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RADARSAT-2 PRODUCT FORMAT DEFINITION

Summary: This document defines the format of RADARSAT-2 products.

13800 Commerce Parkway
Richmond, B.C., Canada, V6V 2J3
Telephone (604) 278-3411
Fax (604) 231-2796

CHANGE RECORD

ISSUE	DATE	PAGE(S)	DESCRIPTION	RELEASE
0/1	May 14, 2001	All	Draft – First Revision	
1/0	Nov. 19, 2001	All	First Issue	
1/1	March 15, 2002	See change bars	Updated for RIDs received at PDS PDR: RSI-RSI-8 CCRS-TIL-11 CCRS-TIL-12 CIS-CIS-6 RSI-RSI-9 RSI-RSI-10	
1/2	June 19, 2002	See change bars	First Issue – Second Revision Updated for corrections discovered during detailed design of product formatting software, and to add specification of units.	
1/3	Feb. 13, 2003	See change bars	First Issue – Third Revision Updated for corrections discovered during implementation of product formatting software.	
1/4	July 28, 2003	Section 5, Pages 18, 19, 24, 25, 34, 37 and 42	First Issue – Fourth Revision Added new fields to handle product flipping to nominally north-up and east-right. Clarified LUTs do not apply to SSG and SPG products.	
1/5	Nov. 24, 2003		First Issue – Fifth Revision	
		5-8	Changed pulsesTransmittedPerDwell to pulsesReceivedPerDwell	
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ISSUE	DATE	PAGE(S)	DESCRIPTION	RELEASE
1/6	June 20, 2007	(viii)	First Issue, Sixth Revision	
		(ix) 1-1	Corrected beamModeMnemonicType to beamList in 9 places	
		2-1	Added chirpPower description	
		5-2, 5-7, 5-8, 5-9,	Added new field, crossCorrelationPeakLoc, to Chirp Quality (ref. Bugzilla 2331)	
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1/7	Mar. 14, 2008		First Issue, Seventh Revision	
			Pre-Launch and Commissioning Phase Updates.	
		5-5, 5-40	Corrected copyright string.	
		5-8	Clarified settableGain	
		5-13	Clarified yaw, roll, pitch.	
		5-14	Corrected payload characteristics ParameterFile min/max values	
		5-15	Added spotlightRadiometricCorrection	
		5-16	Corrected roll angle units attribute. Clarified zeroDopplerTimeFirstLine and zeroDopplerTimeLastLine	
		5-18	Corrected dopplerCentroidCoefficients	
		5-19	Corrected dopplerRateValuesCoefficient, and phaseCoefficients.	
		5-21	Corrected groundToSlantRangeCoefficients.	
		5-33	Corrected ellipsoid parameters.	
		5-36	Corrected acquisitionIdentifiers	
		6-3	Corrected Geotiff fields	
		7-1 – 7-3	Updated Labelling content, updated File Organization and Naming content	

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ACRONYMS AND ABBREVIATIONS

AOS	Acquisition of Signal
ARC	Albers Conical Equal Area
BAQ	Block Adaptive Quantization
bit	binary digit
BSQ	Band Sequential
CC	Cubic Convolution
CD	Compact Disk
CD-ROM	Compact Disk - Read Only Memory
cm	centimeter
CSA	Canadian Space Agency
dB	decibel
DEM	Digital Elevation Model
ECI	Earth Centered Inertial
EH	Extended coverage High incidence beam
EL	Extended coverage Low incidence beam
F	Fine resolution beam
FQ	Fine resolution Quad-polarization beam
FRED	Framed Raw Expanded Data
GATN	Gatineau satellite station
GByte	gigabyte
GeoTIFF	Geographic extensions to the Tagged Image File Format
GHz	Gigahertz
GSI	Geospatial Services, International (a division of MDA)
HH	Horizontal polarization on transmit, Horizontal polarization on receive
HV	Horizontal polarization on transmit, Vertical polarization on receive
Hz	Hertz
HTML	Hypertext Markup Language
I/Q	In phase/Quadrature
ICC	Inter-Component Communications

ICD	Interface Control Document/Drawing
ID	Identifier
IRW	Impulse Response Width
ISLR	Integrated Side Lobe Ratio
ITN	Image Transfer Network
kHz	kilohertz
km	kilometer
LCC	Lambert Conformal Conic
m	meter
MF	Multi-Fine resolution beam
MHz	megahertz
mm	millimeter
ms	millisecond
N	North
NITF	National Imagery Transmission Format
NN	Nearest Neighbor
ns	nanosecond
NSP	National Systems Projection
PASS	Prince Albert Satellite Station
PDS	Processing and Delivery Subsystem
RADAR	Radio Detection and Ranging
RADARSAT	Radar Satellite
RAS	Reception and Archiving Subsystem
RAW	Raw signal data product
s	second
S	South
S	Standard beam
SB	Single Beam mode
S/N	Signal to Noise ratio
SAR	Synthetic Aperture Radar
SCAN	ScanSAR mode
SCN	ScanSAR Narrow beam product

SCW	ScanSAR Wide beam product
SGC	SAR Georeferenced Coarse product
SGF	SAR Georeferenced Fine product
SGX	SAR Georeferenced Extra-Fine product
SLC	Single Look Complex
SPG	SAR Precision Geocorrected product
SQ	Standard Quad-polarization beam
SSG	SAR Systematic Geocorrected product
STPL	State Plane
TBC	To Be Confirmed
TBD	To Be Determined
TIFF	Tagged Image File Format
U	Ultra-fine resolution beam
μs	microsecond
UPS	Universal Polar Stereographic
UTC	Universal Time Coordinated
UTM	Universal Transverse Mercator
VH	Vertical polarization on transmit, Horizontal polarization on receive
VV	Vertical polarization on transmit, Vertical polarization on receive
W	Watts
W	Wide swath beam
W3C	World Wide Web Consortium
XML	Extensible Markup Language
XSD	XML Structure Definitions
XSL	Extensible Stylesheet Language
XSLT	XSL for Transformations

1 INTRODUCTION

1.1 Purpose

This document defines the RADARSAT-2 product format for georeferenced and geocoded products. These include SLC, SGF, SGX, SGC, SSG, and SPG products but not RAW products. The format of RAW data products is specified in the FRED Product Specification (Document R-2).

Note that for the purposes of this document ScanSAR Narrow (SCN) and ScanSAR Wide (SCW) products are considered as SGF products. This results in more consistent product type naming and allows flexibility for handling additional ScanSAR products in the future, such as SSG or SLC products for ScanSAR.

This document is derived form a set of XML schema files which provide the definitive definition of the XML metadata. The schemas will be included with every RADARSAT-2 product. In the case where the contents of this document differ from the schemas, the schemas shall be taken as the definitive definition.

1.2 Scope

This document specifies the content, format and organization of RADARSAT-2 products as generated by the RADARSAT-2 processor. Detailed information on the classification of RADARSAT-2 products and sensor characteristics are provided in the RADARSAT-2 Product Specification (Document A-1) and in the RADARSAT-2 Product Description (Document R-10).

This document is intended for use by MDA, GSI, CSA and end users of RADARSAT-2 products.

1.3 Document Structure

- **Section 1** identifies the purpose and scope of this document.
- **Section 2** lists applicable and reference documents.
- **Section 3** provides a discussion of the concept of RADARSAT-2 products.
- **Section 4** provides a description of the type of files that make up a RADARSAT-2 product.

- **Section 5** presents the definition of the product content and format.
- **Section 6** presents the definition of the GeoTIFF image pixel data format.
- **Section 7** describes the organization of the product files.

2 DOCUMENTS

2.1 Applicable Documents

The following documents of the date/revision indicated form part of this document to the extent referenced herein. Any conflict between this document and any of the applicable documents should be brought to the attention of MacDonald Dettwiler for resolution.

A-1	RN-SP-50-9786	RADARSAT-2 Product Specification Document 1/2, MacDonald Dettwiler, May 24, 2005. (MDA Internal Only)

2.2 Reference Documents

The following documents provide useful reference information associated with this document. These documents are to be used for information only. Changes to the date/revision number (if provided) do not make this document out of date.

R-1	RK-IC-51-2386	RADARSAT-2 Ground Segment Processing & Distribution Subsystem to Product Recipient Interface Control Document, MacDonald Dettwiler.
R-2	DG-MA-50-6897	Framed Raw Expanded Data Product Specification.
R-3		TIFF Revision 6.0, Aldus Corporation, June 3, 1992.
R-4		GeoTIFF Format Specification, GeoTIFF Revision 1.0, Version 1.8.2, November 10, 1995, Niles Ritter and Mike Ruth.
R-5		Extensible Markup Language (XML) 1.0 (Second Edition), W3C Recommendation, 6 October 2000.
R-6		XSL Transformations (XSLT) Version 1.0, W3C Recommendation, November 16, 1999.
R-7		XML Schema Part 1: Structures, W3C Recommendation, May 2, 2001.

R-8		XML Schema Part2: Datatypes, W3C Recommendation, May 2, 2001.
R-9	STDI-0002	Compendium of Controlled Extensions for the NITF, Version 2.1, November 16, 2000.
R-10	RN-SP-52-1238	RADARSAT-2 Product Description, MacDonald Dettwiler.

3 CONCEPTS

The objective of this RADARSAT-2 product format definition is:

1. to define a product format that focuses on the knowledge and information that make up the product;
2. to take a dynamic view of products, allowing third-party image processing tools to iteratively enhance a product by adding new knowledge or information; and
3. to make it easy for the end user to use such products by ensuring that the format is both widely supported and based on current technologies.

In order to meet this objective, the RADARSAT-2 product format definition will be based upon a number of key concepts:

1. A product is simply a collection of information; often loosely referred to as image data and accompanying metadata. Throughout the remainder of this document, the term product means simply a collection of information; image pixel data is regarded as just another type of information presented in a raster organization.
2. This information is layered. The base layer describes the source(s) of the raw information. Additional layers are then appended, incorporating information which describe various aspects of the product such as the location and format of the image pixel data, the geometric and radiometric aspects of the imagery, and the results of applying various processing steps. Within each layer, the information is arranged hierarchically.
3. This information will be captured using Extensible Markup Language (XML). Such an approach is fast becoming an industry accepted standard for the interchange of information, is easy to use and understand by both human and machine, and is recognized by many third-party tools such as translators, browsers, databases and image processors.
4. Any image format can potentially be used to store the pixel information. The product will identify the format and provide references to the file(s) which contain the image pixel information, and it is the responsibility of the end user to ensure that he/she has the necessary tools that can correctly interpret the specified format. The RADARSAT-2 processor generated products will use the GeoTIFF format, which is the geographic extension of the TIFF format. This is also an industry accepted standard and is already supported by most image processors.
5. This product specification deliberately does not support raw, unprocessed sensor data, preferring instead to use a single format, namely FRED, for the interchange of all such level 0 data.

The diagram in Figure 3-1 provides a pictorial view of a hypothetical RADARSAT-2 product. The top of the diagram shows the basic product as generated by the RADARSAT-2 processor and defined in this document. Subsequent image processing steps have been applied to this product, initially by the RADARSAT-2 value-added processing system, followed by the end user's own image processing tools. In this example, quick-look, map overlay, thematic and annotation information was added, and the results of applying a "detection" algorithm (which may, for example, identify oil spills, floods, ice, etc) were then incorporated. The result is a complete, multi-layered set of information that constitutes a product.

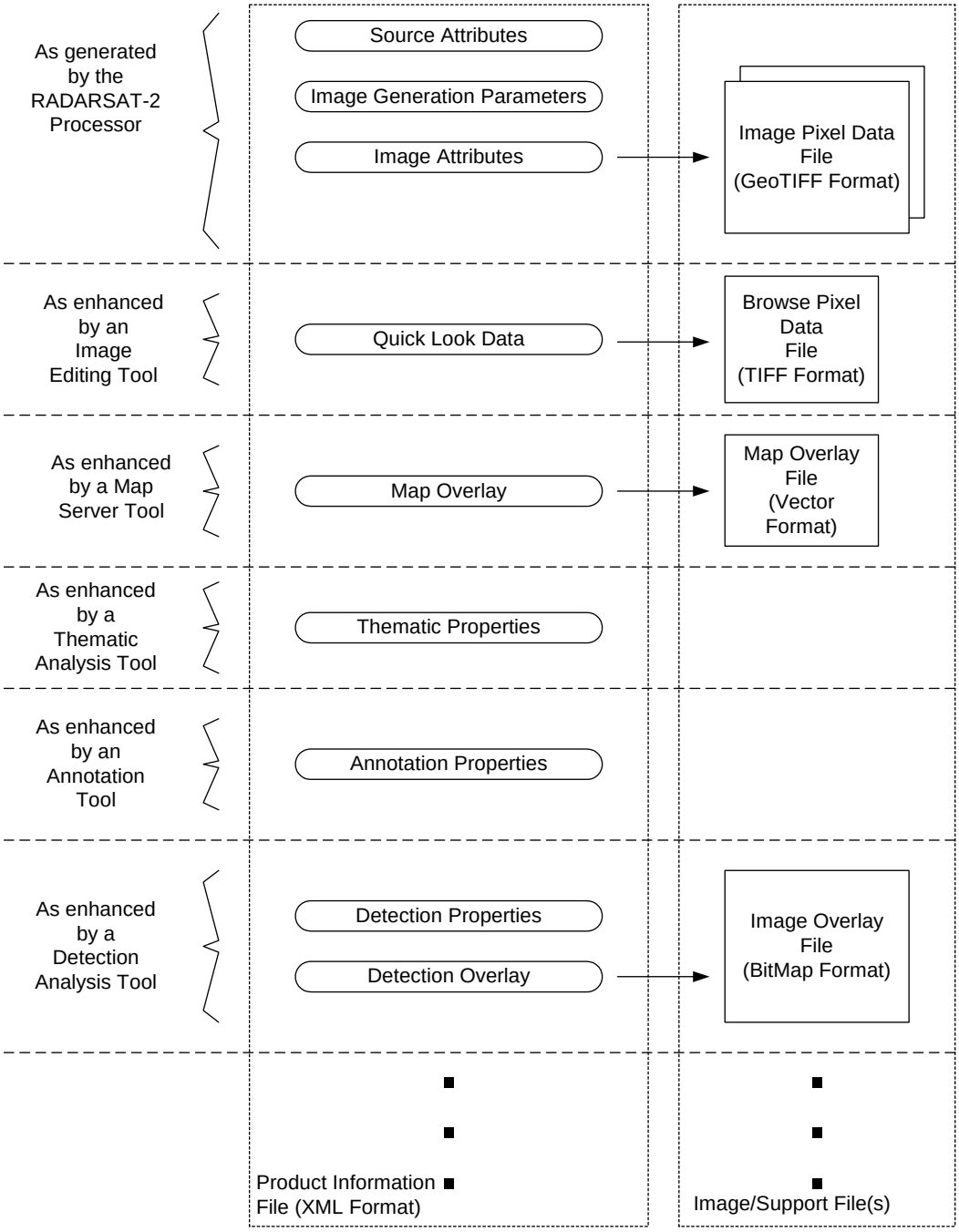

Figure 3-1 Product Format Concept

4 PRODUCT COMPOSITION

This section describes the different types of files included within RADARSAT-2 products. The basic product as generated by the RADARSAT-2 processor contains a Product Information File and one or more Image Pixel Data Files. The composition of RADARSAT-2 products is shown in Figure 4-1.

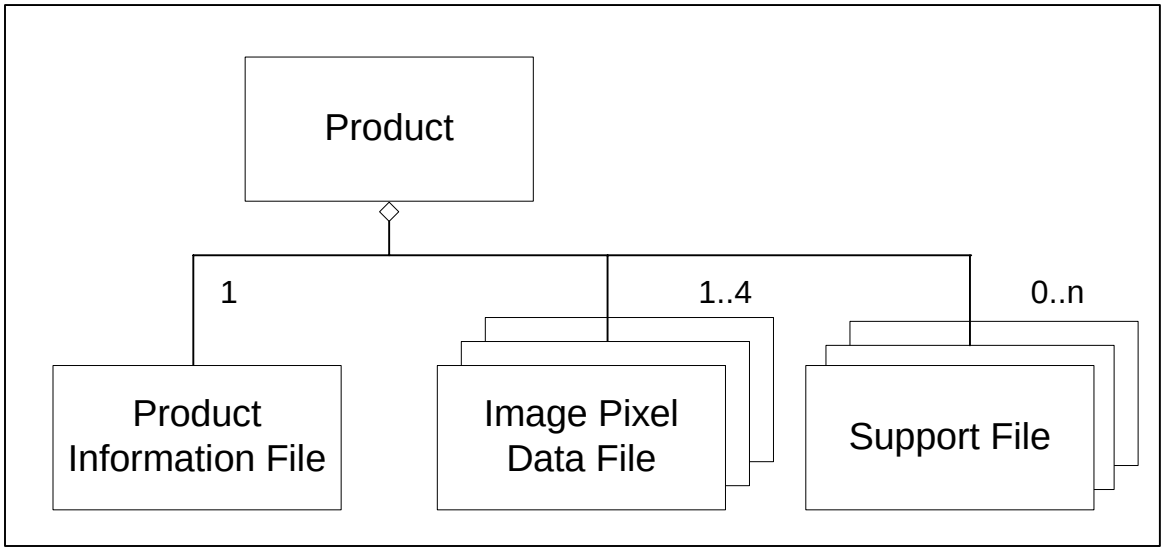

Figure 4-1 Product Composition

4.1 Product Information File

The Product Information File is an ASCII file that logically groups known information on the product. For example, groupings are provided for source, image generation and imagery information related to the product. The content of the Product Information File for the various product types is described in Section 5. The Product Information File will be encoded in Extensible Markup Language (XML) format. XML has the following features:

- Based on Unicode (superset of ASCII)
- Human readable
- Machine readable
- Not position dependent

- Open standard with industry acceptance and support
- Provides hierarchy of information
- Platform independent
- Easily usable as exchange format for distributed environments
- Free parsers available
- Separation of content and presentation

XML 1.0 Specification is described in the W3C Recommendation (Document R-5). XML syntax and features that have been used in the Product Information File are demonstrated in the annotated example below:

Sample XML File	Description
`<?xml version="1.0"?>`	XML file header
`<employeeDatabase>`	Start of an employee database record
`<employee reference="1234">`	Start of an employee record with a reference attribute of **1234**. While the reference attribute in this example may be unique, attributes do not have to be unique
`<lastName>Smith</lastName>`	lastName item with value "**Smith**"
`<firstName>John</firstName>`	firstName item with value "**John**"
`<jobTitle>Engineer</jobTitle>`	jobTitle item with value "**Engineer**"
`<dependents>2</dependents>`	dependents item with value **2**
`<promotionDates>`	Start list of promotionDates
1982 1984 1990	Individual date entries of list separated by spaces
`</promotionDates>`	End list of promotionDates
`</employee>`	End of employee record
`<employee reference="1500">`	Start of next employee record with a reference attribute of **1500** to distinguish from previous employee record
`<lastName>Hunter</lastName>`	lastName item with value " **Hunter**"
`<firstName>Kim</firstName>`	firstName item with value " **Kim**"
`<jobTitle>Manager</jobTitle>`	jobTitle item with value " **Manager**"
`<dependents>0</dependents>`	dependents item with value **0**
`<promotionDates>`	Start list of promotionDates
1991	Individual date entries of list separated by spaces
`</promotionDates>`	End list of promotionDates
`</employee>`	End of employee record
`</employeeDatabase>`	End of employee database record

4.2 Image Pixel Data File

All RADARSAT-2 products include one or more Image Pixel Data Files. One, two, or four Image Pixel Data Files may be included, corresponding to single, dual, or quad polarization modes, respectively. Each file contains the raster SAR image for a given polarization.

4.3 Support File

Support files are not mandatory and not generated by the RADARSAT-2 processor. Examples of the types of files that may be included with the product are:

- "Readme" files to describe the contents of the product.
- HTML files to describe the contents of the product.
- XML Schema files that impose constraints on the Product Information File.
- XSL Stylesheet files to convert the Product Information File into HTML or some other format.

5 FORMAT OF THE PRODUCT INFORMATION FILE

This section describes the format of the Product Information File. Section 5.1 describes the layout of the file and introduces the concept of a Data Store. Section 5.2 explains how the information is presented in the tables used to describe the Data Stores. A description of the tables used to group other information such as identifiers, units, and lists is also described in this section. Section 5.3 contains detailed information on the Data Stores. These Data Stores basically describes a schema that is used to control the contents and format of the Product Information File.

5.1 Layout of the Product Information File

As described in the Concepts section, the product is organized in hierarchical layers, with the basic product layers being supplied by the RADARSAT-2 processor. Related information within the product is grouped into a Data Store. Figure 5-1 shows how the Data Stores fit within the product hierarchy.

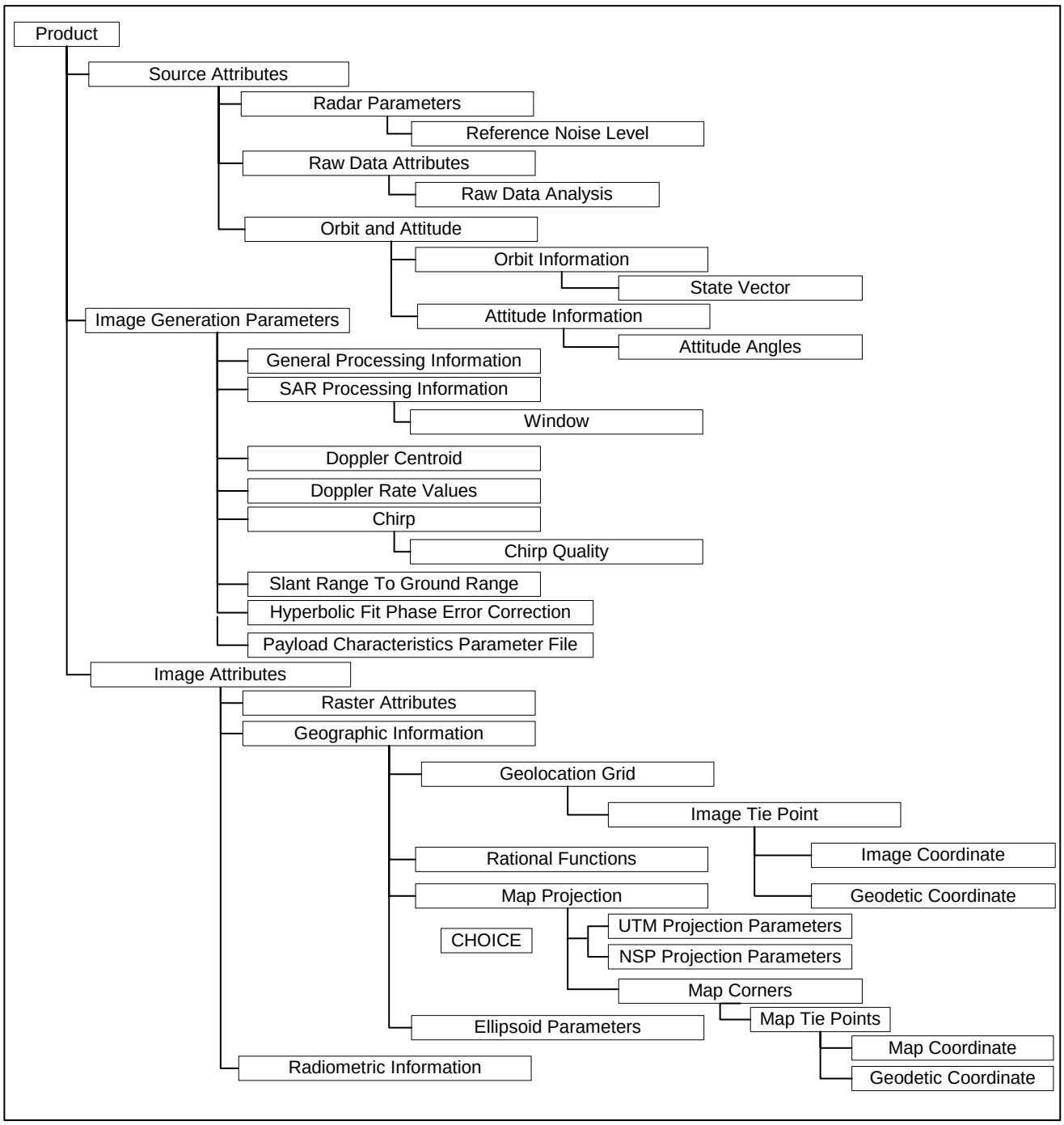

Figure 5-1 Product Data Stores Hierarchy

5.2 Table Descriptions

The tables in the following section describe the contents of the product and its Data Stores. Three additional tables in Section 5.3.6 are provided to group identifiers, units, and lists. Each Data Store table is preceded by an arrow diagram:

```
product→...→<name-of-Data-Store>
```

to indicate the location of the Data Store relative to the product "root". The tables describing the product parameters (root of the product) and common parameters omit this arrow diagram. The columns of the tables are:

- **Name:** A unique XML *tag* name for an *element*. For the Data Store tables the first row is shaded to indicate that the name of the Data Store does not constitute a valid tag name, but is provided to provide context for any attributes or description that may be applicable to the Data Store.
- **Min,max:** The minimum and maximum number of times an element can occur in the product. "0,1" implies that the element is optional. The "∞" symbol implies no upper bound. This column is omitted for the Identifiers, Units, and Lists tables.
- **Type:** The contents of an element may be one of the following types:
  - *complex*: a user-defined type that is not part of the XML specification (Data Store),
  - *simple*: derived from restrictions on a list or atomic type,
  - *list*: finite-length sequence of atomic values,
  - *atomic*: an indivisible type within the context of XML Schema, i.e., primitive or built-in derived type (xsd:string, xsd:integer, etc.)

  Complex types are expanded in their own table. A shaded **choice** block implies that only one of the types enclosed within the block can occur in the product. Simple types are grouped into tables provided for identifiers, units and lists. Both complex and simple types are prefixed with "rs2prod:"; atomic types are prefixed with "xsd:".
- **Attributes:** A modifier on the element. In most cases these are units. However, attributes also exist for polarization (pole), beam types (beam), data representation for real, imaginary, or magnitude (dataStream), pulse identifiers (pulse), fore and aft wing identifiers (wing), incidence angle correction identifiers (incidenceAngleCorrection), and copyright information for the product (copyright).

  All attributes are required when specified. An example of the use of attributes is the settableGain element:

```
<settableGain beam="U1" pole="HH" wing="Fore" units="dB">0.5
</settableGain>
```

The attributes column is omitted for Identifiers, Units and Lists tables.

- **From/To:** Exists only for the Lists table to indicate the minimum/maximum size of a list. The "∞" symbol implies no upper bound, implying that the length of the list will ultimately be determined by the number of entries within the list.
- **Description:** Further details on the element.
  Note that the Identifiers table (Table 5-38) describes the possible values for identifiers referenced in the Type or Attributes columns of the Data Store tables. Each identifier appearing in these columns is specified with the naming convention:

  ```
  rs2prod:<name-of-Identifier>Identifers
  ```

  where name-of-Identifier is uniquely represented in the Identifiers table. Similarly, the Units table (Table 5-38) describes the possible values for units that are referenced in the Attributes column. Each unit appearing in the Attributes column is specified with the naming convention:

  ```
  rs2prod:<name-of-Unit>Units
  ```

  where name-of-Unit is uniquely represented in the Units table.

  Finally, the Lists table (Table 5-39) describes the possible types of lists used within the product. A list specification of the form:

  ```
  rs2prod:<name-of-List>List
  ```

  in the Type column of a Data Store table implies that there is a unique definition for the name-of-List in the List table.

5.3 Schema Details for the Product Information File

5.3.1 Product Parameters

Table 5-1 Products

Name	Min,Max	Type	Attributes	Description
Product	1,1		copyright=xsd:string,	RADARSAT-2 Data and Products (c) MacDonald, Dettwiler and Associates Ltd., <year of acquisition> - All Rights Reserved.
ProductId	1,1	xsd:string		Unique identifier from 1 to 32 characters. (Possible characters: 0-9A-Za-z._-)
documentIdentifier	1,1	xsd:string		Identifies the document and version number which describes this product format.
sourceAttributes	1,1	rs2prod:sourceAttributesDataStore		Source (instrument) attributes. Information describing the sensor characteristics, raw data and satellite orbit and attitude.
imageGenerationParameters	1,1	rs2prod:imageGenerationParameters DataStore		Image generation parameters. Information related to SAR processing, Doppler Centroid, Doppler rates, chirp, chirp quality, and conversion from slant range to ground range.
imageAttributes	1,1	rs2prod:imageAttributesDataStore		Image attributes. Image-related information such as line/pixel information, geographical location, map projection, if applicable, and image pixel data file location.

5.3.2 Source Attributes

Source (instrument) attributes provide information on the sensor characteristics, raw data and satellite orbit and attitude.

product→sourceAttributes

Table 5-2 Source Attributes

Name	Min,Max	Type	Attributes	Description
sourceAttributesDataStore				Source Attributes Data Store
satellite	1,1	rs2prod:satelliteIdentifiers		
sensor	1,1	rs2prod:sensorIdentifiers		
inputDatasetId	1,1	rs2prod:inputDatasetIdType		Archive segment ID in archive
imageId	1,1	rs2prod:imageIdType		Image segment ID
inputDatasetFacilityId	1,1	rs2prod:inputDatasetFacilityNameType		Name of the facility from which the raw data was received. Presently defined entries are “Gatineau”, “Prince Albert” and “Not Specified”
beamModeId	1,1	rs2prod:beamModeIdType		Beam mode ID (an integer which uniquely identifies the Satellite Imaging Configuration)

Name	Min,Max	Type	Attributes	Description
beamModeMnemonic	1,1	rs2prod:beamModeMnemonicType		Beam mode mnemonic (a mnemonic which uniquely identifies the Satellite Imaging Configuration). Presently defined entries for beamModeMnemonic type: "S1", … ,"S7", "W1", … ,"W3", "F1N", "F1M", "F1F", "F2N", "F2M", "F2F", "F3N", "F3M", "F3F", "F4N", "F4M", "F4F", "F5N", "F5M", "F5F", "F6N", "F6M", "F6F", "F21N", "F21M", "F21F", "F22N", "F22M", "F22F", "F23N", "F23M", "F23F", "MF1N", "MF1M", "MF1F", "MF2N", "MF2M", "MF2F", "MF3N", "MF3M", "MF3F", "MF4N", "MF4M", "MF4F", "MF5N", "MF5M", "MF5F", "MF6N", "MF6M", "MF6F", "MF21N", "MF21M", "MF21F", "MF22N", "MF22M", "MF22F", "MF23N", "MF23M", "MF23F", "U1", … , "U47", "EL1", "EH1", … , "EH6", "SQ1", … ,"SQ17", "FQ1", … , "FQ17" "SCNA" "SCNB" "SCWA" "SCWB", "SLA1", "SLA2", …, "SLB1", "SLB2", …
rawDataStartTime	1,1	rs2prod:utcTimeType		Date/time stamp of first raw data line used during the processing
radarParameters	1,1	rs2prod:radarParametersDataStore		Information describing the characteristics of the sensor used to acquire the data
rawDataAttributes	1,1	rs2prod:rawDataAttributesDataStore		Statistics and other analysis on the raw data.
orbitAndAttitude	1,1	rs2prod:orbitAndAttitudeDataStore		Information on the satellite orbit and attitude

product→sourceAttributes→radarParameters

Table 5-3 Radar Parameters

Name	Min,Max	Type	Attributes	Description
radarParametersDataStore				Radar Parameters Data Store. Information describing the characteristics of the sensor used to acquire the data
acquisitionType	1,1	rs2prod:acquisitionIdentifiers		Type of data acquisition
beams	1,1	rs2prod:beamList		Radar beams used to produce this product. Presently defined entries in beams list include: "S1", … ,"S7", "W1", … ,"W3", "F1", … ,"F6", "F21", … , "F23", "MF1", … ,"MF6", "MF21", … ,"MF23", "U1", … , "U47", "EL1", "EH1", … ,"EH6", "Q1", … , "Q17"
polarizations	1,1	rs2prod:polarizationList		Polarizations used to produce this product
pulses	1,1	rs2prod:pulseList		Typically only one entry in list, but two entries ("Lower 50" and "Upper 50") for ultra-fine and Spotlight
pulsesReceivedPerDwell	0,∞	rs2prod:receivedPulsesPerDwell Type	beam=rs2prod:beamList	ScanSAR burst parameter for ScanSAR only. Pulses received and recorded per dwell
numberOfPulseIntervalsPerDwell	0,∞	rs2prod:priPerDwellType	beam=rs2prod:beamList	ScanSAR burst parameter for ScanSAR only. Number of pulse intervals per dwell
rank	1, ∞	rs2prod:rankType	beam=rs2prod:beamList	Rank, one entry per beam. The number of PRI between transmission and reception for each beam in operation. Beam attribute values are same as those used in the beams list.
settableGain	1, ∞	xsd:double	beam=rs2prod:beamList, pole=rs2prod:polarizationIdentifiers, wing=rs2prod:wingIdentifiers, units=rs2prod:powerUnits	Gain values used on the instrument. Gain values will be specified either in terms of pole or wing, not both. Beam attribute values are same as those used in the beams list. (units = dB). Wing can be either fore or aft.
radarCenterFrequency	1,1	xsd:double	units=rs2prod:frequencyUnits	Center frequency of the instrument. (units = Hz)
pulseRepetitionFrequency	1,∞	rs2prod:prfType	beam=rs2prod:beamList, units=rs2prod:frequencyUnits	Pulse repetition frequency used to process this image. Beam attribute values are same as those used in the beams list. (units = Hz)
pulseLength	1,2	rs2prod:pulseDurationType	pulse=rs2prod:pulseIdentifers units=rs2prod:timeUnits	Time duration of pulse. For ultra-fine and Spotlight this is the duration after pulse stitching. (units = s)

Name	Min,Max	Type	Attributes	Description
pulseBandwidth	1,2	rs2prod:pulseBandwidthType	Pulse=rs2prod:pulseidentifiers Units=rs2prod:frequencyunits	Bandwidth of the pulse. For ultra-fine and Spotlight this is the bandwidth after pulse stitching. (units = Hz)
antennaPointing	1,1	rs2prod:antennaPointingIdentifiers		Antenna pointing direction
adcSamplingRate	1,2	rs2prod:rangeSamplingRateType	pulse=rs2prod:pulseIdentifiers units=rs2prod:frequencyUnits	Sampling rate of the radar analog to digital converter (units = Hz)
yawSteeringFlag	1,1	rs2prod:yawSteeringFlagIdentifiers		Indicate if yaw steering is used.
geodeticFlag	1,1	rs2prod:geodeticFlagIdentifiers		Indicate what satellite orientation reference frame is used.
rawBitsPerSample	1,1	rs2prod:rawBitsPerSampleIdentifiers		BAQ encoding level (bits per sample: 1,2,3,4 or 8)
samplesPerEchoLine	1,∞	xsd:unsignedLong	beam=rs2prod:beamList	Samples per echo line. Used to determine sample window length. Beam attribute values are same as those used in the beams list.
referenceNoiseLevel	1,3	rs2prod:referenceNoiseLevelDataStore		Measured instrument noise as a function of image pixel. Three vectors, one for beta nought, one for sigma nought, and one for gamma.
numPRIsPerPointingStep	0,1	xsd:integer		Number of PRIs per pointing step (assume constant PRF throughout and no gaps in timeline). Spotlight mode only.
totalNumberOfPointingSteps	0,1	xsd:integer		Total number of pointing steps. Always an odd number. Spotlight mode only.
stepSizeInAntennaPointing	0,1	xsd:double		Step size in antenna pointing. Spotlight mode only. (units = degrees)

product→sourceAttributes→radarParameters→referenceNoiseLevel

Table 5-4 Reference Noise Level

Name	Min,Max	Type	Attributes	Description
referenceNoiseLevelDataStore			incidenceAngleCorrection= rs2prod:incidenceAngleCorrectionIndentifiers	Reference Noise Level Data Store
pixelFirstNoiseValue	1,1	xsd:integer		Pixel number corresponding to first noise value (first pixel in image is pixel 0)
stepSize	1,1	xsd:integer		Number of pixels between each list entry
numberOfNoiseLevelValues	1,1	xsd:integer		Number of entries in list
noiseLevelValues	1,1	rs2prod:noiseLevelValuesList	units=rs2prod:powerUnits,	(units = dB)

product→sourceAttributes→rawDataAttributes

Table 5-5 Raw Data Attributes

Name	Min,Max	Type	Attributes	Description
rawDataAttributesDataStore				Describes characteristics of the raw SAR data
numberOfInputDataGaps	1,1	xsd:unsignedLong		Number of gaps detected in the raw data used to produce this product. A gap is defined as a predetermined number of range lines
gapSize	1,1	xsd:unsignedLong		Predefined size of a gap in lines
numberOfMissingLines	1,4	xsd:unsignedLong	pole=rs2prod:polarizationIdentifiers	Number of missing lines (not including gaps) detected in the raw data used to produce this product.
rawDataAnalysis	1,4	rs2prod:rawDataAnalysisDataStore		Results from raw data analysis. Possible attributes are pole, wing and pulse.

product→sourceAttributes→rawDataAttributes→rawDataAnalysis

Table 5-6 Raw Data Analysis

Name	Min,Max	Type	Attributes	Description
rawDataAnalysisDataStore			pole=rs2prod:polarizationIdentifiers, wing=rs2prod:wingIdentifiers, pulse=rs2prod:pulseIdentifiers	Raw Data Analysis Data Store
bias	2,2	xsd:double	dataStream=rs2prod:dataStreamIdentifiers	Measured mean of the raw data after BAQ decoding
standardDeviation	2,2	xsd:double	dataStream=rs2prod:dataStreamIdentifiers	Standard deviation of the raw data after BAQ decoding
gainImbalance	1,1	xsd:double		Ratio of variances of real and imaginary channels
phaseOrthogonality	1,1	xsd:double	units=rs2prod:angularUnits	Phase Orthogonality (quadrature departure) (units = deg) A positive value represents +ve I and Q axes less than 90 degs apart.
rawDataHistogram	2,2	rs2prod:histogramList	dataStream=rs2prod:dataStreamIdentifiers	Histogram of the raw data after BAQ decoding

product→sourceAttributes→orbitAndAttitude

Table 5-7 Orbit and Attitude

Name	Min,Max	Type	Attributes	Description
orbitAndAttitudeDataStore				Orbit and Attitude Data Store
orbitInformation	1,1	rs2prod:orbitInformationDataStore		Spacecraft orbit information used for processing
attitudeInformation	1,1	rs2prod:attitudeInformationDataStore		Spacecraft attitude data used for processing

product→sourceAttributes→orbitAndAttitude→orbitInformation

Table 5-8 Orbit Information

Name	Min,Max	Type	Attributes	Description
orbitInformationDataStore				Orbit Information Data Store
passDirection	1,1	rs2prod:passDirectionIdentifiers		Direction of satellite pass defined at the start of the archive segment
orbitDataSource	1,1	rs2prod:orbitDataSourceIdentifiers		Source of orbit data
orbitDataFile	1,1	xsd:anyURI		Name of orbit data file used during processing. If orbitDataSource=Downlinked this file was only used for initial framing of the data.
stateVector	1,∞	rs2prod:stateVectorDataStore		State vector entries

product→sourceAttributes→orbitAndAttitude→orbitInformation→stateVector

Table 5-9 State Vector

Name	Min,Max	Type	Attributes	Description
stateVectorDataStore				State Vector Data Store. Earth Centered Rotating (ECR) coordinates
timeStamp	1,1	rs2prod:utcTimeType		Date/time stamp of current state vectors
xPosition	1,1	xsd:double	units=rs2prod:distanceUnits	(units = m)
yPosition	1,1	xsd:double	units=rs2prod:distanceUnits	(units = m)
zPosition	1,1	xsd:double	units=rs2prod:distanceUnits	(units = m)
xVelocity	1,1	xsd:double	units=rs2prod:velocityUnits	(units = m/s)
yVelocity	1,1	xsd:double	units=rs2prod:velocityUnits	(units = m/s)
zVelocity	1,1	xsd:double	units=rs2prod:velocityUnits	(units = m/s)

product→sourceAttributes→orbitAndAttitude→attitudeInformation

Table 5-10 Attitude Information

Name	Min,Max	Type	Attributes	Description
attitudeInformationDataStore				Attitude Information Data Store
attitudeDataSource	1,1	rs2prod:attitudeSourceIdentifiers		Source of attitude info used for processing
attitudeOffsetsApplied	1,1	xsd:boolean		Attitude offsets from the Payload Characterization file were applied prior to use.
attitudeAngles	1,∞	rs2prod:attitudeAnglesDataStore		Attitude angles used during processing. Maybe from downlink or user specified.

product→sourceAttributes→orbitAndAttitude→attitudeInformation→AttitudeAngles

Table 5-11 Attitude Angles

Name	Min,Max	Type	Attributes	Description
attitudeAnglesDataStore				Attitude Angles Data Store. Rotation sequence about mechanical build axes required to transition from flight axes to build axes in the following order: yaw, then roll, then pitch
timeStamp	1,1	rs2prod:utcTimeType		Date/time stamp of current attitude information
yaw	1,1	xsd:double	units=rs2prod:angularUnits	(units = deg) Zero when the antenna is pointing sideways. Positive for nose right. When Right-Looking, a small positive yaw means that it is pointing slightly backwards. When Left-Looking, a small positive yaw means it is pointing slightly forwards.
roll	1,1	xsd:double	units=rs2prod:angularUnits	(units = deg) Positive when left side up (clockwise). Roll is negative for Right-Looking and positive for Left-Looking.
pitch	1,1	xsd:double	units=rs2prod:angularUnits	(units = deg) Positive when nose up.

5.3.3 Image Generation Parameters

Image generation parameters describe the processing applied to the source data to produce the output product. These include general and SAR processing information, Doppler Centroid, Doppler rates, chirp, chirp quality, and conversion from slant range to ground range.

product→imageGenerationParameters

Table 5-12 Image Generation Parameters

Name	Min,Max	Type	Attributes	Description
imageGenerationParametersDataStore				Image Generation Parameters Data Store
generalProcessingInformation	1,1	rs2prod:generalProcessingInformationDataStore		General information relating to processing location, date and software version
sarProcessingInformation	1,1	rs2prod:sarProcessingInformationDataStore		Detailed information describing the SAR processing parameters
dopplerCentroid	1,∞	rs2prod:dopplerCentroidDataStore		Describes the Doppler Centroid at the time indicated in the record. Refer to dopplerCentroidDataStore
dopplerRateValues	1,1	rs2prod:dopplerRateValuesDataStore		Describes the Doppler rate values at the time indicated in the record.
chirp	1,4	rs2prod:chirpDataStore		Describes the chirp parameters derived from the calibration pulses. Depends on attribute: pulse. Refer to chirpDataStore
slantRangeToGroundRange	1,∞	rs2prod:slantRangeToGroundRangeDataStore		Slant Range to Ground Range conversion information
hyperFitPhaseErrorCorr	0,1	rs2prod: hyperFitPhaseErrorCorrDataStore		Describes the Hyperbolic Fit Phase Error Correction at the time indicated in the record. Refer to hyperFitPhaseErrorCorrDataStore. Spotlight Mode only.
payloadCharacteristicsParameterFile	5,6	xsd:anyURI		Names of Payload Characterization Parameter files.

Product→imageGenerationParameters→generalProcessingInformation

Table 5-13 General Processing Information

Name	Min,Max	Type	Attributes	Description
generalProcessingInformationDataStore				General Processing Information Data Store
productType	1,1	rs2prod:productTypeIdentifiers		
processingFacility	1,1	rs2prod:processingFacilityNameType		Name of facility processing the data
processingTime	1,1	rs2prod:utcTimeType		Date/time at which processing was performed
softwareVersion	1,1	xsd:string		Version of software used to process the data

product→imageGenerationParameters→sarProcessingInformation

Table 5-14 SAR Processing Information

Name	Min,Max	Type	Attributes	Description
sarProcessingInformationDataStore				SAR Processing Information Data Store
lutApplied	1,1	xsd:string		Output scaling LUT applied. Default = “Constant-Beta”
elevationPatternCorrection	1,1	xsd:boolean		If true, antenna elevation pattern correction applied.
rangeSpreadingLossCorrection	1,1	xsd:boolean		If true, range spreading loss correction applied.
pulseDependantGainCorrection	1,1	xsd:boolean		If true, pulse dependent gain correction applied.
spotlightRadiometricCorrection	0,1	xsd:boolean		If true, spotlight radiometric correction has been applied. Spotlight mode only. Default = false
receiverSettableGain	1,1	xsd:boolean		If true, receiver settable gain applied during processing.
rawDataCorrection	1,1	xsd:boolean		If true, raw data correction applied.
rangeReferenceFunctionSource	1,1	rs2prod:rangeReferenceFunctionSourceIdentifiers		Source of range reference function for this product. Default = "Nominal Chirp"
interPolarizationMatricesCorrection	1,1	xsd:boolean		If true, inter-polarization correction matrices applied. Can only be true for quad-pole SLC products

Name	Min,Max	Type	Attributes	Description
dopplerSource	1,1	rs2prod:dopplerSourceIdentifiers		Default = "From Echo Data Analysis"
dopplerAmbiguityComputed	1,1	xsd:boolean		If true, Doppler Ambiguity computed
dopplerAmbiguityUsed	1,1	xsd:boolean		Only has meaning if dopplerAmbiguityComputed = true
estimatedRollAngleUsed	1,1	xsd:boolean		If true, estimated roll angle used. Always false for single beam and Spotlight products.
estimatedRollAngle	0,1	xsd:double	units=rs2prod:angularUnits	Roll angle estimated by processor. Only included if "estimatedRollAngleUsed" is set to true. (units = deg)
radiometricSmoothingPerformed	1,1	xsd:boolean		If true, radiometric smoothing performed. Only applies to ScanSAR, set to FALSE for Single Beam and Spotlight products.
zeroDopplerTimeFirstLine	1,1	rs2prod:utcTimeType		Zero Doppler date/time of first output line of image. For SSG and SPG applies to the intermediate image prior to geocoding. If north-south flipping has occurred, this value refers to the first line after the flip.
zeroDopplerTimeLastLine	1,1	rs2prod:utcTimeType		Zero Doppler date/time of last output line of image. For SSG and SPG applies to the intermediate image prior to geocoding. If north-south flipping has occurred, this value refers to the last line after the flip.
numberOfLinesProcessed	1,4	xsd:integer	pole=rs2prod:polarizationIdentifiers	Number of input raw data lines processed
samplingWindowStartTimeFirstRawLine	1,8	xsd:double	beam=rs2prod:beamList, units=rs2prod:timeUnits	Sampling window start time for the first line of the raw data ingested. Multiple entries for ScanSAR. Beam attribute values are same as those used in the beams list. Time between start of transmission of pulse and opening of receive window. (units = s)
samplingWindowStartTimeLastRawLine	1,8	xsd:double	beam=rs2prod:beamList, units=rs2prod:timeUnits	Sampling window start time of the last line of the raw data ingested. Multiple entries for ScanSAR. Beam attribute values are same as those used in the beams list. Time between start of transmission of pulse and opening of receive window. (units = s)
numberOfSwstChanges	1,∞	xsd:integer	beam=rs2prod:beamList	Number of sampling window start time changes in the raw data used to process this scene. Multiple entries for ScanSAR. Beam attribute values are same as those used in the beams list.

Name	Min,Max	Type	Attributes	Description
numberOfRangeLooks	1,1	xsd:integer		Number of looks used in range processing
rangeLookBandwidth	1,1	xsd:double	units=rs2prod:frequencyUnits	Full bandwidth processed per range look. (units = Hz)
totalProcessedRangeBandwidth	1,1	xsd:double	units=rs2prod:frequencyUnits	Total bandwidth used during range processing. (units = Hz)
numberOfAzimuthLooks	1,1	xsd:integer		Number of azimuth looks
scalarLookWeights	1,1	rs2prod:lookWeightList		Scalar weightings used in look summation, one value per look
azimuthLookBandwidth	1,1	xsd:double	units=rs2prod:frequencyUnits	Total bandwidth processed per azimuth look. (units = Hz)
totalProcessedAzimuthBandwidth	1,1	xsd:double	units=rs2prod:frequencyUnits	Total bandwidth used during azimuth processing. (units = Hz)
azimuthWindow	1,1	rs2prod:windowDataStore		Windowing parameters used for azimuth processing
rangeWindow	1,1	rs2prod:windowDataStore		Windowing parameters used for range processing
incidenceAngleNearRange	1,1	xsd:double	units=rs2prod:angularUnits	Incidence angle at near range at mid-azimuth position of the image. (units =deg)
incidenceAngleFarRange	1,1	xsd:double	units=rs2prod:angularUnits	Incidence angle at far range at mid-azimuth position of the image. (units = deg)
slantRangeNearEdge	1,1	xsd:double	units=rs2prod:distanceUnits	Slant range to near edge at mid-azimuth. (units = m)
satelliteHeight	1,1	xsd:double	units=rs2prod:distanceUnits	Satellite height above reference ellipsoid computed by processor at scene center. (units = m)
slantRangeCentre	0,1	xsd:double	units=rs2prod:distanceUnits	Mid slant range of range compressed data at mid-acquisition time (units = m). Spotlight mode only.

product→imageGenerationParameters→sarProcessingInformation→window

Table 5-15 Window

Name	Min,Max	Type	Attributes	Description
windowDataStore				Window Data Store
windowName	1,1	rs2prod:windowNameIdentifiers		Name of window
windowCoefficient	1,1	xsd:double		Window coefficient

product→imageGenerationParameters→dopplerCentroid

Table 5-16 Doppler Centroid

Name	Min,Max	Type	Attributes	Description
dopplerCentroidDataStore				Doppler Centroid Data Store
timeOfDopplerCentroidEstimate	1,1	rs2prod:utcTimeType		Date/time for Doppler Centroid estimate
dopplerAmbiguity	1,1	xsd:integer		Doppler ambiguity number used during processing/
dopplerAmbiguityConfidence	1,1	xsd:double		Doppler ambiguity confidence estimate. Range from 0.0 (no confidence) to 1.0 (highest confidence)
dopplerCentroidReferenceTime	1,1	xsd:double	units=rs2prod:timeUnits	2-way slant range time used as reference in Doppler Centroid polynomial calculation (t0). (units = s)
dopplerCentroidPolynomialPeriod	1,1	xsd:double		Approximate 2-way slant range time period in seconds corresponding to the slant range swath width. This is the period over which the Doppler centroid polynomial is valid, measured from Doppler centroid reference time (t0). For ScanSAR, this is the time corresponding to the full combined swath width. (units = s).
dopplerCentroidCoefficients	1,1	rs2prod:coefficientsList		List of up to 5 Doppler Centroid coefficients as a function of slant range time: d0, d1, d2, d3, and d4 where: Doppler Centroid = d0 + d1(tSR - t0) + d2(tSR-t0)^2 + d3(tSR-t0)^3 + d4(tSR-t0)^4
dopplerCentroidConfidence	1,1	xsd:double		Doppler Centroid confidence estimate. Range from 0.0 (no confidence) to 1.0 (highest confidence)

product→imageGenerationParameters→dopplerRateValues

Table 5-17 Doppler Rate Values

Name	Min,Max	Type	Attributes	Description
dopplerRateValuesDataStore				Doppler Rate Values Data Store.
dopplerRateReferenceTime	1,1	xsd:double	units=rs2prod:timeUnits	(units = s)
dopplerRateValuesCoefficients	1,1	rs2prod:coefficientsList		List of up to 5 Doppler rate values coefficients as a function of slant range time: r0, r1, r2, r3, and r4 where: Doppler rate values = r0 + r1(tSR - t0) + r2(tSR-t0)^2 + r3(tSR-t0)^3 + r4(tSR-t0)^4

product→imageGenerationParameters→chirp

Table 5-18 Chirp

Name	Min,Max	Type	Attributes	Description
chirpDataStore			pole=rs2prod:polarizationIdentifiers, wing=rs2prod:wingIdentifiers, pulse=rs2prod:pulseIdentifiers	Chirp Data Store
chirpQuality	1,1	rs2prod:chirpQualityDataStore		
chirpPower	1,1	xsd:double	units=rs2prod:powerUnits	Replica energy value calculated during processing (units = dB)
amplitudeCoefficients	1,1	rs2prod:coefficientsList		List of range chirp coefficients (-, s^-1, s^-2, s^-3, ...)
phaseCoefficients	1,1	rs2prod:coefficientsList		List of range phase coefficients (cycles, Hz, Hz/s, Hz/s^2, ...)

product→imageGenerationParameters→chirp→chirpQuality

Table 5-19 Chirp Quality

Name	Min,Max	Type	Attributes	Description
ChirpQualityDataStore				Chirp Quality Data Store
replicaQualityValid	1,1	xsd:boolean		false = unable to reconstruct chirp during processing and chirp reconstruction was requested or the quality is below acceptable levels. true = able to reconstruct all chirps or chirp reconstruction not requested (nominal chirp used) and all quality measures were acceptable
crossCorrelationWidth	1,1	xsd:double		3-dB pulse width of chirp replica cross-correlation function between reconstructed chirp and nominal chirp (units = samples)
sideLobeLevel	1,1	xsd:double	units=rs2prod:powerUnits	First side lobe level of chirp replica cross-correlation function between reconstructed chirp and nominal chirp. (units = dB)
integratedSideLobeRatio	1,1	xsd:double	units=rs2prod:powerUnits	Integrated Side-Lobe Ratio of chirp replica cross-correlation function between reconstructed chirp and nominal chirp. (units = dB)
crossCorrelationPeakLoc	1,1	xsd:double		Cross correlation peak location (units = samples)

product→imageGenerationParameters→slantRangeToGroundRange

Table 5-20 Slant Range to Ground Range

Name	Min,Max	Type	Attributes	Description
slantRangeToGroundRangeDataStore				Slant Range to Ground Range Conversion Data Store
zeroDopplerAzimuthTime	1,1	rs2prod:utcTimeType		Zero Doppler date/time at which this entry applies
slantRangeTimeToFirstRangeSample	1,1	xsd:double	units=rs2prod:timeUnits	2-way slant range time to first range sample for this entry. (units = s)
groundRangeOrigin	1,1	xsd:double	units=rs2prod:distanceUnits	Ground range reference position GR0 (see equation definition below). (units = m)
groundToSlantRangeCoefficients	1,1	rs2prod:coefficientsList		List of coefficients of the ground range to slant range conversion polynomial: s0, s1, s2, s3, s4 and s5 where: Slant Range = s0 + s1(GR - GR0) + s2(GR-GR0)^2 + s3(GR-GR0)^3 + s4(GR-GR0)^4 +s5(GR-GR0)^5 and GR is the ground range distance from the first pixel of the range line. GR0 is the groundRangeOrigin.

product→imageGenerationParameters→hyperFitPhaseErrorCorr

Table 5-21 Hyperbolic Fit Phase Error Correction

Name	Min,Max	Type	Attributes	Description
hyperFitPhaseErrorCorrDataStore				Hyperbolic Fit Phase Error Correction Data Store (Spotlight only).
midAcquisitionTime	1,1	rs2prod:utcTimeType		Date/Time of Mid-Acquisition.
hyperFitPhaseErrorCorrCoefficients	1,1	rs2prod:coefficientsList		List of coefficients of the hyperbolic fit phase error correction polynomial: h0, h1, h2, h3, ... where: Hyperbolic Fit Phase Error Correction = h0 + h1(AT) + h2(AT)^2 + h3(AT)^3 + ... and AT is the azimuth (slow) time in seconds with respect to the mid-acquisition time. (units of h0, h1, h2, h3, ... are radians*sec^{0}, radians*sec^{-1}, radians*sec^{-2}, radians*sec^{-3}, …).

5.3.4 Image Attributes

Image attributes describe image-related information such as raster attributes (line/pixel information), geographical location, map projection, if applicable, radiometric information and image pixel data file location.

product→imageAttributes

Table 5-22 Image Attributes

Name	Min,Max	Type	Attributes	Description
imageAttributesDataStore				Image Attributes Data Store
productFormat	1,1	rs2prod:productFormatIdentifiers		
outputMediaInterleaving	1,1	rs2prod:outputMediaInterleavingIdentifiers		Interleaving method used in image files
rasterAttributes	1,1	rs2prod:rasterAttributesDataStore		Raster attributes describing number of lines/pixels, and line/pixel spacing. Refer to imageInformationDataStore. Information applies to all polarizations.
geographicInformation	1,1	rs2prod:geographicInformationDataStore		Geographic information on the image, if applicable (tie points, map projection etc.)
radiometricInformation	1,2	rs2prod:radiometricInformationDataStore		Radiometric information. Depends on attribute: pole. Refer to radiometricInformationDataStore
lookupTable	0,3	xsd:anyURI	incidenceAngleCorrection=rs2prod:incidenceAngleCorrectionIdentifiers	File name for LUT file which can be used to derive Beta Nought, Sigma Nought or Gamma Nought imagery from the product. The format of the LUT file is described in Section 5.3.6. Not available for geocoded (SSG or SPG) products
fullResolutionImageData	1,4	xsd:anyURI	pole=rs2prod:polarizationIdentifiers	File names for full resolution image data in GeoTIFF format

product→imageAttributes→rasterAttributes

Table 5-23 Raster Attributes

Name	Min,Max	Type	Attributes	Description
rasterAttributesDataStore			pole=rs2prod:polarizationIdentifiers	Raster Attributes Data Store
dataType	1,1	rs2prod:dataTypeIdentifiers		
bitsPerSample	1,2	xsd:unsignedLong	dataStream=rs2prod:dataStreamIdentifiers	2 entries for complex data 1 entry for magnitude detected data
numberOfSamplesPerLine	1,1	xsd:unsignedLong		Number of samples (pixels) per line of imagery including any zero-filled samples
numberOfLines	1,1	xsd:unsignedLong		Number of lines in the image
sampledPixelSpacing	1,1	xsd:double	units=rs2prod:distanceUnits	(units = m)
sampledLineSpacing	1,1	xsd:double	units=rs2prod:distanceUnits	(units = m)
lineTimeOrdering	1,1	rs2prod:timeOrderingIdentifiers		Indicates whether line numbers (i.e. azimuth) increase or decrease with time.
pixelTimeOrdering	1,1	rs2prod:timeOrderingIdentifiers		Indicates whether pixel number (i.e. range) increases or decreases with time.

product→imageAttributes→geographicInformation

Table 5-24 Geographic Information

Name	Min,Max	Type	Attributes	Description
geographicInformationDataStore				Geographic Information Data Store
geolocationGrid	0,1	rs2prod:geolocationGridDataStore		A grid of tie points is included that relates the line/pixel positions in the image to latitude/longitude. Not included for map projected products (SSG, SPG).
rationalFunctions	0,1	rs2prod:rationalFunctionsDataStore		Rational function geopositioning models for non-geocoded products. The rational functions provide a simplified mechanism for geo-positioning pixels in the image. It is computed from image tie points and is included for convenience only. Not included for map projected products (SSG, SPG).
mapProjection	0,1	rs2prod:mapProjectionDataStore		Map Projections available for geocoded products only
referenceEllipsoidParameters	1,1	rs2prod:ellipsoidParametersDataStore		

product→imageAttributes→geographicInformation→geolocationGrid

Table 5-25 Geolocation Grid

Name	Min,Max	Type	Attributes	Description
geolocationGridDataStore				Geolocation Grid Datastore
imageTiePoint	0,∞	rs2prod:imageTiePoint		Tie points for image to geodetic. These provide the definitive geolocation information for the product. Tie point location include the image corners and at regular intervals the first and last samples of range lines

Table 5-26 Image Tie Point

Name	Min,Max	Type	Attributes	Description
imageTiePoint				Image Tie-Point Data Store
imageCoordinate	1,1	rs2prod:imageCoordinate		Co-ordinate Data Stores are described in the Section on Common Parameters
geodeticCoordinate	1,1	rs2prod:geodeticCoordinate		Co-ordinate Data Stores are described in the Section on Common Parameters

product→imageAttributes→geographicInformation→rationalFunctions

Table 5-27 Rational Functions

Name	Min,Max	Type	Attributes	Description
rationalFunctionsDataStore				Rational Functions Data Store
biasError	1,1	xsd:double	units = rs2prod:distanceUnits	Non-time varying 1-sigma error estimate for correlated images measured in meters (units = m)
randomError	1,1	xsd:double	units = rs2prod:distanceUnits	Time varying 1-sigma error estimate for correlated images measured in meters (units = m)
lineFitQuality	1,1	xsd:double		Indicates the quality of the line rational function fit. This value is the RMS line error
pixelFitQuality	1,1	xsd:double		Indicates the quality of the pixel rational function fit. This value is the RMS pixel error
lineOffset	1,1	xsd:integer		Offset used to linearly transform line values to range of [-1,1]
pixelOffset	1,1	xsd:integer		Offset used to linearly transform pixel values to range of [-1,1]
latitudeOffset	1,1	xsd:double	units = rs2prod:angularUnits	Offset used to linearly transform latitude values to range of [-1,1] (units = deg)
longitudeOffset	1,1	xsd:double	units = rs2prod:angularUnits	Offset used to linearly transform longitude values to range of [-1,1] (units = deg)

Name	Min,Max	Type	Attributes	Description
heightOffset	1,1	xsd:double	units = rs2prod:distanceUnits	Offset used to linearly transform height values to range of [-1,1] (units = m)
lineScale	1,1	xsd:integer		Scale used to linearly transform line values to range of [-1,1]
pixelScale	1,1	xsd:integer		Scale used to linearly transform pixel values to range of [-1,1]
latitudeScale	1,1	xsd:double		Scale used to linearly transform latitude values to range of [-1,1]
longitudeScale	1,1	xsd:double		Scale used to linearly transform longitude values to range of [-1,1]
heightScale	1,1	xsd:double		Scale used to linearly transform height values to range of [-1,1]
lineNumeratorCoefficients	1,1	rs2prod:rationalFunctionCoefficientList		20 coefficients representing the polynomial in the numerator of the rational function mapping latitude, longitude and height to line. The order of the coefficients is the same as found in Document R-9
lineDenominatorCoefficients	1,1	rs2prod:rationalFunctionCoefficientList		20 coefficients representing the polynomial in the denominator of the rational function mapping latitude longitude and height to line. The order of the coefficients is the same as found in Document R-9
pixelNumeratorCoefficients	1,1	rs2prod:rationalFunctionCoefficientList		20 coefficients representing the polynomial in the numerator of the rational function mapping latitude, longitude and height to pixel. The order of the coefficients is the same as found in Document R-9
pixelDenominatorCoefficients	1,1	rs2prod:rationalFunctionCoefficientList		20 coefficients representing the polynomial in the denominator of the rational function mapping latitude, longitude and height to pixel. The order of the coefficients is the same as found in Document R-9

The following description is extracted from document [R-9] with some modification:

The geometric sensor model describing the precise relationship between image coordinates and ground coordinates is known as a Rigorous Projection Model. A Rigorous Projection Model expresses the mapping of the image space coordinates of rows and columns (r,c) onto the object space reference surface geodetic coordinates (φ, λ, h).

The RADARSAT-2 product supports a common approximation to the Rigorous Projection Models. The approximation used is a set of rational polynomials expressing the normalized row and column values, (r_n , c_n), as a function of normalized geodetic latitude, longitude, and height, (P, L, H), given a set of normalized polynomial coefficients (LINE_NUM_COEF_n, LINE_DEN_COEF_n, SAMP_NUM_COEF_n, SAMP_DEN_COEF_n). Normalized values, rather than actual values are used in order to minimize introduction of errors during the calculations. The transformation between row and column values (r,c), and normalized row and column values (r_n , c_n), and between the geodetic latitude, longitude, and height (φ, λ, h), and normalized geodetic latitude, longitude, and height (P, L, H), is defined by a set of normalizing translations (offsets) and scales that ensure all values are contained in the range -1 to +1.

P = (Latitude - LAT_OFF) ÷ LAT_SCALE

L = (Longitude - LONG_OFF) ÷ LONG_SCALE

H = (Height - HEIGHT_OFF) ÷ HEIGHT_SCALE

r_n = (Row - LINE_OFF) ÷ LINE_SCALE

c_n = (Column - SAMP_OFF) ÷ SAMP_SCALE

The rational function polynomial equations are defined as:

$$r_n = \frac{\sum_{i=1}^{20} \text{LINE\_NUM\_COEF}_i \cdot \rho_i(P, L, H)}{\sum_{i=1}^{20} \text{LINE\_DEN\_COEF}_i \cdot \rho_i(P, L, H)} \text{ and } c_n = \frac{\sum_{i=1}^{20} \text{SAMP\_NUM\_COEF}_i \cdot \rho_i(P, L, H)}{\sum_{i=1}^{20} \text{SAMP\_DEN\_COEF}_i \cdot \rho_i(P, L, H)}$$

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

$$\sum_{i=1}^{20} C_1 \cdot \rho_i(P, L, H) =$$

C_1	$+C_6 \cdot L \cdot H$	$+C_{11} \cdot P \cdot L \cdot H$	$+C_{16} \cdot P^3$
$+C_2 \cdot L$	$+C_7 \cdot P \cdot H$	$+C_{12} \cdot L^3$	$+C_{17} \cdot P \cdot H^2$
$+C_3 \cdot P$	$+C_8 \cdot L^2$	$+C_{13} \cdot L \cdot P^2$	$+C_{18} \cdot L^2 \cdot H$
$+C_4 \cdot H$	$+C_9 \cdot P^2$	$+C_{14} \cdot L \cdot H^2$	$+C_{19} \cdot P^2 \cdot H$
$+C_5 \cdot L \cdot P$	$+C_{10} \cdot H^2$	$+C_{15} \cdot L^2 \cdot P$	$+C_{20} \cdot H^3$

where coefficients $C_1 \cdots C_{20}$ LC represent the following sets of coefficients:

LINE_NUM_COEF_n, LINE_DEN_COEF_n, SAMP_NUM_COEF_n, SAMP_DEN_COEF_n

The image coordinates are in units of pixels. The ground coordinates are latitude and longitude in units of decimal degrees and the geodetic elevation in units of meters. The ground coordinates are referenced to WGS-84, and pixel and line numbers start at 0.

product→imageAttributes→geographicInformation→mapProjection

Table 5-28 Map Projection

Name	Min,Max	Type	Attributes	Description
mapProjectionDataStore				Map Projection Data Store
mapProjectionDescriptor	1,1	xsd:string		Presently defined entries in mapProjection types include: "ARC", "LCC", "STPL", "UTM", "UPS"
mapProjectionOrientation	1,1	xsd:double	units=rs2prod:angular Units	(units = deg)
productOrientation	1,1	rs2prod:productOrientationIdentifiers		
resamplingKernel	1,1	xsd:string		Presently defined entries in resamplingKernel types include: "NN" "Bilinear" "CC" "8 point Sinc" "DS8" "DS16" "16 point Sinc" "Kaiser 16 point Sinc" "KD16"
elevationCorrection	1,1	rs2prod:elevationCorrectionIdentifiers		
baseElevation	0,1	xsd:double	units=rs2prod:distance Units	Provided only when elevationCorrection = "Base". (units = m)
satelliteHeading	1,1	xsd:double	units=rs2prod:angular Units	Satellite ground track heading in degrees east of North. (units = deg)
start choice				
utmProjectionParameters	1,1	rs2prod:utmProjectionParametersData Store		Universal Transverse Mercator Projection. Universal Polar Stereographic (UPS) projection used from lat 84N and 80S to the respective poles
nspProjectionParameters	1,1	rs2prod:nspProjectionParametersDataS tore		National Systems Projection (any others)
end choice				
positioningInformation	1,1	rs2prod:mapCornersDataStore		Corner positioning of output image

product→imageAttributes→geographicInformation→mapProjection→utmProjectionParameters

Table 5-29 UTM Projection Parameters

Name	Min,Max	Type	Attributes	Description
utmProjectionParametersDataStore				UTM Projection Data Store
utmZone	0,1	xsd:integer		Range from 1 to 60
hemisphere	1,1	rs2prod:hemisphereIdentifiers		Northern or Southern. Required for UTM and UPS
mapOriginFalseEasting	0,1	xsd:double	units=rs2prod:distanceUnits	(units = m)
mapOriginFalseNorthing	0,1	xsd:double	units=rs2prod:distanceUnits	(units = m)

product→imageAttributes→geographicInformation→mapProjection→nspProjectionParameters

Table 5-30 NSP Projection Parameters

Name	Min,Max	Type	Attributes	Description
nspProjectionParametersDataStore				NSP Projection Data Store. To support ARC, LCC, STPL, for which not all the following entries are required.
MapOriginFalseEasting	0,1	xsd:double	units=rs2prod:distanceUnits	(units = m)
mapOriginFalseNorthing	0,1	xsd:double	units=rs2prod:distanceUnits	(units = m)
centerOfProjectionLongitude	0,1	xsd:double	units=rs2prod:angularUnits	(units = deg)
centerOfProjectionLatitude	0,1	xsd:double	units=rs2prod:angularUnits	(units = deg)
standardParallels1	0,1	xsd:double	units=rs2prod:angularUnits	(units = deg)
standardParallels2	0,1	xsd:double	units=rs2prod:angularUnits	(units = deg)
zone	0,1	xsd:integer		Range 1 to 8. Applicable for STPL

product→imageAttributes→geographicInformation→mapProjection→mapCorners

Table 5-31 Map Corners

Name	Min,Max	Type	Attributes	Description
mapCornersDataStore				Map Corners Data Store
upperLeftCorner	1,1	rs2prod:mapTiePoint		Co-ordinates of upper left corner of product
upperRightCorner	1,1	rs2prod:mapTiePoint		Co-ordinates of upper right corner of product
lowerRightCorner	1,1	rs2prod:mapTiePoint		Co-ordinates of lower right corner of product
lowerLeftCorner	1,1	rs2prod:mapTiePoint		Co-ordinates of lower left corner of product

product→imageAttributes→geographicInformation→mapProjection→mapCorners→mapTiePoint

Table 5-32 Map Tie Point

Name	Min,Max	Type	Attributes	Description
mapTiePoint				Map Tie-Point Data Store
mapCoordinate	1,1	rs2prod:mapCoordinate		Co-ordinate Data Stores are described in the Section on Common Parameters
geodeticCoordinate	1,1	rs2prod:geodeticCoordinate		Co-ordinate Data Stores are described in the Section on Common Parameters

product→imageAttributes→geographicInformation→referenceEllipsoidParameters

Table 5-33 Ellipsoid Parameters

Name	Min,Max	Type	Attributes	Description
ellipsoidParametersDataStore				Ellipsoid Parameters Data Store
ellipsoidName	1,1	xsd:string		Name of ellipsoid used to process this product. Presently defined entries in earthEllipsoid types include: “Airy 1830” “Airy 1849” “Australian 1965” “Bessel 1841” “Bessel Modified” “Bessel 1841 Namibia” “Clarke 1858” “Clarke 1866” “Clarke 1866 MICHIGAN” “Clarke 1880 FOOT” “Clarke 1880 ARC” “Clarke 1880 BENOIT” “Clarke 1880 IGN” “Clarke 1880 RGS” “Clarke 1880 SGA 1922” “Everest 1830 1937” “Everest 1830 1967” “Everest 1830 1975” “Everest 1830 Modified” “GEM 10C” “GRS 1980” “Helmert 1906” “Indonesian 1974” “International 1924” “International 1967” “Krassowsky 1940” “NWL 9D” “NWL 10D” “OSU 86F” “OSU 91A” “Plessis 1817” “Struve 1860” “War Office” “WGS84”
semiMajorAxis	1,1	xsd:double	units=rs2prod:distanceUnits	Semi-major axis of the ellipsoid. (units = m)
semiMinorAxis	1,1	xsd:double	units=rs2prod:distanceUnits	Semi-minor axis of the ellipsoid. (units = m)
datumShiftParameters	1,1	rs2prod:datumShiftParametersList	units=rs2prod:distanceUnits	Datum shift parameter referenced to Greenwich: dx. Datum shift parameter perpendicular to Greenwich: dy. Datum shift parameter direction of rotation axis: dz. (units = m)
geodeticTerrainHeight	1,1	xsd:double	units=rs2prod:distanceUnits	Estimated terrain height used during processing. (units = m)

product→imageAttributes→radiometricInformation

Table 5-34 Radiometric Information

Name	Min,Max	Type	Attributes	Description
radiometricInformationDataStore			pole=rs2prod:polarizationIdentifiers	Radiometric measurements for the output image
mean	1,2	xsd:double	dataStream=rs2prod:dataStreamIdentifiers	Mean value of output pixels
standardDeviation	1,2	xsd:double	dataStream=rs2prod:dataStreamIdentifiers	Standard deviation of output pixels

NOTE: for SSG and SPG products, the radiometric information described above is computed on the SAR image prior to geocoding.

5.3.5 Common Parameters

This section describes the data that can be used by any of the Data Stores. Other than describing the image, geodetic and map coordinate Data Stores, it provides details on the enumerated values of the identifiers, units used for attributes, and information on lists. The tables in this section are not preceded by arrow diagrams since they can occur in multiple locations within the hierarchy.

Table 5-35 Image Coordinate

Name	Min,Max	Type	Attributes	Description
imageCoordinate				Image Co-ordinate Data Store
line	1,1	xsd:double		
pixel	1,1	xsd:double		

Table 5-36 Geodetic Coordinate

Name	Min,Max	Type	Attributes	Description
geodeticCoordinate				Geodetic Co-ordinate Data Store
latitude	1,1	xsd:double	units=rs2prod:angularUnits	Geodetic latitude. (units = deg)
longitude	1,1	xsd:double	units=rs2prod:angularUnits	Geodetic longitude. (units = deg)
height	1,1	xsd:double	units=rs2prod:distanceUnits	(units = m)

Table 5-37 Map Coordinate

Name	Min,Max	Type	Attributes	Description
mapCoordinate				Map Co-ordinate Data Store
northing	1,1	xsd:double	units=rs2prod:distanceUnits	(units = m)
easting	1,1	xsd:double	units=rs2prod:distanceUnits	(units = m)

Table 5-38 Identifiers

Name	Type	Description
acquisitionIdentifiers	xsd:string	“Standard” “Wide” “Fine” “Multi-Look Fine” “Ultrafine” “Low Incidence” “High Incidence” “Standard Quad Polarization” “Fine Quad Polarization” “ScanSAR Narrow” “ScanSAR Wide” “SpotlightA” “SpotlightB”
antennaPointingIdentifiers	xsd:string	“Left” “Right”
attitudeSourceIdentifiers	xsd:string	“Downlink” “User Specified”
dataStreamIdentifiers	xsd:string	“Real” “Imaginary” “Magnitude”
dataTypeIdentifiers	xsd:string	“Complex” “Magnitude Detected”
dopplerSourceIdentifiers	xsd:string	“Adaptive Analysis” “Orbit and Attitude” “Default”
elevationCorrectionIdentifiers	xsd:string	“None” “Base” “Coarse DEM” “Fine DEM”
framingMethodIdentifiers	xsd:string	“Raw Data Start Date Time” “Scene Corners”
geodeticFlagIdentifiers	xsd:string	“On-Geodetic” “Off-Geocentric”
hemisphereIdentifiers	xsd:string	“N” “S”
incidenceAngleCorrectionIdentifiers	xsd:string	“Beta Nought” “Sigma Nought” “Gamma”
orbitDataSourceIdentifiers	xsd:string	“Predicted” “Definitive” “Downlinked”
outputMediaInterleavingIdentifiers	xsd:string	“BSQ”
passDirectionIdentifiers	xsd:string	“Ascending” “Descending”
polarizationIdentifiers	xsd:string	“HH” “VV” “HV” “VH”
productFormatIdentifiers	xsd:string	“GeoTIFF”
productOrientationIdentifiers	xsd:string	“Satellite” “Map North” “True North”
productTypeIdentifiers	xsd:string	“SLC” “SGF” “SGX” “SGC” “SSG” “SPG”
pulseIdentifiers	xsd:string	“11.58” “17.28” “30” “50” “Lower_50” “Upper_50”
rangeReferenceFunctionSourceIdentifiers	xsd:string	“Nominal Chirp” “Extracted Chirp Replica”
RawBitsPerSampleIdentifier	xsd:integer	BAQ rate for Raw Data Quantization
satelliteIdentifiers	xsd:string	"RADARSAT-1" "RADARSAT-2"
sensorIdentifiers	xsd:string	"SAR"
windowNameIdentifiers	xsd:string	"Kaiser" "Hamming"
wingIdentifiers	xsd:string	"Fore" "Aft" “Combined”
yawSteeringFlagIdentifiers	xsd:string	“YawSteeringOn" "YawSteeringOff"

Name	Type	Description
timeOrderingIdentifiers	xsd:string	“Increasing” “Decreasing”

Table 5-39 Units

Name	Type	Description
angularUnits	xsd:string	"deg" "rad"
angularVelocityUnits	xsd:string	"deg/s" "rad/s"
distanceUnits	xsd:string	"mm" "cm" "m" "km"
frequencyUnits	xsd:string	"Hz" "kHz" "MHz"
powerUnits	xsd:string	"dB" "W/m^2"
timeUnits	xsd:string	"s" "ms" "us" "ns"
velocityUnits	xsd:string	"m/s" "km/s"

Table 5-40 Lists

Name	Type	From	To	Description
beamList	rs2prod:stringListType	1	∞	Presently defined entries in beams list include: "S1", … ,"S7", "W1", … ,"W3", "F1", … ,"F6", "F21", … , "F23", "MF1", … ,"MF6", "MF21", … ,"MF23", "U1", … , "U47", "EL1", "EH1", … ,"EH6", "Q1", … , "Q17"
coefficientsList	rs2prod:doubleListType	1	10	
datumShiftParametersList	rs2prod:doubleListType	3	3	
histogramList	rs2prod:integerListType	1	256	
gainList	rs2prod:doubleListType	1	20000	
lookWeightList	rs2prod:doubleListType	1	∞	
polarizationList	rs2prod:polarizationListType	1	4	
pulseList	rs2prod:pulseListType	1	2	
rationalFunctionCoefficientList	rs2prod:doubleListType	20	20	
noiseLevelValuesList	rs2prod:doubleListType	1	∞	
stringListType	xsd:string			This is a declaration of a list type whose entries are strings
doubleListType	xsd:double			This is a declaration of a list type whose entries are doubles
integerListType	xsd:integer			This is a declaration of a list type whose entries are integers
polarizationListType	rs2prod:polarizationIdentifiers			This is a declaration of a list type whose entries are polarizationIdentifiers
pulseListType	rs2prod:pulseIdentifiers			This is a declaration of a list type whose entries are pulseIdentifiers

Table 5-41 Data Types

Name	Type	Min	Max Pattern	Description
beamModeIdType	xsd:integer	0	4294967295	A unique value (32-bit) will be defined for each Beam/Mode Definition. This identifier will not change when the Beam/Mode Definition is updated.
beamModeMnemonicType	xsd:string	1	6 [a-zA-Z0-9]+	A string (up to 6 characters) which labels a Beam/Mode. Examples are: S1, W2, SCNA, SQ1, MF1, U23 Note: The format of beamModeMnemonic acceptable to PDS is (S|W|EL|EH)\d | (F|S)Q\d\d? | U\d\d? | (M?F)\d\d?(N?|M?|F?) | SC(N|W)(A|B) | SL(A/B).
imageIdType	xsd:integer	0	4294967295	Unique ID of an Image (32-bit) (generated by Ground Segment when the Acquisition Schedule is generated; it is flowed through to the spacecraft in Ground Pass-Through Data)
inputDataSetFacilityNameType	xsd:token	1	32 [0-9A-Za-z_ \.\-]+	Name of an Archive facility, which maintains Archive Segments (datasets) from which RADARSAT-2 products are produced.
inputDataSetIdType	xsd:token	1	256 [0-9A-Za-z_/:\\\.\-]+	Identifier of an Archive Segment (dataset). When combined with the archiveFacilityId uniquely identifies a dataset.
prfType	xsd:double	>0.0	10000.0	SAR Pulse Repetition Frequency in Hz
priPerDwellType	xsd:integer	0	65535	Number of PRI per dwell (if Number of Beams > 1)
processingFacilityNameType	xsd:token	1	32 [0-9A-Za-z_ \.\-]+	Name of the Processing Facility which generated the product.
pulseBandwidthType	xsd:double			In MHz unless overridden by atrribute, e.g. units=Hz
pulseDurationType	xsd:double			In micro-seconds unless overridden by attribute, e.g. units=s (seconds)
rangeSamplingRateType	xsd:double			The range sampling rate (sampling rate of echo data within each sample window). In MHz unless overridden by attribute, e.g. units=Hz
rankType	xsd:integer	>0	100	Number of PRI between transmission and reception.
transmittedPulsesPerDwellType	xsd:integer	0	65535	Number of pulses Transmitted per dwell (required if Number of Beams > 1) It is assumed that the start of pulse transmissions is the first PRI of the dwell.
utcTimeType	xsd:dateTime		\d\d\d\d-\d\d-\d\dT\d\d:\d\d:\d\d(\.\d+)?Z	UTC Time - this is stored in XML dateTime format as "CCYY-MM-DDThh:mm:ss.uuu...uuZ". Decimal fraction of seconds is optional.

5.3.6 LUT File

Three output scaling Look-up Tables (LUTs) are included with every product, except for SSG and SPG products. These LUTs allow one to convert the digital numbers found in the output product to sigma-nought, beta-nought, or gamma-nought values (depending on which LUT is used) by applying a constant offset and range dependent gain to the SAR imagery.

The format of a LUT file is shown in Table 5-42.

Table 5-42 LUT

Name	Min,Max	Type	Attributes	Description
lut			copyright = xsd:string,	RADARSAT-2 Data and Products (c) MacDonald, Dettwiler and Associates Ltd., <year of acquisition> - All Rights Reserved.
offset	1,1	xsd:double		Constant offset (B)
gains	1,1	rs2prod:gainList		Range dependent gain list (A)

There is one entry in the gains list for each range sample in the imagery. For detected products (SGF, SGX, and SGC), in order to convert the digital number of a given range sample to a calibrated value, the digital value is first squared, then the offset (B) is added and the result is divided by the gains value (A) corresponding to the range sample.

$$\text{calibrated value} = \frac{(\text{digital value}^2 + B)}{A}$$

For SLC products, the following formula should be used:

$$\text{calibrated value} = \frac{|\text{digital value}|^2}{A^2}$$

where "digital value" is a complex number and calibrated value is one of sigma-nought, beta-nought, or gamma-nought, depending on the selected LUT.

6 RADARSAT-2 PRODUCT IMAGE PIXEL DATA FORMAT

6.1 GeoTIFF

GeoTIFF extends Aldus-Adobe's raster Tagged Image File Format (TIFF) (Document R-3) with a set of tags that provide additional geographic information. GeoTIFF is described in the GeoTIFF Format Specification (Document R-4).

This section contains three tables. Table 6-1 describes the contents of the TIFF tags used by all the RADARSAT-2 products considered in this format (i.e. all products except RAW). Table 6-2 describes the GeoTIFF tags used for all products that are georeferenced, but not geocorrected (i.e. specified in slant range or ground range coordinate systems). SLC, SGX, SGF, and SGC products fall into this category and since these products are not geographically corrected, the geographic metadata included in GeoTIFF will be limited to a set of points tying image location to geographic location. Table 6-3 describes the GeoTIFF tags used for all products that have been geocorrected to a map projection. SSG and SPG products are included in this category.

GeoTIFF images will be generated in TIFF strip format. Multipolar images will be generated as separate GeoTIFF image files. All images are oriented such that north is nominally up and east is nominally on the right. If the image covers the North or South Pole, the image direction is determined based on the mid azimuth state vector – if the velocity of the state vector at mid azimuth is positive, then, the pass orientation is ascending. To determine whether flipping as occured, use the lineTimeOrdering and pixelTimeOrdering fields. If lineTimeOrdering is Decreasing, it means that the image is flipped top to bottom, i.e. the first acquired line is at the bottom of the TIFF image. Similarly, if pixelTimeOrdering is Decreasing, it means that the image is flipped left to right, i.e. the nearest-range pixel is at the right edge of the TIFF image.

The contents of TIFF tags used are described in Table 6-1.

Table 6-1 TIFF Tag Description

TIFF Tag Name	TIFF Tag Code	TIFF Tag Type	Description
ImageWidth	256	LONG	Pixels per line.
ImageLength	257	LONG	Lines per band.
BitsPerSample	258	SHORT	Set to 16 for SLC I and Q and non-geocorrected magnitude-detected products. 8 or 16 for geocorrected products.
Compression	259	SHORT	Set to 1, meaning uncompressed.

TIFF Tag Name	TIFF Tag Code	TIFF Tag Type	Description
PhotometricInterpretation	262	SHORT	Set to 1 (black is zero) since multipolar products not represented as RGB
ImageDescription	270	ASCII	Contains a single value to identify the polarization.
StripOffsets	273	Array of LONG	Offsets to image strips in the file.
Orientation	274	SHORT	Set to 1 to indicate that the first sample is the upper left corner.
SamplesPerPixel	277	SHORT	Set to 2 for I and Q. Set to 1 in all other cases
RowsPerStrip	278	LONG	Number of lines per image strip within the file.
StripByteCounts	279	Array of LONG	Sizes of the image strips in the file.
PlanarConfiguration	284	SHORT	TBC: Set to 2 (planar format) to indicate I and Q values are interleaved.
UtcTimeType	306	ASCII	Null terminated string indicating the date and time of file generation in "YYYY:MM:DD HH:MM:SS" format.
SampleFormat	339	Array of SHORT	The array will have SamplesPerPixel elements, each set to 1 to indicate unsigned integer data.

The GeoTIFF fields that will be used for georeferenced products are described in Table 6-2.

Table 6-2 GeoTIFF Fields For Georeferenced Products

Field Name	Value	Description
ModelTiepointTag	Array of 6-tuples (column, row, 0, longitude, latitude, height)	This field is used to map raster coordinates to model coordinates. The mapping will be done for the four corners of the image.
GTModelTypeGeoKey	ModelTypeGeographic	Indicates that the model coordinates are geodetic latitude, longitude, and height.
GTRasterTypeGeoKey	RasterPixelIsArea	Indicates that raster coordinates model a pixel as having area, rather than being a point sample. The (0,0) origin of the raster coordinate system is in the upper left corner of the upper left pixel.
GTCitationGeoKey	"Uncorrected Satellite Data"	This field gives an ASCII representation of the overall configuration of the GeoTIFF file.
GeographicTypeGeoKey	GCS_WGS_84	Indicates that model coordinates are referenced to the WGS84 datum.

The GeoTIFF fields that will be used for geocorrected products are described in Table 6-3.

Table 6-3 GeoTIFF Fields For Geocorrected Products

Field Name	Value	Description
ModelTiePointTag	Single 6-tuple (column, row, 0, x, y, height)	This field is used to map a single raster coordinate to model coordinate. The mapping will be done at the upper left corner of the image. This field will only be present when the image is map north up.
ModelPixelScaleTag	Single 3-tuple (pixel scale, line scale, 0)	This field is used to specify the scale factors used when converting between raster and model coordinates. This field will only be present when the image is map north up.
ModelTransformationTag	Single 4x4 double precision transformation matrix	This field is used to transform raster coordinates to model coordinates. This field will only be present when the image is not map north up – images that are in a satellite heading, for example.
GTModelTypeGeoKey	ModelTypeProjected	Indicates that the model coordinates are map projection x, and y.
GTRasterTypeGeoKey	RasterPixelIsArea	Indicates that raster coordinates model a pixel as having area, rather than being a point sample. The (0,0) origin of the raster coordinate system is in the upper left corner of the upper left pixel.
GTCitationGeoKey	"Corrected Satellite Data"	This field gives an ASCII representation of the overall configuration of the GeoTIFF file.
ProjectedCSTypeGeoKey	Projected coordinate system code	Code indicating the map projection and datum of the corrected image.
PCSCitationGeokey	String	This field gives an ASCII representation of the projected coordinate system. The name of the map projection and ellipsoid are used.
The following fields are only included when ProjectedCSTypeGeoKey is user defined.		
ProjectionGeoKey	Map projection code	Code indicating the map projection of the corrected image.
The following fields are only included when ProjectionGeoKey is user defined.		
ProjLinearUnitsGeoKey	Linear units code	Code indicating which units are used for map projection distances.
ProjCoordTransGeoKey	Map projection type code.	Code indicating the type of map projection used to correct the data.
The following fields are only included when necessary for the type of map projection.		
ProjStdParallel1GeoKey	Latitude	First standard parallel for the projection, in degrees.
ProjStdParallel2GeoKey	Latitude	Second standard parallel for the projection, in degrees.
ProjNatOriginLatGeoKey	Latitude	Projection origin latitude, in degrees.
ProjFalseEastingGeoKey	Distance	Easting (x) value at the projection origin.

Field Name	Value	Description
ProjFalseNorthingGeoKey	Distance	Northing (y) value at the projection origin.
ProjCenterLongGeoKey	Longitude	Projection center longitude, in degrees.
ProjCenterLatGeoKey	Latitude	Projection center latitude, in degrees.
ProjScaleAtCenterGeoKey	Scale factor	Scale factor at projection center.
ProjAzimuthAngleGeoKey	Angle	Projection azimuth angle in degrees.
ProjStraightVertPoleLongGeoKey	Longitude	Longitude below the pole, in degrees.
The following fields are only included when ProjectedCSTypeGeoKey is user defined.		
GeographicTypeGeoKey	Geographic type code	Code indicating which ellipsoid/datum pair is used to correct the data.
The following fields are only included when GeographicTypeGeoKey is user defined.		
GeogGeodeticDatumGeoKey	User defined code	Indicates that the datum is user defined.
GeogCitationGeoKey	String	Name of the ellipsoid and possibly earth center offset parameters.
GeogEllipsoidGeoKey	Ellipsoid code	Code indicating which ellipsoid was used to correct the data.
The following fields are only included when GeogEllipsoidGeoKey is user defined.		
GeogSemiMajorAxisGeoKey	Distance	Semi-major axis of the ellipsoid in meters.
GeogSemiMinorAxisGeoKey	Distance	Semi-minor axis of the ellipsoid in meters.

7 RADARSAT-2 PRODUCT ORGANIZATION

7.1 Media

Sequential Access Media

RADARSAT products may be created on sequential access (tape) media.

GeoTIFF and ASCII files will be written to sequential access media using the Portable Operating System Interface (POSIX) Extended Tape Archive (TAR) format.

Random Access Media

RADARSAT products may be created on the following types of random access media:

- local disk devices
- CD-ROM

7.1.1 Labeling

7.1.1.1 Physical Media

Physical media (CD-ROM and DVD-ROM) are labeled with:

RADARSAT-2 OrbitNumber_PDSnumber,OrderKey_ProductKey_DeliveryKey

for example: RADARSAT-2 ORBIT 01121,PDS_0005246,OK725_PK5873_DK198

and inserts that include all related metdata information. For example:

RADARSAT-2 SCENE DESCRIPTION

PGS_ID	PDS_0005246
MDA ORDER NUMBER	OK725_PK5873_DK198
SCENE START TIME	2008-03-02 00:25:00.342
SCENE STOP TIME	2008-03-02 00:24:15.583
ORBIT	01121
ORBIT DATA TYPE	Ascending
APPLICATION LUT	Sea

ANTENNA DIR	Right
GEOLOCATION	Placename
POL	VV
BEAM MODE	W2 S5 S6
PRODUCT TYPE	SGF
FORMAT	GeoTiff+XML(Standard)
BITS	16
# OF IMAGE LINES	11922
# OF IMAGE PIXELS	11924
PIXEL SPACING	25.00 m
LINE SPACING	25.00 m
SCENE CENTRE	22°25'34" N 94°02'57" W
CORNER COORDINATES:	
23°29'41.73" N 23°59'58.21" N 95°45'38.08" W 92°53'18.97" W	
20°50'56.95" N 21°21'40.89" N 95°10'57.05" W 92°21'57.33" W	

7.1.2 File Organization and Naming

The RSAT-2 product consists of a number of files and sub-directories contained within a parent directory. The name of the parent directory is:

productId/

The following directory structure is proposed for the files/sub-directories contained within the parent directory.

Table 7-1 Product Directory Structure

Directory/File Name	Description	Required
product.xml	Product Information File	√
image_<n>.tif	1 to 4 Image Pixel Data Files. One file for each polarization channel.	√
BrowseImage.tif	Browse image file in TIFF format	
lutSigma.xml	LUT to convert image to sigma-nought	All products except SSG and SPG

Directory/File Name	Description	Required
lutBeta.xml	LUT to convert image to beta-nought	All products except SSG and SPG
lutGamma.xml	LUT to convert image to gamma-nought	All products except SSG and SPG
license.txt or RS2 EULA User License.pdf	Product license info. Version/format is client-dependent.	√
product.html	Wrapper HTML file to visualize the product	
Readme.txt	ASCII text introductory "readme" file	√
label.txt	ASCII label file	
images/	Location for all other image files	
schemas/	Location for XML Schema files that validate the Product Information File	√
styles/	Location for XSL Stylesheet files	
html/	Location for all HTML files used to visualize the product using a browser	

The product naming convention for electronic FTP delivery is as follows:

RSAT2_OrderKey_ProductKey_DeliveryKey_BeamMode_Date_Time_Polarizations_ProcessingLevel.zip

For example: **RS2_OK774_PK6404_DK334_MF23_20080328_075402_HV_SGF.zip**
RS2 = RADARSAT 2
OK774 = Order Key
PK6404 = Product Key
DK334 = Delivery Key
MF23 = Beam Mode
20080328 = Acquisition Date
075402 = Start Time
HV = Polarization
SGF = Processing Level