Pléiades 1A & 1B
SPOT 6 & 7

Status of Astrium GEO-Information Services' EO Satellite Constellation

Drew Hopwood

All the space you need

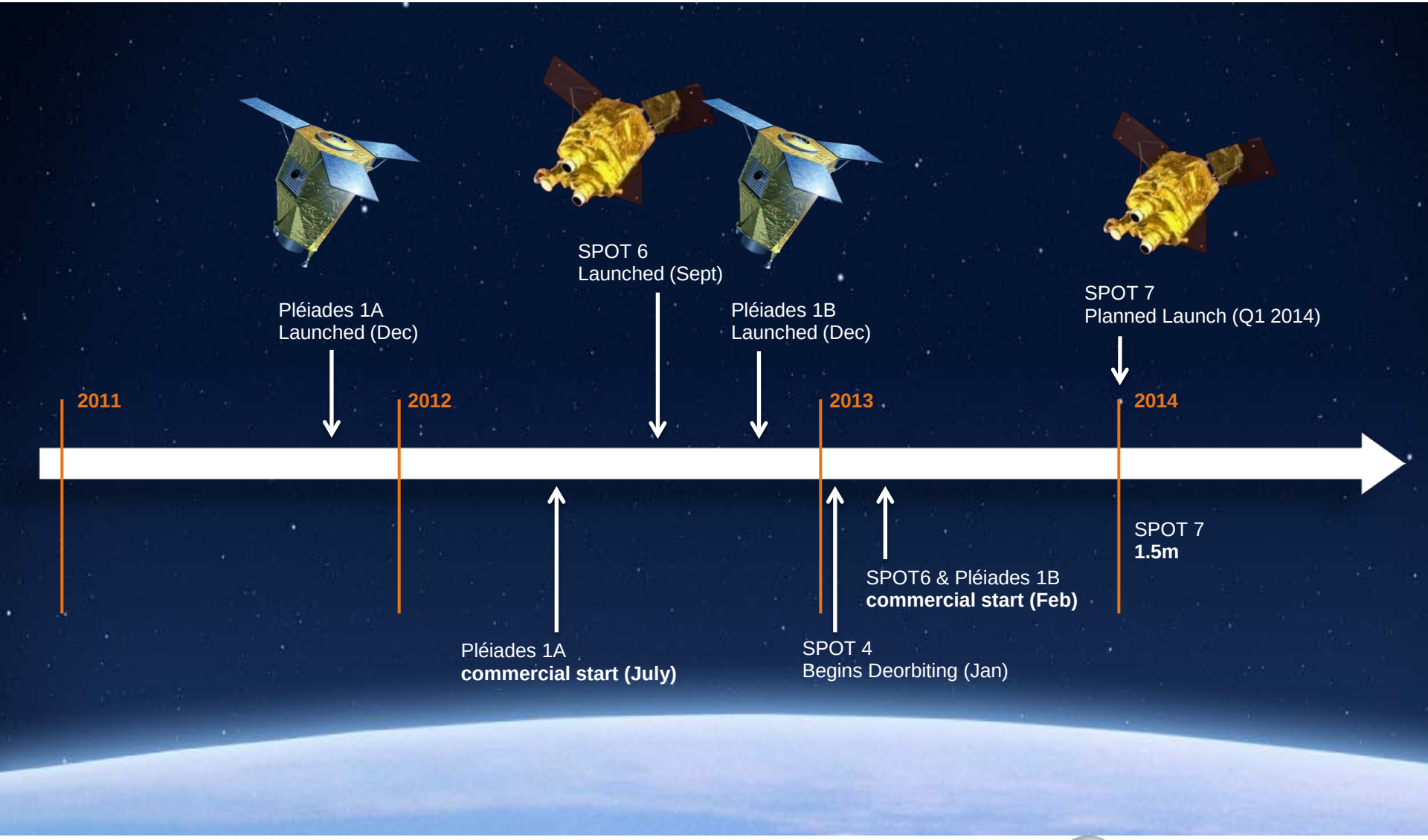
ASTRIUM
AN EADS COMPANY

Agenda

- Overview of the new Satellites
- Satellites
  - Orbit
  - Collection Performance
  - Image Quality
- Ground Segment
  - Tasking
  - Production
- Continuing improvements

This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

A Time of Rapid Growth for Astrium



Product Overview

Sensors

Bands	1 panchromatic 4 multispectral
12 bits	Dynamic range
Color Bundle	Standard mode acquisition

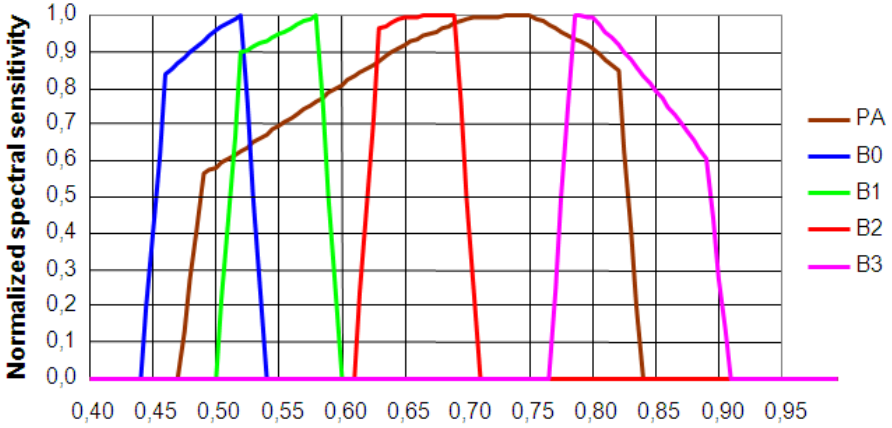
Products

50cm **2m**	Pléiades PAN resolution Pléiades XS resolution
1.5m **6m**	Spot 6 & 7 PAN resolution Spot 6 & 7 XS resolution
Ortho rectified	Fully automatic processing, incl monopass mosaics for Pléiades

This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

Pleiades Product Resolution and Spectral Bands

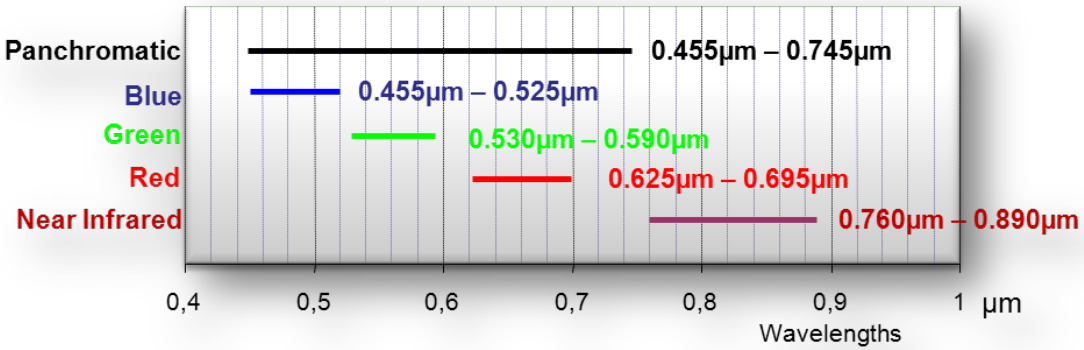
- Panchromatic (50 cm)
  - 480 – 830nm
- Multispectral (2 m)
  - Blue: 430 – 550nm
  - Green: 490 – 610nm
  - Red: 600 – 720nm
  - Near infrared: 750 – 950nm
- Pan & MS Acquired Simultaneously
- 12 bits Dynamic Range
- 20km Collection Swath



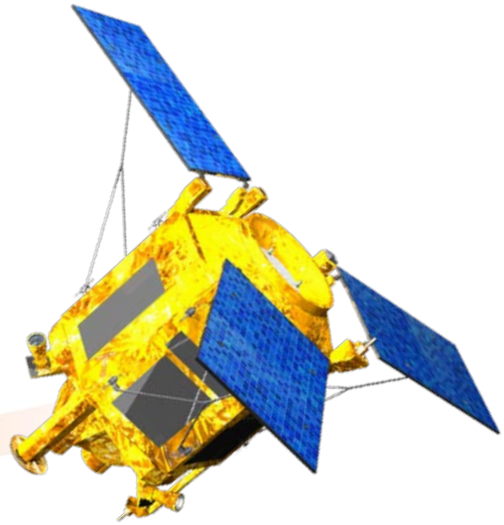
This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

SPOT 6/7 Products

- Panchromatic (1.5 m)
  - 455 – 745nm
- Multispectral (6 m)
  - Blue: 455 – 525nm
  - Green: 530 – 590nm
  - Red: 625 – 695nm
  - Near infrared: 760 – 890nm



- 12 bit Dynamic Range
- Swath: 60 km
- Simultaneous acquisition of Pan & Multispectral



This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

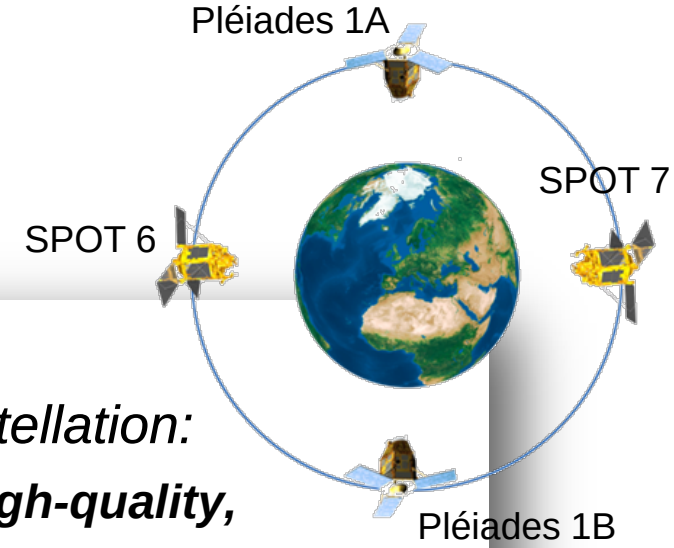
Sensor comparison

		SPOT 4	SPOT 5	SPOT 6/7	Pleiades
Resolution		10m Pan 20m MS	2.5m, 5m Pan 10m MS	1.5m Pan 6m MS	50cm Pan 2m MS
Spectral Bands (µm)	**Pan**	Pan:0.61 - 0.68	Pan:0.48-0.71	Pan:0.45-0.75	Pan:0.47-0.83
	XS0			Blue:0.45-0.52	Blue:0.43-0.55
	XS1	Green:0.50-0.59	Green:0.50-0.59	Green:0.53-0.59	Green:0.50-0.62
	XS2	Red:0.61-0.68	Red:0.61-0.68	Red:0.63-0.70	Red:0.59-0.71
	XS3	NIR:0.78-0.89	NIR:0.78-0.89	NIR:0.76-0.89	NIR:0.74-0.94
	SWIR	SWIR:1.58-1.75	SWIR:1.58-1.75		
Bit Depth		8 bit	8 bit	12 bit	12 bit
Image Swath		60km	60km	60km	20km
Revisit		1-3 days	1-3 days	Daily*	Daily

* When both satellite are operational

This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

Phased orbit



***<u>2 X 2 twins satellites</u>**, featuring a true constellation:*

- *providing coherent products, with the **same high-quality,***
- *coherently operated (**90°** one from the other **on the same orbit**) through a single interface: full leverage of synergies, for*

✓ **Status – All satellites in final orbit**

This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

Phased Orbit & Twin Satellites

Example of places between 33 and 34 lat: Baghdâd, Casablanca, Los Angeles, South Korea, Cape Town, Santiago de Chile, Kabul…

✓ **23 passes** in a month = **23 days** with information, **31/31** with increased angle

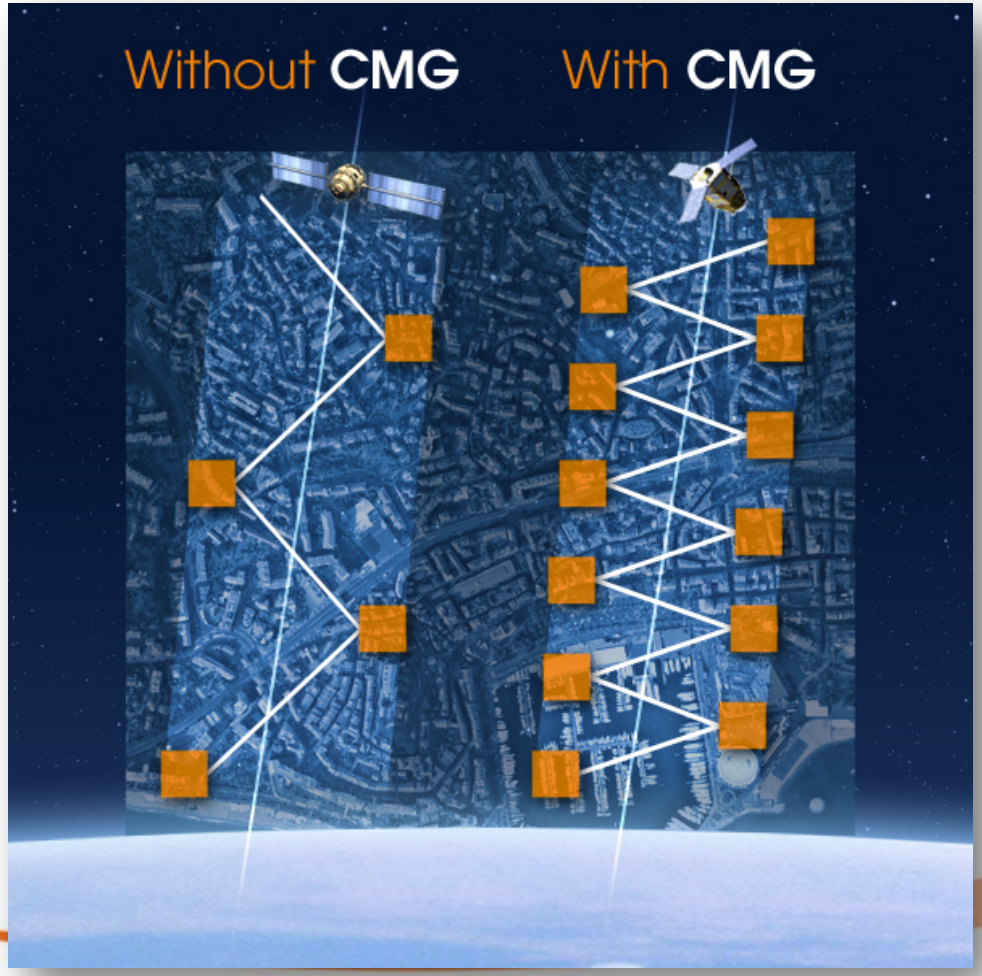
✓ **Unprecedented capacity** with such resolution for crisis or regular monitoring

✓ Twin satellites, one tasking interface, for an **undifferentiated access** any product (stereo, tristereo, color product…)

This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

A State-of-the-Art Agility

Collection Performance



- Twice as many images collected as satellites without CMGs during the same orbit slot

Increase acquisition opportunities, and probability of success:

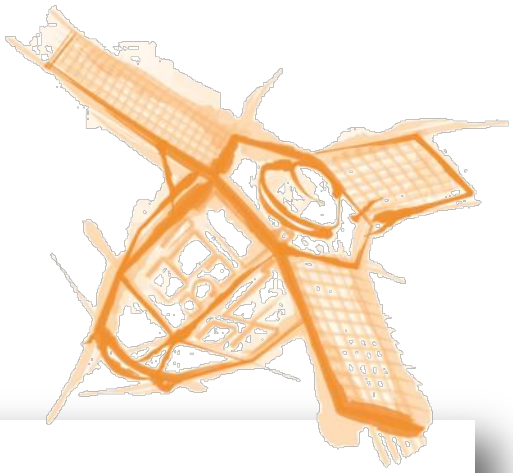
Shortened average acquisition window

This document and its content is the property of Astrium [Ltd/SAS/GmbH] and is strictly confidential. It shall not be communicated to any third party without the written consent of Astrium [Ltd/SAS/GmbH].

This document and its content is the property of Astrium [Ltd/SAS/GmbH] and is strictly confidential. It shall not be communicated to any third party without the written consent of Astrium [Ltd/SAS/GmbH].

Amazing Pléiades

Incredible Agility and Responsiveness

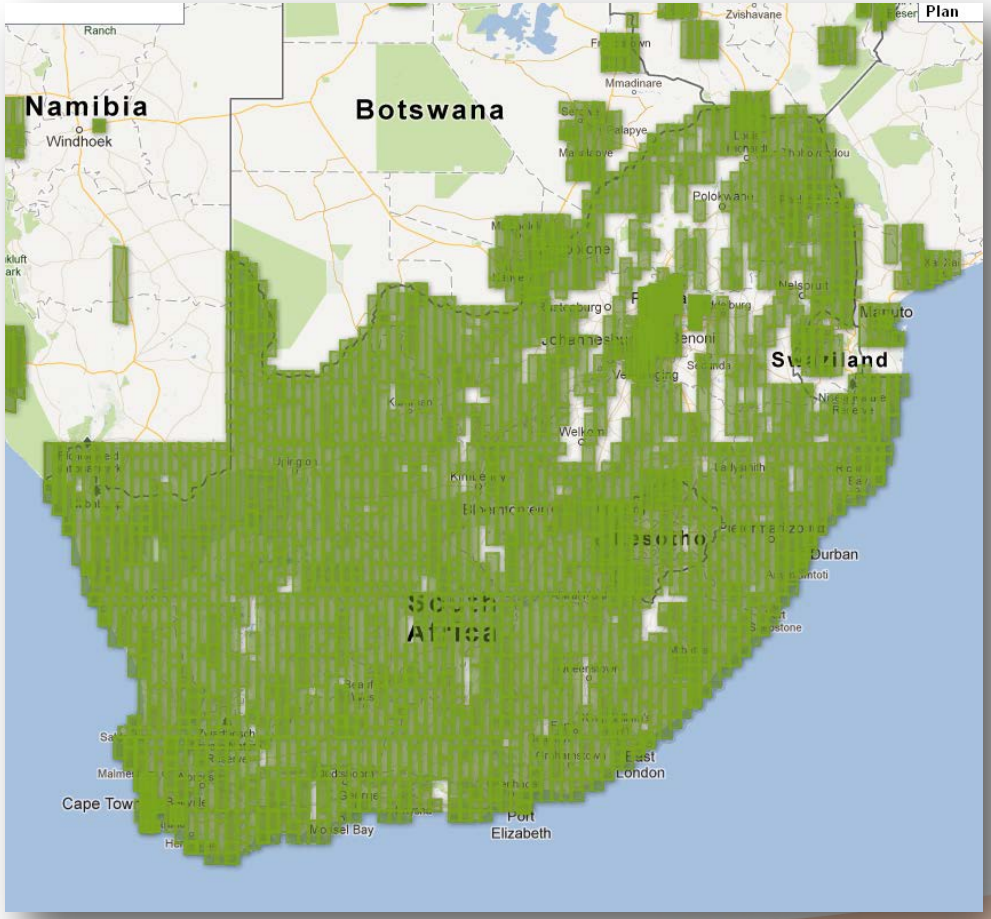


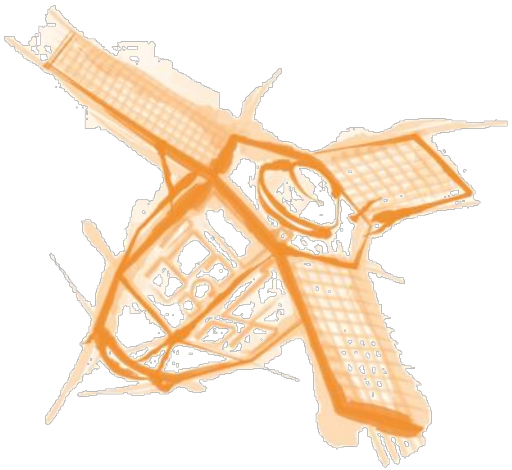
- ✓ Pléiades's superior agility, combined with CNES imagination and smartness, enabled to image another satellite in flight.

- ✓ An impressive achievement, since Pléiades 1A and SPOT 5 are flying at **7.5km/s** and **7.4 km/s**.

Proven Example

Large Areas Covered in Record Time





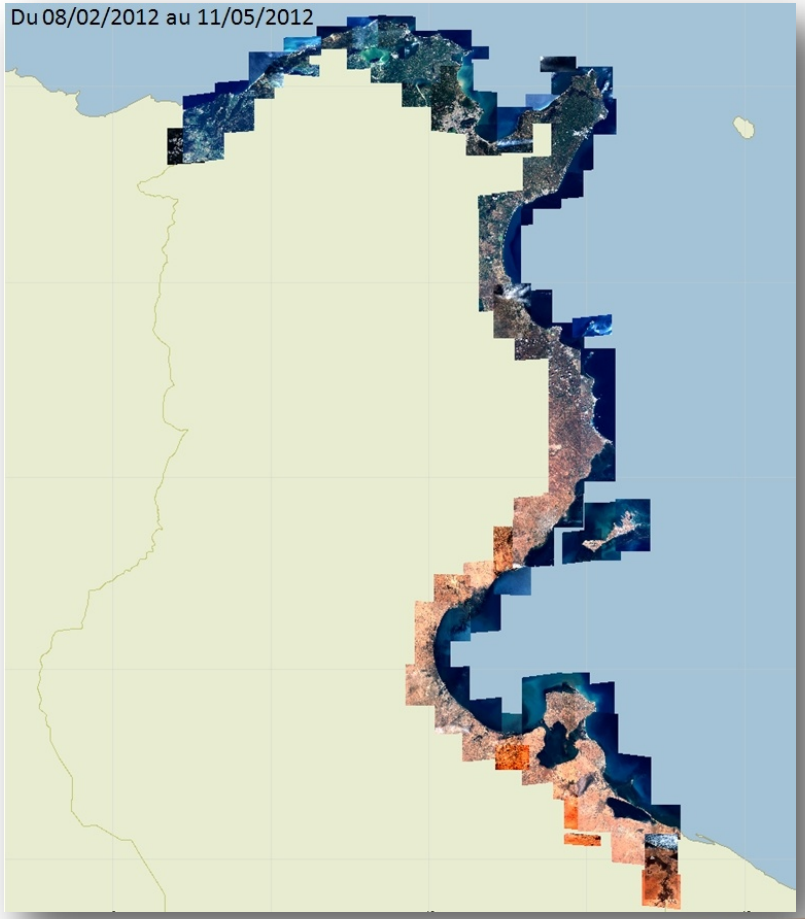
✓ Overview of Pléiades collection over South Africa (with stringent tasking parameters) started on **July, 2nd*** (status April 5th, 2013 - Results with < 15% c.c. only).

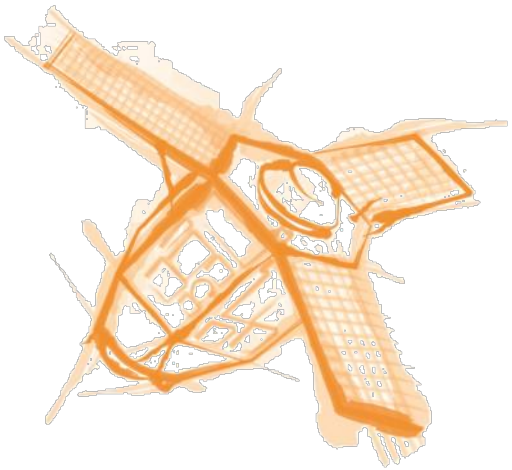
* Pléiades 1B activated end of February

This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

Proven Example

Large Areas Covered in Record Time





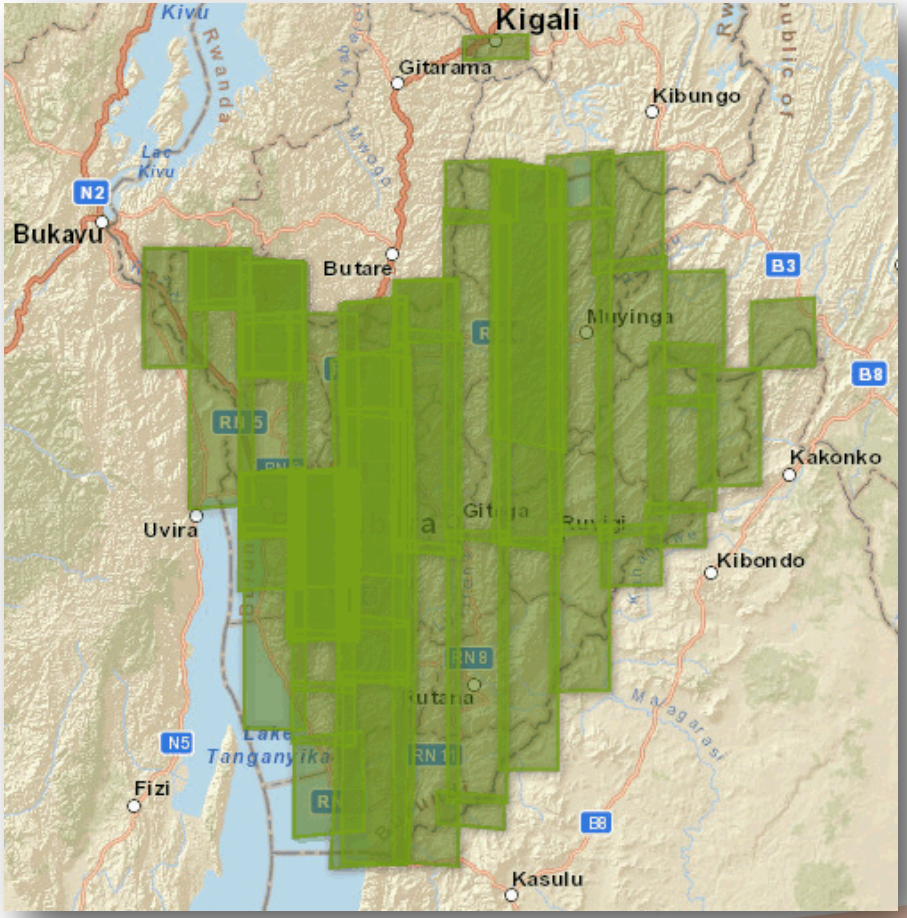
✓ Overview of Pléiades acquisition over Tunisia Coasts (100% of the AOI covered in 3 months) – Pléiades 1A only

This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

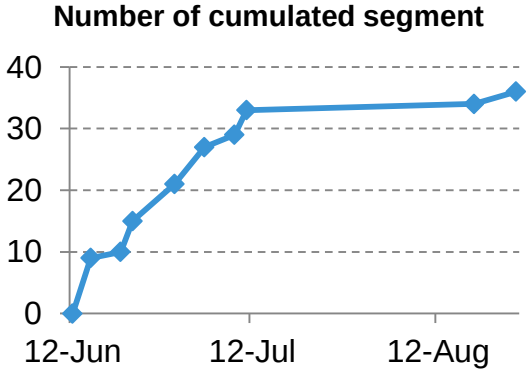
Proven Example

Large Areas Covered in Record Time

3 tasking plans per day improve success rate



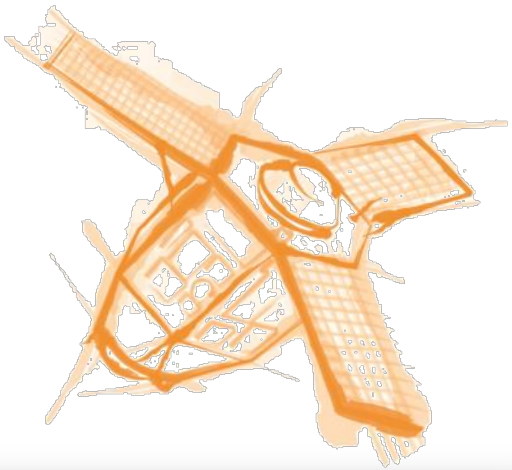
- ✓ Burundi enjoys an equatorial climate.
- ✓ Pléiades 1A acquired Burundi's 25,258 sq.km in two months



This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

Proven Example

Large Areas Covered in Record Time

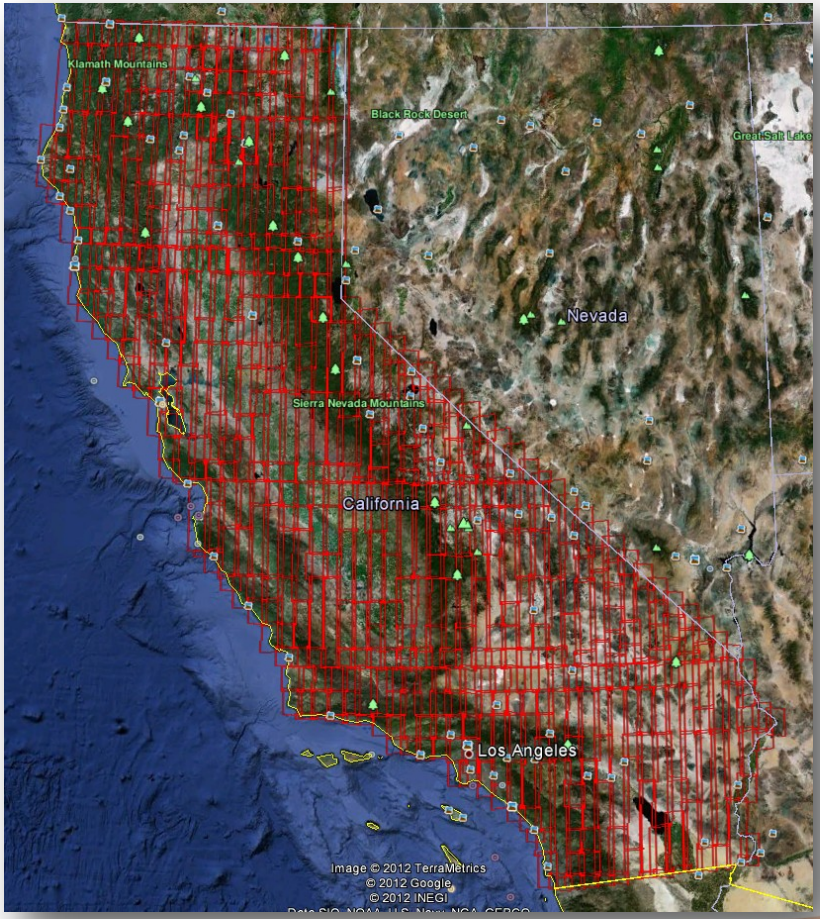


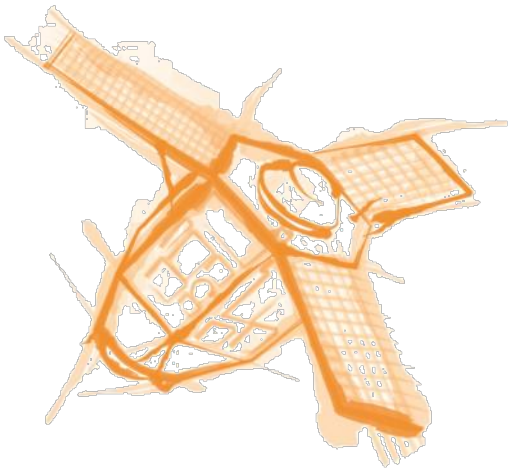
✓ Pipeline Monitoring (one month collection): Pléiades went for the **corridor mode** and collected the entire area in 12 segments only for an **easier data usage and handling**

This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

Proven Example

Large Areas Covered in Record Time



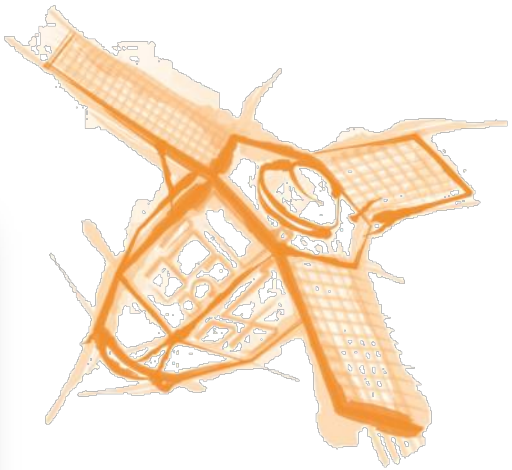


✓ California covered entirely between April and October 2012 (Pléiades 1A only): almost **780 segments acquired**

This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

Proven Example

Large Areas Covered in Record Time

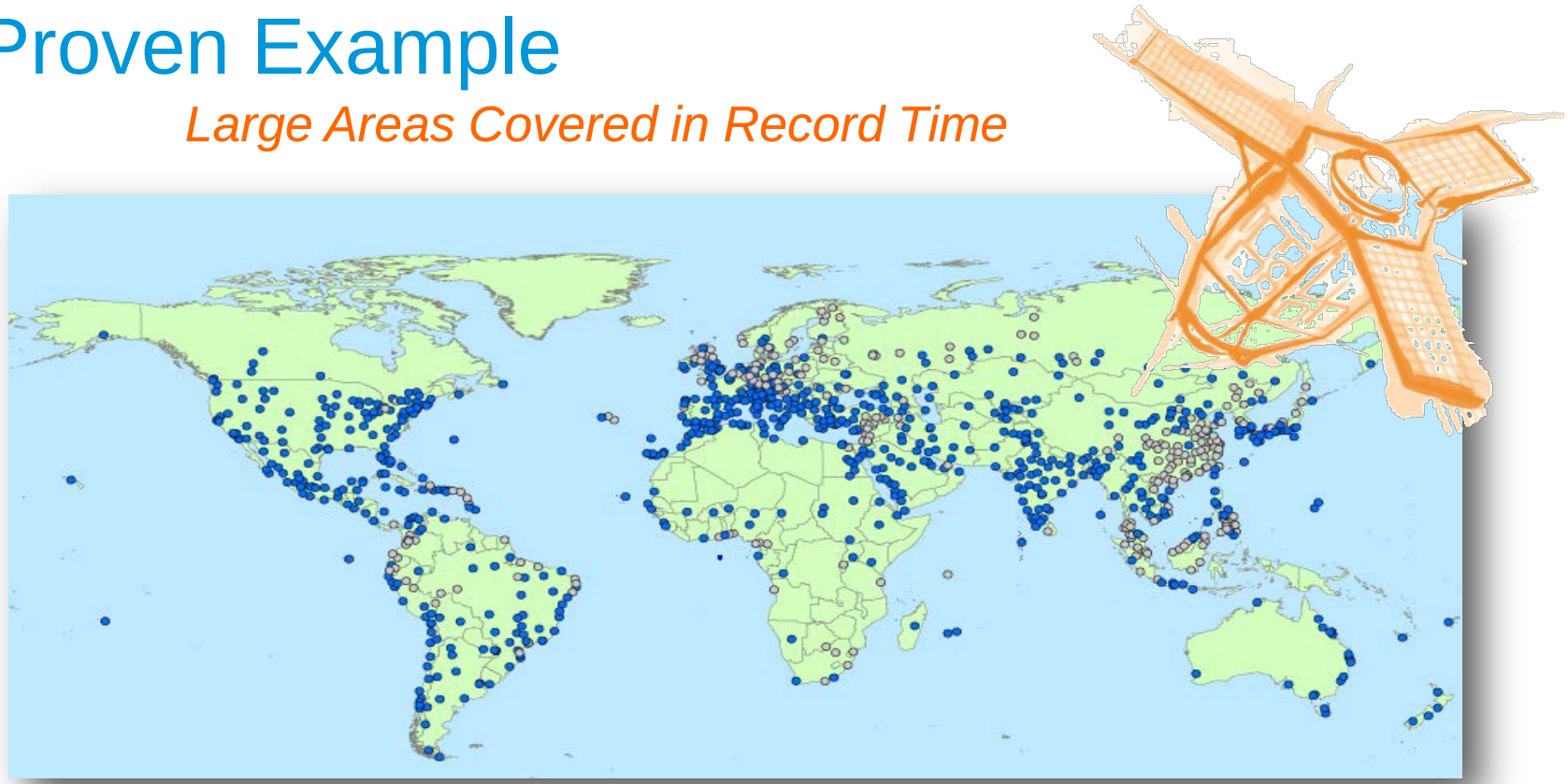


✓ The **entire borders of Saudi Arabia** collected in 10 months (Pléiades 1A only)

This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

Proven Example

Large Areas Covered in Record Time

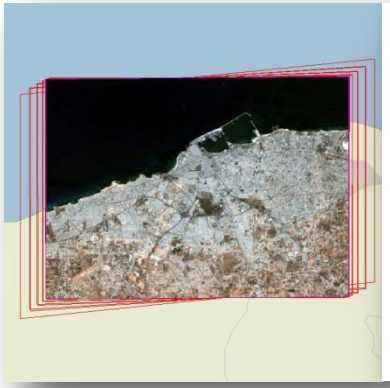


✓ **730 airport** collected in **stereo** since September 2012 (Status Feb, 12th - Pléiades 1B added end of Feb, 2013)

This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

Proven Examples

Pléiades One Day Operation, Selected Extracts



✓ **12 images** shot over Tripoli and Caracas to track moving elements or reveal hidden zones in-between buildings

✓ **Lat and Long competition** dramatically lowered thanks to Pléiades CMGs: acquisition of the 5 main Baltic cities

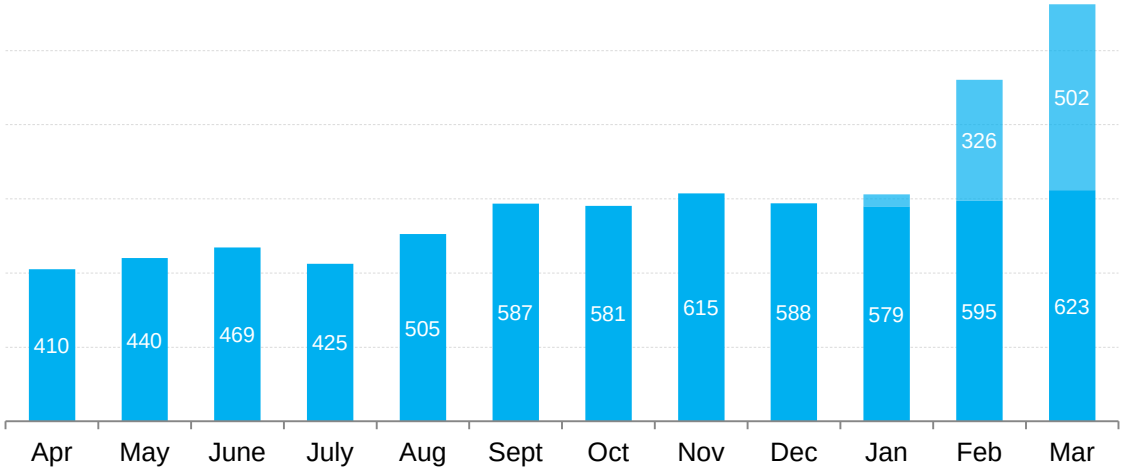
✓ **Tristereo over enlarged swath**, ideal for 3D mapping of large cities

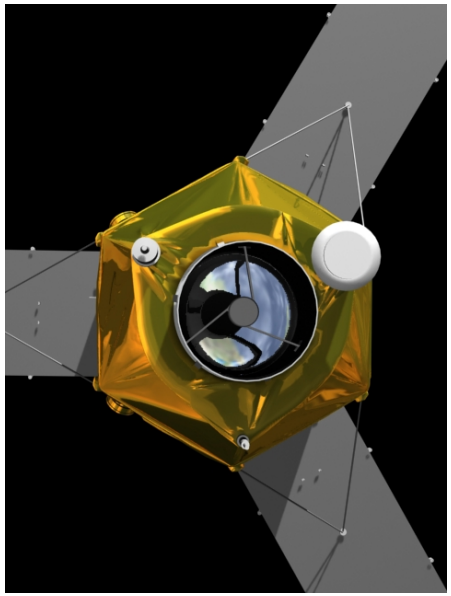
✓ **Three capes were imaged in Strip Mapping mode** to follow Sri Lanka west coastline, a linear and curved target

This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

Pleiades Collection Performances

- Number of images acquired per day (av.)





- Satellite Agility is ‘greatly’ exceeding requirement
- Exceeding Collection Target
  - 600 images per day
- Cloud cover improvement (weather forecast refreshed 3X / day)
  - 50 to 55% of images with less than 10% cc for Pléiades
  - 33% for SPOT 5

This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

Collection capacity

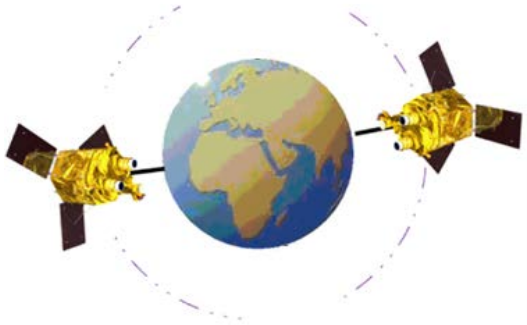
A system fully designed and configured to cover broad areas

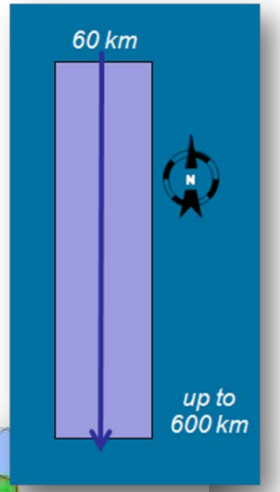
With SPOT 6 & SPOT 7 constellation
→ 6M sq. km / day

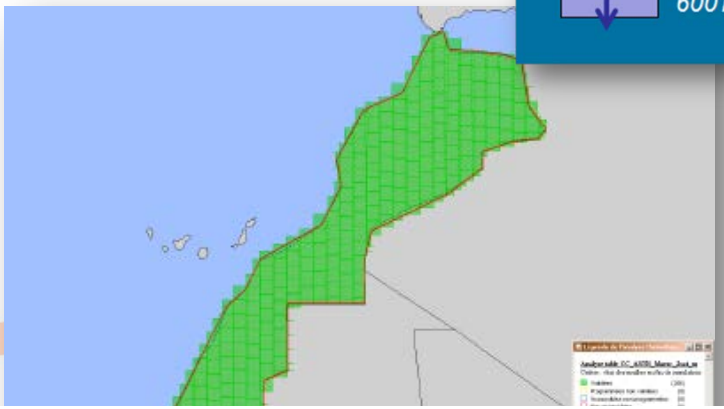
4 weather forecasts per day taken into account
→ Optimization of the resource
→ Increase ratio of successful attempts

Huge onboard storage capacity

Agility
→ Faster access to the next area to be covered
→ Conflicts avoidance

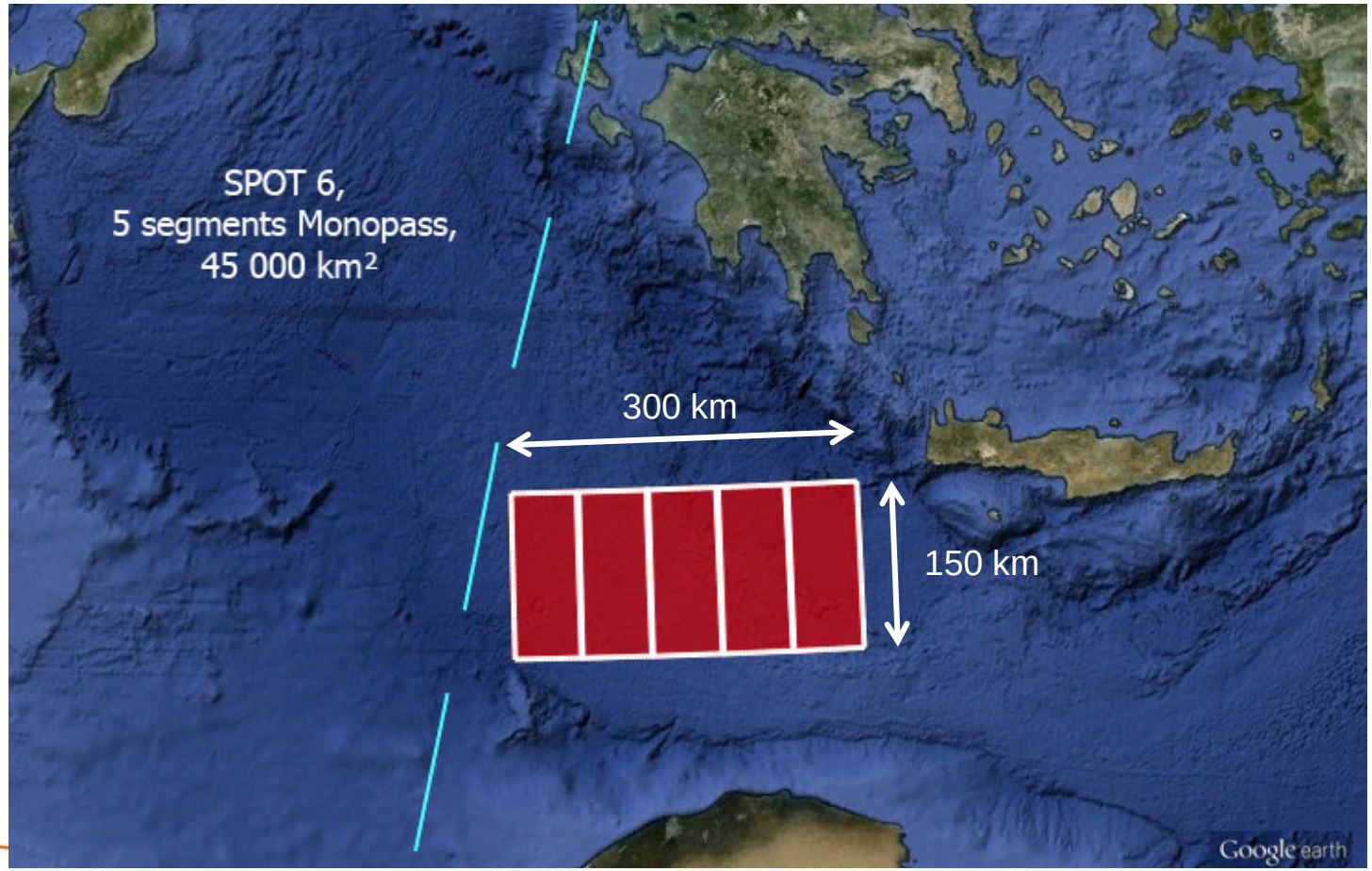






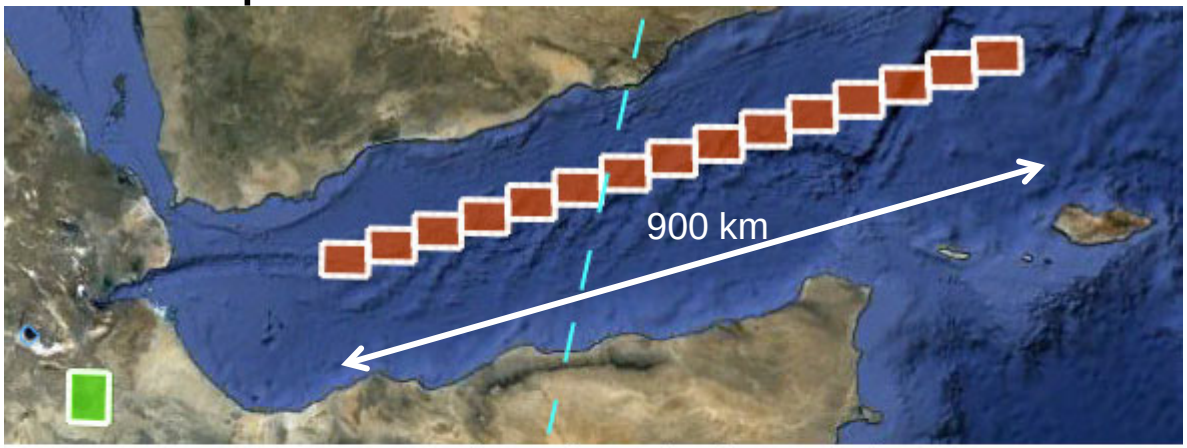
This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

Multistrip in monopass

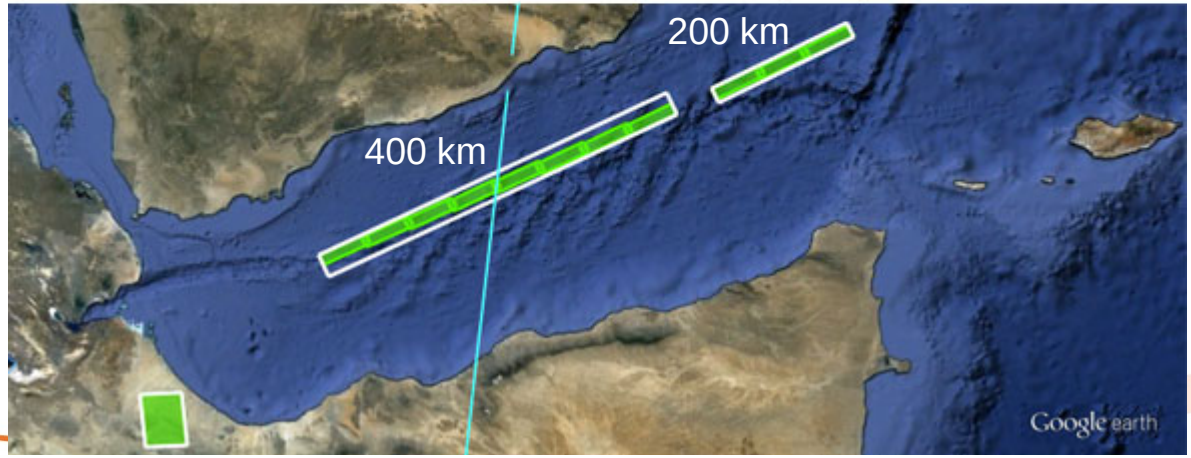


This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

E-W acquisition

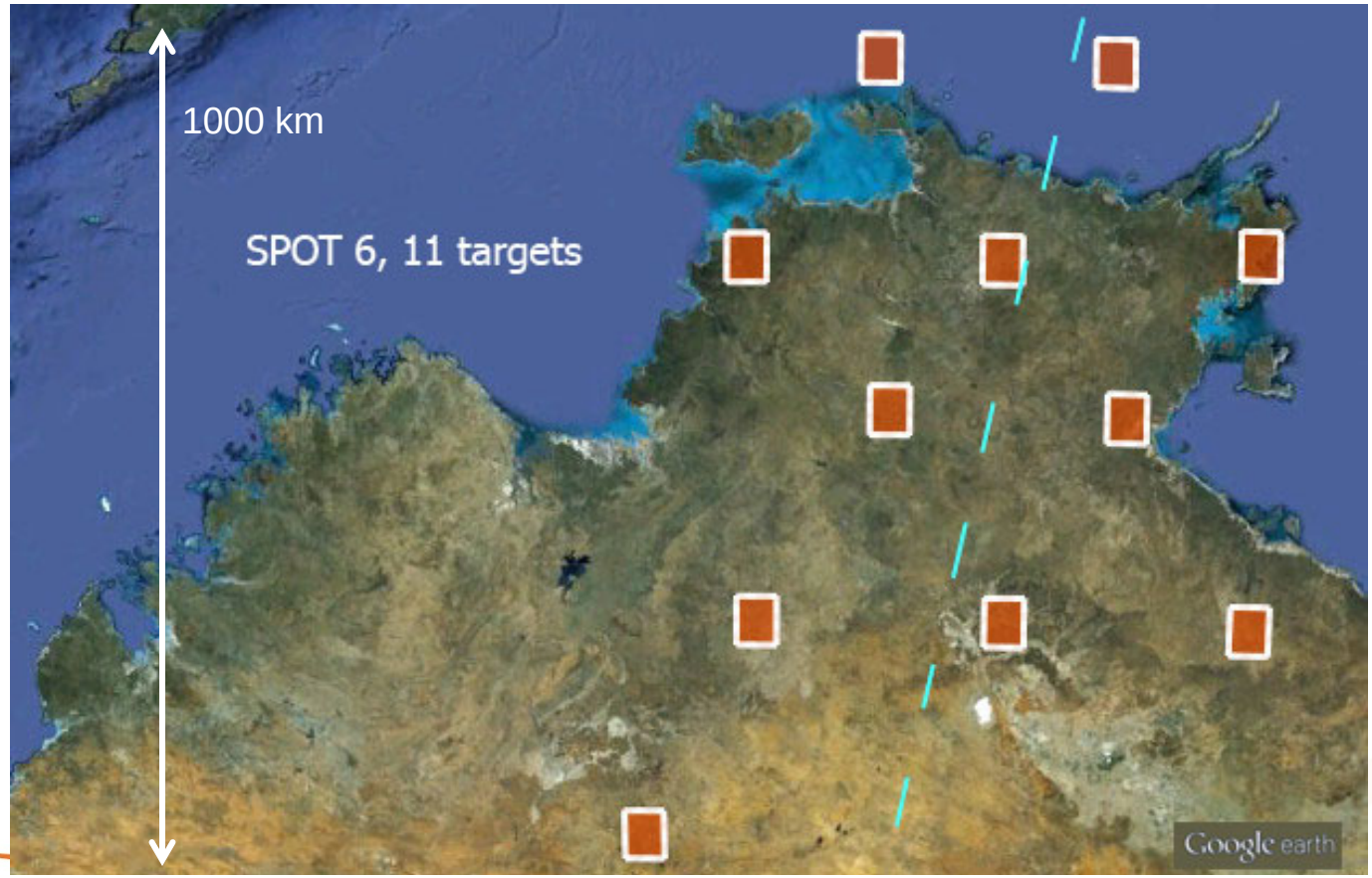


15 images N/S and 900 km long in E/W



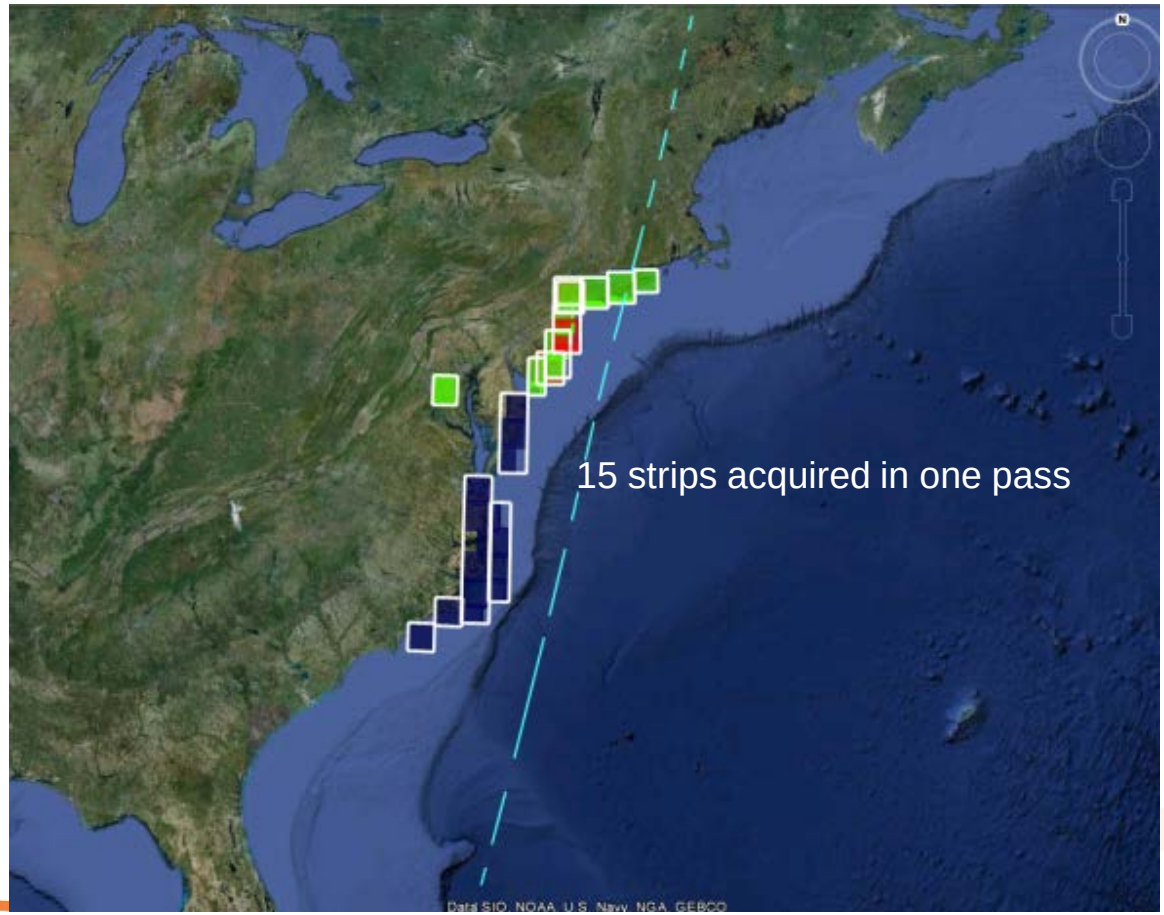
This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

Targets



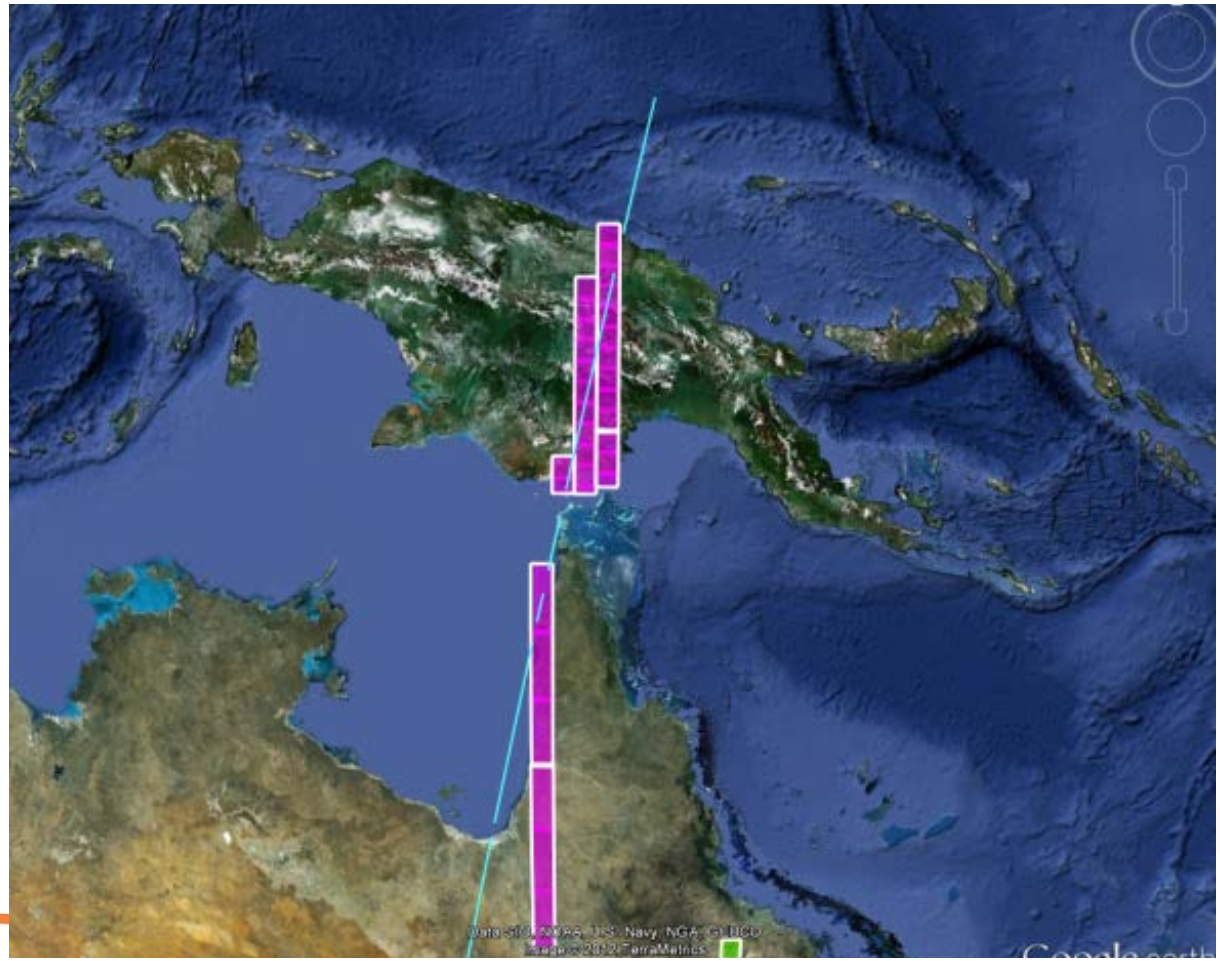
This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

Multi-zones for emergency response



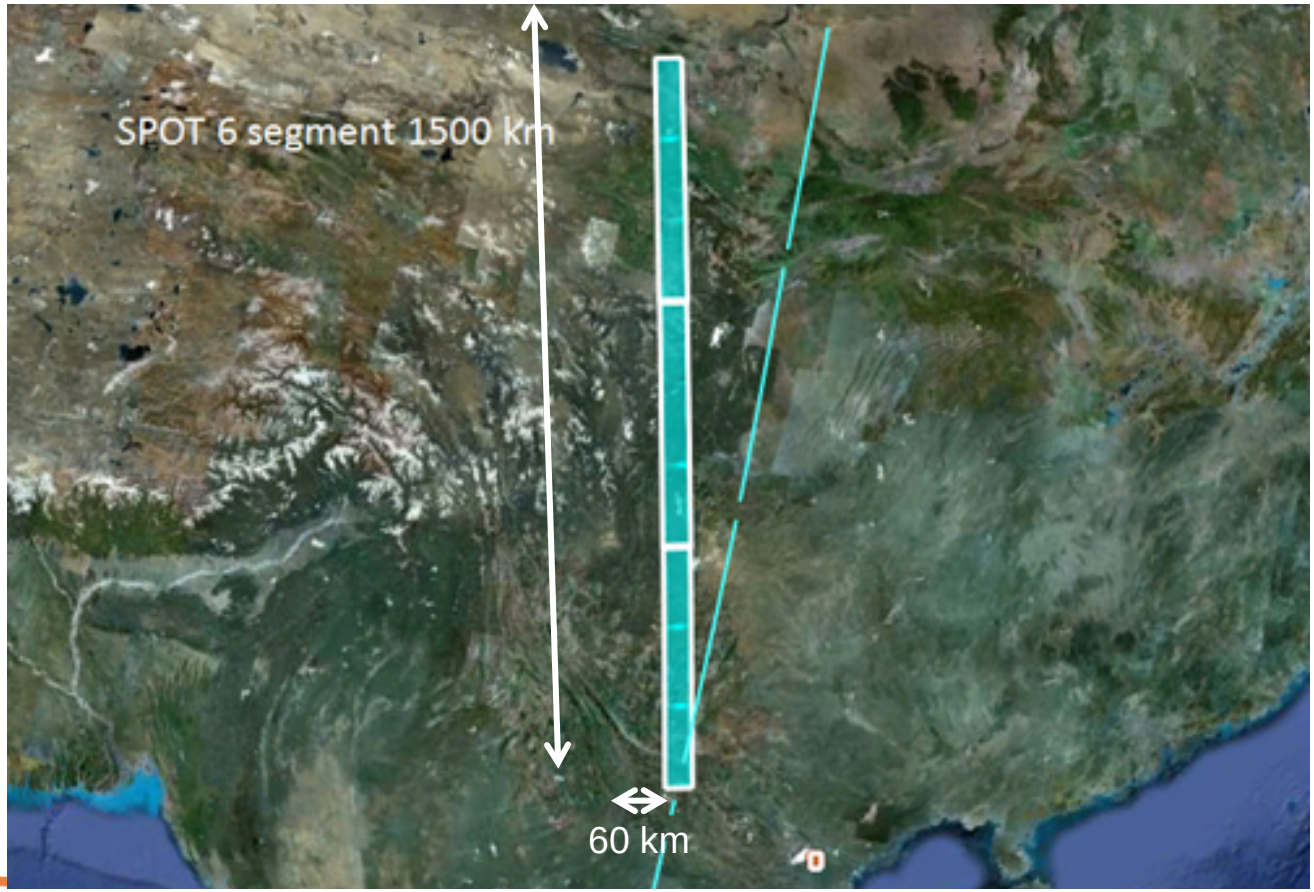
This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

Standard acquisition mode



This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

Long Strip



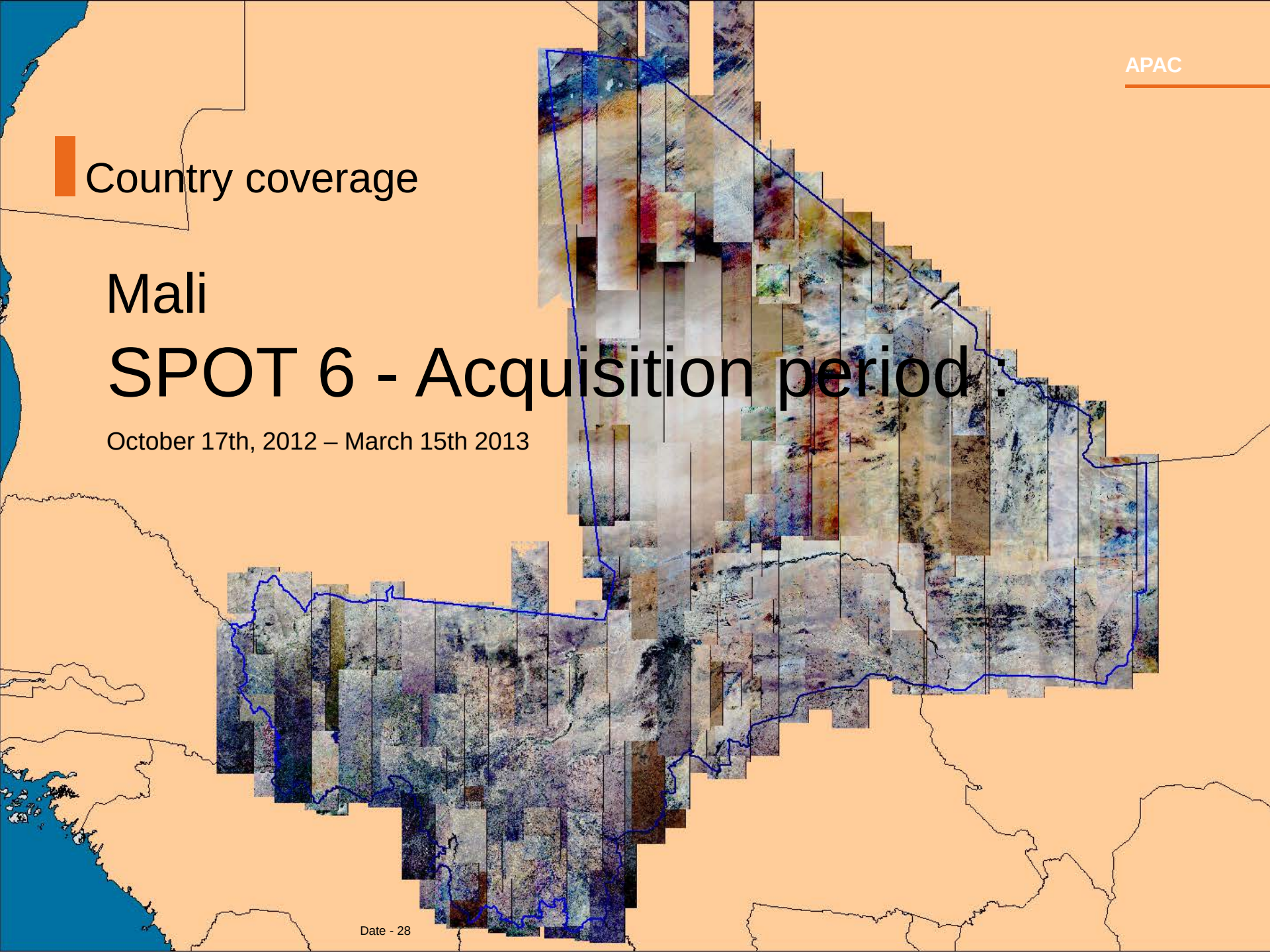
This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

Country coverage

Mali

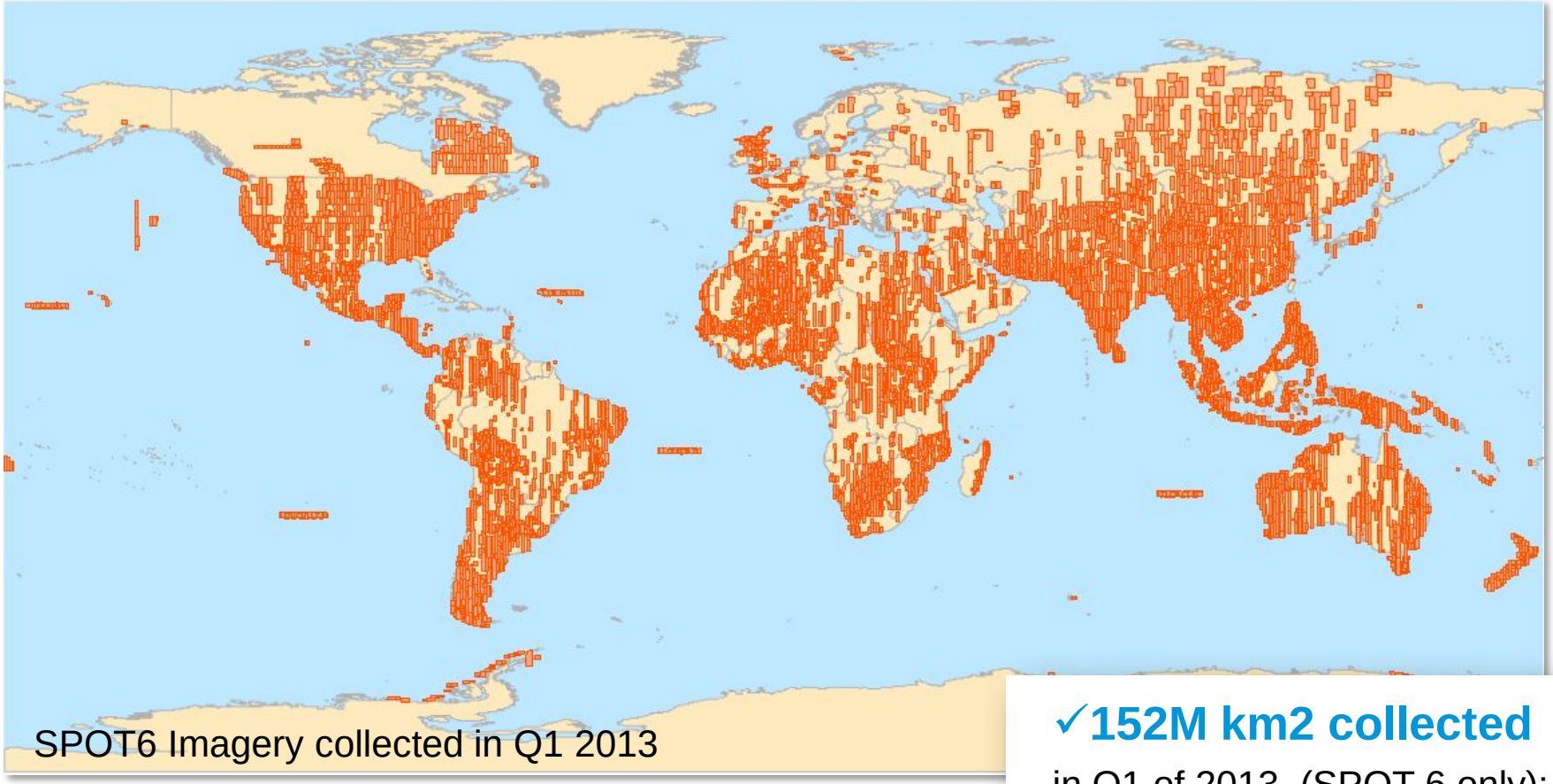
SPOT 6 - Acquisition period :

October 17th, 2012 – March 15th 2013



SPOT 6 Coverage

Rapid Global Collection



✓**152M km2 collected**

in Q1 of 2013 (SPOT 6 only):

✓ **300M km2 collected**

since launch

This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

Collection capacity

A system fully designed and configured to cover broad areas

With SPOT 6 & SPOT 7 constellation

→ 6M sq. km / day

→ Currently Acquiring ~2M sq. km

→ Limited by snowy conditions in northern hemisphere

4 weather forecasts per day taken into account

→ Optimization of the resource

→ Increase ratio of successful attempts

→ Improved Success in Collection of Cloudy areas

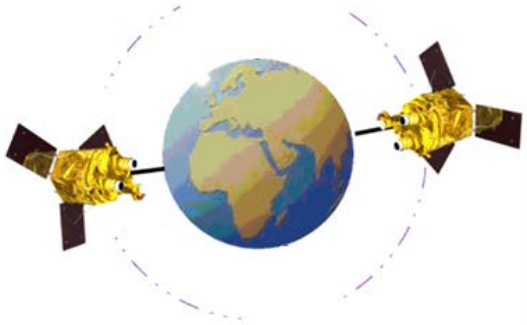
Huge onboard storage capacity

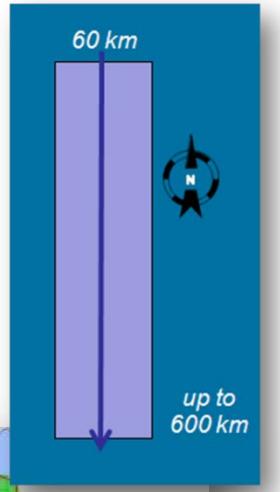
Agility

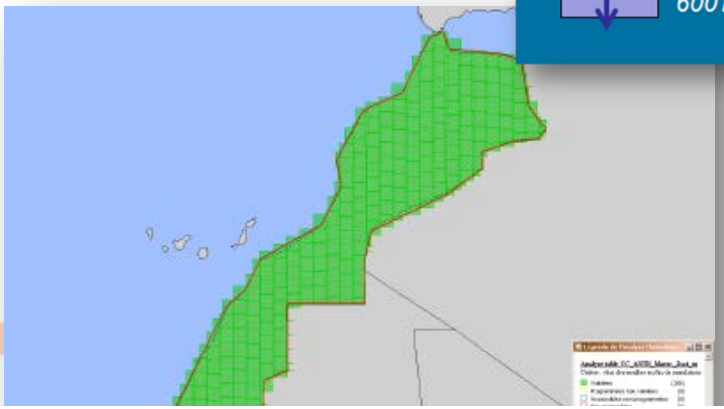
→ Faster access to the next area to be covered

→ Conflicts avoidance

→ Significantly Exceeding design specifications







This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

Pleiades 1A Image Quality Metrics (Oct 2012)

Image Quality Item	Design Specification				Up-to-Date Performance			
GEOMETRY (Rigorous Geometric Model accuracy without GCP: all products)								
Location Accuracy	12m CE90 24m CE99.7				8.5m CE90 @ Nadir 10.5m within 30°			
GEOMETRY (Rigorous Geometric Model accuracy reset on (perfect) GCP and DEM)								
Planimetric Accuracy	Pan: 0.5m CE90				Pan: 0.30m CE90			
Planimetric Accuracy	Multispectral: 0.5m CE90				Multispectral: 0.43m CE90			
Vertical Accuracy B/H=0.6[1]	1m				0.46m LE66 - 0.86m LE99.7			
Vertical Accuracy B/H=0.25[1]	3m				0.7m LE66 - 1.4m LE99.7			
RESOLUTION								
Satellite MTF (X/Y axis)	Pan: 0.08/0.08				Pan: 0.15/0.155			
Satellite SNR	Pan: 90				Pan: 159			
IQF	Pan: 7				Pan: 23.8/24.6			
	Blue	**Green**	**Red**	**NIR**	**Blue**	**Green**	**Red**	**NIR**
Satellite MTF (X/Y axis)	0.2/0.2	0.2/0.2	0.2/0.2	0.2/0.2	0.33/0.28	0.33/0.27	0.33/0.25	0.33/0.26
Satellite SNR	90	90	90	90	158	152	153	190
IQF	18/18	18/18	18/18	18/18	52.1/44.2	50.2/41	50.5/38.2	62.7/49.4

This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

SPOT 6 Image Quality Metrics (Dec 2012)

Image Quality Item	Design Specification				Up-to-Date Performance			
GEOMETRY (Rigorous Geometric Model accuracy without GCP: all products)								
Location Accuracy	50m CE90				20m CE90 @ 30°			
GEOMETRY (Rigorous Geometric Model accuracy reset on (perfect) GCP and DEM)								
Planimetric Accuracy	Pan: 1.5m CE90				Validation in Progress			
Planimetric Accuracy	Multispectral: 6m CE90				Validation in Progress			
Vertical Accuracy B/H=0.8[1]	4m				Validation in Progress			
RESOLUTION								
Satellite MTF (X/Y axis)	Pan: 0.10/0.10				Pan: 0.18/0.16			
Satellite SNR	Pan: 100				Pan: 126			
IQF	Pan: 10				Pan: 22/20			
	Blue	**Green**	**Red**	**NIR**	**Blue**	**Green**	**Red**	**NIR**
Satellite MTF (X/Y axis)	0.2/0.2	0.2/0.2	0.2/0.2	0.2/0.2	0.4/0.26	0.4/0.26	0.4/0.26	0.4/0.26
Satellite SNR	150	150	150	150	259	254	267	293
IQF	30/30	30/30	30/30	30/30	103/67	101/66	106/69	118/76

This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

Image Quality

Recent improvements

- Focal plane
  - New model released on July 20th, very close to the final and definitive internal geometry (line-of-sight accuracy better than 0.1 pixel).
  - All products produced after July 20th are beneficiating of this improvement.

- RPCs
  - New RPCs have been released on September 25th, and now feature a very good consistency with the rigorous model.

Rigorous Model vs RPC [before]	Bias x	Bias y
Product 1	0.18 m	0.12 m
Product 2	0.63 m	1.57 m
Product 3	0.33 m	0.17 m
Product 4	0.21 m	0.10 m

Rigorous Model vs RPC [after]	Bias x	Bias y
Product 1	0.001 m	0.000 m
Product 2	0.004 m	0.000 m
Product 3	0.003 m	0.001 m
Product 4	0.003 m	0.001 m

This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

Image Quality

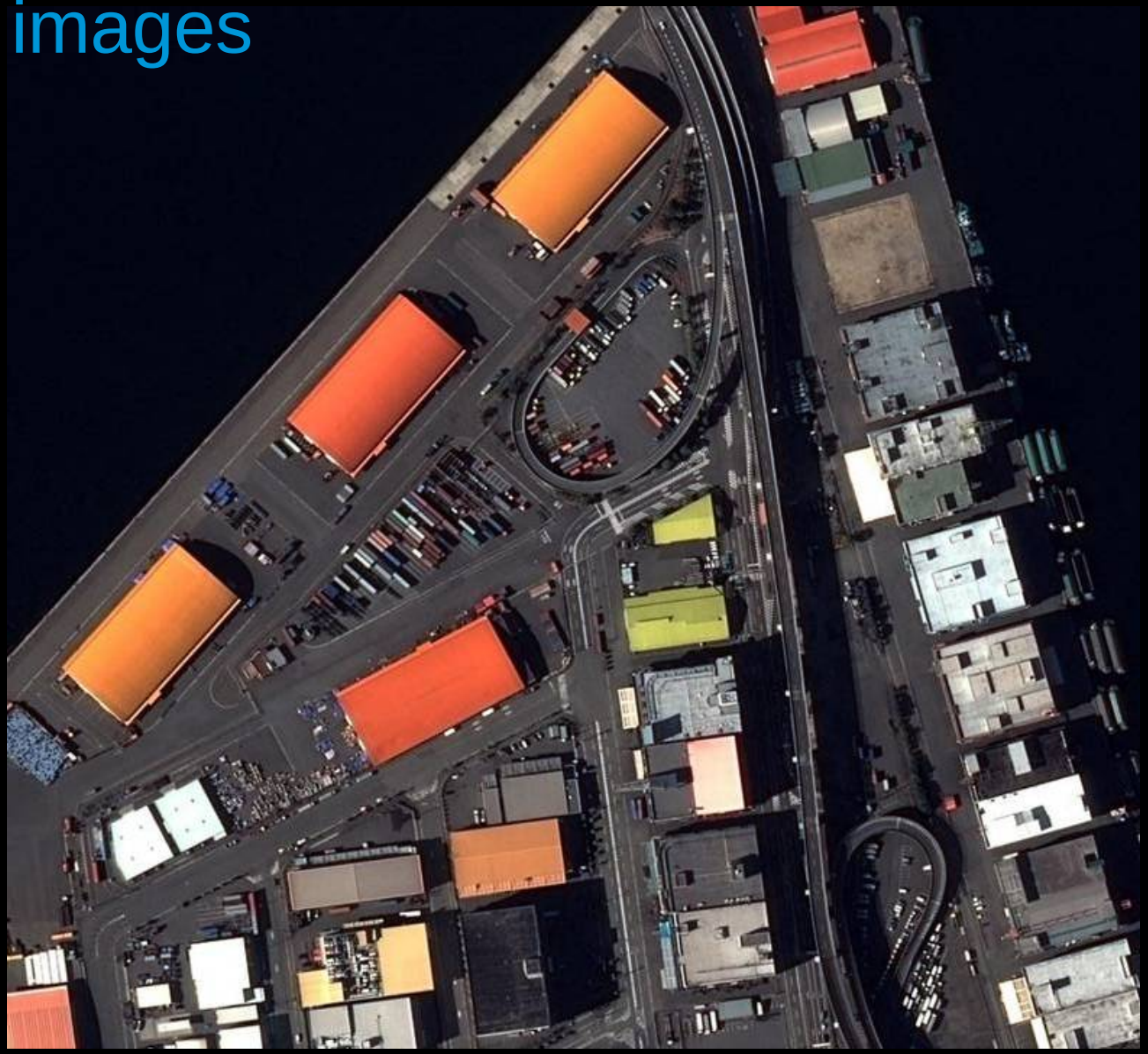
Recent improvements

- Pan-sharpening & inter CCD
  - Reduced bouncing, reduced aliasing, improved sharpness since end of January

t shall not be disclosed.

▲ Example with 30° viewing angle

New images



Ground Segment

- Processing
  - Data Production is functioning nominally

    Pleiades Processing

    - Standard products: 348 in 11 hours
    - Small products: 248 in 4 hours

    SPOT 6

    - No figures available
  - NRT Delivery is available for Pleiades
    - Testing this week for SPOT6

- Tasking
  - All systems functionally nominally

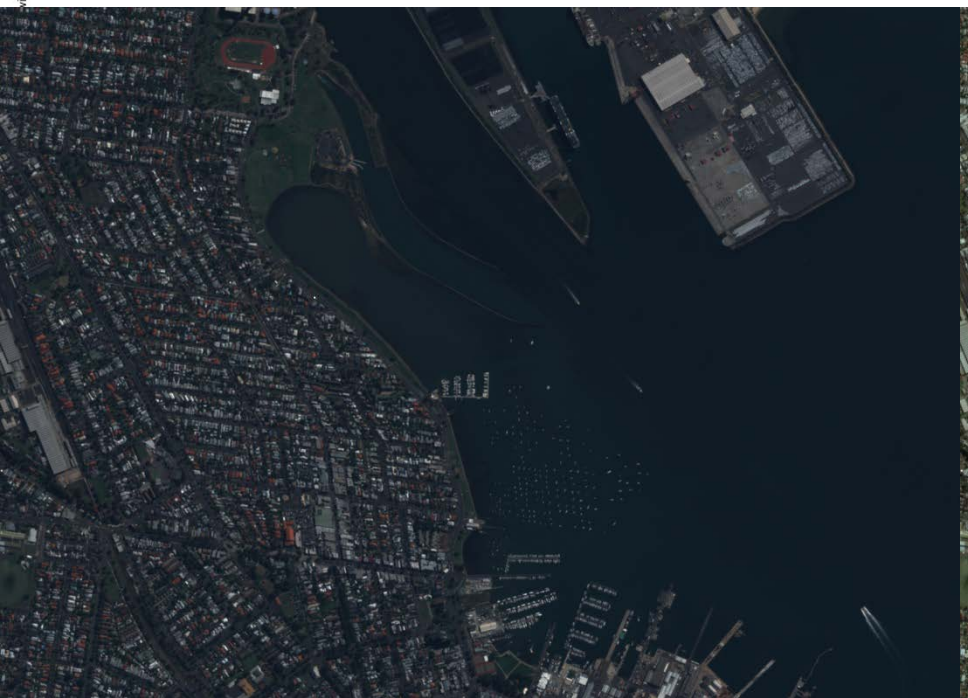
This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

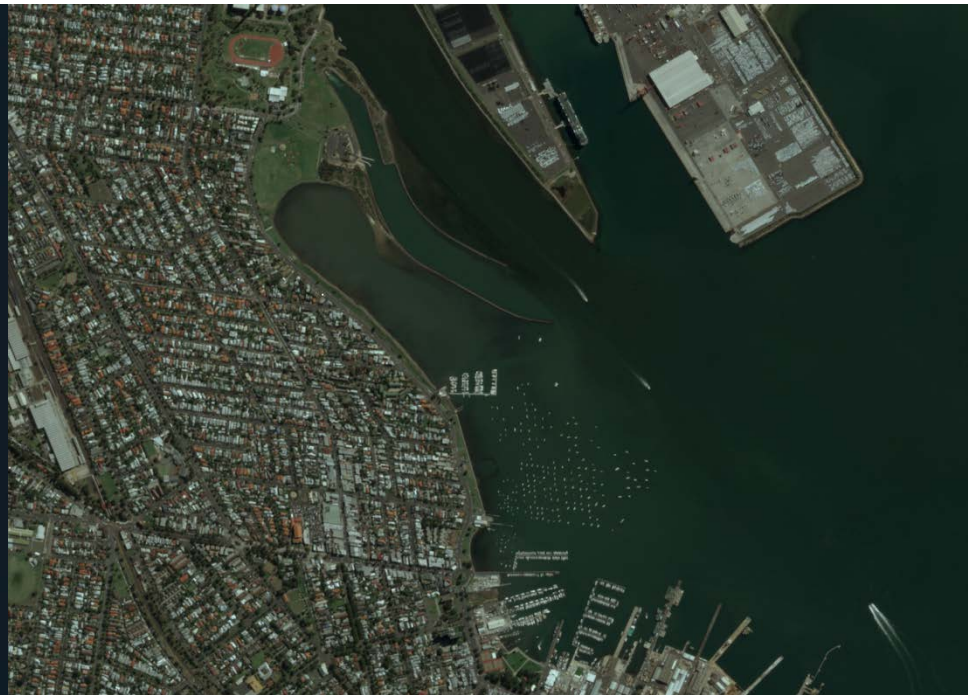
Upcoming options

OVR – Optimized Visual Rendering

- Expected release: June
  - Includes adjustments in terms of Sharpness, Luminosity, Contrast and Atmospheric offset substraction

without prior written agreement. Its content shall not be disclosed.





Upcoming Improvements

Product Formatting

- Refinement of DIMAP v2 deliverable
  - Fixing tile alignment in Primary Product
  - Expected completion in Q2 2013
- Release of a Geocoded processing level
  - Similar to SPOT Level 2A
  - Expected completion in Q3/Q4 2013

This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

Astrium
GEO-Information Services

Drew Hopwood
14595 Avion Parkway, Suite 500
Chantilly, VA 20151
hopwood@astrium-geo.com
(703) 715-3124

This document is the property of Astrium. It shall not be communicated to third parties without prior written agreement. Its content shall not be disclosed.

All the space you need

ASTRIUM
AN EADS COMPANY