spectrum. The product pixel size is 1.5 m (Ortho).

Figure 2.2.1: Example of a panchromatic image

2.2.2 Multispectral

The Multispectral product includes four Multispectral (colour) bands. Specification values are:

- Blue: 0.455μm – 0.525μm
- Red: .   530μm – 0.590μm
- Green: 0.625μm – 0.695μm
- Near Infrared: 0.760μm – 0.890μm.

The product pixel size is 6 m (Ortho).

Figure 2.2.2: Example of a multispectral image

2.2.3 Bundle

The Panchromatic (1.5 m) and Multispectral (6 m) products, simultaneously acquired, are packaged together separately (not merged) and co-registered for a single delivery (1 file for Multispectral + 1 file for Panchromatic).

Panchromatic image   *Multispectral -4 bands- image*

Figure 2.2.3: Example of a bundle product

2.2.4 Pan-sharpened

Pan-sharpened products combine the visual information of the Multispectral data with the spatial information of the Panchromatic data, resulting in a higher resolution 1.5-m colour product. Image fusion is a concept of combining multiple images into composite products, through which more information than that of individual input images can be generated.

As an example of image fusion, Pan-sharpening describes a process of transforming a set of "coarse" spatial resolution Multispectral (colour) images to fine spatial resolution colour images, by fusing a co-registered fine spatial resolution Panchromatic image.
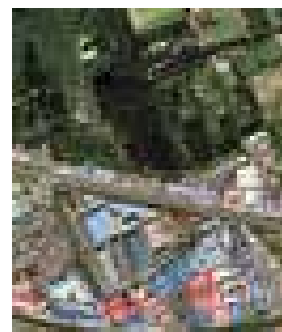
Panchromatic image   *Multispectral image (zoom factor x4)*

Pan-sharpened image

Figure 2.2.4: Pan-sharpened process

The upper left image is a natural colour image with a spatial resolution of 1.5 m (resampled 400%), and the upper right image is a Panchromatic image with a spatial resolution of 1.5 m. By combining these images, a very high-resolution colour Pan-sharpened image is produced. In the merged image, spectral signatures of the input colour image and spatial features of the input Panchromatic image (the best attributes of both input images), are almost completely retained.

Pan-sharpened products are offered as 3-band and 4-band products. The 3-band colour products are available in Natural Colour (Blue, Green and Red) or False Colour (Green, Red and Near Infrared).

The Natural and False Colour images are derived from Multispectral combinations, with bands that have been acquired simultaneously.

- To produce a Natural Colour image, the Red band is put in the red component of the monitor, the Green band is put in the green component of the monitor, and the Blue band is put in blue component of the monitor.

- For a False Colour image, any of the bands can be put in any RGB channel. The band combination can be changed to highlight the desired features.

2.3 Processing Level

SPOT 6 and SPOT 7 imagery products are available in two different processing levels: Primary and Ortho.

All products are corrected for radiometric and sensor distortions, using internal calibration parameters, ephemeris and attitude measurements.

SPOT 6 and SPOT 7 imagery offer contains Panchromatic channel (product resolution: 1.5m), Multispectral channels (4 bands, product resolution: 6m) already registered when ordered in bundle and possibly merged in a Pan-sharpening product.

2.3.1 Primary product

The Primary product is the processing level closest to the natural image acquired by the sensor. This product restores perfect collection conditions: the sensor is placed in rectilinear geometry, and the image is clear of all radiometric distortion. The Primary product is optimal for clients familiar with satellite imagery processing techniques wishing to apply their own production methods (orthorectification or 3D modeling for example). To this end, RPCs and the sensor model are provided with the product to ensure full autonomy and simplicity for users.

The Primary product is:

- In sensor geometry, synthesized on a perfect single and linear push-broom array,

- With an equalized radiometry on the native dynamic range of the sensor, 12 bits (4096 values).

The product is extracted from one strip acquisition, or a collection of acquisitions along the same path (case of stereo pairs or stereo triplets). The support for this extraction is a polygonal region of interest in WGS84 coordinates.

The main geometric processing includes:

- The combination of all sub-swaths across in the field of view (60 km nadir condition): synthesis in a virtual focal plane represented by a single linear array for all spectral bands

- Correction of instrumental and optical distortions: viewing angles adjusted to the single linear array model

- Co-registration of all spectral bands: Multispectral and Panchromatic

- Attitudes and ephemeris data are refined at ground on the mean estimation:

    - Adjustment on ground reference data if available

    - Attitudes filtering over time of acquisition

- Consistent alignment of the physical model ancillary data and RPC analytic model data

The main radiometric processing includes:

- Inter-detector equalization: correction of differences in sensitivity between the detectors (on board correction)

- Aberrant detectors correction (if any)

- Panchromatic band restored

- Pixel sampling at Shannon optimizing image quality for downstream value-added processing: optimized bicubic kernel resampling into the Primary geometry, zoomed to the factor 7 / 5 (equivalent resolution of 1.5/6m in nadir condition)
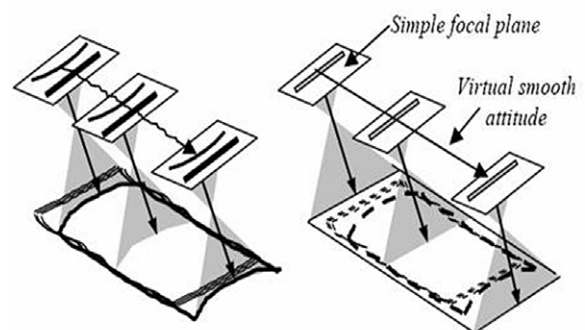
Figure 2.3.1: Perfect sensor geometry

The final format includes:

- Masking of pixels outside the area of interest

- Physical tiling: images beyond a certain size are split into several files (see A.4.4 for more details).

The user selects:

- The spectral band combination: Panchromatic, Multispectral 4-Band or Bundle

- The bit-depth: 12-bit native (4096 values) or reduced to 8 bits (adjusted to 256 values) for screen display without adaptation

- The raster file format: JPEG 2000, with Optimized or Regular compression, or TIFF

Please refer to 3.2.2 for assistance in selecting the appropriate options (Step 6).

2.3.2 Standard Ortho

The Ortho product is a georeferenced image in Earth geometry, corrected from acquisition and terrain offnadir effects. The Ortho is produced as a standard, with fully automatic processing.

The Standard Ortho product is an image that has been corrected (viewing angle and ground effects) so that it may be superimposed on a map. On top of radiometric and geometric adjustments, a geometric process using a relief model (known as orthorectification) eliminates the perspective effect on the ground (not on buildings), restoring the geometry of a vertical shot. The Ortho Product is optimal for simple and direct use of the image. It can be used and ingested directly into a Geographic Information System. This processing level facilitates the management of several layers of products, from the same sensor or others, while reducing localization gaps that can be caused by different viewing angles or relief between the various layers. The standard 3D model used for ground corrections is the worldwide Reference3D dataset, which is part of Airbus defence and Space's Elevation30 suite.

The product is extracted from one to several contiguous strip acquisitions: single ortho or mosaic. Support for this extraction is a polygonal region of interest in WGS84 coordinates.

The Ortho product inherits geometric corrections from the Primary product, with additional adjustments:

- Planimetric reset: On request, if ground reference data is available, the location is reset on Ground

- Control Points (Reference3D Ortho layer)

- Altimetric reset: correction of the panoramic effects induced by the off-nadir incidence angles over the relief thanks to a Digital Elevation Model (DEM). By default, the Reference3D DEM layer is used where available, otherwise SRTM is used.

- Map projection or geographic projection

The Ortho product inherits radiometric corrections from the Primary product, with additional adjustments:

- Pixel sampling at Shannon Sampling (optimized bicubic kernel) at a fixed resolution of 6 m for

Multispectral products and 1.5 m for Panchromatic and Pan-sharpened products

The final format includes:

- Masking of pixels (black fill) outside the region of interest polygon and raster trim to the region of interest bounding box

- Physical tiling: images beyond a certain size are split into several files (see A.4.4) The user selects:

- The possibility to reset the location on Ground Control Points if available

- The spectral band combination: Panchromatic, Pan-sharpened 3-Band Natural Color, Pansharpened 3-Band False Color, Pan-sharpened 4-Band, Multispectral 4-Band, Bundle (please refer to 2.2)

- The bit-depth: 12-bit native (4096 values) or reduced to 8 bits (adjusted to 256 values) for screen display without adaptation

- The raster file format: JPEG 2000, with Optimized or Regular compression, or GeoTIFF

Please refer to part 3.2.2 for assistance in selecting the appropriate option (step 6).

Main Characteristic	Information
Geographic Projections	WGS84 - latitude/longitude (Please refer to A.5.1 for more details)
Mapping Projection	Most of the projections registered by EPSG, in meters (Please refer to A.5.2 for more details)
GCP	Reference3D Ortho layer
DEM	Reference3D DEM layer (DTED2), SRTM (DTED1), GLOBE (DTED0)

Table 2.3: Geometric details of the Ortho product

2.3.3 Tailored Ortho

Aside from the Standard Ortho product, when different specifications are needed, Airbus Defence and Space Services can also provide on-demand, custom orthorectification, with a more precise 3D model provided by the client or acquired for the purpose. The Tailored Ortho product can also be requested to create a mosaic of images acquired at different dates. Ingestion of Ground Control Points can also improve the overall precision of the product. Each Tailored Ortho product is subject to a feasibility study and specific delivery timeframes.

2.4 Products and Image Format

SPOT 6 and SPOT 7 products will be delivered in DIMAP V2, just like Pléiades ones. The DIMAP V2 format is an improved version of SPOT's DIMAP V1 format:

- The image can be output in different raster formats: either GeoTIFF or JPEG 2000 (DIMAP V1 allowed only GeoTIFF)

- Rational Polynomial Coefficients (RPCs) are provided to easier orthorectification and geometric processing

- A KMZ is included for rapid, easy and user-friendly display of the main metadata in a Google Earth environment

- Product file naming has been improved (one product, one name, one ID) to better display the product information (sensor, date, processing level, spectral band combination). This also allows several products to be opened on the same computer (vs. DIMAP V1, where you have to close/ exit an opened product before opening a second one)

- Quality and could cover masks are included

Within the products, the imagery file may come in two different formats, GeoTIFF or JPEG 2000. Although JPEG 2000 is used less today than GeoTIFF, this format saves on file space. JPEG 2000 files can be up to 5 times smaller than GeoTIFF files, making data warehouse management, handling, post-processing and streaming much easier. Depending on your need, you may choose between two compression rates:

- JPEG 2000 Optimized is meant for people looking for fast download and easy data sharing. It has a compression of 3.5 bits/pixel. It uses lossy compression: the compression rate is optimized to avoid any spatial effect but is not reversible. A spectral effect of 1/1000 is tolerated.

- JPEG 2000 Regular is perfect for users willing to do some high precision post-processing. It has a compression of around 8 bits/pixel. It uses lossless compression: the JPEG 2000 compression is completely reversible and does not include any effects in terms of information content.

Both JPEG 2000 compressions ensure no impact in terms of image quality. However, they have a direct impact on the file size: the Regular compression file size is twice as large as the Optimized compression file size.

The (Geo)TIFF format is free of any compression (the standard TIFF specification provides a simple JPEG compression scheme, which is unable to preserve the information content correctly). The file size is huge compared to JPEG 2000 because the GeoTIFF format stores integer values, encoded on the power of two: either 8 or 16 bits. SPOT 6 and SPOT 7 acquire images with a 12-bit depth, so GeoTIFF 16-bit products are storing 4 bits for no use.

Upon request, when a GeoTIFF product has been ordered, we will deliver the JPEG 2000 version free of charge for personal format assessment.

JPEG 2000	GeoTIFF
Pixel encoding 12 bits • Optimized compression • Regular compression	**Pixel encoding 16 bits** **(12 bit-depth dynamic range)** • Without compression
Pixel encoding 8 bits • Optimized compression • Regular compression	**Pixel encoding 8 bits** • Without compression

Table 2.4: Image format options

Please refer to 3.2.2 for assistance in selecting the appropriate option (step 6).

2.5 Licensing

Airbus Defence and Space Services offers flexible licensing options to meet any kind of need.

- **The Standard** End-User License Agreement (EULA) permits the end-user to share the product with affiliated end-users identified in the data request form, in the frame of a joint project. The standard price of the product may include up to 5 affiliated end-users. For 6 or more endusers, the "Multi" option shall be selected and entails price uplift. Under this license, the end-user can:

  - Use the product for their own internal needs

  - Create value added products containing imagery data ("VAP") and use them for their own internal needs

  - Create derivative works ("DW") which do not contain imagery data from the initial product and are irreversible and decoupled from the source imagery data of the product. DW may be freely used and distributed

  - Share the product with their consultant and contractor for use on behalf of the end-user and/or affiliated end-users

  - Print or post online an extract of the product (1024*1024 pixels) for promotion activities

- **The Academic License** is focused on research and educational purposes. It permits the use of the Product by one educational entity for academic research or training. An extract of the product may be reproduced on certain training tools and publications related to the results of a research.

- **The Technical Evaluation License** permits the end-user to use the product for technical evaluation only. The end-user shall not transfer the product to any third party but may make the product available to a consultant or contractor for use on behalf of the end-user. The end-user shall inform Airbus Defence and Space Services of the results of the performed evaluation.

- **Other Needs** For specific commercial needs, we may propose tailored license conditions (such as governmental license, web license, etc.) on a case by case basis. In such a case, please contact us.

3. Product ordering

3.1 Access to SPOT 6 and SPOT 7 Products

SPOT 6 and SPOT 7 products can be ordered either directly through the web portal **http://www.intelligence-airbusds. com/geostore** or contacting our Customer Care Service:

- By phone: +33 5 62 19 40 40
- By email: contact@Airbus Defence and Space-geo.com
- By fax: +33 5 62 19 40 51

Depending on your location, you will be served directly by Airbus Defence and Space or put in contact with a local partner.

The order form is available on our website or can be provided by our Customer Care Service, upon request.

3.2 How to Order?

3.2.1 GeoStore

For the combined arrival of Pléiades 1A & 1B and SPOT 6 & 7, Airbus Defence and Space Services has released a new web portal to offer customers and partners an advanced 24/7 access service for satellite data. This unique e-business portal, called GeoStore, allows users to order and manage their geospatial content online.

This portal is backed by DataDoors. Developed by the U.S.-based company i-Cubed, DataDoors is a leading geospatial e-business platform perfectly suited for browsing and ordering satellite imagery, offering a seamless solution from data searching through to product delivery and order management.

The overall platform features multiple e-business functionalities to address the needs of a wide variety of users: distributors, value-added resellers, end-users, partners on their way to Direct Access Services (Direct Receiving Station), etc. Easy, intuitive and autonomous, user- and map-centric, GeoStore is meant to become the backbone of the relation between the user and Airbus Defence and Space.

Above all, GeoStore is a powerful web catalog, powered by ESRI technology. Alerts can be set up over specific areas so users are notified as soon as new data is available. By default, GeoStore opens on the user's main AOI. Users with little Earth observation knowledge can search the catalog, without any specific technical criteria. Remote sensing experts can perform advanced searches with seasonal criteria, snow cover, cloud cover, angle, resolution, product type, etc., and even download an Arcgis plug-in to perform an archive search directly from their GIS.

Users with Premier accounts are granted access to the full SPOT offer. They can order archived images online, and also request new SPOT 6 and SPOT 7 images through the different tasking services (OneDay, OneNow, OnePlan, OneSeries, see 2.1). The possibility to follow online the status of a specific tasking request is available, including users having the ability to validate collections themselves (based on the quicklook).

The e-business functionalities allow users to:

- Share information and selections in their baskets with other users (e.g. the end-user, in the case of a distributor account). The project sharing functionality enables users to share AOIs, search criteria, annotations over selected images (text, drawings) as well as search results
- Visualize all completed orders
- Sort and/or filter completed orders by date, end-user, country, order ID, or order status and export to an Excel file
- Visualize on a map the AOI of the ordered items, the quicklooks of the selected products and the footprints of the selected products

Other useful tools include:

- User rights management: For a given organization's account, different rights can be granted each individual user, from just being able to view the selections up to the ability to order online
- Automatic email notifications can be set up and sent to the internal manager of the organization's account, for all orders and deliveries done by any of the organization's users
- Easy setup for prepaid accounts.
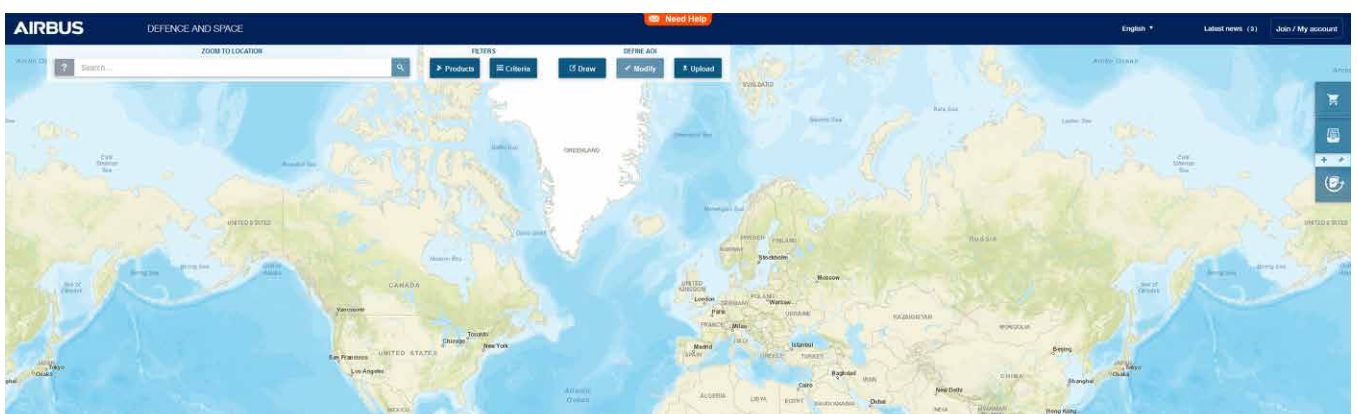
Figure 3.2.1a: GeoStore – research interface
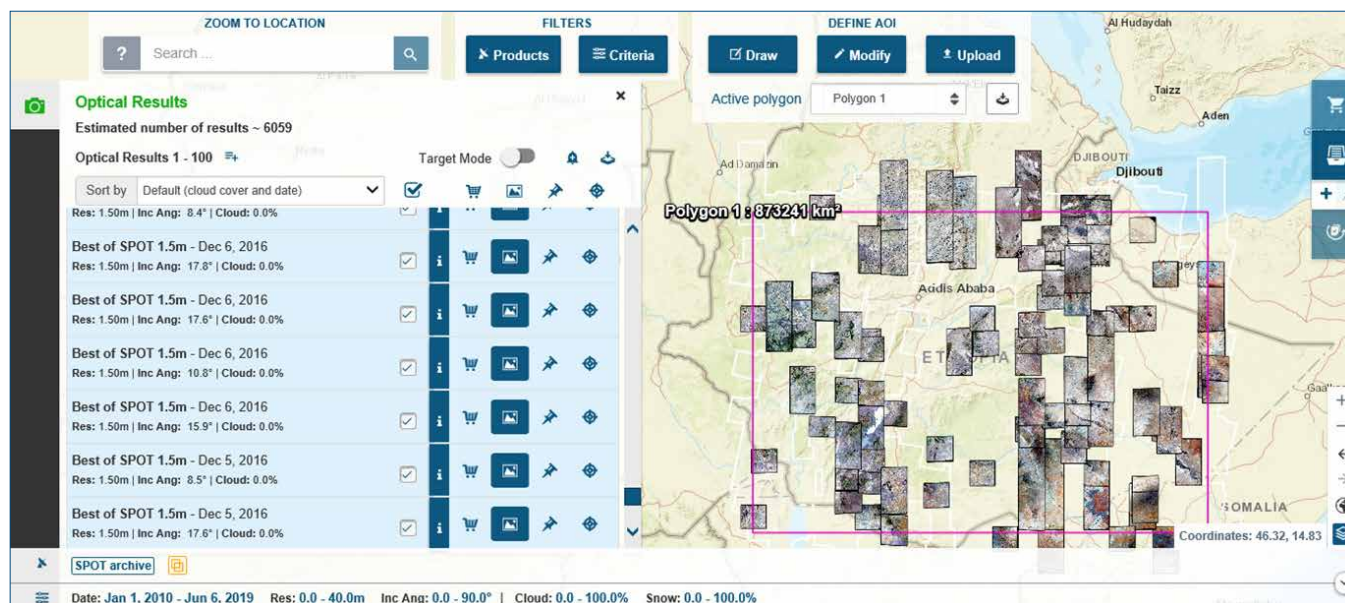
Figure3.2.1b: GeoStore - browsing archive catalog

3.2.2 Ordering Through Customer Services

You can place an order with our Customer Care Services or local partner by completing the *Pléiades & SPOT Data*

Request Form (in PDF format). Over the next few pages, we outline how to fill in the form's requested parameters, and give additional useful information for ordering your products online.

DEFENCE AND SPACE
Intelligence

Pléiades & SPOT
Data Request Form

Step 1: General information (mandatory)
including contact and end-user
information
Step 2: Your requested products:
  • Your Area Of Interest
  • Archive imagery or
    New collection with One Tasking
  • Processing options

AIRBUS

Figure 3.2.2a:
Front cover of the Pléiades & SPOT Data
Request Form

Contact Information

A   Billing Address

Order ID	
Company name	
Contact name	
Address/country	
Phone no.	
Email address(es)	
VAT no.	

A   Delivery Address (if different from the above)

Company name	
Contact name	
Address/country	
Phone no.	

Delivery

B Delivery mode	Network for FTP delivery ◯	Physical media (DVD, hard drive, USB) ◯
FTP address (if needed)		
Email address(es)		
C Delivery turnaround	Standard	

End User Information

D   Final End User Market

Market segment	
If 'Other', please specify	

E   Licensing

License type	Academic
If 'Other', please describe	
If more than one end user, please specify affiliated end users	Contact, company name, country

F   Application

Choose an item	
If 'Other', please specify	

Figure 3.2.2b: Page 2 of the Pléiades & SPOT Data Request Form featuring Contact Information and End User Information

Note: Step 1, A–C, and Step 2, D–F, opposite, refer to page 2 of
the *Pléiades & SPOT Data Request Form*, annotated above.

Step 1: Contact Information and Delivery Method

A) Billing address/Delivery address

Specify customer information, billing address, and shipping address (if different from billing address), as well as the end user details.

B) Delivery mode

- Select from FTP, DVD, hard disk drive or USB flash drive (please refer to the pricelist).

- Airbus will provide the most appropriate delivery media for the size of the image file:

  - **Hard drives:** Available in 500 GB, 1 TB, 2 TB or 3 TB.

  - **Flash drives:** 8 GB, 16 GB, 32 GB or 64 GB.

  - **DVDs:** Up to 4.7 GB.

  - **CDs:** 800 MB.

- Streaming access to Pléiades archive data or new collections is also available as a standard delivery mode or through diverse digital offers.

C) Delivery turnaround

- Standard delivery turnaround is 24 hours, during working days/working hours.

- Rush delivery is 12 hours, 24/7/365.

- For archive products, T0 is the order confirmation sent by our Customer Service (telephone/email ordering) or by the online ordering portal (online ordering).

- For new collections, T0 is when the image appears in our external catalogue.

- The standard delivery lead time applies to FTP or streaming deliveries in all options.

- The rush delivery option is available:

  - For the Primary, Projected Standard Ortho processing levels.

  - In DIMAP or NITF.

  - In GeoTIFF or JPEG 2000.

  - With FTP delivery or streaming access or download API.

- The rush option applies to archive imagery as well as new collections. It is automatically included in OneDay, OneNow, and OneSeries Critical, but it is optional for OnePlan and OneSeries Routine, as these products are delivered within a short timeframe, so image quality control is not performed and Refined Attitude Data is not integrated.

- Both standard and rush delivery times are applicable for archive data stored in one of our main receiving stations: Toulouse, Kiruna, or Svalbard. Delivery turnaround for archive data stored in one of our partner's direct receiving stations might take more time.

- Note that if you place your order online, you can select the image production priority:

  - Standard: only available during working hours but guarantees a quality check on the image prior to the delivery.

  - Rush: allows immediate production but without a manual quality check.

Step 2: End User Information

D) Final End User Market

Specify the activity of the end user.

E) Licensing

Please select the license type that fits your needs (refer to section *2.6 Licensing* for the licensing option summary):

- EULA – up to five affiliated end users.

- Multi – more than six users.

- Academic.

- Technical evaluation.

- Demonstration.

- Web.

- Media.

- Other.

If multiple users will use the same product, please list them and provide their contact details in the Pléiades Data Request Form.

F) Application

Scroll trough the list of options to select the application for which the data will be used.

Area of Interest

G Country and place name

H Please upload your AOI(s) using one of the following options:

ESRI shapefile (UTM WGS84 preferably)	Please send it with this form.	
Google Earth KML / KMZ (UTM WGS84 preferably)	Please send it with this form.	
Circle (UTM WGS84 preferably)	Centre point (latitude/longitude)	Radius (km)
Rectangle (UTM WGS84 preferably)	Upper left (latitude/longitude)	Lower right (latitude/longitude)

Archive Imagery

Minimum Order Size

Satellite	Minimum order size	Minimum width
Pléiades	25km^2	500m in any direction
SPOT 6/7	100km^2	5km in any direction
SPOT 1–5	3,600km^2	1 scene

Optical satellite	Pléiades ⚪	SPOT 6/7 ⚪	SPOT 1-5 ⚪
Mode			
I Segment IDs	Important: please allow one line per ID and press 'Enter' after each.		

Figure 3.2.2c: Page 3 of the Pléiades & SPOT Data Request Form featuring Area of Interest and product type: Archive Imagery.

Note: Step 3, G–H, and Step 4A, I, reviewed opposite and annotated above, refer to page 3 of the *Pléiades & SPOT Data Request Form*.

Step 3: Area of Interest

G) Country and place name

Indicate the country and place name of your area of interest.

H) Upload your AOI(s)

You can define your Area of Interest using coordinates or a Shapefile, KML or KMZ.

- ESRI shapefiles, as well as KML/KMZ files, will be provided in Universal Transverse Mercator Geographic Projection using latitude and longitude, decimal or sexagesimal degrees, based on the WGS84 ellipsoid. Polygons must have a minimum of three points and a maximum of 999 points. The polygon must be one ring and cannot intersect itself. The minimum distance between two contiguous points shall be at least 500 m.

- Coordinates can be provided in two different ways:

  - As a circle, giving latitude and longitude information of the centre in decimal or sexagesimal degrees, based on the WGS84 ellipsoid and a radius size, in kilometres.

  - By specifying the latitudes and longitudes of the upper left and the bottom right corners of a rectangle, still in decimal or sexagesimal degrees and based on the WGS84 ellipsoid.

- In all cases (Shapefile, KML, KMZ, coordinates), the AOI shall be a minimum 25 sq km wide for archive orders and 100 sq km wide for new acquisition orders, with a minimum width of 5 km in any direction for new acquisitions, and 500 m for archive.

Step 4A: Product Type – Archive Imagery

On pages 3 and 4 of the *Pléiades & SPOT Data Request Form*, you specify the product type that you need – archive data and/or a new acquisition.

To order archive data, you will complete the Archive Imagery section of the form.

I) Segment IDs

If you have found the data you need in our online catalogue, please indicate the source segment ID/s.

We also have a specific department in charge of managing archive searches on your behalf. This team can deal with standard or complex requests, including multi-sensor.

If you would prefer Airbus to do the search for you, enter 'Don't know' in the Segment IDs answer field.

Step 4B: Product Type – New Collections with One Tasking

To order a new acquisition, select the One Tasking option that best meets your needs:

This step (4B, J–M) refers to pages 4 and 5 of the *Pléiades & SPOT Data Request Form*, as annotated. Detailed explanations relating to the One Tasking offer and One Tasking specifications are given in section *2.1.2 One Tasking: Committed to Delivering Imager*y.

J) ONE DAY
Choose your acquisition date.

K) ONE NOW
Access useful information in an instant.

L) ONE PLAN
Obtain qualified coverage within an agreed timeframe.

M) ONE SERIES
Get Routine or Critical coverage on a regular basis.

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New Collections with ONE TASKING

Minimum Order Size

Satellite	Minimum order size	Minimum width
Pléiades	100km^2	5km in any direction
SPOT 6/7	500km^2	15km in any direction

J OneDay

Optical satellite	Choose between:	Pléiades ◯	SPOT 6/7 ◯
Acquisition date	DD | MM | YY		
Subscription			
Acquisition mode			
Incidence angle	<30° ◯	<52° ◯	
B/H for 'Stereo' or 'Tristereo'	Min B/H	Max B/H	
Maximum cloud cover	100% accepted		

OneNow

Optical satellite	Choose between:	Pléiades ◯	SPOT 6/7 ◯
Start date	DD | MM | YY		
Acquisition mode			
Incidence angle	<30° ◯	<52° ◯	
B/H for 'Stereo' or 'Tristereo'	Min B/H	Max B/H	
Maximum cloud cover			
If 'Other', please specify			

L OnePlan

Optical satellite	Choose between:	Pléiades ○	SPOT 6/7 ○
Acquisition period	Start DD | MM | YY		End DD | MM | YY
Acquisition mode			
Incidence angle	<20° ○	<30° ○	<52° ○
B/H for 'Stereo' or 'Tristereo'	Min B/H	Max B/H	
Maximum cloud cover			
If 'Other', please specify			

M OneSeries

Optical satellite	Choose between:	Pléiades ○	SPOT 6/7 ○
One Series type*	Choose between:	OneSeries Routine ○	OneSeries Critical ○
Total no. of images required			

Multi-period monitoring	Period 1	Period 2	Period 3
	Start DD | MM | YY	Start DD | MM | YY	Start DD | MM | YY
	End DD | MM | YY	End DD | MM | YY	End DD | MM | YY
	Period 4	Period 5	Period 6
	Start DD | MM | YY	Start DD | MM | YY	Start DD | MM | YY
	End DD | MM | YY	End DD | MM | YY	End DD | MM | YY
	Additional periods: If more than six periods are needed, please detail them below.		

Regular monitoring	Acquisition period	Total number of images required
	Start DD | MM | YY	Minimum interval between two images:
	End DD | MM | YY	days

Acquisition mode		
Incidence angle (select the relevant option)	OneSeries Routine	
	OneSeries Critical	
B/H for 'Stereo' or 'Tristereo'	Min B/H	Max B/H
Maximum cloud cover (select the relevant option)	OneSeries Routine	
	OneSeries Critical	
If 'Other', please specify		

*OneSeries criticality
OneSeries Routine: acquisition period/frequency: 8 days or more; OneSeries Critical: acquisition period/frequency: 7 days or less.
Depending on the requested acquisition time to collect the image, your tasking may be considered as Routine or Critical.

Figure 3.2.2d: Pages 4 and 5 of the Pléiades & SPOT Data Request Form

OneDay option

Choose your acquisition date.

OneDay tasking allows you to task the satellites on a specific day. The satellite resource will be booked for your requested date and the satellite will then cover your area with the highest priority. The collected image will be delivered to you regardless of the cloud cover.

However, the OneDay tasking option for a specific chosen day is now risk-free: 24 hours before your acquisition date, you will receive a weather forecast to let you confirm, postpone or cancel your request at no cost. This option is especially useful when you need an image for a specific event, for example, to provide intelligence to a security agency, which is planning a military operation on a particular day.

Weather Forecast Alert

A weather forecast alert is sent 24 hours before the acquisition.

Acquisition Failure Terms

The success/failure criterion of a OneDay tasking is whether the acquisition happens on the planned day.

- If the acquisition does not occur on the selected day, a 25% voucher of the acquisition value will be offered to the customer. This acquisition failure term does not apply if due to unforeseeable circumstances (please refer to article 11 'Force Majeure' in our terms and conditions).

- In the case of subscriptions, if one acquisition is missing, the tasking is considered as failed and a 25% voucher will be offered and calculated as follows: 25% x (total subscription value)/(total number of acquisitions purchased in the subscription).

- For AOIs covered by multiple images, if one image is missing, the tasking is considered as failed. A voucher representing 25% of the missing acquisition value will be issued to the customer.

  All successful images collected are delivered and invoiced as specified in the acknowledgement of tasking order receipt.
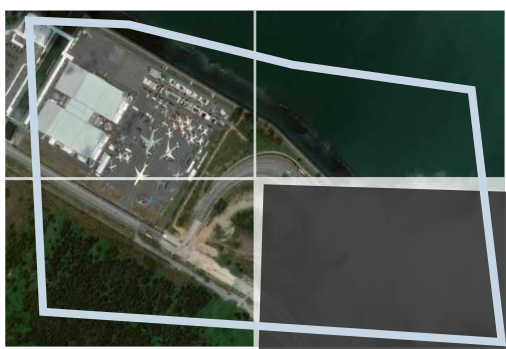
Timeframe	One day	
Number of Acquisitions	1	
Start Date	Any day during the upcoming year.	
Minimum Order Size	Pléiades: 100 km² SPOT 6/7: 500 km²	
Max Bounding Box	Pléiades: 20 km East–West 40 km North-South	SPOT 6/7: 60 km East–West 120 km North-South
	Bigger areas are subject to a feasibility study	
Cloud Cover	Up to 100%	
Acquisition Notification	Acquisition notification will be sent to the customer regardless of the cloud cover, as soon as the image is acquired.	
Acquisition Mode	Mono, Stereo or Tristereo	
Incidence Angle	From 0–52°	
B/H	From 0.2–0.8 By default: 0.4–0.7 for Stereo 0.2–0.35 between each Tristereo pair	
Service Level	Premium	
Delivery Lead Time	Rush	

Tasking parameters

The tasking parameters when selecting the OneDay option include:

- The acquisition date.

- The subscription package if required (choice of 5, 10 or 20).

- The acquisition mode (Mono, Stereo, Tristereo). For further details about the acquisition mode, please see OnePlan option on page 41.

- The incidence angle which is extended by default up to 52°. Accepting extended angles allows you to increase the available number of acquisition dates.

◄ *Figure 3.2.2e: Acquisition failure terms*
If several images are necessary to fully cover the area but one acquisition is missing (bottom right in the example above), the voucher will be calculated on the missing acquisition. All the images acquired that do cover the area will be invoiced.

OneNow option

Access useful information in an instant.

When immediate imagery is required, our satellites can be tasked to deliver valuable insights in the shortest possible timeframe. This option is mainly dedicated to answer emergency needs when up-to-date information on what is happening on the ground is requested.

Thanks to ✷NE NOW✚, we offer intensive acquisitions of the area with the maximum satellite resource allocation. We ensure up to three acquisitions resulting in three deliveries in the shortest possible timeframe. All acquisitions are delivered regardless of the cloud cover. The tasking ends as soon as a good image is acquired. In the event of poor weather conditions, upon your decision, we continue collecting imagery over your area until successful data is acquired or the customer decides to end the tasking.

Timeframe	The shortest period needed to secure three acquisitions; the timeframe may be extended if additional attempts are necessary.	
Number of Acquisitions	Up to three acquisitions. Additional acquisitions are proposed until cloud cover rate reaches 10% or the customer decides to end the tasking.	
Start Date	Any day during the upcoming year. Current day if possible or the day after.	
Minimum Order Size	Pléiades: 100 km² SPOT 6/7: 500 km²	
Max Bounding Box	Pléiades: 20 km East–West 40 km North-South	SPOT 6/7: 60 km East–West 120 km North-South
	Bigger areas subject to feasibility study	
Cloud Cover	≤ 10% – all acquisitions are delivered. A validated acquisition ends the tasking.	
Acquisition Notification	Acquisition notification will be sent to the customer as soon as the image is acquired, regardless of the cloud cover.	
Acquisition Mode	Mono, Stereo or Tristereo	
Incidence Angle	From 0–52°	
B/H	From 0.2–0.8 By default: 0.4–0.7 for Stereo 0.2–0.35 between each Tristereo pair	
Service Level	Premium	
Delivery Lead Time	Rush	

Acquisition Failure Terms

The success or failure of tasking OneNow is based on the initial three planned attempts period (these are not necessarily consecutive days but three attempts).

A voucher will not be issued if an acquisition is missing, but the available imagery will be delivered free of charge in the following cases:

- If one acquisition is missing from the initial three attempts and the other two acquisitions do not meet the validation criteria specified in the tasking proposal accepted by the customer, then these two images are delivered at no charge.

- For AOIs covered by multiple images: if one image is missing, then the acquisition is considered as failed. The other images collected are delivered at no charge.

If an AOI is more than one mesh, in the limit of the maximum bounding box, then the commercial commitment is to collect three times the complete AOI. These three days are communicated at the beginning to the customer. This implies excluding some days where the AOI can only be partially covered. Nevertheless, these partial coverage days will still be attempted in order to make the coverage progress in between. They do not count in the failure rating and are considered as an add-on.

With our commitment to delivering useful results, larger areas are subject to a feasibility study before the acquisition of imagery. In this instance, there is no requirement to collect imagery of the complete area three times. The main objective is to collect the area as soon as possible.

However, if you urgently require only one coverage of your area, you can switch to ✷NE NOW☀ with weather forecast considerations. This option will still acquire the area at the soonest time with the highest satellite tasking priority, but also takes into account weather conditions, so satellite attempts are only made when cloud cover is not expected to be a problem. Then only the validated coverage/image is delivered to you.

In the event of poor weather conditions and upon your decision:

- We extend the survey period and continue to collect the area until it is successfully covered (i.e. within your requested validation criteria).

- This option will soon be available online via GeoStore.

❄ONE NOW ☀ (with weather forecast considerations)		
Timeframe	7 days to collect the area; the timeframe may be extended if additional attempts are necessary.	
Number of Acquisitions	Only one good coverage.	
Start Date	Any day during the upcoming year. Current day if possible or the day after.	
Minimum Order Size	Pléiades: 100 km^2	
Max Bounding Box	Pléiades: 20 km East–West 40 km North-South	SPOT 6/7: 60 km East–West 120 km North-South
	Bigger areas subject to feasibility study	
Cloud Cover	≤ 10% by default or any other selected cloud cover depending on the location of the area or specific requirements. A validated acquisition ends the tasking.	
Acquisition Notification	Acquisition notification will be sent to the customer as soon as the image is acquired, regardless of the cloud cover. Specific acquisition notification threshold can be requested.	
Acquisition Mode	Mono, Stereo or Tristereo	
Incidence Angle	From 0–52°	
B/H	From 0.2–0.8 By default: 0.4–0.7 for Stereo 0.2–0.35 between each Tristereo pair	
Service Level	Premium	
Delivery Lead Time	Rush	

Acquisition Failure Terms

OneNow tasking service acquires the area of interest until an image featuring less than 10% cloud cover (or any other specific cloud cover or validation criteria requested/accepted by the customer) is taken.

- If the AOI is not collected in full and on specification within the acquisition window, a 25% voucher of the missing acquisition/coverage value is granted. In addition, the customer is given the choice to:

    – Extend the acquisition period up to 15 days via the web portal or by directly emailing the customer service.[1]

    – Close the request and receive delivery of everything that has been collected on spec (if applicable). In this particular case, all acquisitions shall be invoiced as per delivery.

- In the case of subscriptions, if one acquisition is missing, the tasking is considered as failed and a 25% voucher will be offered and calculated as follows:

    25% x (total subscription value)/(total number of acquisitions purchased in the subscription). 25% x (total subscription value)/(total number of acquisitions purchased in the subscription).
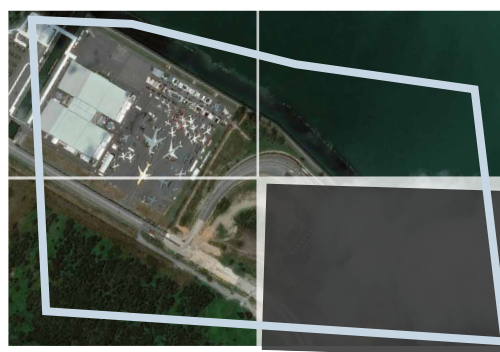
- If several images are necessary to fully cover the area but one acquisition is missing (bottom right in the example above): if one image is missing, then the acquisition is considered as failed:

    – All successful images collected and automatically processed and delivered are invoiced as specified in the acknowledgement of tasking order receipt.

    – The voucher will be calculated on the missing acquisition. All the images acquired that do cover the area will be invoiced.

---

1   If the customer agrees on extending the observation period, and if the tasking request is not completed at the end of this new observation period, no voucher will be issued.

If an AOI is more than one mesh, in the limit of the maximum bounding box, then the commercial commitment is to successfully collect the complete AOI during the initial tasking timeframe agreed with the customer. This implies including some days where the AOI can only be partially covered. These partial coverage days may still be attempted in order to make the coverage progress in between. They do not count in the failure rating and are considered as an add-on.

The success/failure criterion of an acquisition is technically based on the tasking performance to successfully collect the area in full and on specification within the initial 7-day acquisition window.

However, upon customer claim, we accept voucher emission if the production has taken longer than planned (more than the rush SLA after publication in our catalogue).

With our commitment to delivering useful results, larger areas are subject to a feasibility study before the acquisition of imagery. In this instance, there is no requirement to collect imagery of the complete area within a 7-day survey period. The main objective is to successfully collect the area as soon as possible.

Tasking parameters

The tasking parameters when selecting the OneNow option include:

- The start date.

- The acquisition mode (Mono, Stereo, Tristereo). For further details about the acquisition mode, please see details in the OnePlan option (right).

- The maximum cloud cover accepted, especially in the case of ☀NE NOW☀ selected.

- The incidence angle: accepting extended angles allows you to increase the available number of acquisition days but could impact the geometric performance of your product.

- The B/H value if Stereo or Tristereo acquisition requested (please see details in the OnePlan option).

- The subscription package, if required (5, 10 or 20).

OnePlan option
Obtain qualified coverage within an agreed timeframe.

Whether for a map update, infrastructure planning or any other specific project, OnePlan will provide you with the imagery you need. You select timeframes, dates and preferred sensor – we ensure you receive the right qualified coverage, perfectly matching your project milestones.

Timeframe	From 7–365 days
Start Date	Any day during the upcoming year
Cloud Cover	≤10% ≤ 5% Possibility to select three small cloud-free AOIs (Pléiades: 1x1 km, SPOT: 3x3 km)
Minimum Order Size	Pléiades: 100 km² SPOT: 500 km²
Max Bounding Box	Subject to feasibility study
Acquisition Notification	By default, 25% Or customer selected: 5–100%
Acquisition Mode	Mono, Stereo or Tristereo
Incidence Angle	0–20° 0–30° Custom [5–52°]
B/H	From 0.2–0.8 By default: 0.4–0.7 for Stereo 0.2–0.35 between each Tristereo pair
Feasibility	Diagnosis on the probability of collecting the AOI in full complying with the specifications: Achievable, Challenging, Unachievable.
Service Level	Regular
Delivery Lead Time	• Standard • Rush

Acquisition Failure Terms

If the AOI is not collected in full and on specification within the acquisition window, a 10% voucher of the full order value is granted. In addition, the customer is given the choice to:

- Extend the acquisition period, or

- Close the request and receive delivery of all that has been collected on spec (if applicable). In this instance, all acquisitions shall be invoiced as per delivery.

The success/failure criterion of an acquisition is technically based on the tasking performance of the initial tasking timeframe agreed with the customer. If the customer agrees on extending the observation period, and if the tasking

request is not completed at the end of this new observation period, no voucher will be issued.

> *i* **The optimum B/H ratio to process 3D models by automatic correlation is in the range of 0.25 and above, depending on the relief. Generally, for Stereo, you may request a B/H of 0.25–0.40, if the 3D processing is automated, and even more if the processing is manual. You can request an increased B/H ratio for rather flat areas, with little relief or small buildings. In a mountainous or high building area, a large B/H ratio (>0.4) increases the rate of hidden items or areas (in-between two high mountains or around buildings) and decreases the global automatic matching accuracy. This risk can be mitigated by using the Tristereo mode. For Tristereo, a B/H around 0.25 can be recommended for each pair (e.g. 12°/0°/15°).**

- The max incidence angle field allows you to choose between <20°, <30°, <52°.

  Note that <20° viewing angle values are recommended for orthoimagery.

- The B/H (base/height) value if stereo or tristereo acquisition requested; please refer to explanations in panel, left. The optimum B/H is dependent on the relief. If in doubt, our tasking experts will recommend the most adapted values.

- The maximum cloud cover accepted, the standard value is 10%. If you need a lower cloud cover commitment, please select another cloud cover threshold or describe your need in the dedicated section. This space can also be used for requesting other specific requirements such as:

  - A small cloud-free area (max 1 km x 1 km) that will be submitted for a feasibility study with the rest of your parameters.

  - Other specifications (snow, haze, sand wind) can be specified in the blank space left for a customer's comments.

Figure 3.2.2f: Illustration of B/H Ratio
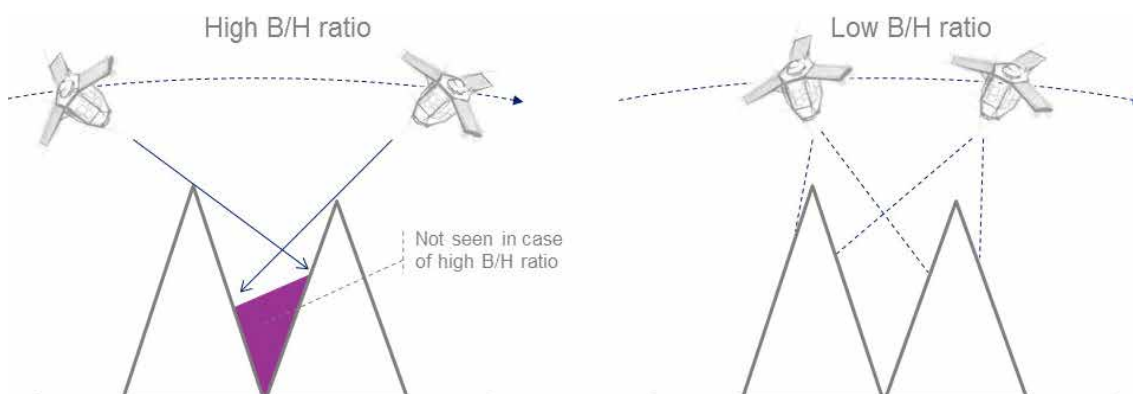
Figure 3.2.2g: Illustration of B/H Ratio and hidden items

Tasking parameters

The tasking parameters when selecting the OnePlan option include:

- **The acquisition period**

  For a single scquisition, you may indicate your preferred collection period, with start and end dates. For instance, if you indicate 01/01/19 – 31/03/19, it means that you want the image to be acquired during the first three months of 2019.

- **The acquisition mode – Mono, Stereo, Tristereo**

  If you need a new image, you can also specify if you need a Mono, Stereo or Tristereo acquisition. A monoscopic image means a single image is delivered over your AOI. Stereoscopic (or Tristereoscopic) acquisition means that the satellite acquires two (resp. three) images over the area of interest within the same orbital pass. Each of the two (resp. three) images are shot with a different viewing angle within the same orbit, enabling the creation of 3D models over the area of interest. For a Tristereo acquisition, the second image is acquired nearly vertically. The near-nadir acquisition minimises the risk of missing hidden items, which is ideal for dense urban and mountainous areas.

  - If you select **Mono**, you can indicate the maximum viewing angle you want. The standard viewing angle is 30° (a maximum of 20° is recommended for Ortho products). Please refer to the *Abbreviations, Acronyms and Terms* section for the definition of the viewing angle.

    Note: the smaller the maximum viewing angle is, the longer the required collection window. The amount of additional time required depends on the latitude of your area of interest and your tasking choice. Please contact Customer Care Service for more information about how the viewing angle will affect your specific order.

  - With **Stereo** or **Tristereo**, you can select your B/H. Please refer to the *Abbreviations, Acronyms and Terms* section for the definition of the B/H ratio.

OneSeries options

Get Routine or Critical coverage on a regular basis.

Whether you are dealing with long-term changes or highly dynamic situations, OneSeries brings you the required intelligence at a time frequency of your choosing. For urgent acquisitions, our cloud cover commitment ensures that you pay only for the most useful results.

OneSeries offers two options – Routine or Critical – dependent on customer requirements.

OneSeries Routine

OneSeries Routine corresponds to standard monitoring of the same area of interest. OneSeries Routine aims to provide regular information on a specific area with a minimum of eight days or more between two acquisitions. This is the perfect solution for fortnightly, monthly and quarterly monitorings.

Cloud Cover	≤10% ≤ 5% Possibility to select three small cloud-free AOIs (Pléiades: 1x1 km, SPOT: 3x3 km)
Acquisition Notification	By default, 25%
Acquisition Mode	Mono, Stereo or Tristereo
Incidence Angle	0–20° 0–30° by default Custom [5–52°]
B/H	From 0.2–0.8 By default, 0.4–0.7 for Stereo 0.2–0.35 between each Tristereo pair
Feasibility	Diagnosis on the probability to collect the AOI in full compliance with the specifications: Achievable, Challenging, Unachievable.
Service Level	Regular or Premium
Delivery Lead Time	• Standard • Rush

Acquisition Failure Terms

If the AOI is not collected in full and on specification within the acquisition window, a 10% voucher is granted on the value of the missed acquisition.

The voucher shall be calculated as follows: the full amount of the order/number of requested acquisitions.

In addition, the customer can choose between:

- Extending the acquisition period of the missed observation, or

- Closing the ongoing period and taking delivery of everything that has been collected on specification (if applicable). In this particular case, all acquisitions shall be invoiced as per delivery.

The success/failure criterion of an acquisition is technically based on the tasking performance of the initial tasking period agreed with the customer.

If the customer agrees to extend the tasking period of the on-going observation and their request is not completed by the end of this second period, no new voucher is issued.

OneSeries Critical

OneSeries Critical has been specially designed for the most demanding monitorings with intensive acquisitions and deliveries with very short observation periods up to daily and forced acquisitions over an area. All data is delivered promptly to provide the most up-to-date information on what is happening on the ground.

Cloud Cover	≤ 10% or 100% in case of daily acquisitions.
Acquisition Notification	You are notified of all images acquired.
Acquisition Mode	Mono, Stereo or Tristereo
Incidence Angle	From 0–52°
B/H	From 0.2–0.8 By default: 0.4–0.7 for Stereo 0.2–0.35 between each Tristereo pair
Feasibility	Diagnosis on the probability to collect the AOI in full compliance with the specifications:
Achievable, Challenging, Unachievable	Regular or Premium
Service Level	Premium
Delivery Lead Time	Rush

Acquisition Failure Terms

If one acquisition is missing on the expected day or during the observation period, a 25% voucher shall be granted on the value of the missed acquisition (= full order value/ number of requested observations).

For AOIs covered by multiple images: if one scene is missing, the acquisition is classed as failed and a voucher of 25% of the value of the missed acquisition will be granted.

Any successful images collected are delivered and invoiced as specified in the acknowledgment of order receipt.

If several images are necessary to fully cover the area but one acquisition is missing (bottom left in the example above), the voucher will be calculated on the missing acquisition. All the images acquired that do cover the area will be invoiced.

In case of cloud cover validation, the success/failure criterion of an acquisition is technically based on the tasking performance of the initial tasking period or acquisition frequency agreed with the customer.

If the customer agrees on extending the tasking period of the on-going observation and their request is not completed by the end of this second period, no new voucher is issued.

For daily acquisitions, the success/failure criteria of an acquisition is technically based on the tasking performance (i.e. if the acquisition happened on the planned day).

Multi-period Monitoring

You can plan several acquisitions over the same AOI with your own custom periods. When acquisitions over the area are validated for one period, the tasking request is stopped until the next period starts.

For example:

- Duration of the construction project: three months from 1 September to 30 November
- Monitoring request: three monthly acquisitions

The customer defines three observation periods: 1–20 September, 1–20 October, and 1–20 November. He will receive one image per period = a total of three images.

The customer will have to provide Airbus DS with the following details.

Number of Observations	2–50 upon customer selection.
Observation Periods	Open start and end dates – upon customer selection.

Regular Monitoring

If regularly monitored, the AOI will be covered several times at regular intervals. A dead period between two acquisitions needs to be specified.

For example:

- Duration of the construction project: three months from 1 September to 30 November
- Monitoring request: three monthly acquisitions
- Dead period: 15 days

Let's assume that a total number of three new acquisitions collected from 1 September to 30 November are required, with a minimum of 15 days between two acquisitions.

The customer will have to provide Airbus DS with the necessary details as outlined below.

Number of Observations	Indicates the number of desired observations: 2–50 upon customer selection.
Start and End Dates	Dates on which the monitoring project starts and ends – on customer selection.
Dead Period	Minimum number of days between two validated images: upon customer selection.
Criticality	Discriminates the request according to: • Multi-period: one period is 'critical' if period end to period start ≤ 7 days; alternatively, it is considered as 'routine' • Regular: the series is considered 'critical' if (end date to start date)/ number of observations ≤ 7 days; alternatively, it is considered 'routine'

How to order a series of images over your AOI

First, define the observation periods for your monitoring. Once you have chosen your OneSeries type, Routine or Critical, you select one of two monitoring options: multi-period or regular.

Tasking parameters

The tasking parameters when selecting the OneSeries option include:

- The acquisition mode (Mono, Stereo, Tristereo)

- Any other requirements you might have, such as:

  – A specific cloud cover percentage.

  – For OneSeries Routine (and upon feasibility study), a small cloud-free area (maximum 1 km x 1 km)

  – Specifications for snow, haze, sand wind or any other weather condition

  can be indicated in the blank Comments field on page 6 of the *Pléiades & SPOT Data Request Form*.

- The maximum incidence angle applicable to your monitoring. Depending on if you opted for OneSeries Routine or OneSeries Critical, different values are available.

- The B/H value if Stereo or Tristereo acquisitions are requested; please refer to explanations indicated in th≠e OnePlan option. The optimum B/H is dependent on the relief. If in doubt, our tasking experts will recommend the most adapted values.

- The maximum cloud cover accepted:

  – For OneSeries Routine, like the OnePlan option, the standard value is 10%, whereas other cloud cover values can be selected depending on your needs or location of your area.

  – OneSeries Critical offers cloud cover validation – upon feasibility study – even though observation periods are usually short. If daily acquisitions are required then no cloud cover restriction can be selected.

Step 5: Processing Options

Note: Step 5, N–T, refer to page 6 of the *Pléiades & SPOT Data Request Form* shown opposite and annotated on the next page.

N) Specify the product resolution

- 50 cm Colour

- 50 cm Black and White

- 2 m Colour

O) Specify the spectral bands combination

- Bundle (Panchromatic, 50 cm + Multispectral 4-Band Colour, 2 m): one Panchromatic image + the Multispectral (Blue, Green, Red and Near Infrared) bands delivered separately (not merged)

- Pan-sharpened 3-Band Natural Colour (50 cm): merging the Panchromatic with the Blue, Green and Red bands

- Pan-sharpened 3-Band False Colour (50 cm): merging the Panchromatic with the Green, Red and Near Infrared bands

- Pan-sharpened 4-Band (50 cm): merging the Panchromatic with the full set of colour Blue, Green, Red and Near Infrared bands

- Panchromatic (50 cm): black and white

- Multispectral 4-Band (2 m): full set of colours Blue, Green, Red and Near Infrared bands

(See section *2.2 Spectral Band Combinations* for complete details.)

P) You can also select the geometric processing level

- **Primary:** Sensor image, not georeferenced or map-projected. delivered with RPC file and rigourous model metadata (attitude, ephemeris) allowing geometric processing (orthorecification – DEM extraction).

- **Projected:** Map projected image at a constant altitude (mean). Delivered with RPC file allowing geometric processing (orthorectification – DEM extraction).

  Note that if you place your order online through GeoStore and need a projected level, select 'Elevation' (option only available for the projected processing level).

  By default, the constant average altitude over the AOI is proposed. For the high relief variation, the average value may not be representative. In this case, you can specify your preferred value.

- **Ortho:** Map projected image corrected from off-nadir and relief effects (rectified as nadir position through DEM knowledge) and possibly improved with GCP.

If you require an Ortho level, select the level needed from the following:

- **Standard Ortho:** Automatically processed with the best DEM available.

- **Tailored Ortho:** When DEM and/or GCPs are provided by the customer.

  If you select Tailored Ortho, please indicate your specifications in terms of location accuracy. Before a Tailored Ortho order is accepted, Airbus DS Intelligence must verify that we can obtain the required DEMs and GCPs to make your product or use and ingest the DEM and GCPs you provide to compute your orthorectified product. In the first instance, Airbus DS Intelligence will work to acquire the appropriate support data for your order, as determined by the specifications of the product. Alternatively, we can accept customer provided DEMs and GCPs upon request. DEMs and GCPs must conform to format requirements that are available through our Customer Care Service.

- **Premium Ortho:** Acquisition of stereo or tristereo pairs in order to process a DTM that will be used to orthorectify the Pléiades imagery.

  Note that a maximum viewing angle of 20° is recommended.

See section *2.3 Geometric Processing Levels* for the differences between Primary, Projected and Ortho levels.

See section *2.3.3 Orthoimages* for complete details on Ortho level options.

Q) Specify the projection for your Projected and Ortho products

Universal Transverse Mercator (UTM)/WGS 84 cartographic by default or WGS 84 geographic projection, or most cartographic projections registered by EPSG library. Please refer to *Appendix A.5* for available geographic and cartographic projections.

If you place your order online through GeoStore, please select 'Orthorectification DEM reference' (only for Ortho); By default, the best DEM available is selected to orthorectify your product (Elevation30, SRTM, Globe). Select from:

- Best available

- SRTM

- Globe

'Best available' will select Airbus Elevation30 DEM (DTED2 class) if available, otherwise SRTM DEM (DTED1) or Globe DEM (DTED0). Choosing SRTM or Globe lower resolutions will smooth the orthorectification.

R) Specify the suitable radiometric processing

Basic: Digital numbers from the sensor acquisition (native pixel values after equalisation). This option is mainly for proficient users who are able to process pure/raw data and are familiar with satellite imagery applications and image processing tools, and who need to carry out calibration and their own spectral analysis.

Reflectance: Pixel values radiometrically corrected from sensor calibration and systematic effects of the atmosphere (molecular or 'Rayleigh' diffusion). Image values are provided in reflectance physical values. Especially suitable and ready to use for spectral analysis and most applications based on image processing. Thanks to auxiliary data, users are able to reverse back to sensor count (Basic) or to apply an optimal true colour visual rendering (Display option) neutral for the imagery values themselves.

Display: Image optimised for a direct true colour rendering on the screen. The true colour is properly retrieved from sensor calibration and correction of systematic effects of the atmosphere. For users who need ready-to-use images and high aesthetic display. Perfectly adapted for display applications and direct integration on GIS. For visual analysis and communication purposes, not reversible to spectral values.

See section *2.4 Radiometric Processing Levels* for complete details.

S) Specify the product and image format

Select from:

- DIMAP – JPEG 2000 Optimised
- DIMAP – JPEG 2000 Regular
- DIMAP – GeoTIFF
- NITF – JPEG 2000 Regular
- NITF – GeoTIFF

DIMAP V2 is the default Pléiades product format. Inside that product, you can select an image format:

- JPEG 2000: regular compression (8 bits/pixels), recommended for users willing to do some high precision post-processing.

- JPEG 2000: optimised compression (3.5 bits/pixels), perfect for fast download and easy data sharing.

- GeoTIFF: uncompressed.

NITF 2.1 can also be selected instead of DIMAP V2. NITF is standard for exchanges of geographic data between defence organisations – highly recommended for users who already work regularly with this format.

See section *2.5 Product and Image Format* for further details. Full technical details can be found in *Appendix A.4 Image Format*.

T) Specify the bit depth (pixel depth or pixel coding)

Pixel depth determines the maximum number of colours that can be displayed at one time. The dynamic range of the Pléiades sensor is 12 bits at acquisition.

If you are interested in easy-to-use images for visual interpretation, you should select 8-bit images. In an 8-bit image, each pixel is represented by 256 shades of gray per band. If you are interested in the full dynamic range, you should select the 12-bit option where each pixel is represented by 4,096 shades of gray, which provides more information to discern subtle feature differences. Some older software versions cannot manage 12 bits. Contact your software provider or our Technical Support for more details (**CustomerTechnicalSupport@spotimage.fr**).

The Pléiades products are available as either:

- JPEG 2000: 8 bits or 12 bits depth per pixel

- GeoTIFF: 8 bits or 16 bits (only the 12-bit depth is used) per pixel

N	Product resolution
O	Spectral bands combination
P	Geometric processing level
Q	Projection (only for projected and ortho product levels)
	If 'Other', please specify
R	Radiometric processing level
S	Product and image format
T	Bit depth
	Comments

Figure 3.2.2h: Extract from page 6 of the Pléiades & SPOT Data Request Form featuring Processing Options

Bit depth selection according to the radiometric processing level previously selected:

Radiometric processing level	JPEG2000	GeoTIFF
Basic	8 or 12 bits	8 or 16 bits
Reflectance	Pixel values are scaled with a factor of 10,000 (i.e. 10,000 corresponds to a reflectance of 1), therefore only the JPEG 2000/GeoTIFF 16-bit coding is available.	
Display	We highly recommend that you choose the 8-bit coding, either JPEG 2000 or GeoTIFF.	

When you select 8-bit image, a **linear adjustment** is necessary to range the original 4096 shade scale into a 256 shade scale. As the 8-bit image is intended for users who do not have the software tools to custom stretch imagery on native 12-bit imagery, the 8-bit linear adjustment should be done with a linear stretch adjustment, possibly with a luminosity enhancement.

We recommend you select Auto to let the system enhance the image luminosity. If None is selected, no luminosity enhancement is applied, preserving any addition of saturation. The level of shade might decrease with 8-bit images, this product is not recommended for users intending to perform scientific analysis or spectral classification, as the pixel values of the original data cannot be accurately recovered from the 8-bit dynamically adjusted product. The 12-bit image maintains absolute radiometric accuracy and full dynamic range. No linear adjustment will be performed prior to delivery.

Figure 3.2.2i: Example of an 8-bit product without linear adjustment (top) and with linear adjustment (bottom).

If you have any questions about any of the parameters, please contact our Customer Care Service.

Step 6 – Feasibility Study and Order Confirmation

Once you have submitted your order, you will be contacted by a member of our customer care team within the day or you will receive an automatic order confirmation, immediately after you place your order online.

When a new tasking order is submitted online, and the automatic diagnosis is achievable, then the tasking is activated automatically and your data is automatically delivered after acquisition.

When new tasking is requested through our Customer Service, our tasking experts will study the feasibility of your request and propose the best tasking parameters that will allow Pléiades satellites to collect your area on time and within the requested specifications.

For further details on tasking feasibility studies, please refer to section *2.1.2.4 Feasibility Study*.

3.3 Order Cancellation, Order Modification, Terms and Conditions

Please refer to our General Supply Conditions of Satellite Imagery Products on our website.

4. Product delivery

4.1 Order Completion and Delivery

Once an order is confirmed, users can begin requesting information about the progress of their requests either by logging on to the order management page of GeoStore (www.intelligence-airbusds.com/geostore), or through our Customer Care Service.

On the GeoStore, users can track all completed orders, sort and/or filter them by country, date, amount, enduser, order ID and order status. This list may be exported to an Excel file to ensure easy compatibility with the Information System of your organization.
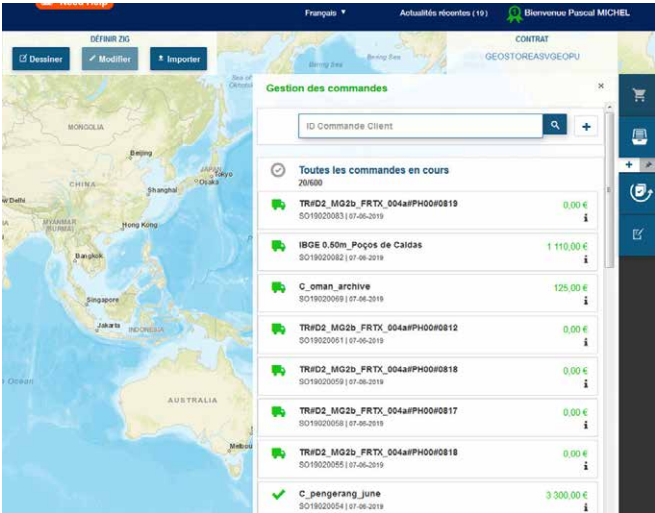
Figure 4.1a: GeoStore order management page – list view

You may also view the AOI, quicklooks and footprints of each order on the map. Users are also able to track and follow tasking requests online, including seeing all completed attempts and personally validating attempts based on quicklooks.
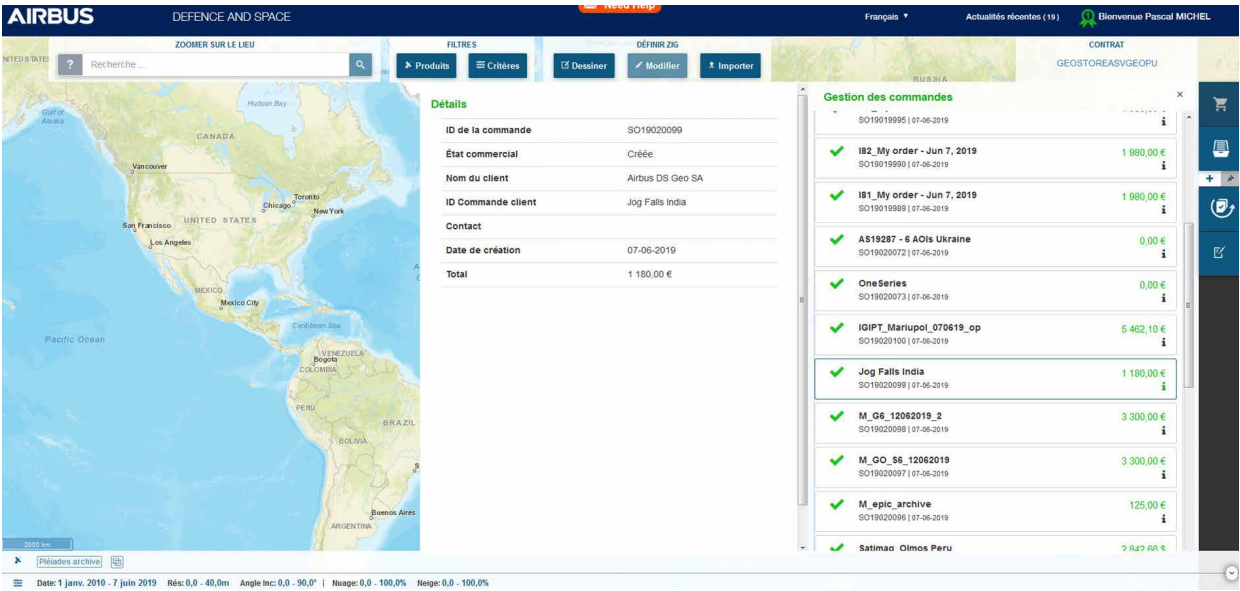
Figure 4.1b: GeoStore order management page – map view

After Airbus Defence and Space has successfully collected all of the appropriate data, we will process and deliver orders. The table below describes the estimated processing timelines based on the combination of the product and order parameters chosen.

Description	Standard	Rush
Primary, Standard Ortho, any spectral band combination – source segment data available in Toulouse storage or Kiruna	24 hours	12 hours during working days, JPEG 2000 or GeoTIFF, FTP delivery only
Primary, Standard Ortho, any spectral band combination – source segment data available in a Partner's Direct Receiving Station	Please contact our Customer Care Department	N.A.
Tailored product	Ad hoc estimate provided with the quotation	N.A.

Table 4.1: Delivery time

Processing timelines for all Tailored Ortho products do not begin until all imagery is collected and all the necessary support data (DEMs and GCPs) are received. The timeframe to obtain DEMs and GCPs depends on the geographic location of the area of interest. Large orders may require additional processing time.

Depending on the delivery method selected, the order will either be posted to an FTP site or shipped. Please contact our Customer Care Service at any time during the order process for further information or to check on the status of your order.

4.2 Deliverable

There are various delivery methods to choose from: FTP, DVD, Hard Drive, or Flash Drive.

Product Size

The product size depends on the area size, spectral mode, resolution, format, and image compression. The table below illustrates an example for a 1.5-m, Pan-sharpened 4-band, 3,600 sq.km product.

JPEG 2000	GeoTIFF
Bit-Depth 12 bits • Optimized: 2.6 GB • Regular: 6 GB (max)	Bit-Depth 12 bits (storage 16 bits) • 12 GB
Bit-Depth 8 bits • Optimized: 2.6 GB • Regular: 6 GB (max)	Bit-Depth 8 bits • 6 GB

Table 4.2a: Examples of file size

For 12-bit products, a JPEG 2000 file is two times smaller with a Regular compression, and around five times smaller with an Optimized compression, than the same product delivered as a GeoTIFF.

➔ *JPEG 2000 12-bits vs. GeoTIFF 16-bits: the image features the same dynamic and the same quality, but the file size is much smaller.*

Theoretically, for JPEG 2000, file sizes are the same for 8 and 12 bits in Optimized and Regular compression. This is related to the fact that the JPEG 2000 compression process determines a targeted bitrate (3.5 bits/pixel for Optimized compression, 8 bits/pixel for Regular), which can be directly linked to a target file size, whether the dynamic range is 8 or 12 bits.

➔ *JPEG 2000 12-bits vs. JPEG 2000 8-bits: the image features a larger dynamic, but the file size is almost the same.*

Image Files

The product contains one image file (regardless of tiling) for each spectral mode, containing one or several bands:

Band Combination products	Image files (*)	Number of band
Panchromatic (Black and White, 1.5m)	1	1
Pan-sharpened 3-Band (Natural Color, 1.5m)	1	3
Pan-sharpened 3-Band (False Color, 1.5m)	1	3
Pan-sharpened 4-Band (Color, 1.5m)	1	4
Multispectral 4-Band (Color, 6m)	1	4
Bundle (Panchromatic, 1.5m + 4-Band Color, 6m)	1+1	1+4

(*) Regardless of tiling
Table 4.2b: number of image files and of bands per product type

Image Tiling

Products exceeding a certain size limit are broken up into smaller pieces called "tiles" constituting the whole product. Each tile can be opened separately.

*Figure 4.2: Product tiling*If a product is not tiled, the file name is: 'product_R1C1.JP2'

```
IMG_SPOT6_P_201210250959306_SEN_605179101_R1C1.JP2
IMG_SPOT6_P_201210250959306_SEN_605179101_R1C2.JP2
IMG_SPOT6_P_201210250959306_SEN_605179101_R1C3.JP2
IMG_SPOT6_P_201210250959306_SEN_605179101_R2C1.JP2
IMG_SPOT6_P_201210250959306_SEN_605179101_R2C2.JP2
IMG_SPOT6_P_201210250959306_SEN_605179101_R2C3.JP2
```

If a product is tiled, there are as many image files as tiles, named 'Product_RiCi.JP2'.

A ESRI worldfile J2W (or TFW for GEOTIFF products) is associated to each image tile (tile assembling for Primary products or georeferencing for Ortho products)

```
IMG_SPOT6_P_201210250959306_SEN_605179101_R1C1.J2W
IMG_SPOT6_P_201210250959306_SEN_605179101_R1C2.J2W
IMG_SPOT6_P_201210250959306_SEN_605179101_R1C3.J2W
IMG_SPOT6_P_201210250959306_SEN_605179101_R2C1.J2W
IMG_SPOT6_P_201210250959306_SEN_605179101_R2C2.J2W
IMG_SPOT6_P_201210250959306_SEN_605179101_R2C3.J2W
```

All other metadata (RPC XML and DIM XML) are not tiled and are applicable to the whole product.

Since the product size depends on the image format, the same product will be cut into more tiles in GeoTIFF than in JPEG 2000. For example, for one Pan-sharpened, 4-band, 3,600 sq.km product, a JPEG 2000 12-bit (Optimized) product will be 2.6 GB: no tiling is needed. A GeoTIFF 12-bit product will be approximately 12 GB, with 6 image tiles.

4.2.1 Overview of the Product

SPOT 6 and SPOT 7 products are delivered in DIMAP V2 format.
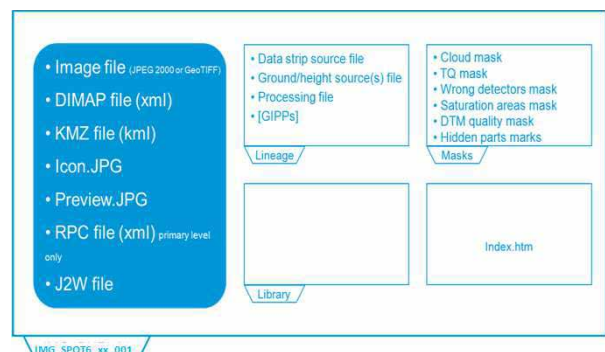
Figure 4.2.1: DIMAP v2 structure

4.2.2 Example
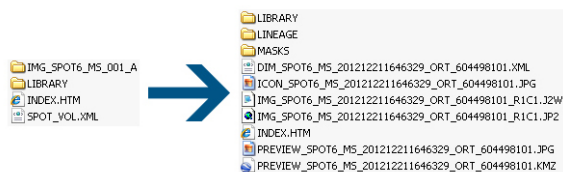
Figure 4.2.2a: example of dimap v2 structure

Delivery File

A delivery file in pdf format will provide general technical information of the product such as: acquisition angles, band information, coordinate system, and histograms.

Image File / KMZ (PREVIEW_...KMZ)

This file gives a visual and easy-to-use overview of the products. You can open it from Google Earth and:
- Preview the footprints:

Figure 4.2.2b: kmz preview, footprint

- Click on different objects to get more information:

Figure 4.2.2c: kmz preview, bubble

The file contains several information layers which can be displayed or hidden:
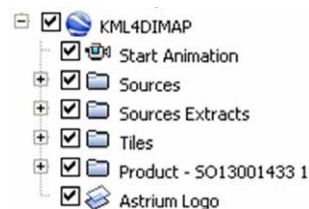
Figure 4.2.2d: kmz preview, layers

Start animation: By double-clicking on this layer, you zoom on the product.

Sources: This layer displays the entire footprint and information (date) of the source strip, necessary for the production of the product.

Sources Extracts: This layer provides the footprint of the source strip swath, intersecting with the area of interest.

Tiles: This layer shows the footprint and information (name, Volume ID) of each tile contained in the product.

Product: This layer gives the footprint, information (name, mode, angle …), and preview of the whole product.

Image File / Main Metadata File (DIM_...XML)

The file contains all the product metadata needed for image processing.

Top level information can be found by opening it in a web browser like Internet Explorer or Mozilla Firefox: product description, quicklook, coordinate system …

More information can be found by opening it with a text editor like WordPad: find all data related to the image acquisition, processing parameters, etc. Examples:
- Radiometric values: gain and offset to radiance count:

      <GAIN>9.9225</GAIN>
      <BIAS>0</BIAS>

- Geometric values: Acquisition angles :

      <AZIMUTH_ANGLE>61.4816816459</AZIMUTH_ANGLE>
      <VIEWING_ANGLE_ACROSS_TRACK>-5.24525959689
      </VIEWING_ANGLE_ACROSS_TRACK>
      <VIEWING_ANGLE_ALONG_TRACK>4.68608489805
      </VIEWING_ANGLE_ALONG_TRACK>
      <VIEWING_ANGLE>7.01737330178</VIEWING_ANGLE>
      <INCIDENCE_ANGLE_ALONG_TRACK>-3.81165895086
      </INCIDENCE_ANGLE_ALONG_TRACK>
      <INCIDENCE_ANGLE_ACROSS_TRACK>6.8246901863
      </INCIDENCE_ANGLE_ACROSS_TRACK>
      <INCIDENCE_ANGLE>7.70697203876</INCIDENCE_ANGLE>

RPC File (RPC_...XML)

This file allows users to do geometric processing (orthorectification, DEM extraction) easily with software that supports RPC models.

J2W or TFW File (IMG_...J2W)

This file (worldfile) allows software to georeference Ortho images or to assembly tiles for Primary products.

Please refer to part APPENDIX A:for a complete DIMAP V2 description.

4.3 How to Open Your Product

To open a SPOT 6 or SPOT 7 product and access the image coordinates and metadata, it is possible to use a GIS or image processing software. Most commercial off-the-shelf software is able to read, georeference and process (orthorectify, etc.) SPOT 6 and SPOT 7 products. The various software packages use different methods to georeference SPOT 6 and SPOT 7 products. Georeferencing is achieved by reading:

a. The GMLJP2 header*, J2W worldfile*, or XML metadata file for products in JPEG 2000

b. The GEOTIFF header*, TFW worldfile*, or XML metadata file for products in GeoTIFF

(*) Not applicable for Primary products, use XML or RPC metadata files.

For any question regarding image processing software and versions able to integrate SPOT 6 and SPOT 7 products feel free to contact the technical support at **technicalsupport@intelligence-airbusds.com.**

4.4 Technical Support and Claims

No matter whether you are looking for specific metadata, need to know how to use the RPC file, have questions about the format you need, think your image does not look right, cannot open the file, or anything else, we are here to help. For any question, advice or problem, please contact your Customer Care representative or the Technical Support Team: **technicalsupport@intelligence-airbusds.com.** They will give you information about products, format,

Appendix A: File Format – DIMAP V2

The following physical format applies to Primary and Ortho products. For Tailored Ortho products, the physical format is shared with other sensors and is based on the standard described hereafter.

- a prefix
- a suffix (possibly)
- a variable string composed of key information contained in the DIMAP V2 metadata file
- a file extension

A.1 File and Folder Naming

A.1.1 Naming Conventions

Names provide concise information about the product and its context. The naming is composed of:

A.1.1.1 Fixe Names

The prefixes are as shown in the table below:

Prefix	Folder	File	Subject	Remark
PROD_	X		Encapsulation directory of all acquisitions of a same pass	One to three linked acquisitions of a same pass
VOL_	X		Single acquisition directory (volume)	One per acquisition
IMG_	X	X	Single imagery directory, or image file(s), or associated georeferencing file(s)	Folder: One per spectral imagery
DIM_		X	DIMAP, main product metadata file	
RPC_		X	DIMAP, RPC metadata file	Primary Product only
PREVIEW_		X	Quicklook raster file, or associated KMZ file	
ICON_		X	Thumbnail raster file	
STRIP_		X	DIMAP, Data Strip Source metadata file	One per Data Strip Source
GROUND_		X	DIMAP, Ground Source metadata file	If Ground reset at Ortho level, one per source
HEIGHT_		X	DIMAP, Height Source metadata file	If Vertical reset, one per source
PROCESSING_		X	DIMAP, processing lineage file	
CLD_		X	Cloud vector mask	
QTE_		X	Synthetic QT vector mask	
ROI_		X	Region of Interest vector mask	
SNW_		X	Snow vector mask	
DET_		X	Out of order detectors vector mask	
VIS_		X	Hidden part vector mask	Ortho only
SLT_		X	Straylight and saturation vector mask	Optional
DTM_		X	DTM quality vector mask	(optional)

Table A.1a: Naming - prefixes

The suffixes are:

Suffix	Folder	File	Subject	Remark
_LIST		X	Dataset packaging index file	
_PROD	X	X	Index file of products related to acquisitions of a same pass	
_VOL		X	Index file of products related to a single acquisition	
_DIM		X	Various DIMAP metadata files (different from the main product metadata file)	
_RiCj		X	Image product file, possibly tiled	ij, Row (R) and Col (C) tile indexes
_MSK		X	Mask, raster or vector	Vector, GML format

Table A.1b: Naming - suffixes

The following files/directories have fixed naming:

Names	Folder	File	Subject	Remark
DELIVERY		X	Delivery note	
LINEAGE	X		Directory for source information	
MASKS	X		Directory for mask information	
LIBRARY	X		Directory for files activated by the XML Style Sheet	
LOGO		X	Logo file	

Table A.1c: Naming - main directories

The file extensions are:

Extension	File	Subject	Remark
.GML	X	GML vector files	Mask file
.HTM	X	HTML file	
.JPG	X	JPEG raster file	Thumbnail and quicklook files
.JP2	X	JPEG 2000 raster file(s)	Image file(s)
.J2W	X	ESRI World file(s) for JPEG 2000	Simple assembling/georeferencing file(s)
.KMZ		KML file (archived in zip format)	Preview file
.PDF	X	PDF file	Delivery file
.TIF	X	TIFF/GeoTIFF raster file(s)	Image file(s)
.TFW	X	ESRI World file(s) for TIFF/GeoTIFF	Simple georeferencing file(s)
.XML	X	DIMAP file encoding in XML or simple XML file	Metadata files
.XSL	X	XML Style Sheet file	

Table A.1d: Naming - extensions

A.1.1.2 Variable Key Information

The naming convention uses key information contained in the DIMAP product metadata file.

The product directory name is comprised of:

<DirImage_ID>

POT<SAT_NUMBER>_<SPECTRAL_ PROCESSING>_<PROD_ID>_<VOL_ID>

Example: **SPOT6_PMS_001_A**

Where:

<SAT_NUMBER> = {6, 7}, SPOT 6 or SPOT 7
<SPECTRAL_PROCESSING> = {P, MS, PMS, MS-N, MS-X, PMS-N, PMS-X}

SPECTRAL_ PROCESSING	Spectral Mode
P	Panchromatic
MS	Multispectral 4 bands
PMS	Pan-sharpened 4 bands
PMS-N	Pan-sharpened 3 bands (B, G, R bands)
PMS-X	Pan-sharpened 3 bands (G, R, NIR bands, False colour)

Table A.1e: Naming – spectral processing

<PROD_ID> = {001, 002, 003}, single acquisition index (PROD_SPOTx_PROD_ID). Format is three digits increased by one
<VOL_ID> = {A, B}, single imagery index (VOL_SPOTx_ PROD_ID_VOL_ID). Format is one letter increased by one

The product name for Primary and Ortho files is comprised of:

<Product_ID>

SPOT<SAT_NUMBER>_<SPECTRAL_ PROCESSING>_<IMAGING_TIME>_<PROCESS_ LEVEL>_<JOB_ID>
Example: **SPOT6_PMS_201006181052299_ ORT_123456789**

Where:
<SAT_NUMBER> = see previous section
<SPECTRAL_PROCESSING> = see previous section
<IMAGING_TIME> = UTC strip source acquisition start time. Format = "YYYYMMDDHHMMSSS"
<PROCESS_LEVEL> = {SEN, ORT}

PROCESS_LEVEL	Product
SEN	Primary (abbreviation for SENSOR)
ORT	Ortho, single image

Table A.1f: Naming – processing levels

<JOB_ID> = Internal production identifier. Format = variable string

Name(s) of SPOT 6/7 Data Strip Source metadata file(s) is comprised of:

<DATA_STRIP_ID>

DS_POT<n>_<YYYYMMDDHHMMSSS>_ <AAA>_<aaa>_<RRR>_<rrr>_<XxxxYyy>_<TTTTT>
Example: **STRIP_DS_SPOT6_201212051035424_ FR1_FR1_FR1_FR1_E002N41_01174**

Where:<n> = satellite number {6, 7}
<YYYYMMDDHHMMSSS> = UTC strip source acquisition start time
<AAA> = effective archiving center acronym
<aaa> = planned archiving center acronym
<RRR> = effective receiving center acronym
<rrr> = planned receiving center acronym
<XxxxYyy> = closest square degree of the strip center with:
    X = {W,E}, West or East, xxx longitude degree (000 to 180)
    Y = {N,S}, North or South, yy latitude degree (00 to 90)
<TTTTT> = Number of PAN source frames

Name(s) of Height Source metadata file(s) for an Ortho produced with a standard DEM is comprised of:

<DEM_Source_ID>

- For Reference3D DTED2 DEM layer (one arc second):
  <DEM_Source_ID> = R3D_DT2_<Tile_ID>

  Example: R3D_DT2_N44E001

  Where:

  <Tile_ID> = one-square-degree tile South-West corner geographic coordinates in degrees {N|S}xx{E|W}yyy

- For SRTM1 DEM Source (nine arc seconds):
  <DEM_Source_ID> = SRTM_DT1

  Example: SRTM_DT1

- For Global DEM Source (thirty arc seconds):
  <DEM_Source_ID> = GLOBE

  Example: GLOBE

Name(s) of Ground Source metadata file(s), for an Ortho reset on standard ground source is comprised of:

<OR_Source_ID>

- For the Reference3D Ortho layer Source (one sixth of an arc second)
  <OR_Source_ID> = R3D_OR_<Ref3D_Tile_ID>
  Example: R3D_OR_N44E001

  Where:
  <OR_Source_ID> = one-square-degree tile South-West corner geographic coordinates in degrees {N|S}xx{E|W}yyy

A.1.2 Tree Structure

The complete layout is as follow:

Primary, Ortho Imagery

SPOT_LIST.XML	Root packaging layout level
INDEX.HTM	
DELIVERY.PDF	
📁 LIBRARY	
📁 IPROD_SPOTx_*<PROD_ID>* [1:n]	pass level (n=1)
SPOT_PROD.XML	
INDEX.HTM	
📁 LIBRARY	
📁 VOL_SPOT*x_<PROD_ID>_<VOL_ID>* [1:3]	acquisition level
*<MISSION>*_VOL.XML [1:1]	
INDEX.HTM [1:1]	
📁 LIBRARY	
📁 IMG_<DirImage_ID> [1:2]	spectral imagery level
INDEX.HTM	
DIM_<Product_ID>.XML [1:1]	
📁 LINEAGE	
📁 MASKS	
📁 LIBRARY	
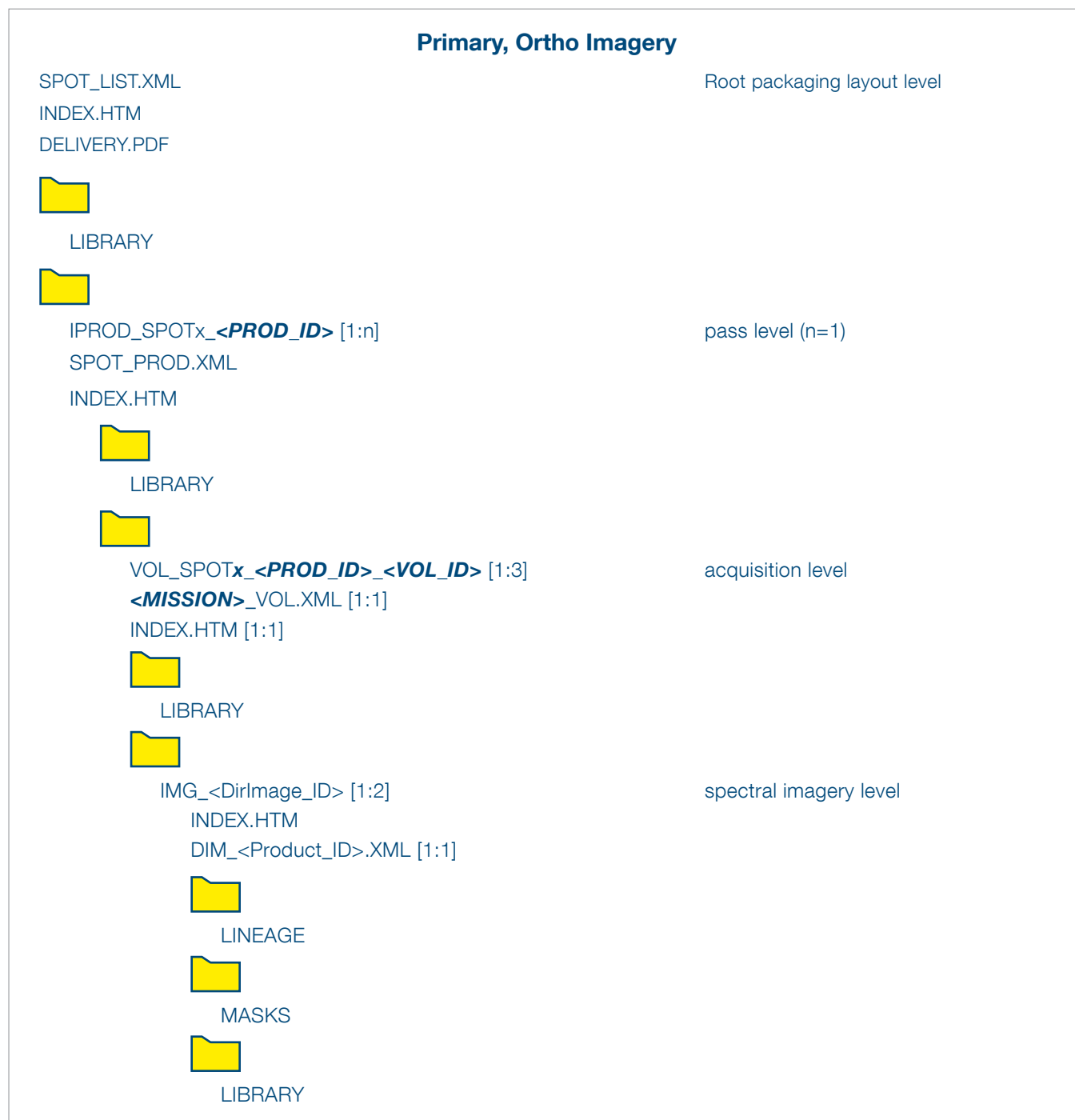
The layout is the same for all kinds of deliveries, physical delivery (DVD, Hard Drive or Flash Drive) or electronic delivery via FTP.

A.1.2.1 The packaging layout

The packaging layout allows collecting several acquisitions of a same pass in a single delivery:

- One acquisition for Panchromatic, Multispectral, Pan-Sharpened or bundle for for single orders
- Two acquisitions or three acquisitions for stereo pair or stereo triplet orders

	PROD directory	VOL directory	IMG directory
One Panchromatic	1	1	1
One Multispectral	1	1	1
One Pan-sharpenend	1	1	1
One Bundle	1	1	2
One stereo pair	1	2	2 or 4 (bundle case)
One stereo triplet	1	3	3 or 6 (bundle case)

Depending of the ordering system, stereo pair and stereo triplet should also be packaged separately.

The case of acquisitions of different passes (meaning several PROD directories) is not provided in standard delivery.

A.1.2.2 The imagery layout

The delivery tree layout is a typical DIMAP product data structure, with three hierarchic levels of information:

- A root level index
- An spectral imagery level (1 to 2)
- Inside an imagery level, a set of sub-levels with additional information like striping masks

The usual file structure is as follows (primary and ortho products):

Primary and Ortho products

VOL_**<MISSION>**.XML [1:1]
INDEX.HTM [1:1]

📁 LIBRARY
  VOL_LOGO.JPG
  VOL_STYLE.XSL

📁 IMG_**<DirImage_ID>** [1:2]
  INDEX.HTM
  DIM_**<Product_ID>.XML** [1:1]
  RPC_**<Product_ID>.XML** [0:1]   for Primary Product only
  PREVIEW_**<Product_ID>**.KMZ [1:1]
  PREVIEW_**<Product_ID>**.JPG [1:1]
  ICON_**<Product_ID>**.JPG [1:1]
  IMG_**<Product_ID>**_RiCj.{JP2, TIF} [1:n]   n if image is physically tiled
  IMG_**<Product_ID>**_ RiCj.{J2W,TFW} [1:n]   n if image is physically tiled

  📁 LINEAGE [1:1]
    PROCESSING_**<Product_ID>**_DIM.XML [1:1]
    STRIP_**<DATA_STRIP_ID>**_DIM.XML [1:1]
    GROUND_**R3D_OR_<Ref3D_Tile_ID>**_DIM.XML [0:n]   if ground reset
    HEIGHT_**R3D_DT2_<Ref3D_Tile_ID>**_DIM.XML [0:n] nor
    HEIGHT_**SRTM_DT1**_DIM.XML [0:n]   nor
    HEIGHT_**GLOBE**_DIM.XML [0:n]   if vertical reset

  📁 MASKS [1:1]
    CLD_**<Product_ID>**_MSK.GML [1:1]
    DET_**<Product_ID>**_MSK.GML [1:1]
    DTM_**<Product_ID>**_MSK.GML [0:1]   for ortho product only
    QTE_**<Product_ID>**_MSK.GML [1:1]
    ROI_**<Product_ID>**_MSK.GML [1:1]
    SLT_**<Product_ID>**_MSK.GML [1:1]
    SNW_**<Product_ID>**_MSK.GML [1:1]
    VIS_**<Product_ID>**_MSK.GML [0:1]   for ortho product only

  📁 LIBRARY
    LOGO.JPG
    STYLE.XSL

For products delivered in TIFF/GeoTIFF format instead of JPEG 2000 format, file extensions TIF and TF replace file extensions JP2 and J2W

A.1.2.3 Product Delivered on a physical Media

The type of media for physical delivery (DVD, Blue-ray, USB, Hard Disk Drive) is selected according to the product size.

A.2 Levels of Information and File Short Contents

File name	Standard Products	
	Primary	Ortho
XML Dataset Index File	Y	Y
HTML Dataset Index File	Y	Y
Delivery File	Y	Y
XML Index File	Y	N
HTML Index File	Y	Y
XML Index File	Y	Y
HTML Index File	Y	Y
Product File	Y	Y
RPC File	Y	N
World File	Y	Y
KMZ Fil	Y	Y
Preview File	Y	Y
Thumbnail File	Y	Y
Data Strip Source File	Y	Y
Ground Source File	N	If set
Height Source File	N	Y
Processing File	Y	Y
Mask File	Y	Y

Table A.2a: Overview of available information vs. Processing levels

A.2.1 The Dataset Packaging Root Level

The root level provides information on all products collected by the delivery order. The delivery may be stored on one or several media. The delivery contains one or several products. Each is a component of the full delivery.

A.2.1.1 Dataset Index Metadata File

SPOT_LIST.XML: file encoding = XML, metadata format = DIMAP V2

The Dataset Index metadata file, lists all components of the delivery order (i.e. all unitary products on the media): the access path to next level index metadata files.

Using Web tools supporting XLST, the integrated XSL style sheet allows the main information and product navigation to be displayed. The display is activated with the file itself or through the INDEX.HTM file.

A.2.1.2 Delivery File

DELIVERY.PDF: format = PDF

The delivery PDF file is easier to print than the XML/HTML files. It gathers significant information from the index, product metadata files and imagery files. The order and processing identifications are summarized in the headings. Like the index metadata file, the first page gives an overview of the media content.

The content provides, for each imagery, a selection of information, and possibly for standard products, the histograms of each spectral band and quicklook.

A.2.2 The Pass Acquisitions Level

The Pass Acquisition level encapsulated all imagery acquired in a same pass. The delivery contains one or several spectral products. Each is a component of the full delivery.

A.2.2.1 Index Acquisition Pass Metadata File

SPOT_PROD.XML: file encoding = XML, metadata format = DIMAP V2

This index file is a subset of the Dataset index file, limited of all acquisitions of a same pass: mono acquisition (Bundle or one of PAN or MS or Pan-sharpened) or stereo pair or stereo triplet.

A.2.3 The Acquisition Level

A.2.3.1 Index Acquisition Metadata File

VOL_<MISSION>.XML: file encoding = XML, metadata format = DIMAP V2

The Index Acquisition metadata file, or Volume file, lists all components of a single acquisition (i.e. all unitary products on the medium): the access path to spectral product metadata files and associated thumbnail images.

Using Web tools supporting XLST, the integrated XSL style sheet allows the main information and product navigation to be displayed. The display is activated with the file itself or through the INDEX.HTM file.

A.2.4 The Spectral Imagery Product Level

IMG_<DirImage_ID>

The product directory contains the spectral product itself and the associated discovery files.

A.2.4.1 Product Metadata File

DIM_<Product_ID>.XML: file encoding = XML, metadata format = DIMAP V2

The product metadata file provides, in detail, the product information consistent with its final processing level. It also provides links to all files incorporated into the product: image, lineage files, and mask files.

The information is organized by groups of DIMAP metadata, with the following:

Metadata_Identification	Metadata format and language identification.
Dataset_Identification	Brief text and a visual representation of the dataset. This informationis mainly provided for dataset search and discovery purposes. Rights and constraints to access and use.
Dataset_Content	Localization of the dataset and geometric extent: each vertex located using the rigorous model of the image at the elevation values given by the system DEM (possibly coarse)User should use this information for cataloging purposes and not for accurate positioning. Links to the main files encapsulated into the current dataset (component).
Product_Information	Responsible party of the product: contact, order, and delivery information.
Coordinate_Reference_System	Coordinate Reference System (CRS) into which the data will be related. The DIMAP CRS scheme is based on the industrial standard. EPSG. It includes five single entities: • Projected: map projection, horizontal plane usually Cartesian coordinates in linear unit • Geodetic: Earth mapping based on a geographic (angular unit) or geocentric shape of the Earth • Vertical: CRS used for gravity-related (geoid) height or depth data • Temporal: CRS used for recording time data • ECI: CRS used for recording Earth-Centered Inertial data Projected and geodetic are the common ones for image mapping. • Conventionally, Primary image are recorded with WGS84 geodetic CRS CRS are recorded to EPSG registry if known. Subsequent parameters are only given if no identifier is found in the registry (commonly known as a "user-defined" definition).
Geoposition	Easiest relationship between the dataset coordinates and the CRS coordinates: • Georectified data (Ortho): insertion point and dimension • Raw image (Primary): link to RPC analytic model
Processing_Information	Information on production facility, level of processing, processing settings: geometric, radiometric, sampling, MTF.
Raster_Data	Raster file path(s) and tiling size organization, encoding and displaying.
Radiometric_Data	Radiometric information, how to set the image count (pixel values) to radiometer measurement: dynamic range, radiometric adjustment performed on data, histogram, radiometric calibration values as spectral range, radiance, solar irradiance.

Geometric_Data	Geometric information: • Raw image (Primary): data for rigorous sensor model (acquisition time and date, ephemeris, attitudes, and geometric calibration of the instrument). This data is consistent with the inner image geometry and self-contained for the user processing (any data in other files is required, please refer to Technical Appendix) • Pre-computed useful geometric location data at fixed posting in the image: acquisition angles, solar incidence, ground sample distances
Quality_Assessment	Quality information. Should be: • Planimetric accuracy (Ortho Product) • Vertical accuracy (DEM product) • Link to various data giving quality information: lineage masks
Dataset_Sources	Original data identification from which the current dataset was made and a link to the corresponding lineage metadata file(s).

Table A.2b: Metadata organization

Using Web tools supporting XLST, the integrated XSL style sheet allows the main information and product navigation information to be displayed. The display is activated with the file itself or through the INDEX.HTM file.

A.2.4.2 RPC Metadata File

RPC_<Product_ID>.XML: file encoding = XML, metadata format = DIMAP V2 (NITF V2.1 naming)

The RPC file contains the coefficients and normalization parameters for the Rational Polynomial Coefficients (also called Rapid Positional Capability, Rational Function Model) geometric analytic model. This file is only given for images supporting a sensor geometry (Primary product).

The metadata names are those specified by the Controlled Extension (CE) of NITF V2.1 (direct model). The coefficients are arranged in the RPC00B order.

The RPC file provided the following functions:
• Direct analytic model (Image Ground)
• Inverse analytic model (Ground Image)

Each function is estimated for the whole image (Global).RPC is a generalized analytic model independent of the sensor data handling by the most current software. Users needing the highest level of accuracy (estimation greater than 3rd degree polynomial, block adjustment...) should prefer the rigorous sensor model.

The specific metadata are in the following DIMAP groups:

Direct_ Model	Rational function polynomial coefficients from image to ground.
Inverse_ Model	Rational function polynomial coefficients from ground to image.
Global_ RFM	Global model defining the best fit model to the whole dataset, as delimited by the RFM validity.

Table A.2c: RPC metadata file

A.2.4.3 World File

IMG_<Product_ID>_RiCj.J2W/TFW: file encoding = ASCII, metadata format = ESRI

ESRI World File is a popular way for geographic information systems to reference the image in the image Ground Coordinate Reference System (CRS). For details, users can refer to ESRI ArcGIS documentation. (See help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#//009t00000028000000.htm or refer to the georeferencing section A.6).

The J2W is the file extension of JPEG 2000 raster format. The TFW is the file extension of (Geo)TIFF raster format.

For Primary products the World File is adapted to assemble raster tile files, if any. At this level World File has no ability to georeference the image (sensor geometry), please use XML metadata files (Dimap or RPC).

A.2.4.4 KMZ File

PREVIEW_<Product_ID>.KMZ: file encoding = ZIP, metadata format = KML V2.2

The KML fulfills the KML specification with the Google extension namespace. The Google extension is selected for advanced objects in KML. As specified by the OGC, these specific tags must be ignored by a KML parser based on the standard version V2.2.

The KML file is zipped with the associated PREVIEW image into a KMZ file for independent distribution such as e-mail or web server.

The KML file is composed of six layers of features displayed or selected by double-clicking on the viewer. The places panel may be helpful to arrange hierarchically or expand the features. These layers provide a preview of features positioning. The associated place marks are textual information brought into DIMAP and GML mask files.

Meanwhile the content would be unified with Pléiades, the current different layer contents are the following:

| Start Animation	A quick animation activated by double-clicking on the layer from the satellite to the dataset footprint (Viewer supporting Google extension).
Sources	The acquisition extent of source strip(s) and acquisition scan line positioning at the middle of the extract for the current product.
Sources Extracts	The outline extract(s) performed by the data production system for the current product. Could be ignored and turned-off by end user (will be simplified, current is one feature = one subswath per band).
Tiles	The footprint of each image tile.
Product	The footprint of the whole product (produced polygon from the ordered polygon) and its PREVIEW image.
Logos Layer	

Table A.2d: KML Metadata File
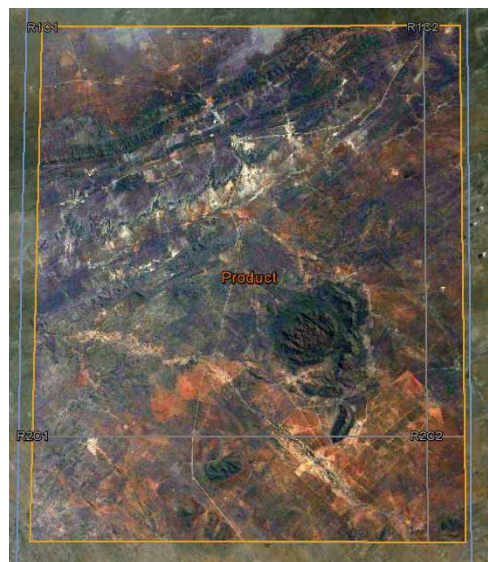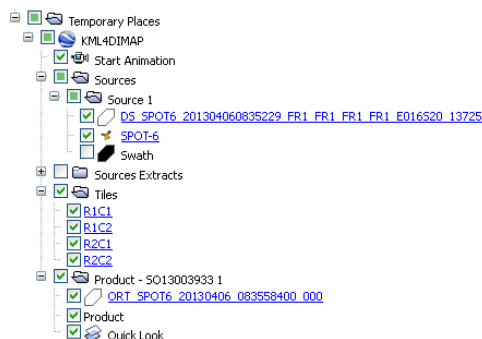
Figure A.2.4.4: kmz overview

Note: KML figures are provided for preview or discovering purposes only. For exact positioning, please refer to the metadata information. The reason is KML features are not necessary located at the true Ground Surface, but positioning with the following estimated positioning:

- Sources - the source strip extent(s), vertex positions using the rigorous model of the image with a possibly coarse DEM.

- Source extracts - the outline extract(s), vertex positions using the rigorous model of the raw strip with a possibly coarse DEM.

- Tiles - the footprint of each tile is positioned:

  - For Primary products, at the elevation values given at each vertex by the system DEM (possibly coarse).
  - For Ortho products, at Ground surface, according to planimetric accuracy of the product.

- Product - the footprint of the product is positioned:

  - For Primary products, using the rigorous model of the image at the elevation values given at

  each vertex by the system DEM (possibly coarse).

  - For Ortho products, at Ground surface, according to planimetric accuracy of the product.

For products with a significant acquisition angle and/or on significant relief, some misalignments between KML features may occur, especially with Primary products. In Google Earth, we recommend to deactivate the "Show terrain" option to avoid incorrect mapping.

A.2.4.5 Preview Raster File

PREVIEW_<Product_ID>.JPG: file format = JPEG

The sub-sampled image (also called a quicklook), is compressed. The PREVIEW image is sub-scaled from the full resolution image to fit a fixed size of nearly 1000 columns.

> *i* **A radiometric enhancement is planned before end of 2013**

A.2.4.6 Thumbnail Raster File

ICON_<Product_ID>.JPG: file format = JPEG

This is the thumbnail of the image. The ICON image is sub-scaled from the PREVIEW image to fit a fixed size of nearly 128 columns.

A.2.5 Sub-Levels With Additional Information

A.2.5.1 The Lineage Sub-Level
LINEAGE
The lineage directory deals with information about the processing history. It gathers files from the initial source data used to process the current product and also a processing metadata file.

A.2.5.1.1 Data Strip Source Metadata File

STRIP_<DATA_STRIP_ID>_DIM.XML: file encoding = XML, metadata format = DIMAP V2

The data strip file relates to the full imagery strip used to generate the product. It is generally a variable portion extracted from a strip, given by the order polygon. For mosaic products resulting from the mosaicking of several input strips, extracts of each original data strip file are provided.

The information contained in data strip files relates to their processing level before the extraction of the product. As this processing level (Archive, L1...) is prior to the final product processing level, the content must be used for information use only or some raw data assessment by expert.

The specific metadata are in the following DIMAP groups:

Strip_ Identification	Brief identification of the strip, the mission and the instrument.
Acquisition_ Configuration	Configuration information and specific data about the spacecraft, its subsystems and instruments at strip acquisition.
Telemetry_ Acquisition	Downlink and receiving information.
Raster_Data	Raster file extracted from the original imagery strip.
Radiometric_Data	Erroneous data into the original data strip if any.
Geometric_Data	Acquisition time and date of the full strip
Catalog	Coordinate of the strip as stored in the catalogue system.

Table A.2e: Datastrip source metadata file

A.2.5.1.2 Ground Source Metadata File

GROUND_R3D_OR_<Ref3D_Tile_ID>_DIM: file encoding = XML, metadata format = DIMAP V2

The ground source file describes the quality of the planimetric source data used at Primary or Ortho level to reset the native location of the image on GCP, if requested and available when placing the imagery order. This file is not supplied for products with no reset applied (native location of the sensor data).

For Standard products, the location reset is performed on the Reference3D™ database orthorectified layer, organized by square degree. For each tile used for the processing, the file stores the tile identifier and its accuracy values.

The specific metadata are in the following DIMAP groups:

Source_Information	Name of the source data.
Source_Content	Source data identifier.
Quality_Assessment	Accuracy measurements (specification values).

Table A.2f: Ground Source metadata fle

A.2.5.1.3 Height Source Metadata File

HEIGHT_{R3D_DT2_<Ref3D_Tile_ID>, SRTM_DT1, GLOBE}_DIM.XML: file encoding = XML, metadata format = DIMAP V2

The height source file describes the quality of the elevation source data used at orthorectification to reset the off-nadir effects of the image caused by the relief in the orthorectification process.

For Ortho products, the location reset is performed on the Reference3D™ database DTED2 layer. If Reference3D is unavailable, SRTM DTED1 is used, and if SRTM is unavailable, the location reset is done on the global DTED0 DEM. For each tile used for the processing, the file stores the tile identifier and its accuracy values.

For Primary products, this file is not used.

DIMAP groups: same as Ground Source metadata file.

A.2.5.1.4 Processing Metadata File

PROCESSING_<Product_ID>_DIM: file encoding = XML, metadata format = DIMAP V2

The processing file describes the processing steps and the ground image processing parameters (GIPP) files activated during the process from the archiving system to standard level production. Downstream steps might not be documented. The specific metadata are in the following DIMAP groups:

Processing_Step_ List	Significant processes or events occurring during the dataset production.
Processing_ Parameter_List	Significant ground image processing parameters applied at dataset production.

Table A.2g: Processing metadata File

A.2.5.2 The Mask Sub-level

MASKS
The mask directory contains the overlaying masks delivered with the product in GML vector format.

A.2.5.2.1 Mask Files

{ROI, CLD, SNW, QTE, DET, SLT, VIS, DTM}_<Product_ID>_ MSK.GML: file encoding = XML, metadata format = GML V3.1.1

GML vector masks are available for standard products. They are registered with the image product (same geometry and CRS) for overlaying purposes. They include:

- Masks related to an ordering parameter: cloud cover (CLD), snow indicator (SNW), technical quality rate (QTE).

- Masks built by the data process:

  - Product footprint (ROI, Region Of Interest - one per strip extract for mosaics, i.e. the intersection between the global ROI and each strip)

  - Image quality masks: out of order detectors (DET), saturation or straylight (SLT), hidden areas (VIS, visibility).

A.3 Metadata Contents and Organization

The metadata are encoded in DIMAP format using XML scheme. DIMAP is a public-domain format for describing geographic data, developed in partnership with space agencies like CNES, SSC and ESA. The format was introduced in May 2002 for SPOT products. The format has been improved in 2012 with DIMAP V2. DIMAP V2 is the standard used by Airbus Defence and Space Services for Pléiades 1A, Pléiades 1B, SPOT 6 and SPOT 7 products and other Ortho imagery.

For an overview of the main improvements brought by DIMAP V2 compared to DIMAP, please refer to part 2.4.

A.4 Image Format

Products are available in two raster formats:
- TIFF (including GeoTIFF)
- JPEG 2000

The file sizing is managed by image tiling. Both formats offer dynamic range (also called bit-depth or radiometric resolution) of 12 bits (4096 values) or 8 bits (256 values). The original 4096 scale into a 256 scale is performed with a linear adjustment. The original 4096-bit scale could be recovered with the DIMAP group Dynamic_Adjustment (MIN, MAX, BIAS, SLOPE).

A.4.1 JPEG 2000

The CODEC uses Part I of the JPEG 2000 standard, ISO/IEC 15444-1, plus some options of Part II. Using the Kakadu Library, settings should be expressed as (informative):

flush_period=2048 Stiles=\{2048,2048\} Sprecision=12 (or 8) Cycc=yes (except for PAN) Creversible=yes/no Qstep=0.000244 (or 0.0039) Cblk=\{64,64\} Clevels=5 Cuse_precincts=yes Cprecincts=\{256,256\},\{256,256\},\{256,256\},\{256,256\},\{256,256\},\{256,256\ Corder=RPCL ORGgen_plt=yes Clayers=10.

Two compression schemes are available:

- JPEG 2000 Optimized is meant for people looking for fast download and easy data sharing. It has a compression of 3 bits/pixel. It uses the so-called lossy compression: the compression rate is optimized to avoid any spatial effect but is not reversible. A spectral effect of 1/1000 is tolerated.

- JPEG 2000 Regular is perfect for users willing to do some high precision post-processing. It has a compression of around 8 bits/pixel. It uses the so-called lossless compression: the JPEG 2000 compression is in this case completely reversible and does not include any effects in terms of information content.

- Both JPEG 2000 compressions ensure no impact in terms of image quality; however, they have a direct impact on the file size. The Regular compression file size is about twice as large as the Optimized compression file size.

A.4.2 TIFF

The file is coded according to the TIFF V1.0 specification. The 32-bit offset capability (4 GB) like BigTIFF is not used. The TIFF requires huge file sizes compared to JPEG 2000, as TIFF is not a compressed format and the 12-bit dynamic range is coded over 2 bytes (16 bits).

A.4.3 Raster file Band Index

JPEG2000 and TIFF files are both organized in multi-band files (one single file for all spectral bands). According a direct RGB load and go at screen. The raster loader at screen should follow the default order:

Spectral Processing	Nbands	RGB (Red)	RGB (Green)	RGB (Blue)	Extra Channel	Intensity Channel
PAN	1	–	–	–	–	1
MS	4	1(B2)	2(B1)	3(B0)	4(B3)	–
PMS	4	1(B2)	2(B1)	3(B0)	4(B3)	–
PMS-N	3	1(B2)	2(B1)	3(B0)	–	–
PMS-X	3	1(B3)	2(B2)	3(B1)	–	–

Table A.4: Raster file index for default RGB display

A.4.4 Image Tiling

Products exceeding a certain size limit are broken in several image pieces, called physical tiles. This limit isapproximately:

- 2 GB file size for GeoTIFF products
- Max. 4 GB file size for JPEG 2000

In the future, this limit could change as software capabilities progress.

The physical tiling is based on an orthonormal regular grid (as a matrix): y-axis for each row (Ri) and x-axis for each column (Cj) of the grid.

The tile size is constant, meaning all tiles have the same size, with a possible exception of the tiles in the last rows and columns, as black fill pixels are not included to fill the constant size.

- The tiles of the first row begin at the upper and left borders of the bounding rectangle of the AOI
- The tiles of the last row and column are trimmed to the bottom and right borders of the bounding rectangle of the AOI
- Tiles are not overlapping

The product metadata file describes:
- The tiling characteristic for the full product (Raster_Data/Raster_Dimensions)
- The list of all tiled images composing the product (Raster_Data/Raster_Access)

The Index metadata file (multi-volume) describes the distribution of tile images within one or several media.
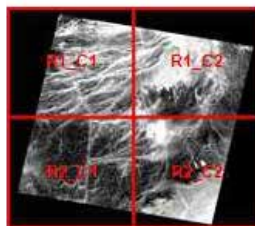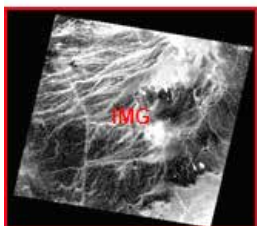
Figure A.4.4: tiling (below)
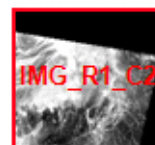
Non-tiled product

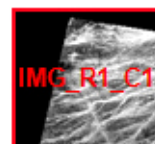**Media1**

PHR*_001

IMG_*R1C1.JP2

Tiled product

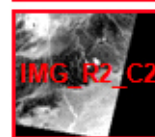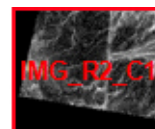**Media1**

PHR*_001

IMG_*R1C1.JP2

IMG*_R1C2.JP2

Media2

PHR*_001

IMG_*R2C.JP2

IMG*_R2C2.JP2

A.5 Available Geographic and Cartographic Projections

Airbus Defence and Space Services offers orthorectification in nearly any geodetic parameters and National Mapping System registered in the EPSG database.

A.5.1 Geographic Projections

A Geographic projection is a simple mapping projection based on a geodetic datum and ellipsoid model of the Earth to convert the coordinates to a planar system with angular coordinates.

Airbus Defence and Space's geographic projections are related to WGS84 geodetic datum/ellipsoid in decimal degree angular unit. The pixels are regularly posted in latitude/longitude with a unique constant sampling step, identical on both Northing and Easting Axis.

As Coordinate Axis are in angular unit (preserves only angles not distance), we do not recommend Geographic projection for visualization applications (anamorphosis effect along Easting Axis).

A.5.2 Mapping Projections

A mapping projection is based on a geodetic Coordinate Reference System (CRS) and uses a map projection model to convert the coordinates to a horizontal plane as Cartesian linear coordinates.

Airbus Defence and Space's mapping projections are related to National Mapping Agencies or International Authorities. The default parameter values are those registered in EPSG. The linear unit is the meter.

Some six hundred CRS mapping projections are offered for Standard Ortho Products. Others are available for Tailored Ortho Products. Please ask Customer Care Service for availability.
The CRS should use one of the following map projection models.

Map Projections
Albers Equal Area
American Polyconic
Azimuthal Equivalent
Azimuthal Equidistant
Bonne
Cassini-Soldner
Hotine Oblique Mercator
Laborde Oblique Mercator
Lambert Conic Conformal (1SP)
Lambert Conic Conformal (2SP)
Mercator (1SP)
Mercator (2SP)
Oblique Mercator
Transverse Mercator
Transverse Mercator (South Oriented)
Mollweide
Oblique Stereographic
Polar Stereographic

Table A.5: Map projections

A.6 How to georeference the image?

The product offers various ways to georeference the image.
The following table gives the corresponding fields, if relevant:

DIMAP	TIFF/GeoTIFF	JPEG 2000/GMLJP2	World File
NCOLS	ImageWidth	gml:high (1)	n/a
NROWS	ImageLength	gml:high (1)	n/a
NBITS	BitsPerSample	In Jp2h :ihdr	n/a
NBANDS	SamplesPerPixel	In Jp2h :ihdr	n/a
XDIM / YDIM	ModelPixelScaleTag	gml:offsetVector (2)	A / E
ULXMAP/ULYMAP	ModelPixelScaleTag	gml:pos	C / F
Projected_CRS or Geodetic_CRS	GTModelTypeGeoKey		n/a
PROJECTED_CRS_CODE	ProjectedCSTypeGeoKey	attribut SrsName	n/a
PROJECTED_CRS_NAME	PCSCitationGeokey		n/a
GeoDETIC_CRS_CODE	GeographicTypeGeoKey	attribut SrsName	n/a
GeoDETIC_CRS_NAME	GeoCitationGeokey		n/a
VERTICAL_CRS_NAME	VerticalCitationGeoKey		n/a
VERTICAL_CRS_CODE	n/a		n/a

(1) GML: counting from 0 (gml:high = NROWS-1 NCOLS-1); DIMAP & GeoTIFF: counting from 1

(2) GML: offset; DIMAP & GeoTIFF: dimension

Table A.6a: Georeferencing

A.6.1 GMLJP2

The GMLJP2 header is stored in the XML box embedded in the JPEG 2000 file according to the OGC V1.0 Specification (OGC-05-047r3): JPEG 2000 Part I (XML BOX) and II (label BOX and association BOX).

- Primary products: the image is in raw geometry, header does not have any geocoding information and uses a simple Grid feature scheme.
- Ortho products: the header uses the RectifiedGrid feature type scheme (grids.xsd)

    - Upper left pixel as the location origin and a vector that specify the posting locations into the image. Axes are ordered in conformity with EPSG standard.

    - Coordinate Reference System (CRS) encoding in conformance with the EPSG standard.

A.6.2 GeoTIFF Tags

The GeoTIFF tags are embedded in the TIFF file, according to the GeoTIFF V1.0 Specification:

- Primary products: the image is in raw geometry, no GeoTIFF information
- Ortho products:
    - Upper left pixel as the location origin and a dimension for sizing the pixel
    - Coordinate Reference System (CRS) encoding in conformance with the EPSG standard (ifunknown "user-defined" encoding)

A.6.3 World File

Georeferencing with world file is dedicated for image is in map geometry (Ortho).

For image in sensor geometry (Primary) georeferencing must be performed though a geometric model. Please refer to the RPC metadata file or the geometric modeling section.

One World File is associated with each image tile. It describes the georeferencing through an affine transformation. The six parameters of the affine transformation are in the form:

$$x1 = Ax + By + C$$
$$y1 = Dx + Ey + F$$

Where:

x1 = calculated x-coordinate of the pixel on the Ground CRS
y1 = calculated y-coordinate of the pixel on the Ground CRS
x = column number of a pixel in the image
y = row number of a pixel in the image
A = x-scale; dimension of a pixel in CRS units in x direction (XDIM)
B, D = rotation terms
C, F = translation terms; x, y CRS coordinates of the center of the upper left pixel (UL{X,Y}MAP)
E = negative of y-scale; dimension of a pixel in CRS units in y direction (YDIM)

For Ortho product, the CRS is the one formatted with the product.

For Primary products the World File is adapted to assemble raster tile files, if any. The CRS is the raster Coordinate System (column,row).

The y-scale (E) is negative because the origins of an image and a Ground coordinate system are different. Row values in the image increase from the origin downward, while y-coordinate values in the map increase from the origin upward.

The rotation terms B and D are:

- Zero value if the image is in Map geometry: Ortho-image and Mosaic
- Other than zero, if the image is in sensor geometry. In that case, they are computed from the (lat, long) coordinates of the global image corners provided in the metadata

The translation terms C and F, for tilled images, are the location of the center of the upper left pixel for each tile.

The World File is an ASCII file containing six lines, giving the six parameters in the following order (one per line):

Parameter	Example
A	20.17541308822119
D	0.00000000000000
B	0.00000000000000
E	-20.17541308822119
C	424178.11472601280548
F	4313415.90726399607956

Table 3A.6b: Projected or Ortho Worldfile

Parameter	Example
A	1
D	0
B	0
E	-1
C	1
F	-1

Table A.6c: Primary Worldfile

Appendix B: Image Quality

B.1 Design Specification vs. Performances

The following table gives Image Quality performances (measured in Dec 2012) significant for the user. They are compared with the original design specification of the S6/7 satellites.

The measurements are expressed as:

- Geometry - inside the cone of 30° around nadir
- Radiometry - at nearly 100 W/m²/sr/microns (L2)
- Resolution - no sampling factor. Bpp= 2.86 for Pan and 3.33 for MS

Abbreviations: MTF: Modulation Transfer Function; SNR: Signal to Noise Ratio; IQF: Image Quality Factor; bpp: bit per pixel. MTF/SNR: Satellite = RAW data; Restored = after Ground denoising and deconvolution

Image Quality Item	Design Specification	Up-to-Date Performance	Remark
GEOMETRY – Global			
Pointing Accuracy (satellite tasking)	Across track: 600m LE95 Along track: 1000m LE95	Across track: 50m LE95 Along track: 260m LE95	
Dynamic Effect (high frequency jittering)	Along Lines: 0.2pixel PAN LE95 Along columns: 0.1 pixel PAN LE95	Along Lines: <0.1pixel PAN LE95 Along columns: < 0.1 pixel PAN LE95	
Static effect (regularity of resampling between adjacent pixels due to focal plan design)	0.2 pixel CE99.7	0.2 pixel CE99.7	-Intra-array: 0.05 pixel CE99.7
GEOMETRY (Rigorous Geometric Model accuracy without GCP: all products)			
Location accuracy	50m CE90@30°	20m CE90@30°	
Length Distortion	1/1000 CE90	0.5/1000 CE90	Between 2 points distant of 1000 pixels Panchromatic
MS Registration	0.25 pixel MS CE99.7	<0.15 pixel MS CE99.7	
MS and Pan Co-registration	1 pixel PAN CE99.7	<0.4 pixel PAN CE99.7	
Global RPC Discrepancy vs. Rigorous Model	_	<0.25 pixel PAN	
GEOMETRY (Rigorous Geometric Model accuracy reset on (perfect) GCP and DEM)			
Planimetric Accuracy (Panchromatic)	1 pixel CE90	0.9 pixel CE90 (1.35mCE90)	
Vertical accuracy (Pan) B/H=0.5 (absolute error)	1 pixel CE90	0.4 pixel CE90 (2.4mCE90)	
Vertical Accuracy (Pan) B/H=0.25 (absolute error)	B/H = 0.8 within radius of 9km: ≤20%: 4mLE90 20 to 40%: 8mLE90	At B/H=0.5 for slopes: ≤20%: 2.4mLE90 20 to 40%: 2.6mLE90	Operational case is close to B/H=0.5

Image Quality Item	Design Specification	Up-to-Date Performance	Remark
RADIOMETRY **Radiometric Model accuracy (DN conversion to Radiance)** **Known accuracy performance with pre-launch measurement**			
Absolute Calibration	≤6%	Preliminary values: PAN: <5% Blue: <5% Green: <5% Red: <5% NIR: <10%	
Relative Cross-band Calibration	≤3%	3%	
Relative Multi-temporal Calibration	≤5%	5%	
RESOLUTION			
Satellite MTF (X/Y axis): Panchromatic		Pan: 0.16/0.15	
Satellite SNR: Panchromatic		Pan: 160	
IQF (MTF x SNR): Panchromatic		Pan: 25/24	
Restored MTF (target): Panchromatic		0.39	
Satellite MTF (X/Y axis): Multispectral		Blue: 0.3/0.25	
Satellite SNR: Multispectral		Blue: 150 Green: 155 Red: 155 NIR: 195	
IQF (MTF x SNR): Multispectral		Blue: 45/37 Green: 46.2/39 Red: 46/39 NIR: 58/49	

Table B: Specifications and performance

Appendix C: Geometric Modeling

The aim of geometric modeling is to describe the relationship between image and ground coordinates for agiven sensor.

C.1 Geometry

C.1.1 Focal plane

SPOT 6/7 raw products are very complex and not user-friendly, due in particular to the complexity of the focal plane. Indeed, the full swath focal plane is a combination of two individual focal planes belonging to two individual cameras.

Moreover, each raw focal plane is composed on two detectors separated along the satellite track within the field of view.

The Primary product has been designed to remove this complexity and offer end-users a simple product with state-of-the-art geometric and radiometric accuracy. Technically, the Primary processing is also called Sensor, Perfect Sensor or Virtual Sensor.

The geometric reference frame for Primary imagery simulates the imaging geometry of a single pushbroom linear array, located on a virtual line corresponding to the average of the four panchromatic TDI arrays.

Hereunder Figure C.1.1a describes the whole focal plane. This is a virtual representation as far as both cameras are physically independent.
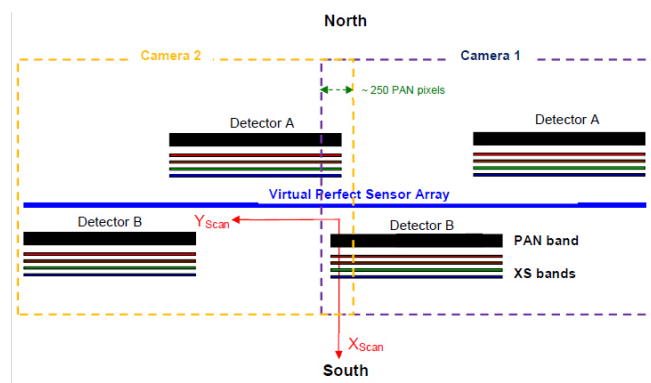

Figure C.1.1a: Full focal plane layout (swath) and location of primary virtual array.

Both cameras of previous figure are strictly identical. Each individual focal plane is designed as shown hereunder:
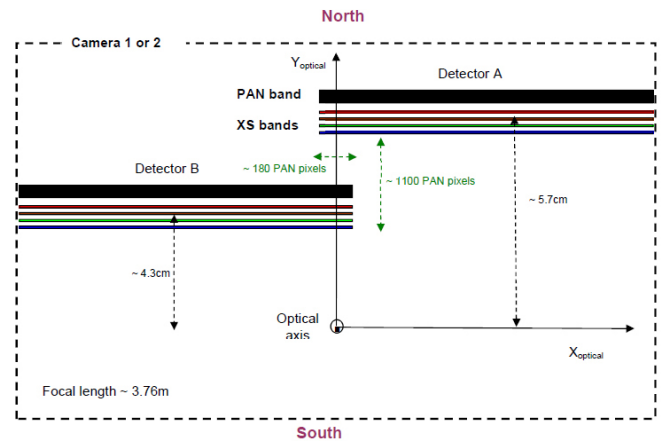

Figure C.2.2b: Raw focal plane layout and location of primary virtual array

C.1.2 Primary product geometrical properties

Besides, this ideal array is supposed to belong to a perfect instrument with no optical distortion and carried by a platform with no high attitude perturbations. This attitude variation correction (made with a polynomial fitting) allows for both simple attitude modelling and more accurate precision of the imaging geometry by the rational functions sensor model.

The pixel reference is the centre of the pixel ("pixel is point").

C.1.2.1 GSD

The Primary product resolution is related to the raw imagery GSD, which varies according to the viewing angle (see Table 34).

Global viewing angle from satellite α (°)	PAN GSD (cm)	MS GSD (m)	SWATH (km) width	PAN GSDc (cm)	MS GSDc (m)	SWATHc (km) width	GSDc-GSD (m)	GSD Error (%)
Please refer to part C.4.1 for more details	Without taking into the rotundity of the Earth			Taking into the rotundity of the Earth			-	-
0	2.19	8.77	84.6212	2.19	8.77	84.6212	0.0	0%
5	2.21	8.83	85.2689	2.21	8.85	85.3804	0.00	0.13%
10	2.26	9.04	87.2522	2.27	9.09	87.7179	0.01	0.53%
15	2.35	9.40	90.6968	2.38	9.51	91.8237	0.03	1.23%
20	2.48	9.93	95.8314	2.54	10.16	98.0547	0.06	2.27%
25	2.67	10.67	103.022	2.77	11.09	107.012	0.10	3.73%
30	2.92	11.69	112.828	3.10	12.40	119.687	0.18	5.73%
35	3.27	13.07	126.11	3.57	14.27	137.763	0.30	8.46%
40	3.74	14.94	144.202	4.25	17.02	164.256	0.52	12.21%
45	4.38	17.53	169.243	5.31	21.25	205.067	0.93	17.47%
47	5.30	21.22	204.807	7.08	28.33	273.45	1.78	25.10%

Table C: GSD vs viewing angle

Notes:

$$GSD = h_{sat}.\tan(\alpha + IFOV) - h_{sat}.\tan(\alpha)$$

without taking into account the rotundity of the Earth.w

$$GSD_c = R_E.\left[\frac{\left(1+\frac{h_{sat}}{R_E}\right).\cos(\alpha)}{\sqrt{1-\left(1+\frac{h_{sat}}{R_E}\right)^2.\sin^2(\alpha)}} - 1\right].IFOV$$

taking into account the rotundity of the Earth.

With:

hsat (km)	699
PAN IFOV (rad)	3.14E-06
MS IFOV (rad)	1.25E-05
Earth	
Semi-major axis (km)	6378.14
Semi-minor axis (km)	6356.75
R_E (km) (mean)	6367.45

C.1.2.2 Primary Grids Alignment (Bundle)

With Primary bundle delivery PAN and MS bands sampling grid are phased as shown on Figure C.1.2.2.
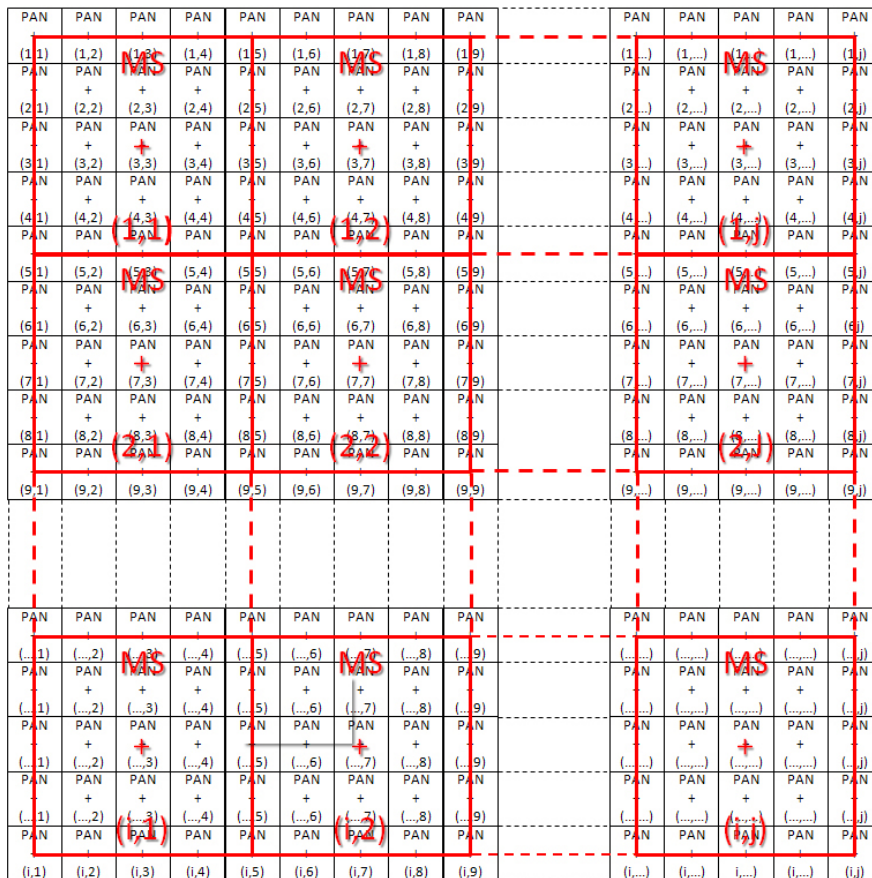

Figure C.1.2.2: Primary bundle grids alignment

Centre of the first MS pixel corresponds exactly to the centre of the third column (or third line) PAN pixel centre. PAN image is larger than MS image by 0.5 pixel "all around" MS image footprint.

C.1.3 Ortho product geometrical properties

The pixel reference is the upper left corner of the pixel ("pixel is area").

C.1.3.1 GSD

The Ortho product resolution is also related to the raw imagery GSD (see Table 34). To ensure perfect radiometric accuracy and image restoration, the Ortho end product is zoomed with a fix sampling of 1.50m for Panchromatic and 6.0m for Multispectral imagery (or equivalent angular value at equator for geographic projection).

C.1.3.2 Ortho Grids Alignment (Bundle)

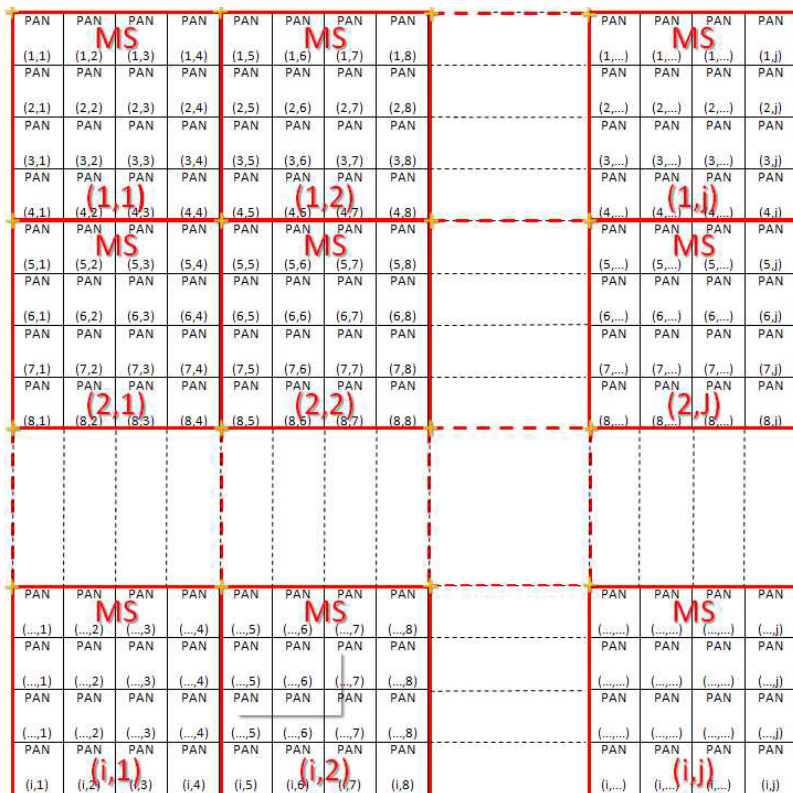On an Ortho bundle delivery PAN and MS bands sampling grid are phased as shown on Figure C.1.3.2.

Figure C.1.3.2: Ortho bundle grids alignment

Upper-left corner of the first MS pixel corresponds exactly to upper left corner of the first column (or first line) PAN pixel.

C.2 Using the Physical Model for the Primary Products

Two reference frames are used in the physical model for Primary products: image focal plane frame and geocentric Earth frame.
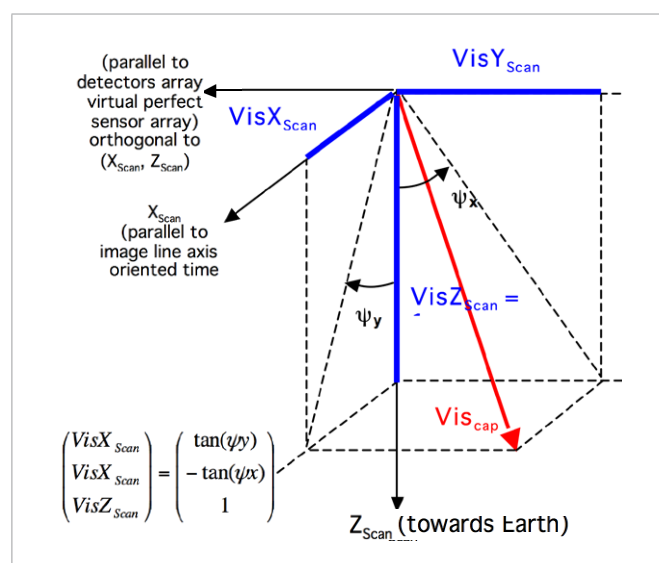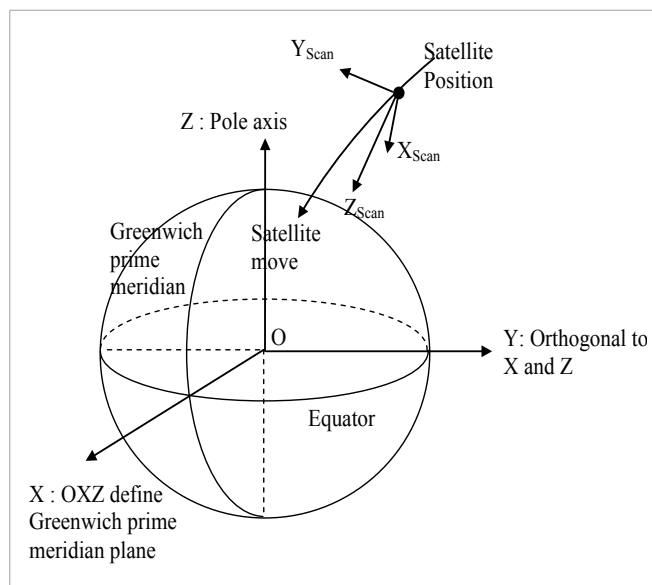

Figure C.2a: Image focal plane frame

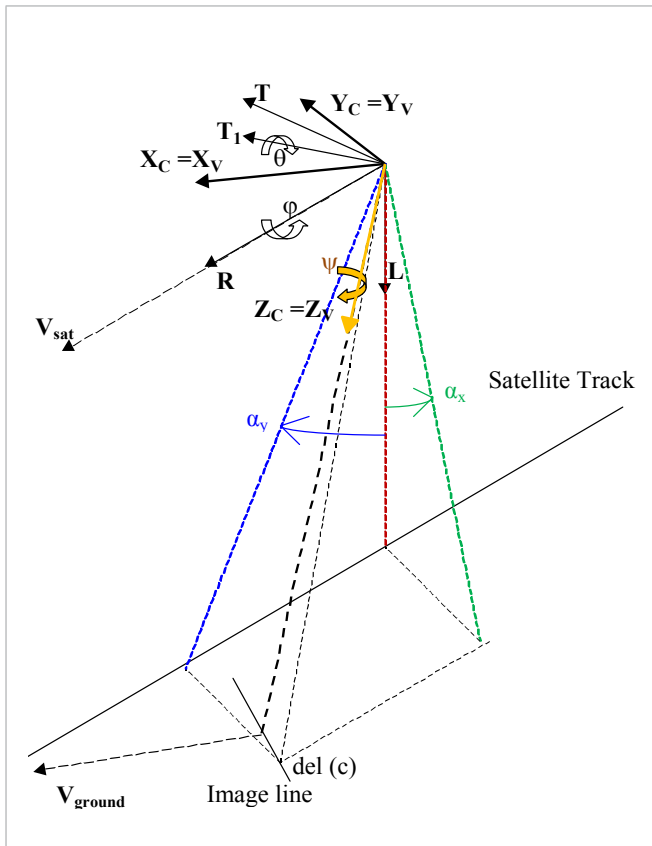*Figure C.2b: Geocentric earth frame (WGS84)*

Figure C.2c: Frames summary

Notes

- Image orientation and satellite track are different

- In case of Virtual Perfect Sensor Array, image focal plane frame (X_{Scan}, Y_{Scan}, Z_{Scan}) and frame to pilot (X_v, Y_v, Z_v) are identical

- A set of quaternions sampled at 16Hz describes satellite attitude. At a given time, one can compute the quaternion and build directly the transformation matrix between image focal plane frame and geocentric earth frame (WGS84)

- All the data needed by the physical model is in the "DIM_*.XML" metadata file under the node <Refined_ Model>

- All acquisitions times and dates are expressed in UTC

- All satellite locations are expressed in Cartesian coordinates (O, X, Y, Z) in the ECF frame WGS84

- In the dataset extent, ground coordinates are expressed in geographic coordinates (unit degrees)

- All of these coordinates are related to the WGS84 geodetic system

C.2.1 Direct Localization: Image to the Ground

Given image coordinates (col, lin) and altitude h, ground geographic coordinates (λ, φ) can be found by using physical model data. The ground coordinates may be calculated as followed:

Viewing time calculation for a given image line
$t_{lin} = t_{ref}° + period * (lin - lin_{ref})$
Default value: $lin_{ref} = 1$

Calculation of viewing angle in image focal plane frame for a given column image (detector):

Apply the polynomial models:

$$TanPsiX = \sum_{i=0}^{n} CoeffPsiX_i * (col - col_{ref})^i$$

$$TanPsiY = \sum_{i=0}^{n} CoeffPsiY_i * (col - col_{ref})^i$$

By convention for SPOT 6/7 Primary product TanPsiY = 0 and first column index is 0;

Calculation of the viewing angle in the image focal plane frame:

$$\begin{pmatrix} VisX_{Scan} \\ VisY_{Scan} \\ VisZ_{Scan} \end{pmatrix} = \begin{pmatrix} TanPsiY \\ -TanPsiX \\ 1 \end{pmatrix}$$

$$\begin{pmatrix} VisX_{Scan} \\ VisX_{Scan} \\ VisZ_{Scan} \end{pmatrix} = \begin{pmatrix} \tan(\psi y) \\ -\tan(\psi x) \\ 1 \end{pmatrix}$$
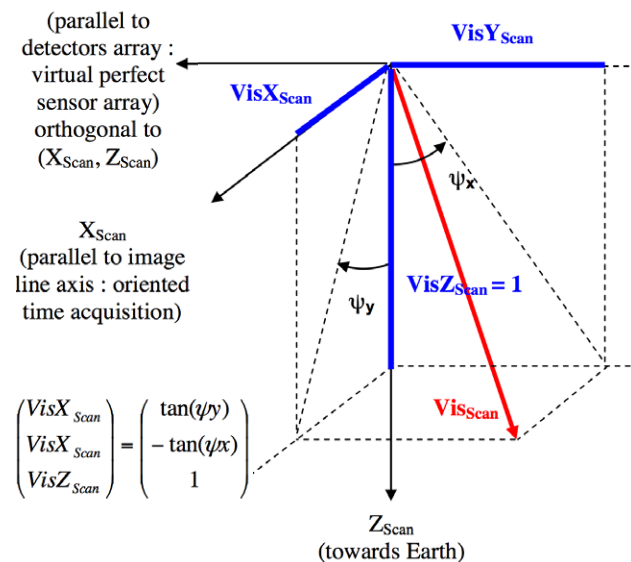
Figure C.2.1a: Viewing angle in image focal plane frame

Satellite location interpolation for a given time

Centring acquisition times and dates is recommended:

$$t_{mean} = \frac{\sum_{i=1}^{m} t_i}{m} \text{ and } trel_i = t_i - t_{mean}$$

Each satellite location component (PosX, PosY, PosZ), is calculated by Lagrange interpolation with n samples:

$$PosX(t) = \sum_{i=1}^{n} \frac{\prod_{j=1, j\neq i}^{n}(trel - trel_j)}{\prod_{j=1, j\neq i}^{n}(trel_i - trel_j)} * PosX(t_i)$$

Notes:
- n = 8 is recommended when time step between sample is 30 s.

The same formula is used to compute PosY(t) and PosZ(t).

In order to compute the viewing direction in the Earth geocentric frame, only the attitude quaternion is used (transformation between image focal plane frame and earth geocentric frame). Velocity data is not necessary for viewing direction orientation.

Velocity is used when the user would like to improve the model (computation of Orbital Local Frame Axis, which needs satellite inertial velocity in WGS84 ECF frame).

Satellite orientation interpolation for a given time

Sattelite orientation for a given time is deduced from the quaternion list. Quaternions components Q1, Q2, and Q3 are respectively the three rotation vector component and Q0 is the rotation angle component. Each quaternion comes along with a time stamp.

Quaternion components must be interpolated at the time of interest. Each component must be interpolated individually. A cubic interpolation is recommended.

Attitude quaternion normalisation and transfer matrix calculation between image focal plane frame and geocentric earth frame

Quaternion normalisation:

$$norme = \sqrt{Q0^2 + Q1^2 + Q2^2 + Q3^2}$$

$$\begin{pmatrix} w \\ x \\ y \\ z \end{pmatrix} = \begin{pmatrix} \dfrac{Q0}{norme} \\ \dfrac{Q1}{norme} \\ \dfrac{Q2}{norme} \\ \dfrac{Q3}{norme} \end{pmatrix}$$

Transformation matrix calculation between the image focal plane frame and the geocentric Earth frame:

$$Mat_{PF \rightarrow Ter} = \begin{pmatrix} w^2 + x^2 - y^2 - z^2 & 2.*(x*y - w*z) & 2.*(x*z + w*y) \\ 2.*(x*y + w*z) & w^2 - x^2 + y^2 - z^2 & 2.*(y*z - w*x) \\ 2.*(x*z - w*y) & 2.*(y*z + w*x) & w^2 - x^2 - y^2 + z^2 \end{pmatrix}$$

Calculation of the viewing angle in the geocentric Earth frame

Apply the transformation matrix on the viewing angle in the image focal plane frame:

$$\begin{pmatrix} VisX_{Ter} \\ VisY_{Ter} \\ VisZ_{Ter} \end{pmatrix} = Mat_{PF \rightarrow Ter} * \begin{pmatrix} VisX_{Scan} \\ VisY_{Scan} \\ VisZ_{Scan} \end{pmatrix}$$

Ground position computation given satellite location, viewing angle (in geocentric earth frame) and earth model (ellipsoid)

Given:

Satellite location at a given time:

$$\overrightarrow{Pos} = \begin{pmatrix} PosX(t) \\ PosY(t) \\ PosZ(t) \end{pmatrix}$$

Viewing angle in geocentric Earth frame:

$$\overrightarrow{Vis} = \begin{pmatrix} VisX_{Ter} \\ VisY_{Ter} \\ VisZ_{Ter} \end{pmatrix}$$

Earth model (ellipsoid) with two axes (a, b)

Find the point on the ground at height h above ellipsoid.

Note

Finding the intersection point between the viewing direction and an ellipsoid (a + h, b + h) is different than finding the point at height h (see Figure below).

The method is iterative in order to find the substitute ellipsoid (a + h + dh, b + h + dh), which gives the point at height h above ellipsoid.

Toward Satellite
Viewing direction in ECF
(Earth Centered Fixed)
Frame

M:
Intersection between
straight line and
ellipsoide (a+h, b+h)

h' < h

substituate ellipsoïd
(a+h, b+h)

ellipsoide (a, b)

Toward Earth
Center

Normal to ellipsoid at M

Toward Satellite

Vis
Viewing angle in
geocentric earth frame

M:
Intersection between straight
line and ellipsoide (a+h+δh,
b+h+δh)

h

substituate ellipsoid
(a+h+δh, b+h+δh)

ellipsoide (a, b)
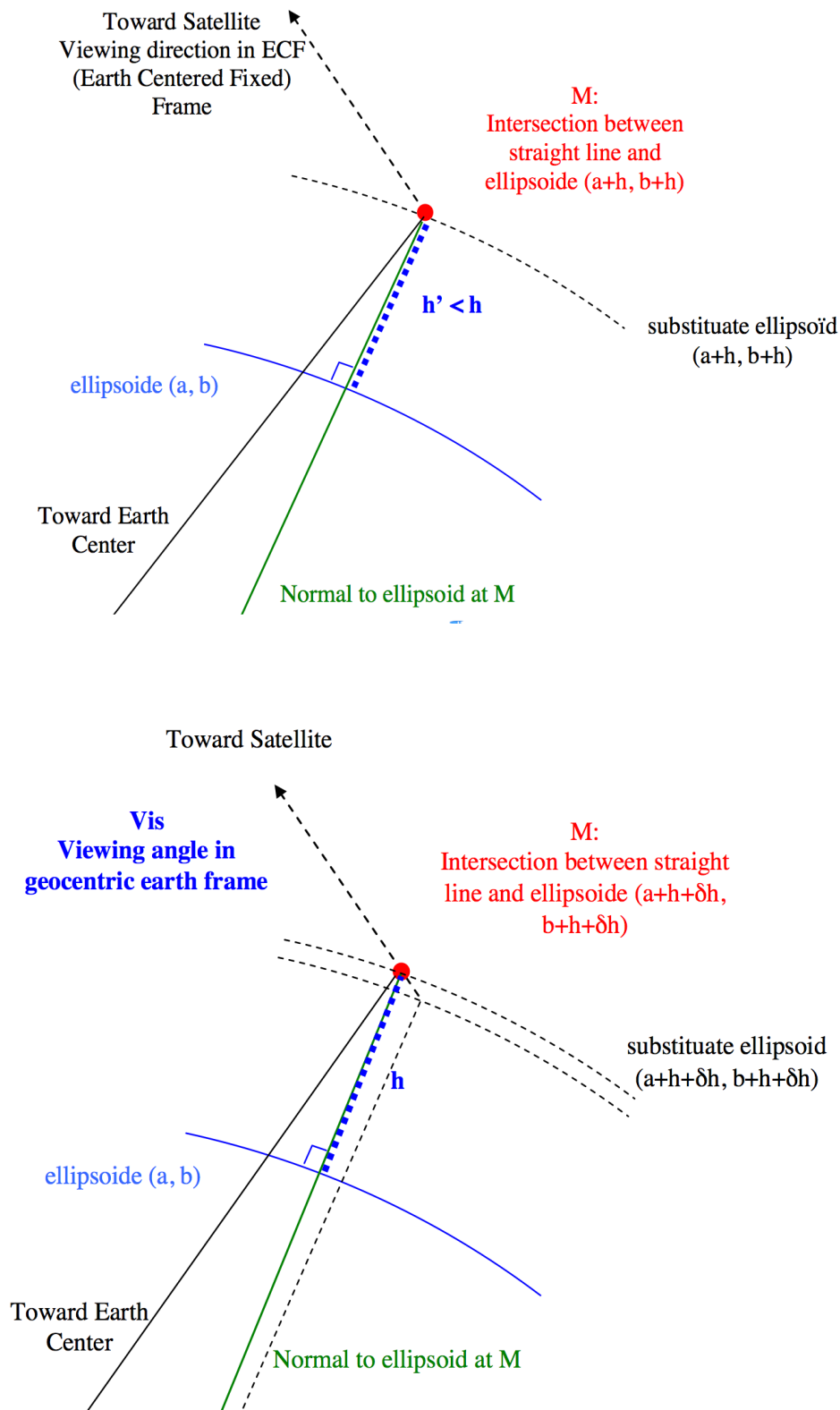
Toward Earth
Center

Normal to ellipsoid at M

Figure C.2.1b: Find the point on the ground at the right altitude H

Let's start with he = h.

Do {

Compute point M (X, Y, Z) in ECF frame: Intersection between viewing direction and substitute ellipsoid (a + he, b + he).

(X, Y, Z) coordinates are the solution of the following equation system:

$$\begin{pmatrix} PosX(t) - X \\ PosY(t) - Y \\ PosZ(t) - Z \end{pmatrix} = \alpha * \begin{pmatrix} VisX_{Ter} \\ VisY_{Ter} \\ VisZ_{Ter} \end{pmatrix}, (1)$$

$$\frac{X^2 + Y^2}{(a + he)^2} + \frac{Z^2}{(b + he)^2} = 1, (2)$$

Equation (1) means that point M belongs to the viewing direction straight line: satellite location, viewing direction.

Equation (2) means that point M belongs to the substitute ellipsoid (a + he, b + he).

Finding the solution is equivalent to solve a quadratic equation (unknown α).

The solution is the smallest root.

Transform orthogonal coordinates (X, Y, Z) into geographic coordinates and height above ellipsoid (λ, φ, η').

See: **http://geodesie.ign.fr/contenu/ fichiers/documentation/algorithmes/ notice/NTG_80.pdf**

ALG0012 – Coordinate transformation: Cartesian coordinates ➜ Geographic coordinates

Calculate the height difference: $\delta h = h - h'$

Continue with he += δh

} Until height difference δh will be less than the tolerance (parameter).

Note that preceding algorithm does not take into account neither the atmospheric refraction nor the light transmission delay. Nevertheless, the corresponding geolocation error is about 2.5m at 30° viewing angle and 5m at 40° viewing angle which is one order of magnitude below SPOT 6 geolocation performance.

C.2.2 Inverse Localisation: Ground to Image

Given ground plane coordinates (λ, φ) and an altitude h, find the image coordinates (col, lin) by using the physical model.

First, it is necessary to calculate an inverse localisation predictor at different altitudes.

This may be calculated as follows:

Calculation of a direct localisation grid at different altitudes.

(col, lin) ➜ (λ, φ)$_{h1}$ (λ, φ)$_{hi}$ (λ, φ)$_{hn}$

For each altitude, compute an inverse localisation predictor by least-squares using grid samples (col, lin, λ, φ):

col$_{hi}$ = f$_{hi}$ (λ, φ)

lin$_{hi}$ = g$_{hi}$ (λ, φ)

Compute an approximation of the image position.

Apply the polynomial at different altitudes:

col$_{h1}$ = f$_{h1}$(λ, φ)   col$_{hi}$ = f$_{hi}$(λ, φ) .colhn = f$_{hn}$(λ, φ)

lin$_{h1}$ = g$_{h1}$(λ, φ)   lin$_{hi}$ = g$_{hi}$(λ, φ) .linhn = g$_{hn}$(λ, φ)

Interpolate the approximate image position at the given altitude h:

col_app$_h$ = Interpolate (col$_{h1}$, … col$_{hi}$, …col$_{hn}$)

lin_app$_h$ = Interpolate (lin$_{h1}$, … lin$_{hi}$, …lin$_{hn}$)

Let's start the iterative process with the approximate image position:

col$_{cur}$ = col_app$_h$

lin$_{cur}$ = lin_app$_h$

Do {

    Direct localisation function is applied on the current image position at altitude h in order to obtain the current ground position:

        DirLoc (col$_{cur}$, lin$_{cur}$, h) ➡ (λ_{cur}, φ_{cur})

    Calculate the difference between the current ground coordinates and the target ground coordinates:

        dλ = ($\lambda - \lambda_{cur}$)

        dφ = ($\varphi - \varphi_{cur}$)

    Calculate the image coordinates variation corresponding to the ground coordinates difference by using inverse partial derivatives:

$$\begin{pmatrix} dcol \\ dlin \end{pmatrix} = \begin{pmatrix} \dfrac{\partial \lambda}{\partial col} & \dfrac{\partial \lambda}{\partial lin} \\ \dfrac{\partial \varphi}{\partial col} & \dfrac{\partial \varphi}{\partial lin} \end{pmatrix}^{-1} * \begin{pmatrix} d\lambda \\ d\varphi \end{pmatrix}$$

    Apply the correction to the current image coordinates:

        col$_{cur}$ += dcol

        lin$_{cur}$ += dlin

}

The process iterates until image coordinates converge (image coordinates difference (dcol, dlin) less than a tolerance parameter).

C.3 Using the Analytical Model or the Rational Polynomial Coefficient (RPC) Model

All the data relative to the rational polynomial coefficient model (RPC) are in the RPC file (RPC_*.xml).

The polynomial coefficients order follows the NITF 2.1 norm (RPC00B model).

The rational polynomial coefficient (RPC) model is an analytical model which gives a relationship between:

- Image coordinates + altitude and ground coordinates (direct model: image ➡ ground)

- Ground coordinates + altitude and image coordinates (inverse model: ground ➡ image)

Ground coordinates used by inverse model or calculated by direct model are (longitude, latitude) in WGS84 geodetic system, the 'altitude' used is a height above ellipsoid.

As NITF has only documented inverse models, inverse model is the most popular method in COTS.

All coordinates must be centre-normalised.

Centre-normalised coordinates are calculated as followed:

    col$_{CN}$ = (col – SAMP_OFF) / SAMP_SCALE

    lin$_{CN}$ = (lin – LINE_OFF) / LINE_SCALE

    lon$_{CN}$ = (lon – LONG_OFF) / LONG_SCALE

    lat$_{CN}$ = (lat – LAT_OFF) / LAT_SCALE

    alt$_{CN}$ = (h$_{ground}$ – HEIGHT_OFF) / HEIGHT_SCALE

C.3.1 Direct Localisation Algorithm

When using direct model (image ➡ ground), users give image coordinates (col, lin) and an altitude (alt). The results of the application model are geographic coordinates (lon, lat).

Transform image coordinates into centre-normalised image coordinates:

    col$_{CN}$ = (col – SAMP_OFF) / SAMP_SCALE
    lin$_{CN}$ = (lin – LINE_OFF) / LINE_SCALE

Transform altitude coordinate into centre-normalised altitude coordinate:

    alt$_{CN}$ = (alt – HEIGHT_OFF) / HEIGHT_SCALE

For direct model, the rational function polynomial equations are defined as:

$$lon_{CN} = \frac{\sum_{i=1}^{20} SAMP\_NUM\_COEFF_i \bullet \rho_i(lin_{CN}, col_{CN}, alt_{CN})}{\sum_{i=1}^{20} SAMP\_DEN\_COEFF_i \bullet \rho_i(lin_{CN}, col_{CN}, alt_{CN})}$$

$$lat_{CN} = \frac{\sum_{i=1}^{20} LINE\_NUM\_COEFF_i \bullet \rho_i(lin_{CN}, col_{CN}, alt_{CN})}{\sum_{i=1}^{20} LINE\_DEN\_COEFF_i \bullet \rho_i(lin_{CN}, col_{CN}, alt_{CN})}$$

The rational function polynomial equation numerators and denominators are each 20-term cubic polynomial functions of the form:

$$\sum_{i=1}^{20} C_i \bullet \rho_i(lin_{CN}, col_{CN}, alt_{CN}) =$$

$$C_1 \dots + C_6 \bullet col_{CN} \bullet alt_{CN} + C_{11} \bullet lin_{CN} \bullet col_{CN} \bullet alt_{CN} + C_{16} \bullet lin_{CN}^3$$
$$+ C_2 \bullet col_{CN} \dots + C_7 \bullet lin_{CN} \bullet alt_{CN} + C_{12} \bullet col_{CN}^3 \dots + C_{17} \bullet lin_{CN} \bullet alt_{CN}^2$$
$$+ C_3 \bullet lin_{CN} \dots + C_8 \bullet col_{CN}^2 \dots + C_{13} \bullet col_{CN} \bullet lin_{CN}^2 \dots + C_{18} \bullet col_{CN}^2 \bullet alt_{CN}$$
$$+ C_4 \bullet alt_{CN} \dots + C_9 \bullet lin_{CN}^2 \dots + C_{14} \bullet col_{CN} \bullet alt_{CN}^2 \dots + C_{19} \bullet lin_{CN}^2 \bullet alt_{CN}$$
$$+ C_5 \bullet col_{CN} \bullet lin_{CN} + C_{10} \bullet alt_{CN}^2 \dots + C_{15} \bullet col_{CN}^2 \bullet lin_{CN} \dots + C_{20} \bullet alt_{CN}^3$$

Where coefficients C1..C20 represent the following sets of coefficients:

SAMP_NUM_COEF_n, SAMP_DEN_COEF_n, LINE_NUM_COEF_n, LINE_DEN_COEF_n, which can be found under the node 'Direct Model' in the RPC file.

Transform centre-normalised ground coordinates into ground coordinates:

lon = lonCN * LONG_SCALE + LONG_OFF

lat = latCN * LAT_SCALE + LAT_OFF

C.3.2 Inverse Localisation Algorithm

When using the inverse model (ground ➜ image), the user supplies geographic coordinates (lon, lat) and an altitude (alt). The results of the application model are image coordinates (col, lin).

Transform ground coordinates into centre-normalised ground coordinates:

lonCN = (lon – LONG_OFF) / LONG_SCALE

latCN = (lat – LAT_OFF) / LAT_SCALE

Transform altitude coordinate into centre-normalised altitude coordinate:

altCN = (alt – HEIGHT_OFF) / HEIGHT_SCALE

For inverse model, the rational function polynomial equations are defined as:

$$lin_{CN} = \frac{\sum_{i=1}^{20} LINE\_NUM\_COEFF_i \bullet \rho_i(lat_{CN}, lon_{CN}, alt_{CN})}{\sum_{i=1}^{20} LINE\_DEN\_COEFF_i \bullet \rho_i(lat_{CN}, lon_{CN}, alt_{CN})}$$

The rational function polynomial equation numerators and denominators are each 20-term cubic polynomial functions of the form:

$$\sum_{i=1}^{20} C_i \bullet \rho_i(lat_{CN}, lon_{CN}, alt_{CN}) =$$

$$C_1 \ldots\ldots\ldots + C_6 \bullet lon_{CN} \bullet alt_{CN} + C_{11} \bullet lat_{CN} \bullet lon_{CN} \bullet alt_{CN} + C_{16} \bullet lat_{CN}^3$$
$$+C_2 \bullet lon_{CN} \ldots\ldots + C_7 \bullet lat_{CN} \bullet alt_{CN} + C_{12} \bullet lon_{CN}^3 \ldots\ldots\ldots + C_{17} \bullet lat_{CN} \bullet alt_{CN}^2$$
$$+C_3 \bullet lat_{CN} \ldots\ldots + C_8 \bullet lon_{CN}^2 \ldots\ldots + C_{13} \bullet lon_{CN} \bullet lat_{CN}^2 \ldots\ldots + C_{18} \bullet lon_{CN}^2 \bullet alt_{CN}$$
$$+C_4 \bullet alt_{CN} \ldots\ldots + C_9 \bullet lat_{CN}^2 \ldots\ldots + C_{14} \bullet lon_{CN} \bullet alt_{CN}^2 \ldots\ldots + C_{19} \bullet lat_{CN}^2 \bullet alt_{CN}$$
$$+C_5 \bullet lon_{CN} \bullet lat_{CN} . + C_{10} \bullet alt_{CN}^2 \ldots\ldots + C_{15} \bullet lon_{CN}^2 \bullet lat_{CN} \ldots\ldots + C_{20} \bullet alt_{CN}^3$$

Where coefficients C1...C20 represent the following sets of coefficients:

SAMP_NUM_COEF_n, SAMP_DEN_COEF_n, LINE_NUM_COEF_n, LINE_DEN_COEF_n, which can be found under the node 'Inverse Model' in the RPC file.

Transform centre-normalised image coordinates into image coordinates

col = colCN * SAMP_SCALE + SAMP_OFF
lin = linCN * LINE_SCALE + LINE_OFF

C.4 Other Informative Geometric Data

The other geometric data associated to the image area are under the node:

<Dimap_Document><Geometric_Data>
<Use_Area><Located_Geometric_Values>

These data are given for information only. These data are given at the beginning, the middle and the end of image acquisition.

C.4.1 Acquisition Angles

C.4.1.1 Incidence and viewing angles
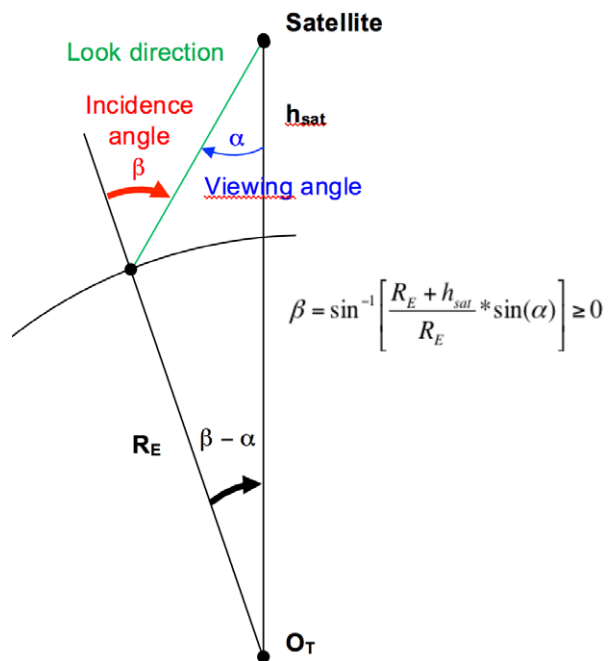
Figure C.4a: Relation between incidence angle and viewing angle

Incidence angle β (or global incidence) is the angle between the ground normal and look direction from satellite. For SPOT 6/7, the range for the incidence angle is [0, 55 degrees].

The satellite azimuth angle is the angle between the meridian passing through the centre of raw scene and the line passing through the centre of raw scene and the satellite nadir point. The range for the azimuth angle is [0, 360 degrees], clockwise positive. As shown on Figure C.4b.

Satellite azimuth angle

The satellite azimuth angle Az_{sat} is the angle between the meridian indicating the north passing through an image point and the line passing through this image point and the satellite nadir point. The range for the satellite azimuth angle is [0, 360 degrees], clockwise positive. As shown below in *Figure C.4b*.

Figure C.4b: Satellite azimuth angle

- Position **P1** of swath center pixel is computed
- North direction **N** is computed for this point
- Satellite nadir point **P2** is computed
- Direction **V** between nadir point P2 and centre swath P1 is computed
- Direct angle between **N** and **V** is the azimuth

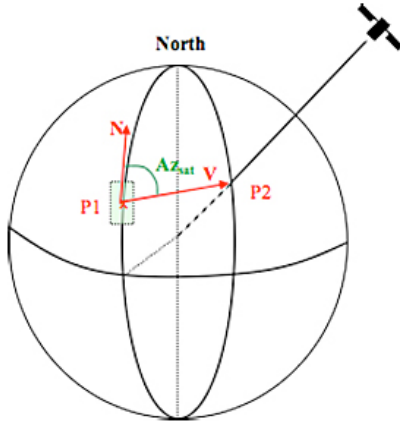The look direction from the satellite on the ground may be projected on two planes: (normal to the ground, Scan Axis) and (normal to the ground, OrthoScan axis).

Thus, incidence may be measured in both planes:

- INCIDENCE_ANGLE_ALONG_TRACK: Incidence in the Scan axis direction (image line axis on the ground)

- INCIDENCE_ANGLE_ACROSS_TRACK: Incidence in the OrthoScan axis direction
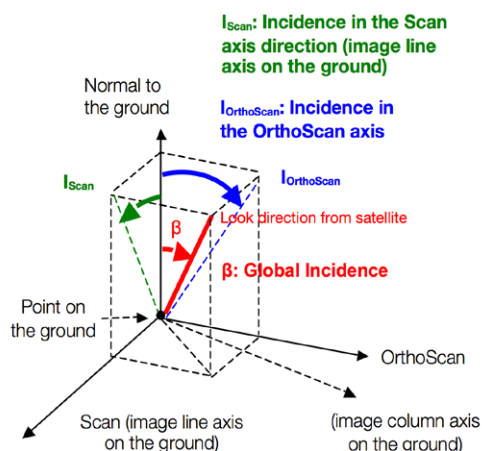
Figure C.4c: incidence angle projected on two planes

The viewing angle from the satellite α (also named VIEWING_ ANGLE in DIMAP format) is the angle between look direction from the satellite and nadir. For Pléiades, the range for the viewing angle is nominally [0, 30 degrees] – but can be opened to raise revisit frequency over a given target.

Look direction angle from the satellite may be projected onto two planes defined in the local orbital frame: (yaw axis, pitch axis) and (yaw axis, roll axis) – see *Figure C.4d* – Thus, viewing may be measured in both planes:

- VIEWING_ANGLE_ACROSS_TRACK (aX): viewing angle in the across-track axis direction (roll)

- VIEWING_ANGLE_ALONG_TRACK (aY): viewing angle in the along-track axis direction (pitch)
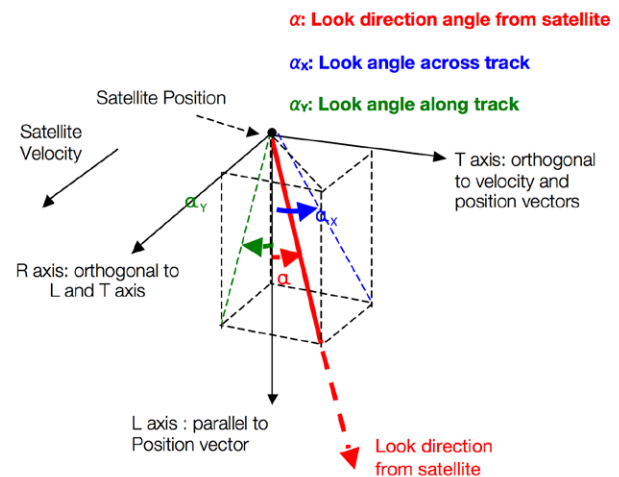
Figure C.4d: Viewing angle along and across track

C.4.2 Solar Angles

The following angles (see Figure C.4e) are calculated in a local Earth frame (Normal to the ground, North, East):

- SUN_AZIMUTH (Az_{sun})
- SUN_ELEVATION (El_{sun})
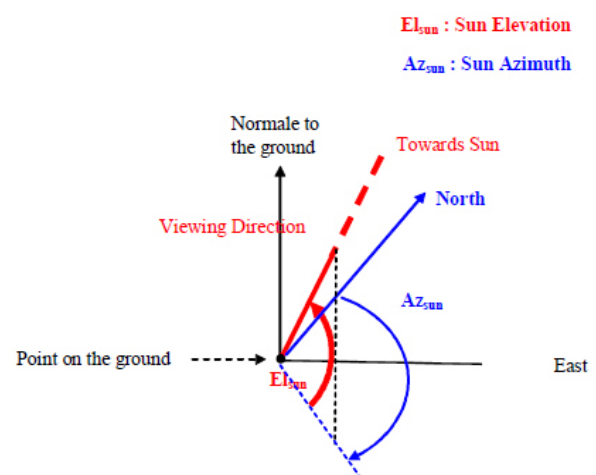
Figure C.4e: Solar incidences

C.4.3 Ground Sample Distance (GSD)

Ground Sample Distance (GSD) is the Ground distance in meters viewed on board by two consecutive pixels along both directions: image line direction and image column direction at acquisition.

GSD_ACROSS_TRACK: pixel size along image column direction

GSD_ALONG_TRACK: pixel size along image line direction

Appendix D: Spectral Modelling

Pixel values are raw Digital Counts numbers (DN) representing quantity of photons measured by the onboard sensor. Integrating many contributors at instrument level (detector efficiency, filters, optical effect on mirrors...) these Digital Counts are relative to a physical spectral measure like spectral radiance. They are not cross-band neither physically normalized.

Physical applications require conversion of raw Digital Count numbers to physical units. Current physical measurements include radiance (at-Ground or at-Top Of Atmosphere), reflectance, or albedo. The conversion to such physical values is explained hereunder.

D.1 SPOT 6 Spectral Bands

SPOT 6 acquires images in five spectral ranges. Compared to the spectral ranges specification (see Table 35) following spectral ranges are based on a rejection measurement at 1%:

| Spectral ranges	λmin	λmax
PAN - Panchromatic	0.455 μm	0.744 μm
B0 – Blue	0.454 μm	0.519 μm
B1 – Green	0.527 μm	0.587 μm
B2 – Red	0.624 μm	0.694 μm
B3 – Near Infrared	0.756 μm	0.880 μm

Table D: SPOT 6 spectral bands

D.2 Spectral Sensitivity of the SPOT 6 Sensor

Any sensor is sensitive to all wavelengths of the electromagnetic spectrum. For each band, the sensor has a characteristic response curve as a function of wavelength.

The spectral normalized sensitivities of the SPOT 6 sensor are represented on Figure D:
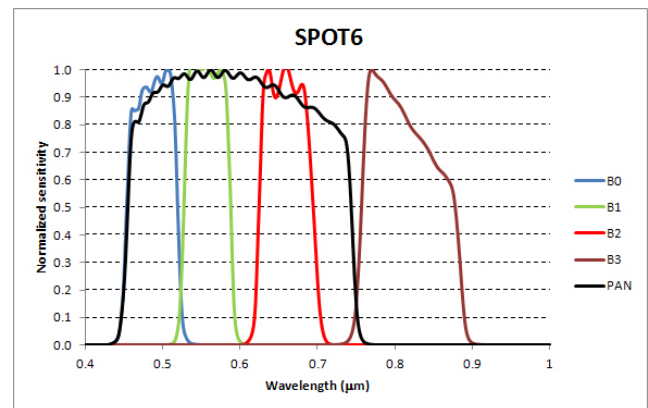
Figure D.2: Spectral normalized sensitivities of SPOT 6 sensors

The min and max sensitivities given for spectral band range are asset with a rejection at 1%.

D.3 Converting Digital Count to TOA Radiance

For a respective band (b), the conversion of the Digital Count of a pixel DC(p) to Top Of Atmosphere (TOA) radiance L_b(p) (in W·sr^{-1}·m^{-2}·µm^{-1}) is done by the absolute radiometric calibration coefficients GAIN and BIAS:

$$L_b(p) = \frac{DC(p)}{GAIN(b)} + BIAS(b)$$

Absolute radiometric calibration coefficients are updated periodically, typically 4 times per year, asset on the sensor native radiometric range of 12 bit-depth.

The coefficients are recomputed for products ranged to 8 bit-depth with a linear adjustment, meaning a nonzero BIAS value. These coefficients have no sense when other radiometric adjustments like seamless (Mosaic) have been applied on the data.

D.4 TOA Spectral Reflectance

The Top Of Atmosphere (TOA) spectral reflectance is the ratio of the TOA radiance normalized by the incoming solar irradiance:

$$\rho_b(p) = \frac{\pi . L_b(p)}{E_0(b) . \cos(\theta_s)}$$

User may complete this basic equation with additional terms like variation of solar illumination with Earth-Sun distance, etc.

To take into account the spectral sensitivity of the sensors (see D.2), an equivalent spectral radiance will be computed:

$$L_{eq}(b) = \frac{\int L_b . S_b(\lambda) . d\lambda}{\int S_b(\lambda) . d\lambda}$$

For applications requiring very accurate radiometric profiles, these data values can be provided upon request by submitting an email to **technicalsupport@intelligence-airbusds.com.**

Abbreviations, Acronyms and Terms

Area Of Interest (AOI): The abbreviation for area of interest. An AOI outlines a particular region by panel, shape, preset values, or by a defined line and sample. An AOI is used for clipping an image area or for processing a subset of image data.
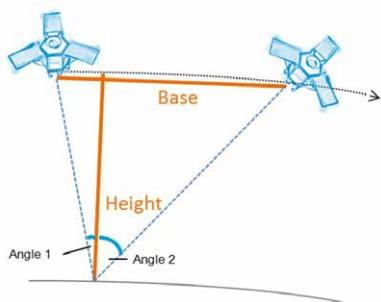

Figure F1: Stereoscopic – B/H

Attitude: The angular orientation of a spacecraft as determined by the relationship between its axes and a reference line or plane or a fixed system of axes. Usually, 'Y' is used for the axis that defines the direction of flight, 'X' for the 'cross-track' axis perpendicular to the direction of flight, and 'Z' for the vertical axis. Roll is the deviation from the vertical axis (the angle between the Z axis of the vehicle and the vertical axis, or angular rotation around the Y axis). Pitch is the angular rotation around the X axis. Yaw is rotation around the Z axis.

Azimuth: The arc of the horizon measured clockwise from the north point to the point referenced, expressed in degrees. Azimuth indicates direction, and not location.

B/H: The Base-over-Height ratio of a stereo pair. This parametre characterises the stereoscopic capacity of a couple (see *Figure F2*), given that the 'Height' value is constant and equals the altitude of the satellite, the larger the base, the larger the angle). Thus, the Base-over-Height ratio reflects the angular difference between the two images. It should be high for rather flat areas and low for urban or mountainous areas. See page 13 for more details about how to select the right B/H ratio.

CE90: Circular Error with a confidence level of 90% (positioning accuracy on both axes). It indicates that the actual location of an object is represented on the image within the standard accuracy for 90% of the points. See also Geolocation accuracy, RMSE.

Map Scale	1:2,400	1:4,800	1:12,000	1:24,000	1:50,000
CE90	2m	4m	10m	12m	25m
RMSE	1m	2m	5m	6m	15m

Table T1: Approx mapscale equivalencies based on US NMAS

CMGs – Control Moment Gyros: The CMG principle relies on the gyroscopic effect to rapidly and instantaneously generate an important output torque by using the spin axis' rotation of a momentum wheel thanks to a cardan gimbaled mechanism. The CMGs are used both for the manoeuvre guidance to ensure transitions between image acquisitions and for the acquisition guidance in order to guarantee the image quality. See section *1.1 Flexibility, Agility and Availability* for benefits of CMGs.

Figure F2: A control moment gyro

Conflict: Two (or more) tasking requests are said to conflict when the satellite is not in a position to image the two (or more) areas during the same orbit. These two tasking requests are also said to be in competition. When there are different priority levels attached to each tasking request, the satellite will image the tasking request with the highest priority level first.

Coordinate Reference System (CRS): A coordinate system related to the Earth through one datum. This definition includes coordinate systems based on geodetic or Cartesian coordinates and coordinate systems based on map projections.

DEM – Digital Elevation Model (or DSM – Digital Surface Model): A digital 3D ground model, including the maximum altitude in every point: with human superstructures and canopy.
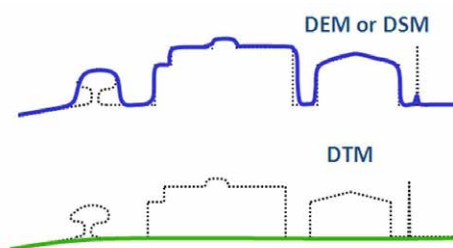

Figure F3: DEM vs. DTM

DRS – Direct Receiving Station: An antenna and a terminal enabling a given partner to receive Pléiades telemetry directly at their facility. For more details about Pléiades DRS, please feel free to contact us.

DTM – Digital Terrain Model: A digital natural ground (bare Earth) model, meaning without human superstructures or canopy. See DEM.

	Level 0	**Level 1**	**Level 2**	**Level 3**
Posting	30 arc sec.	3 arc sec.	1 arc sec.	0.4 arc sec.
At Equator	± 900 m	± 90 m	± 30 m	± 12 m
At 45° latitude	± 630 m	± 63 m	± 21 m	± 9 m
Posting values decrease towards the poles to cope with meridian convergence.				
Absolute horizontal		50 m CE90	23 m CE90	10 m CE90
Absolute vertical		30 m CE90	18 m CE90	10 m CE90
Relative horizontal		–	–	3–10 m CE90
Relative vertical		20 m CE90	12–15m CE90	1–3 m CE90

Table T2: DTED Classes

DTED – Digital Terrain Elevation Data Level: A uniform gridded matrix of ground elevation. It is a standard used to classify DEMs upon their precision and posting. DTED standards encompass several levels of accuracy, from DTED level 0 to DTED level 3. Level 0 content is equivalent to the elevation information of a 1,000,000-scale map (more or less equivalent to GTOPO30, or GLOBE), DTED level 1 to a 250,000-scale map (SRTM public data), and DTED level 2 to a 1:50,000 map.

ECF or ECEF – Earth Centred Earth Fixed coordinates: The Earth Centred Earth Fixed or conventional terrestrial coordinate system rotates with the Earth and has its origin at the centre of the Earth. The X axis passes through the equator at the prime meridian. The Z axis passes through the North Pole but it does not exactly coincide with the instantaneous Earth rotational axis. The Y axis can be determined by the right-hand rule to be passing through the equator at 90° longitude. For more information: **metadata. dod.mil/mdr/ns/GSIP/crs/WGS84C_3D**

FOR – Field Of Regard: The area covered by the detector of the system when pointing to all mechanically possible positions.

Geometric Modelling: The relationship between image and ground coordinates for a given sensor.

GeoTIFF – Geographic Tagged Image File Format: GeoTIFF is a public domain metadata standard which allows georeferencing information to be embedded within a TIFF file. The potential additional information includes map projection, coordinate systems, ellipsoids, datums, and everything else necessary to establish the exact spatial reference for the file.

GIS – Geographic Information System: A geographic information system is a system designed to capture, store, manipulate, analyse, edit, manage, and present all types of geographical data.

Ground Control Point (GCP): A geographic feature of a known location (e.g. corner of a building, rock reflector…) that is recognisable on an image and can be used to determine geometric corrections to improve the geolocation accuracy of the image.

Ground Sampling Distance (GSD): The Ground Sampling Distance is the distance at ground view by two consecutive pixels (in meters) along both directions: image line direction and image column direction. See IFOV and *FigureF4*.
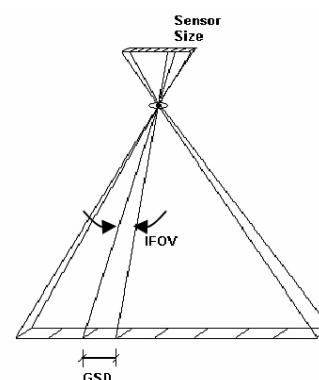

Figure F4: IFOV and GSD

HR – High Resolution: Imagery with a resolution between 1–10 m.

Incidence Angle: See Viewing angle.

Instantaneous Field Of View (IFOV): (1) In a scanning system, this refers to the solid angle subtended by the detector when the scanning motion is stopped. Instantaneous field of view is commonly expressed in milliradians or picoradians. (2) The ground area covered by this solid angle. See GSD.

JPEG 2000: An image compression standard and coding system. It is the default image format for Pléiades products. See section *2.5 Product and Image Format* for more information about JPEG 2000 benefits.

KML – Keyhole Markup Language: An XML notation for expressing geographic annotation and visualisation within internet-based, two-dimensional maps and three-dimensional Earth browsers. KML was developed for use with Google Earth, which was originally named Keyhole Earth Viewer. It was created by Keyhole Inc, which was acquired by Google in 2004. KML is an international standard of the Open Geospatial Consortium.

LE90: A linear error with a confidence level of 90% (positioning/vertical accuracy on one axis). It indicates that the actual elevation of an object is represented within the stated accuracy for at least 90% of the elevation posts.

Linear Adjustment: An algorithm used to rescale bit-depth from 12 to 8 bits. It does not affect the properties of the image histogram (linear transformation) in order to preserve the initial radiometric quality of the imagery. It is activated each time a customer orders 8-bit products, either with automatic values or custom values.

Location Accuracy: Location accuracy means positional accuracy using satellite ancillary data only. It is a measure of the possible difference between the locations of features in the data versus their actual location on the ground. It is usually expressed in units plus or minus some distance (e.g. + or - 50 m) from the actual ground position in either the horizontal or vertical plane. To exclude local terrain effects the specification is asset globally on Ellipsoid. See also CE90, RMSE.

Monoscopic: Acquisition mode which has been obtained by imaging a precise area from a single viewpoint on the orbit.

Mosaic: A mosaic is the end result of combining multiple smaller images into one larger, cohesive image. Geographically, a mosaic is a raster data set composed of multiple raster datasets merged together.

MTF – Modulation Transfer Function: a measure of the image sharpness (the spatial frequencies) of a camera and/or image.

Multispectral (MS): Generally denotes remote sensing in two or more spectral bands (and less than 20 bands), such as visible and infrared. Multispectral capacity enables a sensor to deliver colour images.

Nadir: The point on the ground vertically beneath the sensor.

Near Infra-Red (NIR): The preferred term for the shorter wavelengths in the infrared region (the entire infrared region extends from about 0.7 μm, visible red, to about 3 μm).

Orthogonal: Having three right angles.

Orthorectified: Describes an image which has had the displacements due to tilt and relief removed. The resulting image can be virtually overlaid on a map.

OVR – Optimized Visualization Rendering: An algorithm used to enhance the imagery histogram (like DRA, etc). It modifies the luminosity and contrast of the imagery. Through this enhancement, the initial radiometric properties of the imagery are lost, but the colour balance is adjusted to get an aesthetically pleasing image on a screen. With OVR turned on, the pixel values of the original data cannot be recovered from the product. That is why this option is not recommended for users intending to perform scientific analysis, photointerpretation or spectral classification. OVR is different from linear adjustment (see below).

Pan-sharpening: The practice of using the highest resolution Panchromatic band in conjunction with the other lower resolution multispectral bands to increase the apparent spatial resolution of a multi-band (colour) product.

Panchromatic (PAN): Detectors that are sensitive to visible colours of the spectrum. Pléiades has a Panchromatic band that extends into the near-IR and covers the spectral region between 0.47–0.83 μm.

Pitch: The rotation of a spacecraft about the horizontal axis normal to its longitudinal axis (in the along-track direction) so as to cause a nose-up or nose-down attitude. The pitch axis is referred to as the X axis. See Attitude.

Planimetric Accuracy: The positional accuracy of the image projected on an Earth mapping system and reset with a DEM (vertical reset) and possibly with GCPs (horizontal reset). Unlike Location Accuracy, the Planimetric Accuracy depends on the intrinsic accuracy of the external data (DEM and GCP). Planimetric Accuracy is dedicated for georeferenced products like ortho images.

Priority: A hierarchal system for different tasking requests. In areas of high competition, priority service requests are served first, so customers will see a shorter collection window for priority service requests than for standard service requests.

Pushbroom: The pushbroom scanner, otherwise known as the linear array sensor, is a scanner without a mechanical scanning mirror, or moving parts. Instead, it has a linear array of sensors with one sensor for each area sampled on the ground. Charge-coupled devices (CCDs) are usually used for the sensors. This enables the pushbroom scanner to record one line of an image simultaneously, with this line being perpendicular to the flight direction.

As with mechanical scanners, forward motion is achieved through the flight direction of the platform. See figure below.
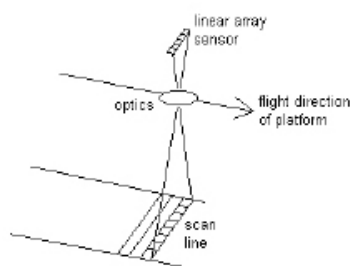

Figure F5:
Pushbroom sensor

Quicklook: Sometimes called a browse image. A quicklook provides an overview of the product with a degraded resolution to make browsing an image catalogue quicker and easier. It gives an immediate understanding of the image quality and cloud cover. Quicklooks of images are, for instance, the images that are used and displayed in the GeoStore catalogue. Basically, the quicklook is a subsampled image. It is compressed and dynamically stretched (by default 2%). Typically, the quicklook image is subsampled by a ratio of 32 vs. the original Panchromatic image sampling (approximately 22 m).

Radiance: A measure of radiant intensity per unit of a projected source area in a specified direction. The unit is the rate of transfer of energy (Watt, W) at sensor input, per square metre on the ground, for one steradian (solid angle from a point on Earth's surface to the sensor), per unit wavelength being measured.

Reference3D®: A database that has been designed to take advantage of highly accurate SPOT 5 stereoscopic images. It consists of three information layers: SPOT DEM (30 m resolution, uniform grid of terrain elevation values of the area of interest), Orthoimage (5 m resolution, orthorectified images from the DEM stereo pairs) and Quality Masks; with a specification of circular planimetric accuracy between 6–10 m for 90% of the points, depending on the location, and an elevation accuracy better than 10 m for 90% of the points, depending on the steepness of the slopes. The average is 5 m. For more information: **http://www.intelligence-airbusds.com/elevation-models/#elevation30**.

Refined attitude data: The attitude data is a main element for geolocation accuracy without GCP. It provides information about the attitude/orientation of the satellite and it is measured by the satellite sensors for each acquired image. The refined attitude data is the average of attitude data gathered on various consecutive orbits. It allows minimising individual attitude data errors (improve geolocation). It is calculated twice per day and automatically re-integrated in the processing chain. It is not available case of rush production of a recently acquired image (< 12h). It is neutral if on-board attitude data are already accurate. This automatic processing secures Pléiades' geolocation and is nominally integrated in Direct Receiving Stations ground processing chains.

Reflectance: The ratio of the reflected radiance divided by the incoming radiance. Reflectance provides a standardised measure, which is directly comparable between images. Reflectance is unitless and thus is measured on a scale from 0 to 1 (or 0–100%). Top-of-Atmosphere (TOA) reflectance does not attempt to account for atmospheric effects and has a directional aspect. Surface reflectance attempts to correct for the atmosphere while also converting to reflectance.

Resolution (spatial resolution): A measure of the smallest angular or linear separation between two objects that can be resolved by the sensor. There is a relationship between the size of the feature to be sensed and the spatial resolution of the optical system. It is simply the dimension in meters of the ground-projected instantaneous field of view (IFOV).

RFC: Rational Function Coefficients (from RPC).

RFM: Rational Function Model (with RPC).

RMSE (root mean squared error): Commonly used for quoting and validating geodetic image registration accuracy. A RMSE value is a single summary statistic that describes the square root of the mean horizontal distance between all photo-identifiable GCPs and their respective twin counterparts acquired in an independent geodetic survey. See also CE90.

Roll: The rotation of a spacecraft about its longitudinal axis (in the along-track direction), so as to cause a side-up or side-down attitude. The roll axis is referred to as the Y axis. See Attitude.

RPC (rational polynomial coefficient): A mathematical model of the image geometry, in the form of a set of rational polynomial coefficients, that one can use to orthorectify the image. This procedure also requires a DEM (Digital Elevation Model). One can often improve the fit of the rational polynomial model to a particular image by re-georeferencing the image using accurate 3D ground control points. See Orthorectified.

Sensor model: A sensor model is a physical representation of a sensor in its state at the time of image collection. The algorithm accounts for refraction, position, orientation, velocity, and viewing directions along the sensor array through the camera. It calculates the transformation between 3-D ground space and image line and sample coordinate points, and vice versa. Every image has unique sensor model parameters that reflect the location and orientation of the sensor at the time the image was collected. The sensor model is native to the image's support measurement functions with ground surface.

Scan line: The ground trace of a narrow strip that is recorded by the instantaneous field of view of a detector in a scanner system.

SHP (shapefile): A popular geospatial vector data format for Geographic Information Systems software. It is developed and regulated by ESRI as a (mostly) open specification for data interoperability among ESRI and other software products.

Shapefiles spatially describe vector geometries: points, polylines, and polygons. These, for example, could represent water wells, rivers, and lakes, respectively. Each item may also have attributes that describe the items, such as the name or temperature.

SNR (signal to noise ratio): SNR measures the radiometric accuracy of an image.

Spectral band: An interval in the electromagnetic spectrum defined by two wavelengths, frequencies, or wave numbers (e.g. Pléiades' blue band covers an area between 0.43–0.55 µm).

Stereo(scopic): Acquisition mode which has been obtained by imaging from two viewpoints on the same orbit.

Sun-synchronous: An Earth satellite orbit in which the orbital plane remains at a fixed angle with respect to the Sun, precessing through 360° during the period of one year. The Pléiades satellites are in a near-polar orbit of this type and maintain an orbital altitude, such that each pass over a given latitude on the Earth's surface occurs at the same mean Sun time every day.

Swath: The width of an image. Pléiades' swath is 20 km at nadir. The swath increases proportionally with the angle.

TDI (time delay integration): A time delay integration charge-coupled device (CCD) is widely used for observation of high-speed moving objects undetectable by classic CCD. This technique senses charge patterns and shifts them across the charge-coupled device (CCD) array in sync with the movement of the image, to integrate more light from the scene.

UTC: Universal time coordinated.

UTM – universal transverse mercator: A projection system that divides the Earth into sixty zones, each a six-degree band of longitude, and uses a secant transverse Mercator projection in each zone.

VHR – very high resolution: Imagery with a resolution below 1 m.

Viewing angle: The angle from the instrument point of view. It represents the angle between the look direction from the satellite and nadir, combining the pitch and roll angles. It is different from the incidence angle.
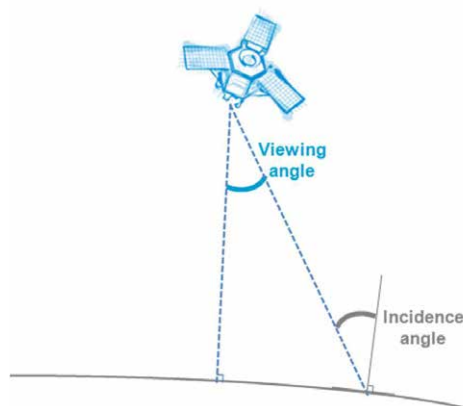

Figure F6: Viewing angle

Yaw: The rotation of a spacecraft about its vertical axis so as to cause the spacecraft's longitudinal axis to deviate left or right from the direction of flight. The yaw axis is referred to as the 'Z' axis. See Attitude.

Zenith: The point in the celestial sphere that is exactly overhead. The opposite of nadir.

Table of symbols and values location in DIMAP V2

This section defines all the symbols (mathematical or specific to SPOT 6/7 involved within at least one of the equations of this document.

Symbol	Description <Location of values in DIMAP V2 format>
Az_i	Scan line azimuth angle of the image line axis between the geographic north and the scan line direction (image orientation). Unit in degree (°). <Geometrice_Data><Use_Area><Located_Geometric_Values><Acquisition_Angles><AZIMUTH_ANGLE>
B	Spectral band identifier. Examples P, B0, B1, B2, B3 = Resp. Panchromatic, Blue, Green, Red and Near Infrared bands. <Band_Measurement_List><Band_Radiance><BAND_ID><GAIN>
BIAS	A bias value. <Band_Measurement_List><Band_Radiance><BAND_ID><BIAS>
C	Light speed.
CoeffPsiX(i)	Polynomial model coefficients: TanPsiX = f(col −colref). <Geometric_Data><Refined_Model><Geometric_Calibration><Instrument_Calibration><Polynomial_Look_Angles><XLOS_(i)>
CoeffPsiY(i)	Polynomial model coefficients: TanPsiY = g(col −colref). <Geometric_Data><Refined_Model><Geometric_Calibration><Instrument_Calibration><Polynomial_Look_Angles><YLOS_(i)>
Col	Image column coordinate.
Col_{ref}	Reference column for polynomial models. <Geometric_Data><Refined_Model><Geometric_Calibration><Instrument_Calibration><Swath_Range><FIRST_COL>
del(c)	Elementary detector.

Symbol	Description
$E_o(\beta)$	$E_o(\beta)$ is the mean Top of Atmosphere (TOA) solar irradiance for the band (b) in W/m²/micrometer. <Band_Measurement_List><Band_Solar_Irradiance><BAND_ID><VALUE>
ERR_BIAS_X	Error at 99.7% (corresponding to 3 * standard deviation) for the longitude (unit meter) between RPC model and physical model. <ERR_BIAS_X>
ERR_BIAS_Y	Error at 99.7% (corresponding to 3 * standard deviation) for the latitude (unit meter) between RPC model and physical model. <ERR_BIAS_Y>
ERR_BIAS_COL	Error at 99.7% (corresponding to 3 * standard deviation) for the column (sample) (unit pixel) between RPC model and physical model. <ERR_BIAS_COL>
ERR_BIAS_ROW	Error at 99.7% (corresponding to 3 * standard deviation) for the line (sample) (unit pixel) between RPC model and physical model. <ERR_BIAS_ROW>
FIRST_COL LAST_COL	Validity domain for column image coordinate (sample) available for Global RFM or partial RFM. <Rational_Function_Model><Global_RFM> or <Partial_RFM><RFM_Validity><Direct_Model_Validity_Domain><…>
FIRST_ROW LAST_ROW	Validity domain for line image coordinate (row) available for Global RFM or partial RFM. <Rational_Function_Model><Global_RFM> or <Partial_RFM><RFM_Validity><Direct_Model_Validity_Domain><…>
FIRST_LAT LAST_LAT	Validity domain for latitude coordinate available for Global RFM or partial RFM. <Rational_Function_Model><Global_RFM> or <Partial_RFM><RFM_Validity><Inverse_Model_Validity_Domain><…>
FIRST_LON LAST_LON	Validity domain for longitude coordinate available for Global RFM or partial RFM. <Rational_Function_Model><Global_RFM> or <Partial_RFM><RFM_Validity><Inverse_Model_Validity_Domain><…>

GAIN	A gain value. <Band_Measurement_List><Band_ Radiance><BAND_ID><GAIN>		LINE_NUM_ COEFF_i	Polynomial coefficients used to calculate the numerator (P) in order to obtain centre-normalised latitude (i from 1 until 20).
H	Altitude.			Direct model: <Rational_Function_Model><Global_ RFM><Direct_Model><LINE_NUM_COEFF_ i>
h_{ground}	Ground altitude.			
h_{sat}	Altitude of satellite.			Inverse model:
HEIGHT_ OFF	Altitude offset used in RPC model. <Rational_Function_Model><Global_ RFM><RFM_Validity><HEIGHT_OFF >			<Rational_Function_Model><Global_ RFM><Inverse_Model><LINE_NUM_ COEFF_i>
HEIGHT_ SCALE	Altitude scale factor used in RPC model. <Rational_Function_Model><Global_ RFM><RFM_Validity><HEIGHT_SCALE >		LINE_OFF	Line offset used in RPC model. <Rational_Function_Model><Global_ RFM><RFM_Validity><LINE_OFF>
I	Viewing incidence.		LINE_ SCALE	Line scale factor used in RPC model. <Rational_Function_Model><Global_ RFM><RFM_Validity><LINE_SCALE>
Lin	Image line coordinate.			
lin_{ref}	Reference line to line-timing model.		LONG_OFF	Longitude offset used in RPC model. <Rational_Function_Model><Global_ RFM><RFM_Validity><LONG_OFF>
lat, long	Geographic coordinates.			
LAT_OFF	Latitude offset used in RPC model. <Rational_Function_Model><Global_ RFM><RFM_Validity><LAT_OFF>		LONG_ SCALE	Longitude scale factor used in RPC model. <Rational_Function_Model><Global_ RFM><RFM_Validity><LONG_SCALE>
LAT_SCALE	Latitude scale factor used in RPC model. <Rational_Function_Model><Global_ RFM><RFM_Validity><LAT_SCALE>			
			M	Number of time stamp samples found in the product.
LINE_DEN_ COEFF_i	Polynomial coefficients used to calculate the denominator (Q) in order to obtain centre-normalised latitude (i from 1 until 20).		(O, X, Y, Z)	Terrestrial Cartesian Coordinate.
			O	Earth gravity centre.
			X	OXZ define Greenwich prime meridian plane.
	Direct model: <Rational_Function_Model><Global_ RFM><Direct_Model><LINE_DEN_COEFF_i>		Y	Y orthogonal to X and Z.
			Z	Pole axis.
	Inverse model: <Rational_Function_Model><Global_ RFM><Inverse_Model><LINE_DEN_COEFF_ i>		O_S	Satellite gravity centre.
			(O_S, T, R, L)	Local Orbit Frame.
			T	Pitch axis: $\vec{T} = \dfrac{\overrightarrow{Vit} \wedge \overrightarrow{Pos}}{\left\| \overrightarrow{Vit} \wedge \overrightarrow{Pos} \right\|})$
			R	Roll axis: $\vec{R} = \vec{T} \wedge \vec{L}$

L	Yaw axis (build with Satellite Position: $\vec{L} = -\dfrac{\overrightarrow{Pos}}{\left\|\overrightarrow{Pos}\right\|}$)
(O_G, X_v, Y_v, Z_v)	Steering frame (or viewing frame).
X_v	Parallel to scan line direction.
Y_v	Parallel to detector array.
Z_v	Towards Earth.
(O_G, X_c, Y_c, Z_c)	'Pointing' frame. $(X_c, Y_c, Z_c) = (X_v, Y_v, Z_v)$ when attitude control is perfect.
Period	Line period (in ms). <Geometric_Data><Refined_Model><Time><Time_Stamp><LINE_PERIOD>
PosX(t) PosY(t) PosZ(t)	Satellite location at the given time.
PosX(t_i) PosY(t_i) PosZ(t_i)	Satellite locations at different times ti. <Geometric_Data><Refined_Model><Ephemeris><Point_List><Point(i)> < LOCATION_XYZ>
Q0	Quaternion component: Q0. <Geometric_Data><Refined_Model><Attitudes><Quaternion_List><Quaternion><Q0>
Q1	Quaternion component: Q1. <Geometric_Data><Refined_Model><Quaternion_List><Quaternion><Attitudes><Q1>
Q2	Quaternion component: Q2. <Geometric_Data><Refined_Model><Quaternion_List><Quaternion><Attitudes><Q2>
Q3	Quaternion component: Q3. <Geometric_Data><Refined_Model><Attitudes><Quaternion_List><Quaternion><Q3>
R_E	Mean Earth Radius (RE ≈ 6367,45km).
S_b	The spectral sensor sensitivity of b band.

SAMP_OFF	Column (sample) offset used in RPC model. <Rational_Function_Model><Global_RFM><RFM_Validity><SAMP_OFF>
SAMP_SCALE	Column (sample) scale factor used in RPC model. <Rational_Function_Model><Global_RFM><RFM_Validity><SAMP_SCALE>
SAMP_DEN_COEFF_i	Polynomial coefficients used to calculate the denominator (Q) in order to obtain centre-normalised longitude (i from 1 until 20). Direct model: <Rational_Function_Model><Global_RFM><Direct_Model><SAMP_DEN_COEFF_i> Inverse model: <Rational_Function_Model><Global_RFM><Inverse_Model><SAMP_DEN_COEFF_i>
SAMP_NUM_COEFF_i	Polynomial coefficients used to calculate the numerator (P) in order to obtain centre-normalised longitude (i from 1 until 20). Direct model: <Rational_Function_Model><Global_RFM><Direct_Model><SAMP_NUM_COEFF_i> Inverse model: <Rational_Function_Model><Global_RFM><Inverse_Model><SAMP_NUM_COEFF_i>
Scale	Scale factor used in Centred normalised time value calculation. <Geometric_Data><Refined_Model><Attitudes><Polynomial_Quaternions>< SCALE>
T	Viewing time computed for a given line.
t_{CN}	Centred normalised time value.
t_i	Ephemeris point times. <Geometric_Data><Refined_Model><Ephemeris><Point_List><Point><TIME>
t_{mean}	Absolute mean time computed with ephemeris point times.

trel$_i$	Ephemeris point times relative to mean absolute time.
t$_{ref}$	Reference time corresponding to reference line (see lin$_{ref}$). <Geometric_Data><Refined_Model><Time><Time_Range><START>
V$_{ground}$	Image orientation on the ground.
V$_{sat}$	Satellite velocity.
Vis$_{Scan}$	Viewing angle in image focal plane frame.
VisX$_{Scan}$	X coordinate of Vis$_{Scan}$
VisY$_{Scan}$	Y coordinate of Vis$_{Scan}$
VisZ$_{Scan}$	Z coordinate of Vis$_{Scan}$
X$_{Scan}$	Parallel vector to image line axis.
Y$_{Scan}$	Parallel vector to detector array.
Z$_{Scan}$	Vector towards Earth.
α	Incidence angle (°). <Geometric_Data><Use_Area><Located_Geometric_Values><Acquisition_Angles><VIEWING_ANGLE>
α$_x$	Viewing angle in the across-track axis direction (roll). <Geometric_Data><Use_Area><Located_Geometric_Values><Acquisition_Angles><VIEWING_ANGLE_ACROSS_TRACK>
α$_y$	Viewing angle in the along-track axis direction (pitch). <Geometric_Data><Use_Area><Located_Geometric_Values><Acquisition_Angles><VIEWING_ANGLE_ALONG_TRACK>

β	Incidence angle (°). <Geometric_Data><Use_Area><Located_Geometric_Values><Acquisition_Angles><INCIDENCE_ANGLE>
θ$_s$	The sun zenith angle (sun zenith angle = 90°– sun elevation angle) <Geometric_Data><Use_Area><Located_Geometric_Values><Solar_Incidences><SUN_ELEVATION>
θ	Pitch angle.
ρ	Reflectance
φ	Roll angle.
ψ	Yaw angle.
ψ$_x$	Viewing direction angle in the Y$_{Scan}$ direction (parallel to detector array).
ψ$_y$	Viewing direction angle in the X$_{Scan}$ direction (parallel to image line axis).
Ω	Earth rotation angular speed.

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