



RAPIDEYE™ MOSAICS PRODUCT SPECIFICATIONS

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Abbreviations

CE90	Circular Error 90%
DEM	Digital Elevation Model
DTED	Digital Terrain Elevation Data
GCP	Ground Control Point
JPEG	Joint Photographic Experts Group
ISD	Image Support Data
N/A	Not Applicable
NIR	Near Infra-red
NMAS	National Map Accuracy Standards
RMSE	Root Mean Squared Error
SRTM	Shuttle Radar Topography Mission
TBC	To Be Confirmed
TBD	To Be Defined
TIFF	Tagged Image File Format
UTC	Coordinated Universal Time
UTM	Universal Transverse Mercator
WGS	World Geodetic System

1. INTRODUCTION

Planet offers image users a data source containing an unrivaled combination of large-area coverage, frequent revisit intervals, high resolution and multispectral capabilities. These attributes are leveraged to create the RapidEye Mosaic product. This document provides information related to the RapidEye satellites system and the RapidEye Mosaic product in the following area:

RapidEye Satellite:	The RapidEye satellite constellation offers something new and unique to the world of commercial remote sensing.
Product Description:	RapidEye Mosaic product attributes and quality are discussed.
Product Ordering:	Details on how to order RapidEye Mosaic products are described.
Product and Delivery Options:	RapidEye Mosaic products are offered with several processing and delivery options.
Product Licensing:	Planet offers customers several licensing options to ensure that all users who need to use the imagery may do so.
Product Naming:	Provides a description of the product naming convention used for the RapidEye Mosaic products.
Image Support Data:	All RapidEye Mosaic products are supported with several different metadata files to aid the customer with the use and analysis of the data.

2. RAPIDEYE SATELLITE CONSTELLATION

Table 1 below outlines general mission characteristics for the RapidEye system.

Table 1: RapidEye System Specifications

Mission Characteristic	Information												
Number of Satellites	5												
Spacecraft Lifetime	Over 7 years												
Orbit Altitude	630 km in Sun-synchronous orbit												
Equator Crossing Time	11:00 am local time (approximately)												
Sensor Type	Multi-spectral push broom imager												
Spectral Bands	Capable of capturing all of the following spectral bands: <table border="1"> <thead> <tr> <th>Band Name</th> <th>Spectral Range (nm)</th> </tr> </thead> <tbody> <tr> <td>Blue</td> <td>440 - 510</td> </tr> <tr> <td>Green</td> <td>520 - 590</td> </tr> <tr> <td>Red</td> <td>630 - 685</td> </tr> <tr> <td>Red Edge</td> <td>690 - 730</td> </tr> <tr> <td>NIR</td> <td>760 - 850</td> </tr> </tbody> </table>	Band Name	Spectral Range (nm)	Blue	440 - 510	Green	520 - 590	Red	630 - 685	Red Edge	690 - 730	NIR	760 - 850
Band Name	Spectral Range (nm)												
Blue	440 - 510												
Green	520 - 590												
Red	630 - 685												
Red Edge	690 - 730												
NIR	760 - 850												
Ground Sampling Distance (nadir)	6.5 m												
Pixel size (orthorectified)	5 m												
Swath Width	77 km												
On board data storage	Up to 1500 km of image data per orbit												
Revisit time	Daily (off-nadir) / 5.5 days (at nadir)												
Image capture capacity	Up to 5 million sq km/day												
Camera Dynamic Range	12 bit												

3. RAPIDEYE MOSAIC PRODUCT SPECIFICATIONS

RapidEye Mosaic products consist of multiple RapidEye image takes that have been orthorectified and radiometrically color balanced to a uniform appearance that are then assembled to create a single, seamless large area image. This product was designed for a wide variety of applications that require background imagery with an accurate geolocation and a uniform appearance with minimal clouds. Off-the-shelf RapidEye Mosaic products have the following basic characteristics (please see Section 5 for possible custom processing options):

- Three-band, true color (RGB)
- Image bit depth of 8-bit
- Five (5) meter pixel spacing
- Cloud-free (less than 3 % cloud cover, some areas excluded)
- Images geometrically aligned and radiometrically balanced to one another
- Positional accuracy of 15 m RMS or better (25 m CE90 or better)
- UTM, WGS84 projection
- Delivered in GeoTIFF format

The RapidEye Mosaic product is radiometric, sensor and geometrically corrected and aligned to a cartographic map projection. The geometric correction uses DEMs with a post spacing of between 30 and 90 meters. Ground Control Points (GCPs) are used in the creation of every product and the positional accuracy of the product will vary depending on the quality of those points.

Table 2 lists the attributes for the standard RapidEye Mosaic product.

Table 2: Attributes for RapidEye Mosaic Products

Level	Description
Product Components and Format	RapidEye Mosaic product consists of the following file components: Image File - GeoTIFF file that contains image data and geolocation information Metadata File - XML format metadata file Browse Image File - GeoTIFF format Spatial Image Map (SIM) fileset - ESRI shapefile (SHP) format
Image Bands	Red, Green, Blue (RGB)
Image Bit Depth	8-bit unsigned integer
Pixel spacing	5 m
Cloud cover	3% or less (except in tropical area or areas with persistent clouds)
Product Size	Standard tile size is a 30 minute x 30 minute tile which corresponds to approximately 55 km (11,000 lines) by 55 km (11,000 columns) at the Equator. < 0.5 GB per Tile for 3 band, 8-bit images.
Horizontal Datum	WGS84

3.1. Product Tiling and Tile Naming

All RapidEye Mosaic products are tiled from a larger parent image. Tiling of the product is done to insure that output product does not exceed the allowable size for the image format, and allows the end user the ability to quickly load only needed tiles into their system. This section describes the product tiling and tile naming convention used for the standard, off-the-shelf mosaic product.

Description

All standard RapidEye Mosaic products are tiled to an area of 30 minutes by 30 minutes based on a 1 degree geocell grid. Each tile will represent one of four quadrants within a defined one degree geocell. Each one degree geocell is defined to the appropriate whole degree values for both latitude and longitude for the UTM zone that the geocell belongs to since the product has a UTM projection. Since longitudinal distance varies by latitude, geocell and their quadrants will vary in size depending on their location.

Tile Naming

Each mosaic tile has two naming components: 1) a geocell name, and 2) a quadrant name. The geocell name is based on the lower left hand corner value of the latitude and longitude, and the quadrant name is based on which quadrant of the geocell the imagery is coming from. Quadrants are named according to row and column starting with the upper left quadrant. The complete tile name is in the following format and is also illustrated in Figure 1:

`<geocell name> - <quadrant name>`

where:

`<geocell name> = <lat>N/S_<long>E/W`
 <lat> = nn
 <long> = nnn
`<quadrant name> = <RnCn>`

For example: **52N012E-R2C1**

Custom mosaic products will follow the same tiling and naming scheme unless otherwise requested by the customer during the ordering process, subject to feasibility.

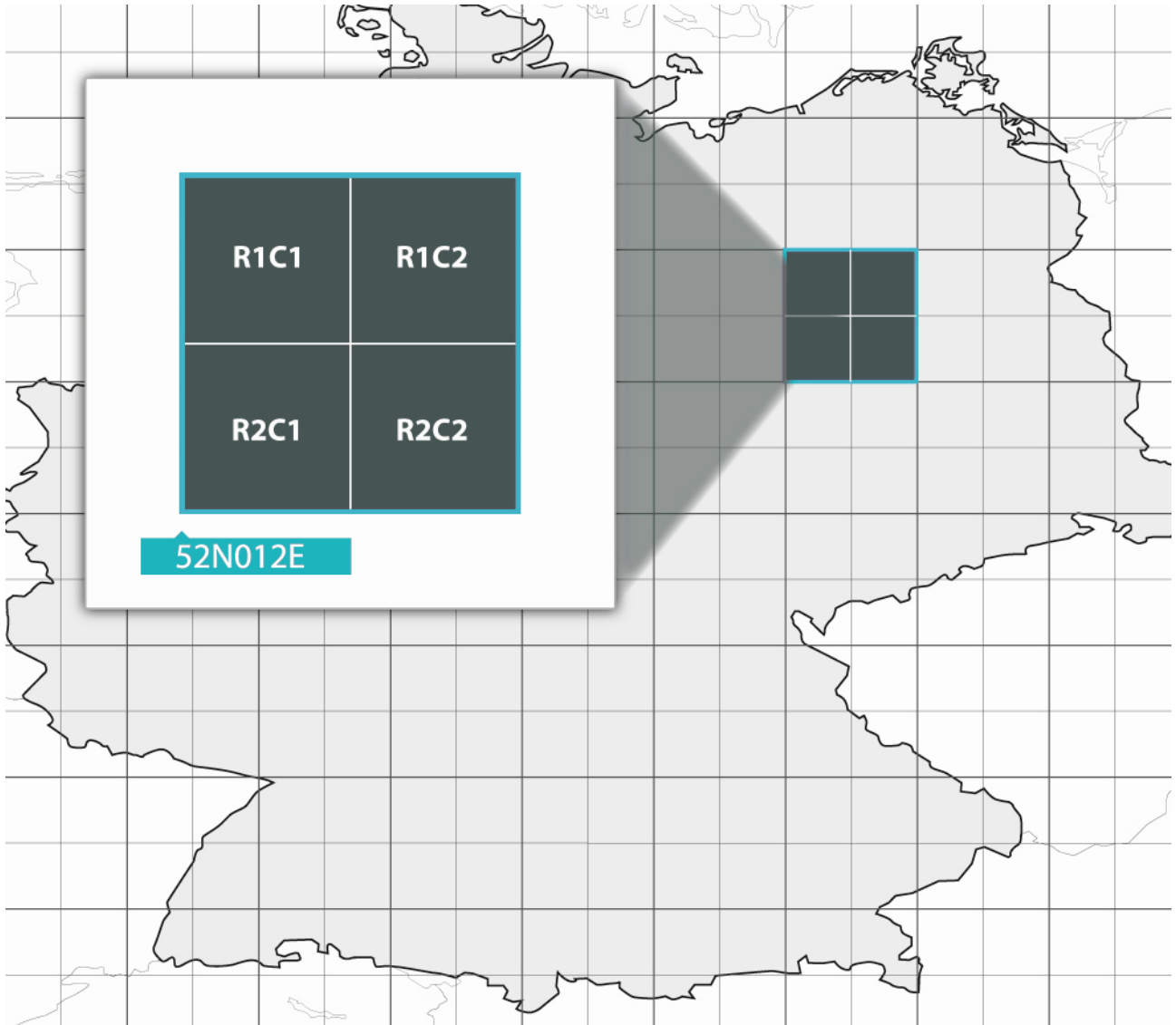


Figure 1: Example of Tile Naming

3.2. Product Quality Attributes

The following sections detail the quality attributes related to the RapidEye Mosaic product.

3.2.1. Geometric Product Accuracy

3.2.1.1. Product Locational Accuracy

The accuracy of the RapidEye Mosaic products depends on the quality of the reference data used (GCPs and DEMs). The positional accuracy of the RapidEye Mosaic product will meet 15 m RMS (25 m CE90) based on areas with a slope of 10 degree or less. In cases where this accuracy cannot be met those mosaics will be identified and a suitable accuracy for the product will be agreed upon.

3.2.1.2. Internal Geometric Accuracy

The images used to create the RapidEye Mosaic product will be put together in such a way as to create a seamless product that contains no or very minimal geometric breaks of linear features (e.g. Roads, rivers, etc.) that lie in multiple images. If such noticeable geometric breaks are unavoidable they will be below 2.5 pixels (12.5 m) between images.

3.2.2. Cloud Cover

RapidEye Mosaic products are created with less than 3 percent cloud cover in most cases, with many areas being cloud-free. However, in tropical regions or other areas of high persistent cloud cover the allowable cloud cover percentage may exceed 3 percent and an attempt will be made to minimize the cloud cover within a reasonable Time of Interest (TOI) for the product. In special cases for custom mosaic products, Planet will work with the customer to achieve an acceptable cloud cover for problematic areas. The RapidEye Mosaic product may also contain minor areas with visible haze and cloud shadow.

3.2.3. Product Radiometry and Radiometric Accuracy

All RapidEye Mosaic products will be tonally balanced to create a visually pleasing, seamless product. The images used to create the mosaic will come from as limited a time range as possible, subject to cloud cover requirements, so as to minimize differences between images. However, in some cases it may be possible to see seasonal variations in vegetation and other features between images and no guarantee can be made that all images in the RapidEye Mosaic can be seamlessly color balanced.

3.2.4. Handling of Water and Water Bodies

All inland water bodies will contain valid imagery within a mosaic. Some exceptions may be made on a per case basis for the largest of the global inland water bodies. All mosaics containing coastlines will contain water out to 3km from the main coast line, but the color balancing of that water can not be guaranteed. Mosaics in areas with numerous small islands will contain valid imagery over the water that connects the islands up to a point where open water is reached, and then the limits applicable to coastlines (as described above) are applied from there.

4. PRODUCT AND DELIVERY OPTIONS

Table 3 summarizes the product and delivery options available for all RapidEye Mosaic products.

Table 3: Product Processing and Delivery Options

Processing Option	Discussion
	For off-the-shelf mosaics <ul style="list-style-type: none">• RGB (Red, Green, Blue - standard)
Spectral Band Combinations	For custom mosaics <ul style="list-style-type: none">• RGB (Red, Green, Blue)• 5-band (Blue, Green, Red, Red Edge, Near-Infrared)• CIR (Near-Infrared, Red, Green)
Image Bit depth	For off-the-shelf mosaics <ul style="list-style-type: none">• 8-bit (standard) For custom mosaics <ul style="list-style-type: none">• 8-bit• 16-bit
Delivery	FTP Pull USB Hard Drive USB Memory stick

5. PRODUCT NAMING

The naming of RapidEye Mosaic products provides useful important information about the product and allows the user to quickly identify or sort multiple products. The name of each product is designed to be unique and is composed of the following elements:

`<tileID>_<production year>_<processing level>_<order number>.<file extension>`

For example: **53N012E-R1C2_2011_RE-3M_0123456789.tif**

where:

`<tileID>` = 53N012E-R1C2
= 53N012E is lower left coordinate of one degree geocell
= R1C2 is the quadrant tile of the geocell
`<production year>` = 2011 (year mosaic was produced)
`<processing level>` = RE-3M (RapidEye orthomosaic product)
`<order number>` = 0123456789
`<file extension>` = tif (GeoTIFF)

Note: ISD Metadata files for the product will have a file type name appended to the appropriate file after the order number, please see Section 8 for more information. Product tiling and naming are described in Section 3.1.

6. IMAGE SUPPORT DATA

All RapidEye Mosaic orders are accompanied by a set of image support data (ISD) files. These ISD files provide important information regarding the mosaic image or are useful sources of ancillary data related to construction of the mosaic image. The four ISD files are:

1. XML Metadata File
2. Browse Image File
3. License File
4. Spatial Image Map Fileset

Each file is described along with its contents and format in the following sections.

6.1. XML Metadata File

All RapidEye Mosaic products will be accompanied by a single XML metadata file. This file contains a description of basic elements of the image. The file is written in Geographic Markup Language (GML) version 3.1.1.

6.1.1. Contents

Table 4 describes the fields present in the XML metadata file for all product levels.

Table 4: XML Metadata File Field Descriptions

Field	Description	Range/Value
“metaDataProperty” Block		
EarthObservationMetaData		
identifier	Dataset name and production year	
acquisitionType	Type of image acquisition	NOMINAL
productType	Product level of image	L3M
status	Status type of image, if newly acquired or produced from a previously archived image	ARCHIVED
archivedIn		L3M
archivingInformation		
archivingCenter	Location where product is archived	BER
archivingDate	Date when product was archived	
archivingIdentifier	Catalog ID of product within the RE Archive Management System	
productCreationDate	Date the product was created	
license		
licenseType	Name of selected license for the product	

Metadata File Field Contents

Field	Description	Range/Value
resourceLink	Hyperlink to the physical license file	
versionIsd	Version of the ISD	
orderIdXX	Order ID of the product	
pixelFormat	Number of bits per pixel per band in the product image file(s).	8U - 8 bit unsigned 16U - 16 bit unsigned
“validTime” Block		
TimePeriod		
beginPosition	Start date and time of acquisition for source image take used to create mosaic, in UTC	
endPosition	End date and time of acquisition for source image take used to create mosaic, in UTC	
“target” Block		
Footprint		
multiExtentOf		
MultiSurface	Defines the EPSG code of the polygon projection	
surfaceMembers		
Polygon	Defines the surface polygon of the mosaic order	
exterior		
LinearRing		
posList	Position listing of the nodes that define the order polygon in geodetic coordinates in the format: ULX ULY URX URY LRX LRY LLX LLY ULX ULY where X = latitude and Y = longitude	
centerOf		
Point		
pos	Position of center of the order in geodetic coordinate X and Y, where X = latitude and Y = longitude	
“resultOf” Block		
EarthObservationResult		
product		
productFormat	File format of the mosaic product	GeoTIFF JPEG2000

Metadata File Field Contents

Field	Description	Range/Value
rowGsd	The GSD of the rows (lines) within the mosaic product	
columnGsd	The GSD of the columns (pixels) within the mosaic product	
numBands	Number of bands in the mosaic product	1-5
bandCombination	Combination of spectral band included in the product: - RGB = (Red, Green, Blue) - 5-band = (Blue, Green, Red, Red-Edge, NIR) - CIR = (NIR, Red, Green)	1 = RGB 2 = 5-band 3 = CIR 4 = Custom
The following fields are repeated for each image used to create the mosaic		
sourceImageryPool		
archivingIdentifier	Catalog ID of the image used from the RapidEye DMS processing system	
acquisitionDate	Date and time image was acquired from the satellite	
The following fields are repeated for each mosaic tile in the order		
mosaicDecomposition		
mosaicTile	Field contain name of the geocell and quadrant of the tile	
fileName	Name of mosaic tile	
size	The size of the mosaic tile in kbytes	
referenceSystemIdentifier	Identifies the reference system used for the mosaic tile	
footprint		
multiExtentOf		
MultiSurface		
surfaceMembers		
Polygon	Defines the surface polygon of the mosaic tile in geodetic coordinates X and Y, where X = latitude and Y = longitude	
exterior		
LinearRing		
posList	Position listing of the four outermost corners for the mosaic tile in geodetic coordinates in the format: ULX ULY URX URY LRX LRY LLX LLY ULX ULY where X = latitude and Y = longitude	
browse		
browseInformation		
type	Type of browse image that accompanies the image product as part of the ISD	QUICKLOOK
referenceSystemIdentifier	Identifies the reference system used for the browse image	
fileName	Name of the browse image	
sourceImageryIdList	List of all image catalog IDs used to create the tile	

6.1.2. File Naming

The XML metadata file will follow the naming convention `<orderID>_metadata.xml`.

For example: `0123456789_metadata.xml`

6.2. Browse Image File

All RapidEye Mosaic product tiles will be accompanied by a reduced resolution browse image file.

6.2.1. Contents

The browse image file contains a reduced-resolution representation of the product. It has the same aspect ratio and radiometric corrections as the product, but with a pixel resolution of roughly 50 m. The GeoTIFF file will contain 3 bands and will be an 8-bit image that is georeferenced to a WGS84 Geographic (Latitude-Longitude) projection. The 3-band browse image contains the Red, Green, and Blue bands. Since the browse image is derived from the parent image, the re-projection into geographic coordinates may create areas of blackfill on the borders of the browse image that will not be present in the full resolution parent image.

6.2.2. File Naming

The Browse Image file will follow the naming convention described in Section 7

Example: `53N012E-R1C2_2011_RE-3M_0123456789_browse.tif`

6.3 License File

All RapidEye Mosaic orders will be accompanied by a license file for the order.

6.3.1. Contents

The license file is a simple text file that contains the text of the license that was selected at the time the image order was placed. The license file is a simple text file that contains the text of the license that was selected at the time the image order was placed.

6.3.2. File Naming

The license file will follow the naming convention `<orderID>_license .txt`.

Example: **0123456789_license.txt**

6.4 Spatial Image Map (SIM) Dataset

All RapidEye Mosaic orders will be accompanied by a Spatial Image Map dataset.

6.4.1. Content

The Spatial Image Map (SIM) dataset consists of a vector polygon file showing the outline of the images used to create the image mosaic imagery for the order area. The polygon is formatted as a series of files in ESRI® shapefile format and is in a WGS84 Geographic projection. Each polygon within the shapefile will have the following fields of metadata information:

Shape ID	the ID number of the polygon
identifier	name of 1B image used
acqDate	date of acquisition of the image used in the mosaic
serialID	ID of the RapidEye satellite used to take the image
scViewAng	spacecraft off-nadir viewing angle
illAzAng	illumination (sun) azimuth angle for image
illElevAng	illumination (sun) elevation angle for image
catID	catalog ID of the image used in the mosaic

6.4.2. File Naming

The SIM dataset shapefile will follow the naming convention `<orderID>_SIM.<file_extension>`

Example: **0123456789_SIM.dbf**
0123456789_SIM.prj
0123456789_SIM.shp
0123456789_SIM.shx

APPENDIX A – GLOSSARY OF TERMS

The following list defines terms used to describe RapidEye Mosaic products.

Digital Elevation Model (DEM)	A digital model of the terrain surface, usually derived from stereo imagery. A DEM is used to remove terrain distortions from the imagery for the geo-corrected products.
Dynamic Range	The number of possible DN values for each pixel in a band of an image. The RapidEye sensor has a 12-bit dynamic range which translates into 4096 possible values.
Geocell	An area that conforms to a one degree by one degree area of latitude and longitude. At the Equator this area is approximately 110 kilometers by 110 kilometers and decreases in size toward the poles.
Ground Control Point (GCP)	A visible point on the ground with known geographic coordinates. GCPs can be planimetric (latitude, longitude) or vertical (latitude, longitude, elevation). GCPs can be collected from ground survey, maps, or orthorectified imagery.
Ground Sample Distance (GSD)	The size of one pixel, as measured on the ground.
Metadata	Ancillary data that describes and defines the RapidEye imagery product. See Section 8 for a complete breakdown of metadata files and the fields within them.
Orthorectification	The correction of distortions caused by terrain relief displacement on the image.
Pixel	The smallest element comprising a digital image.
Resolution	The resampled image pixel size derived from the GSD.
Sun-Synchronous	An orbit which rotates around the earth at the same rate as the Earth rotates on its axis.
Swath Width	The width of the ground area that is recorded by one image strip.
Terrain Correction	The correction for variations in data caused by terrain displacement due to off-nadir viewing.