

Reference: S2-PDGS-MPC-L2A-PDD-V14.2 Issue: 4.5 Date: 2016-11-25





# **L2A Product** Definition **Document**

Ref. S2-PDGS-MPC-L2A-PDD-V14.2





ACRI

















## **Authors Table**

	Name	Company	Responsibility	Date	Signature
Written by	U. Mueller- Wilm	TPZD	Project Manager L2A Maintenance	2016-11-25	
Verified by	O Devignot	CS	Quality Manager	2016-11-25	
Approved by	L. Pessiot	CS	Service Manager	2016-11-25	

# Change Log

Issue	Date	Reason for change	Pages(s)/Section(s)
1 Draft A	06 Feb 2009	Initial Issue.	All
1 Draft B	26 Feb 2009	Incorporated refinements as per ESA requirements.	All
1 Draft C	20 Aug 2009	Reorganised to match section structure used for L2B and L3 products.	All
		Major rewrite of most sections.	
		Updated table of possible applications for L2A according to latest version of DAP.	
1	8 Oct 2009	Updates following Review by ESA,	All
		Document renamed from S2PAD.TN.001 to S2PAD-VEGA-PD-0001.	
2	6 Nov 2009	Fixed RIDs from S2PAD_PDR_1:	All
		PDR-1, PDR-2, PDR-3, PDR-8, PDR-11, PDR- 13, PDR-18, PDR-42, PDR-47, PDR-74, PDR- 75, PDR-76, PDR-77, PDR-78, PDR-87, PDR- 88, PDR-89, PDR-91, PDR-93, PDR-94, PDR- 95, PDR-96, PDR-97, PDR-99, PDR-100	
2.1	13 Nov 2009	Updated according to the comments received from ESA on 11th November 2009.	All
2.2	15 Apr 2010	Fixed RIDs from S2PAD_PDR_2:	All
		PADPDR-43, PADPDR-53, PADPDR-92, PADPDR-93, PADPDR-94, PADPDR-95, PADPDR-98, PADPDR-104, PADPDR-143, PADPDR-144	
4.0	3 Jul 2012	Issue for S2PAD Phase 2 CDR.	All
		Updated according to the comments received from ESA on 23 <sup>rd</sup> March 2011.	













3/35

4.1	29 Aug 2012	Issue after S2PAD Phase 2 CDR. Updated according to ESA comments and discussion on CDR 02/08/2012	All
4.2	21 Mar 2014	Issue for Acceptance Review	All
4.3	16 Jun 2014	Document Change Requests from Sen2Cor Acceptance Review Board report.	All
4.4	1 Apr 2016	Issue for the delivery of Sen2Cor v2.2	All
4.5	25. Nov 2016	Update to PSD 14.2, delivery of Sen2Cor 2.3.0	2.2.4, 2.4.2, 2.4.3

























This Page Is Intentionally Blank











# Table of contents

1. INTRO	ODUCTION	7
1.1 Pu	urpose of the document	7
1.2 D	ocument structure	7
1.3 Re	eferences	8
1.1 No	ormative Reference Documents	8
1.2 In	nformative Reference Documents	8
1.3 Re	elation to other Documents	8
1.4 De	efinitions of Terms and Conventions	8
2. LEVEL	L-2A PRODUCT DEFINITION	9
2.1 O	verview	9
2.1.1	Input data of L2A processing	9
2.1.2	Product Summary	10
2.2 In	nage Data	16
2.2.1	Atmospheric correction images	16
2.2.2	Scene Classification image	19
2.2.3	Digital Elevation Map (DEM)	20
2.2.4	True Colour Image (TCI, since PSD V.14.2)	20
2.2.5	Preview Data	21
2.3 M	etadata	21
2.3.1	Product Level Metadata	21
2.3.3	1.1 Brief Metadata	22
2.3.3	1.2 Standard Metadata	23
2.3.3	1.3 Expertise Metadata	23
2.3.2	Tile Level Metadata	23
2.3.	2.1 Brief Metadata	23
2.3.	2.2 Stalludru Metadata	24
2.3.	uality Indicator Data	····· 24
241	Product Level Quality Indicators	24
2.1.1	Tile Level Quality Indicators	21
2.4.2	Pixel Level Quality Indicators	30
25 Ai	uxiliary Data	31
2.5.1	Provided Auxiliary Data	
2.5.2	Referenced Auxiliary Data	
2.6 Fi	le Size Estimation (single tile)	32



elecnor

gm⁄





This Page Is Intentionally Blank

















## 1. Introduction

In the frame of the Global Monitoring for Environment and Security programme (GMES) jointly implemented by ESA and EC, ESA is developing the Sentinel-2 system, providing globally with systematic acquisition high resolution (10-20 m) optical observations with a high revisit tailored towards the needs of operational land services.

The Sentinel-2 mission will offer an unprecedented combination of the following capabilities: (1) Systematic global coverage of land surfaces: from 56°South to 84°North, coastal waters and all Mediterranean sea; (2) High revisit: every 5 days at equator under the same viewing conditions with two satellites; (3) High spatial resolution: 10m, 20m and 60m; (4) Multi-spectral information with 13 bands in the visible, near infra-red and short wave infra-red part of the spectrum, and (5) Wide field of view: 290 km.

The Level-1C product provides ortho-rectified, i.e. a map projection of the acquired image using a system DEM to correct ground geometric distortions, Top-Of-Atmosphere (TOA) reflectance with a sub-pixel multi-spectral and multi-date registration. This Level-1C product is converted to Bottom-of-Atmosphere (BOA) reflectance and an associated scene classification, which constitutes the Level-2A product.

#### **1.1 Purpose of the document**

This document defines the content of the Sentinel-2 Level-2A product. It delivers a collection of the Level-2A related input and output data, covering Scenes, AOT and Water Vapour maps and Quality Indicators. The document has to be considered as a specialisation of the definition provided in [S2-PDD] for the Level-2A product.

The general parts which are common to all products are thus part of the main document [S2-PDD] and will be referred at the corresponding sections.

### **1.2 Document structure**

The document aligns to the structure of products definition given in [S2-PDD]. According to this scheme, the Chapter 2 of this document defines the structure of Level-2A products into six sections:

- Overview, in section 2.1;
- Image data, including preview in section 2.2;
- Metadata, in section 2.3;
- Quality Indicator Data, in section 2.4;
- Auxiliary Data, in section 2.5;
- File Size Estimation, in section 2.6.















#### **1.3 References**

The reference list of all project related documents with their version number and issue date is given in:

[S2-L2A-GLOS] S2PAD Project Glossary S2PAD-VEGA-GLO-0001, version 3.5, 22.05.2015

#### **1.1 Normative Reference Documents**

[GS-FFS]	Ground	d Segment File	e Forr	nat Si	tandard		
[GS-FFS-TSM]	Earth	Observation	GS	File	Format	Standard	-
	Tailori	ng for the Sent	tinel	Missio	ns PDGS		

#### **1.2 Informative Reference Documents**

[ECMWF]	ECMWF Deterministic Atmospheric Model Products, http://www.ecmwf.int/en/forecasts
[GSCDA-DAP]	GMES Space Component - Data Access Portfolio Requirement Document (DAP/R)
[S2-PDD]	GMES Space Component – Sentinel-2 Payload Data Ground Segment (PDGS), Product Definition Document
[S2-PFS]	Sentinel-2 Product Specification
[S2-MRD]	Sentinel-2 Mission Requirements Document
[S2-L2A-PFS]	Sentinel-2 MSI – Level 2A Product Format Specification Technical Note
[S2-L2A-ATBD]	Sentinel-2 MSI - Level 2A Products, Algorithm Theoretical Basis Document
[S2-L2A-DPM]	Sentinel-2 MSI – Level 2A Detailed Processing Model
[S2-L2A-SUM]	Sentinel-2 MSI – Level 2A Prototype Processor Installation and User Manual

#### **1.3 Relation to other Documents**

The Sentinel-2 MSI - Level 2A Products Algorithm Theoretical Basis Document [S2-L2A-ATBD] define the algorithms used during Level 2A processing which are labelled as 2A-SC for Level 2A Scene Classification and 2A-AC for Level-2A Atmospheric Correction.

The Sentinel-2 MSI - Level 2A Products Specification Technical Note [S2-L2A-PFS] describes Sentinel-2 Level 2A file naming convention and presents how the Sentinel-2 Level 2A XSD schemas are organized.

#### **1.4 Definitions of Terms and Conventions**

Please refer to section 2.4 of [S2-PDD] for definition of Sentinel-2 mission and terms, e.g. Datatake, Datastrip, MSI Spectral bands, User-product, etc.















# 2. Level-2A Product Definition

#### 2.1 Overview

Level-2A processing consists in scene classification and atmospheric correction applied to Level-1C orthoimage product.

Level-2A main output is an orthoimage Bottom-Of-Atmosphere (BOA) reflectance product. Additional outputs are Aerosol Optical Thickness (AOT) map, Water Vapour (WV) map, Scene Classification map together with Quality Indicators data.

Level-2A products are resampled as Level-1C products with a constant GSD (Ground Sampling Distance) of 10m, 20m and 60m according to the native resolution of the different spectral bands.

The delivery of 10m, 20m or 60m product is optional. Product content is detailed in section 2.1.2.

#### 2.1.1 Input data of L2A processing

**Table 2-I** lists the input data of Level-2A processing.

Level-1C TOA (Top-Of-Atmosphere) reflectance is the main input for the Level-2A product generation. Main part of Level-1C metadata will be included in the Level-2A product. The definition of Level-1C product is given in [S2-PDD] and therefore Level-1C metadata would not be further described in this document.

Input of Level-	Description
From Level-1C	Image Data: Level-1C Top-Of-Atmosphere reflectance values
	Metadata from Level-1C
	Ancillary data from the Level-1C (satellite and ground
	ancillary data, including solar and incidence angles)
	Quality Indicator files from Level-1C
	Ozone Total Column from ECMWF
Auxiliary Data	GIPP: Level-2A processing parameters
(see section 2.5)	Digital Elevation Model (provided by user)
	LibRadtran LUTs (internal)

Table 2-I: Input of Level-2A processing

















10/35

Input of Level- 2A processing	Description
	Snow climatology (internal)

#### 2.1.2 Product Summary

The geographic coverage of Level-2A products is the same as the Level-1C input products.

One Level-2A product refers always to one Datatake. It may refer to one or several Datastrips from the same Datatake.

The Level-2A product may cover the full Datatake or an extract of the Datatake.

In the case of an extract, the image data are provided to cover the selected extract. In the case of an extract, the ancillary data are always provided through a metadata file on the full Datatake temporal extent.

Level-2A processing is performed on Level-1C products geometrically refined that are identified with a dedicated flag in the Level-1C metadata.

Figure 2-1 gives an overview of the L2A Product Physical Format. Please refer to [S2-L2A-PFS] and following sections of this document for more details.



#### Figure 2-1 Level-2A Product Physical Format

The Level-2A product is characterised by the main following contents, outputs of the scene classification and atmospheric corrections algorithms:

**AIRBUS** 

- Scene classification tiles

elecnor

gn∕



ACRI











The Scene Classification (attaching an attribute to each pixel 0 to indicate its type) at 20m and 60m resolution [Image Data];

4.5

2016-11-25

- Statistics on percentage of pixels belonging to each class [QI 0 Data];
- The Quality Indicators for snow and cloud probability (20m 0 and 60 m) [QI Data].

#### Atmospheric correction tiles

- The 60m resolution product [Image Data]; 0
  - The surface (BOA) reflectance cube with 11 channels (B1, B2, B3, B4, B5, B6, B7, B8a, B9, B11, B12) excluding the 1375 nm cirrus band B10, as it does not contain surface information.
  - The aerosol optical thickness map AOT (550nm) at 60m resolution;
  - The water vapour map WV at 60 m resolution;
  - A True Colour Image based on the three channels B2, B3, B4, since PSD V14.2 and above at 60 m resolution;
- The 20m resolution product [Image Data]; 0
  - The surface (BOA) reflectance cube with 9 channels (B2, B3, B4, B5, B6, B7, B8a, B11, B12), omitting the original 60 m channels (see [RD10] for further details).
  - The aerosol optical thickness map AOT (550nm) at 20m resolution;
  - The water vapour map WV at 20 m resolution;
  - A True Colour Image based on the three channels B2, B3, B4, since PSD V14.2 and above at 20 m resolution;
- The 10m resolution product [Image Data]; 0
  - The surface (BOA) reflectance cube with 4 channels (B2, B3, B4, B8), omitting the original 20 and 60 m channels (see [S2-L2A-ATBD] for further details).
  - The resampled AOT (aerosol optical thickness) map (550nm) at 10m resolution;
  - The scene-averaged WV (Water Vapour) map at 10 m resolution;

















 A True Colour Image based on the three channels B2, B3, B4, since PSD V14.2 and above at 10 m resolution;

Note: the user is able to select the output of the L2A processor: 10m resolution product only, 20m resolution product only or 60m resolution product only. By default all resolutions are provided.

# Table 2-II gives an overview of the components of Level-2A product. Table 2-II: Level-2A Product – Summary Table

Name	Level-2A
Common Cha	racteristics for L2A Products
Identifier	S2_L2A
Product level	L2A
Description	<ul><li>The L2A product contains the following product components:</li><li>BOA reflectance images (10m, 20m, 60m);</li></ul>
	Aerosol Optical Thickness (AOT) maps (10m, 20m, 60m);
	• Water Vapour (WV) maps (10m, 20m, 60m);
	• Scene classification map (on pixel basis) (20m, 60m);
	• True Colour Image (10m, 20m, 60m) for PSD V 14.2 and above;
	• Quality Indicators for Snow and Cloud probability (20m, 60m).
Parent	L1C
Product	
Coverage	Regional
Packaging	Tiles (same size and area coverage as Level 1C input data)
Geo-location	Identical to the level 1C geo-location performance.
accuracy	
Frequency	Variable upon Level 1C products availability.
Format	SAFE format, see section 1.7 of [S2-PFS].
Size	See section 2.6.
BOA Reflecta	nce [Image Data]











Name	Level-2A
Algorithm	The surface reflectance is computed using the "Sentinel-2 Atmospheric Correction" (L2A_AtmCorr) algorithm and is based on reference radiative transfer code. Look Up Tables (LUTs) are based on LibRadtran. The aeorosol optical thickness retrieval is based on the dense dark vegetation (DDV) algorithm The water vapour retrieval over land is performed with the atmospheric precorrected differential absorption (APDA) algorithm
Unit	None
Range	0.0 to 1.0 (Reflectance could be above 1 with anisotropic targets and for certain viewing directions, e.g. specular configuration)
Sampling	15 bits/pixel
Channels and Resolution	B1 (443nm): 60m         B2 (490nm): 60m, 20m, 10m         B3 (560nm): 60m, 20m, 10m         B4 (665nm): 60m, 20m, 10m         B5 (705nm): 60m, 20m         B6 (740nm): 60m, 20m         B7 (783nm): 60m, 20m         B8 (842nm): 10m         B8a (865nm): 60m, 20m         B9 (945nm): 60m, 20m         B11 (1610nm): 60m, 20m         B12 (2190nm): 60m, 20m         Note: The MSI of the Sentinel-2 has 13 spectral channels. Channel B10 (Cirrus correction, 1375nm) which does not contain surface information will be barred. All the other channels will be processed.
Radiometric Accuracy	Mission requirement is 5%



















Name	Level-	2A			
Water Vapour	Map [lı	mage Data]			
Algorithm	L2A_A	\tmCorr			
Unit	Dimen	isionless			
Range	0.4 – 5	5.5 cm			
Sampling	16 bit				
Resolution	60m, 2	20m, 10m			
Accuracy	5 – 10 (Schlä	% pfer 1998, Chylek et al. 2003, Richter and Schläpfer	<sup>-</sup> 2008)		
Aerosol Optic	al Thicl	kness (AOT) Map [Image Data]			
Algorithm	L2A_A				
Unit	Dimen	Dimensionless			
Range	0 – 1	0 – 1			
Sampling	16 bit	16 bit			
Resolution	60 m,	60 m, 20m, 10m			
Accuracy	To be	established by S2MPC			
Scene Classif	ication	[Image Data]			
Algorithm	L2A_S	SceneClass			
Unit	None				
Range	0	No Data (Missing data on projected tiles) (black)			
	1	Saturated or defective pixel (red)			
	2	Dark features / Shadows (very dark grey)			
	3	Cloud shadows (dark brown)			
	4	Vegetation (green)			
	5	Bare soils / deserts (dark yellow)			













Name	Level-	-2A			
	6	Water (dark and bright) (blue)			
	7	Cloud low probability (dark grey)			
	8	Cloud medium probability (grey)			
	9	Cloud high probability (white)			
	10	Thin cirrus (very bright blue)			
	11	Snow or ice (very bright pink)			
	Note:	Scene Classification pixels are set to 1 (Saturated or defective	Э		
	pixel) i	if at least one band involved in the L2A_SC is affected by Leve	el-		
	1C qua	ality masks. See section 2.4.3 for details.			
Sampling	n/a (bi	nary parameter)			
Resolution	60m	60m			
Accuracy	80%				
	(To be consolidated by S2MPC)				
Cloud Probab	ility [QI	I Data]			
Algorithm	L2A_S	L2A_SceneClass			
Unit	Dimen	Dimensionless			
Range	0 - 100	0 - 100			
Sampling	8 bit/sa	8 bit/sample			
Resolution	60m, 2	60m, 20m			
Accuracy	See Cloud Confidence Table 2-X				
Snow Probability [QI Data]					
Algorithm	L2A_S	SceneClass			
Unit	Dimen	Dimensionless			
Range	0 – 10	0			













S2-PDGS-MPC-L2A-PDD-V14.2 4.5 2016-11-25

Name	Level-2A
Sampling	8 bit/sample
Resolution	60m, 20m
Accuracy	See Snow Confidence Table 2-X

### 2.2 Image Data

The Level-2 A image data is composed of BOA reflectance images, Aerosol Optical Thickness (AOT) maps, Water Vapour (WV) maps and a Scene classification map.

The Level-2A image data product uses the same tiling, encoding and filling structure as Level-1C as described in detail in section 8.2.1 and 8.2.2 of [S2-PDD].



Figure 2-2: Example of Level-2A product tiled in several files

#### 2.2.1 Atmospheric correction images

elecnor

gn∕

For BOA Reflectance images, pixel value is encoded on 16 useful bits and is directly proportional to Bottom-Of-Atmosphere reflectance values.

**Table 2-III** below lists the data type, the encoding, data size and resolution of the Atmospheric correction image data generated by the Level-2A processing.

 Table 2-III: Atmospheric correction Image Data

**AIRBUS** 



ACRI









Name	Data Type	Data Size	Resolution	Description				
		(HBytes)						
60m product								
BOA Reflectance								
B1 channel	JPEG 2000, 16bit	3.2	60m	Image				
B2 channel	JPEG 2000, 16bit	3.2	60m	Image				
B3 channel	JPEG 2000, 16bit	3.2	60m	Image				
B4 channel	JPEG 2000, 16bit	3.2	60m	Image				
B5 channel	JPEG 2000, 16bit	3.2	60m	Image				
B6 channel	JPEG 2000, 16bit	3.2	60m	Image				
B7 channel	JPEG 2000, 16bit	3.2	60m	Image				
B8a channel	JPEG 2000, 16bit	3.2	60m	Image				
B9 channel	JPEG 2000, 16bit	3.2	60m	Image				
B11 channel	JPEG 2000, 16bit	3.2	60m	Image				
B12 channel	JPEG 2000, 16bit	3.2	60m	Image				
Water Vapou	r Map							
WV map	JPEG 2000,	3.2	60 m	Image				













Name	Data Type	Data Size	Resolution	Description
		(MBytes)		
	16 bit			
Aerosol Optic	al Thickness	; Мар		
AOT map	JPEG 2000,	3.2	60 m	Image
	10 Dit			
20m product				
BOA Reflecta	nce			
B2 channel	JPEG 2000, 16bit	28.8	20m	Image
B3 channel	JPEG 2000, 16bit	28.8	20m	Image
B4 channel	JPEG 2000, 16bit	28.8	20m	Image
B5 channel	JPEG 2000, 16bit	28.8	20m	Image
B6 channel	JPEG 2000, 16bit	28.8	20m	Image
B7 channel	JPEG 2000, 16bit	28.8	20m	Image
B8a channel	JPEG 2000, 16bit	28.8	20m	Image
B11 channel	JPEG 2000, 16bit	28.8	20m	Image
B12 channel	JPEG 2000, 16bit	28.8	20m	Image
Water Vapor	Мар			
WV map	16 bit	28.8	20 m	Image













Name	Data Type	Data Size (MBytes)	Resolution	Description			
Aerosol Optio	cal Thickness	з Мар					
AOT map	16 bit	28.8	20 m	Image			
10m product							
BOA Reflecta	nce						
B2 channel	JPEG 2000, 16bit	115.4	10m	Image			
B3 channel	JPEG 2000, 16bit	115.4	10m	Image			
B4 channel	JPEG 2000, 16bit	115.4	10m	Image			
B8 channel	JPEG 2000, 16bit	115.4	10m	Image			
Water Vapor	Мар						
WV map	JPEG2000, 16 bit	115.4	10 m	Image			
Aerosol Optio	Aerosol Optical Thickness Map						
AOT map	JPEG2000, 16 bit	115.4	10 m	Image			

#### 2.2.2 Scene Classification image

**Table 2-IV** below lists the data type, the encoding, data size and resolution of the scene classification Image data as generated by the Level-2A processing. JPEG2000 is very efficient for this type of dataset with only 12 available values with a compression rate of the order of 10.

Name	Data Type	Data Size (MBytes)	Resolutio n	Description			
Scene Classification							



ACRI











Name	Data Type	Data Size (MBytes)	Resolutio n	Description
		· · ·		
Pixel Type	JPEG 2000,	1.0	60m	Array covering all
	8bit			picture columns/rows at
				60m spatial resolution.
Pixel Type	JPEG 2000,	5.5	20m	Array covering all
	8bit			picture columns/rows at
				20m spatial resolution.

#### 2.2.3 Digital Elevation Map (DEM)

**Table 2-IV** below lists the data type, the encoding, data size and resolution of an optional Digital Elevation Map as generated by the Level-2A processing. OpenJPEG is only able to store unsigned integer values, thus an offset of +10.000 has been applied in order to allow negative heights. The scale of the DEM is thus (meter – 10.000).

Data Type	Data Size (MBytes)	Resolution	Description
ation Map			
JPEG 2000,	60m: <3.2	60m	Array covering the
16bit	20m: < 28.8	20m	digital elevation map
	10m < 115.4	10m	in m + offset of
			10.000, to allow
			negative height.
	Data Type ation Map JPEG 2000, 16bit	Data TypeData Size (MBytes)ation MapJPEG 2000,60m: <3.2	Data Size (MBytes)Resolutionation MapJPEG 2000,60m: <3.2

#### Table 2-V: Digital Elevation Map

#### 2.2.4 True Colour Image (TCI, since PSD V.14.2)

**Table 2-VII** below lists the data type, the encoding, data size and resolution of the true color image data as generated by the Level-2A processing.

#### Table 2-VI TCI Data

Name	Data Type	Data Size (MBytes)	Resolution	Description		iption
True Colour Image for BOA Reflectance						
TCI Image	JPEG2000,	60m: <5	60m	RGB	(3	channels:



ACRI

ARGANS



elecnor









Name	Data Type	Data Size	Resolution	Description
		(MBytes)		
	8bit	20m: < 40	20m	RED = B4; GREEN =
		10m < 180	10m	B3; BLUE = B2).
				Preview dynamic is
				stretched (by default
				2% population
				threshold is applied).

#### **2.2.5 Preview Data**

**Table 2-VII** below lists the data type, the encoding, data size and resolution of the preview and browse image data as generated by the Level-2A processing.

Table	2-VII	Preview	Data
-------	-------	---------	------

Name	Data Type	Data Size (MBytes)	Resolution	Description
Preview Ima	ge (Quick Lo	ok) for BOA	Reflectance	
Preview Image	JPEG2000, 8bit	<0.3	320m	RGB (3 channels: RED = B4; GREEN = B3; BLUE = B2). Preview dynamic is stretched
				(by default 2% population threshold is applied).

#### 2.3 Metadata

ARGANS

This section describes the metadata provided with the Level-2A product. Metadata provided by Level-2A processing is indicated **in bold** in following sections.

**AIRBUS** 

#### 2.3.1 Product Level Metadata

elecnor

The following information is applicable to the whole product.

gn∕



ACRI



ThalesAlenia







22/35

#### 2.3.1.1 **Brief Metadata**

The following information is provided in the Level-2A "brief" metadata:

- Product level information:
  - 0 Datatake information (inherited from Level-0 metadata, see [S2-PDD]):
    - Datatake unique identifier;
    - Spacecraft name (Sentinel-2A/B/...);
    - Datatake type (MSI Operation Mode: Nominal, Dark Signal, etc, ...);
    - Imaging start time;
    - Imaging orbit number; .
    - Imaging orbit direction.

#### Processing Level (Level-2A); 0

- $_{\odot}$  List of Level-2A tiles composing the product and the dimensions of each tile;
- Tiles aggregation flag (Boolean); 0
- Image format and pointer to the image data files; 0
- Spectral bands (relation between product image channels and 0 on-board spectral bands);
- Reflectance quantification value (in order to convert 0 digit count into reflectance) and unit;
- Special values encoding (e.g. NODATA, SATURATION). 0
- Datastrip level information (repeatable for each Datastrip composing the product):
  - Datastrip unique identifier;

q m

Preview data information:

elecnor

ARGANS

Pointer to preview image files (see section 2.2.5); 0

ThalesAlenia

Product level quality indicators (see section 2.4.1).

**AIRBUS** 









#### 2.3.1.2 Standard Metadata

The following information is provided in the standard metadata structure:

- Brief metadata, as in section 2.3.1.1.
- Following information repeatable for each Datastrip:
  - Auxiliary data information:
    - Auxiliary data from Level-1C;
    - Identification of OGCD/GIPP used for Level-2A (identifier and version), including Meteorological data listed in section 2.5.

#### 2.3.1.3 Expertise Metadata

The following information is provided in the expertise metadata structure:

- Brief metadata, as in section 2.3.1.1;
- Standard metadata, as in section 2.3.1.2;
- Following information repeatable for each Datastrip:
  - Datastrip generation information (Level-2A generation date, software version,...);
  - Level-1C expertise metadata.

#### **2.3.2 Tile Level Metadata**

The following metadata are provided on tile level:

#### 2.3.2.1 Brief Metadata

The following information is provided in the Level-2A "brief" metadata for each Level-2A tile:

- Tile identifier, as referenced by Level-1C data;
- Tile geocoding:
  - Upper-left coordinates (ULX, ULY) of the tile (in meters);
  - Pixel dimensions (XDIM, YDIM) within the tile (in meters and depending on band GSD);
  - Tile size in number of lines/columns.

gn∕















#### 2.3.2.2 Standard Metadata

For each tile of the Level-2A product, the following information is provided in the standard metadata:

- Brief metadata
- Tile identification and reference to a given Datastrip;
- Grid of sun angles (zenith and azimuth) and the correction which takes into account earth-sun distance variation and for each band sun equivalent irradiance
- Mean sun angle;
- Grid of incidence angles (zenith and azimuth) (per bands and detectors);
- Mean incidence angle;
- Tile level quality indicators as listed in section 2.4.2;
- Pixel level quality indicators (as a pointer to the QI files) as listed in section 2.4.3.

#### 2.3.2.3 Expertise Metadata

At tile level, the expertise metadata is composed by the same information as in the standard metadata structure (see section 2.3.2.2).

#### 2.4 Quality Indicator Data

The following quality indicators (QI) are provided with Level-2A products. Some QIs provided in Level-2A products are inherited from Level-1C QIs.

#### **2.4.1 Product Level Quality Indicators**

The following Level-2A QIs are provided on product level and refer to one Datatake. They are provided through the metadata file.

#### Table 2-VIII: Product Level Quality Indicators

Name	Data	Data	Resolutio	Description	
	Туре	Size	n		
		(Byte			
		)			
Level-2A Quality Indicators					













Name	Data Type	Data Size (Byte )	Resolutio n	Description
% of saturated or defective pixels	Unsigned Integer	1	n/a	This information is derived from the scene classification image based on Level-1C radiometric quality masks.
% of pixels classified as dark features /shadows	Unsigned Integer	1	n/a	For Level-2A products the recognition of cloud, land, water etc. pixel is made checking the pixel radiometry. Ranging from 0 for 0% to 100 for 100%.
% of pixels classified as cloud shadow	Unsigned Integer	1	n/a	11
% of pixels classified as vegetation	Unsigned Integer	1	n/a	11
% of pixels classified bare soils	Unsigned Integer	1	n/a	"
% of pixels classified as water	Unsigned Integer	1	n/a	"
% of pixels classified as low probability cloud	Unsigned Integer	1	n/a	11













Name	Data Type	Data Size (Byte )	Resolutio n	Description
% of pixels classified as medium probability cloud	Unsigned Integer	1	n/a	
% of pixels classified as high prb. Cloud	Unsigned Integer	1	n/a	
% of pixels classified as cirrus	Unsigned Integer	1	n/a	11
% of pixels classified as cloud coverage	Unsigned Integer	1	n/a	This is a combination of the three previous classes medium, high clouds and cirrus and is added for PSD Version 14.2 and above. Ranging from 0 for 0% to 100 for 100%.
% of pixels classified as snow or ice	Unsigned Integer	1	n/a	
Declared accuracy of the radiative transfer model	String	10	n/a	Libradtran code achieves a relative accuracy of 5% - 10% http://www.bmayer.de/index.html ?radtran.html&1
Water vapour retrieval accuracy	String	10	n/a	APDA (Atmospherically Precorrected Differential













Name	Data	Data	Resolutio	Description
	Туре	Size	n	
		(Byte		
		)		
				Absorption) method achieves a
				typical relative accuracy of 5 -
				10% except over very dark
				surfaces.
				(Schläpfer 1998, Chylek et al.
				2003, Richter and Schläpfer
				2008)
Traceability and Ac	curacy of A	uxiliary	Data	
n/a			n/a	n/a
Embedded Level-1	C Quality In	dicators	s (Datastrip	level)
Geometric Quality			n/a	Orbit level quality
indicators				indicators from Level-0:
				Absolute location,
				Planimetric stability, and
				ephemeris and ancillary
				data quality. See section
				5.5.1 of [S2-PDD] for
				details.
				Orbit level quality
				indicators from Level-1B:
				Geometric refining quality,
				average, mean quadratic
				residuals, histograms of
				spatio-triangulation
				residuals on ground for
				each axis (X, Y, Z) and in
				image reference frame for
				each axis (row, col). See
				section 7.4.1 of [S2-PDD]













Name	Data Type	Data Size (Byte )	Resolutio n	Description
				for details.
% of degraded MSI and ancillary data over the product	Unsigned Integer	1	n/a	Level-1C Quality Indicator

#### **2.4.2 Tile Level Quality Indicators**

The following Level-2A Quality Indicators are provided on tile level in the tile metadata.

Name	Data Type	Data Size (Byte)	Resolutio n	Description
Level-2A Quality	Indicators (	Tile level	)	
% of no data pixels (missing data on projected tiles)	Unsigned Integer	1	n/a	This information is derived from the scene classification image based on Level-1C radiometric quality masks.
% of saturated or defective pixels	Unsigned Integer	1	n/a	"
% of pixels classified as dark features /shadows	Unsigned Integer	1	n/a	This information is derived from the scene classification image based on Level-1C radiometry. Ranging from 0 for 0% to 100 for 100%.

#### Table 2-IX: Level-2A Tile Level Quality Indicators













Name	Data Type	Data Size (Byte)	Resolutio n	Description
% of pixels classified as cloud shadow	Unsigned Integer	1	"	11
% of pixels classified as vegetation	Unsigned Integer	1	"	"
% of pixels classified bare soils	Unsigned Integer	1	п	-
% of pixels classified as water	Unsigned Integer	1	11	"
% of pixels classified as low probability cloud	Unsigned Integer	1	Π	11
% of pixels classified as medium probability cloud	Unsigned Integer	1	п	"
% of pixels classified as high prb. Cloud	Unsigned Integer	1	"	11
% of pixels classified as cirrus	Unsigned Integer	1	n/a	11
% of pixels classified as cloud coverage	Unsigned Integer	1	n/a	This is a combination of the three previous classes medium, high clouds and















30/35

Name	Data Type	Data Size (Byte)	Resolutio n	Description	
				cirrus and is added for PSD Version 14.2 and above. Ranging from 0 for 0% to 100 for 100%.	
% of pixels classified as snow or ice	Unsigned Integer	1		11	
Embedded Level-	Embedded Level-1C Quality Indicators (Tile level)				
% of degraded MSI and ancillary data over the tile	Unsigned Integer	1	n/a	Level-1C Quality Indicator	

#### **2.4.3 Pixel Level Quality Indicators**

These quality indicators are provided at tile level through dedicated quality masks that provide quality information at pixel level.

Please note that high-level radiometric quality information is also available at pixel level through the scene classification image (2 classes: no data pixels and defective/saturated pixels).

QIs provided by Level-2A processing are provided at 60m and 20m resolution as raster masks, the same resolution as the Pixel Classification. Users may resample this to lower or higher resolution, if required.

The following Level-2A QIs are provided on pixel level.

 Table 2-X: Level-2A Pixel Level Quality Indicators

Name	Data Type	Data Size (Byte)	Resolution	Description
Cloud	Unsigned	1	60m / 20m	Ranging from 0 for high
Confidence	Integer			confidence clear sky to 100 for
				high confidence cloudy.















Name	Data Type	Data Size (Byte)	Resolution	Description
Snow or Ice Confidence	Unsigned Integer	1	60m / 20m	Ranging from 0 for high confidence no snow/ice to 100 for high confidence snow/ice.
Embedded Lev	vel-1C Qua	lity Indica	ators (Pixel le	evel)
Radiometric quality masks	GML file	N/A	Vector	These masks are derived from Level-1B processing and are provided for each band and tile (defective pixels mask, saturated pixels mask and no-data pixels mask).
Local Technical quality mask files	GML file	N/A	Vector	These L1C technical quality masks (MSI lost data, MSI degraded data, ancillary lost data, ancillary degraded data) are provided for each band and tile.
Detector footprint mask	GML file	N/A	Vector	A mask providing the ground footprint of each detector within a tile.

Note: QIs inherited from Level-1C products are provided as vector files; one for each type of mask and each tile. Each vector mask file consists of a set of polygons defined in ground geometry: (X, Y) in the projected frame.

#### **2.5 Auxiliary Data**

elecnor

All Auxiliary Data used for Level-2A processing are referenced in the Level-2A Metadata whereas only GIPPs and Level-1C meteorological datasets are provided within Level-2A product.

**AIRBUS** 

Please refer to [S2-L2A-ATBD] for details on auxiliary data.

gn∕



ACRI

ARGANS







31/35



#### **2.5.1 Provided Auxiliary Data**

The following auxiliary data is provided in the Level-2A product structure:

- Ground Image Processing Parameter List (GIPP List) used. These GIPPs are provided as a separate XML file as listed in[ L2A-IODD]
- Level-1C inherited Auxiliary Data which consists in an elementary set of meteorological datasets extracted and resampled from ECMWF forecast output (cf. [ECMWF]).

#### 2.5.2 Referenced Auxiliary Data

The following auxiliary data is referenced in the Level-2A metadata:

- The Digital Elevation Model (provided by user) used for the Level-2A processing is provided in the AUX data subfolder on the GRANULE level, labelled by resolution.
- The LibRadtran LUTs used for the Level-2A processing are not provided within the product but only as a reference to the data used.
- The Snow climatology used for the Level-2A processing is not provided itself within the product but only as a reference to the data used.

### **2.6 File Size Estimation (single tile)**

The total size of Image data and QI Data output can be calculated based on sections 2.2 and 2.4. The data size has been calculated for a single tile assuming an image size of 110km \* 110km and lossless JPEG2000 compression, with a mean compression rate of 2.0 for surface reflectance bands and higher compression rate for AOT, WVP, DEM and Scene Classification

The following data have been neglected in the file size estimation, due to their relatively small size:

- Product Metadata
- Quality Indicators provided in Metadata
- Preview Images

elecnor

ARGANS

- Embedded Level-1C Quality indicators (TBC)

#### Table 2-XI: Total File Size (110x110km<sup>2</sup> tile)













Name	Data	Resolutio	MBytes	Description			
	Format	n					
60m Image Data							
60m Product	JPEG2000	60m	35.2	Primary Output, Image			
BOA	, 16bit			Data (BOA) for			
Reflectance				spectral channels B1,			
				B2, B3, B4, B5, B6,			
				В7, Боа, Б9, Б11, В12.			
				One JP2 file per band.			
60m WV map	JPEG2000	60m	~3.3	Water Vapour map at			
	, 16 bit			60m resolution			
60m AOT map	JPEG2000	60m	~3.3	Aerosol Optical			
	, 16 bit			Thickness map			
60m Scene	JPEG2000	60m	~1.0	Category of the pixel,			
Classification	, 8 bit			e.g. land, water,			
				cloud, cloud shadow,			
				snow or ice			
60m TCI image	JPEG2000	10m	~5.0	True Color Image Data			
	, 8 bit x 3			(BOA) for spectral			
				Channels BZ, B3, B4			
60m DEM	JPEG2000	10m	~3.3	Digital Elevation Map			
(optional)	, 16 bit			(optional)			
Total (60m)			~53.0	MBytes			
20m Image Dat	a						
20m Product	JPEG2000	20m	259.2	Primary Output, Image			
BOA	, 16bit			Data (BOA) for			
Reflectance				spectral channels B2,			













2 34/35

Name	Data	Resolutio	MBytes	Description
	Format	n		
				B3, B4, B5, B6, B7, B8a, B11, B12.
				One JP2 file per band.
20m WV map	JPEG2000 , 16 bit	20m	~20.0	20m Water Vapour map
20m AOT map	JPEG2000 , 16 bit	20m	~1.0	20m Aerosol Optical Thickness map
20m Scene Classification	JPEG2000 , 8 bit	20m	~5.0	Category of the pixel, e.g. land, water, cloud, cloud shadow, snow or ice
20m TCI image	JPEG2000 , 8 bit x 3	10m	~50	True Color Image Data (BOA) for spectral channels B2, B3, B4
20m DEM (optional)	JPEG2000 , 16 bit	10m	~20.0	Digital Elevation Map (optional)
Total (20m)			~355.0	MBytes
10m Image Dat	a			
10m Product BOA Reflectance	JPEG2000 , 16bit	10m	461.6	Primary Output, Image Data (BOA) for spectral channels B2, B3, B4, B8. One JP2 file per band.
10m WV map	JPEG2000 , 16 bit	10m	~50.0	20m Water Vapour map
10m AOT map	JPEG2000	10m	~2.0	20m Aerosol Optical













Name	Data	Resolutio	MBytes	Description
	Format	n		
	, 16 bit			Thickness map
10m TCI image	JPEG2000 , 8 bit x 3	10m	~150	True Color Image Data (BOA) for spectral channels B2, B3, B4
10m DEM (optional)	JPEG2000 , 16 bit	10m	~50.0	Digital Elevation Map (optional)
Total (10m)			~710.0	MBytes
Quality Indicators Data				
60m/20m Cloud Confidence	JPEG2000 , 8 bit	60m 20m	~1.0 ~5.0	Q.I. for cloud, ranging from 0 for high confidence clear sky to 100 for high confidence cloudy.
60m/20m Snow or Ice Confidence	JPEG2000 , 8 bit	60m 20m	~1.0 ~5.0	Q.I. for snow, ranging from 0 for high confidence no snow to 100 for high confidence snow.
Total			850.0	MBytes







