Sentinel-3 Core PDGS Instrument Processing Facility (IPF) Implementation

Product Data Format Specification - Level 0 Products

Ref: S3IPF.PDS.001
Issue: 1.3

Date: 12 February 2013

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AMENDMENT POLICY

This document shall be amended by releasing a new edition of the document in its entirety. The Amendment Record Sheet below records the history and issue status of this document.

Amendment Record Sheet

ISSUE	DATE	REASON
1.0	24 Jul 2012	DR0 data-package release
1.1	01 Oct 2012	DR1 update
1.2	18 Dec 2012	DR0+DR1 RIDs
1.3	12 Feb 2013	Change of Template

Document Change Record

No.	Change in Issue	Description	Affected Section
1	1.1	S3IPF-80 (from ICD): section 1.3 on ICD described types that at the end are not used in the L0 product spec. So nothing is changed on this document	1.3
2	1.1	S3IPF-96 (from ICD): List of APIDs per product is checked on Table 16	Appendix A
3	1.1	S3IPF-10: - Section 3.1and *Table 2* are updated. Product naming is linked to the section where it is summarized -*Table 2* and *Table 7* are updated regarding product contents - Text at beginning of section 4 is updated	3.1
4	1.1	S3IPF-12: TBCs related with the use of nominal vs. redundant packets are deleted through the document. It is clarified also that on the L0 product both nominal and redundant can appear	5.2.1, 5.2.5 and 5.2.6
5	1.1	S3IPF-14: Paragraph with SALP reference on section 5.2.8 is deleted	5.2.8
6	1.1	S3IPF-15: DORIS PCAT assignations are corrected in text on section 5.2.6 and *Table 14*	5.2.6

No.	Change in Issue	Description	Affected Section
7	1.1	3IPF-18: Event reporting and GNSS housekeeping (PCAT 3, 4) are included in section 5.2.5 and Table 16. Sentence at the end of section 5.2.5 is clarified.	5.2.5
8	1.1	3IPF-19: Filenaming convention is clarified in section 3.2	3.2
9	1.1	S3IPF-21: Table 5 and Table 6 updated with the latest xsd information	
10	1.1	S3IPF-22: Closed with the update on S3IPF-21. This includes management of percent figures in the metadata	
11	1.1	S3IPF-23: Schemas are deleted from*Table 6*.	
12	1.1	S3IPF-25: Section 5.1.2.2 is updated with the example from ESA	5.1.2.2
13	1.1	S3IPF-26: The *Table 10* does not include anymore “ID”; URI is corrected to URL; ISPAnnotation is added; OLQCReport is added	
14	1.1	S3IPF-27: Section 5.1 is updated with the latest manifest	5.1
15	1.1	S3IPF-29: New SAFES3 schemas to be provided in agreement with S3IPF-27	
16	1.1	S3IPF-30: Table 16 is corrected for SRAL products	Appendix A
17	1.1	S3IPF-31: and corresponding section 5.1.2.1.1 are updated with latest manifest	
18	1.1	S3IPF-32: Excel document with manifest is delivered with the updates as required	
19	1.1	S3IPF-33: ADS2 are deleted for STM on section 5.3.1. References to algorithms on the STM branch are also deleted on section 5.3.1	5.3.1
20	1.1	S3IPF-34: solved with the update corresponding to S3IPF-32 and the new excel sheet.	

No.	Change in Issue	Description	Affected Section
21	1.1	S3IPF-81: Whenever is needed, OLCI CR1 product is shown (section 4.1, *Table 7*section 5.2.3, Table 17, etc.)	4.1, 5.2.3, Appendix B
22	1.1	S3IPF-86: According the closeout from VEGA, no update is necessary, because document is aligned with granule format TN at the time of writing	
23	1.1	S3IPF-90: reference to AD-27 is deleted on section 4.2. Note also that manifest information is updated	4.2
24	1.1	S3IPF-91: the clarification on the orbit files is proposed instead at the beginning of section 3.1. Note that section 3.1 contains new metadata.	3.1
25	1.1	S3IPF-94: Section 5.3.1 is updated with the latest agreement on ADS2 – only OLCI needs it while for the other instruments with ADS1 and ADS3 is enough	5.3.1
26	1.1	S3IPF-97: Acronyms are explicit on section 1.5, including PID and PCAT	1.5
27	1.1	S3IPF-99: section 5.4 corrects the reference to Appendix C	5.4
28	1.1	S3IPF-109: section 1.3 and 1.4 include explicit references and calls to [CIDL] are deleted	1.3, 1.4
29	1.1	S3IPF-112: section 4 is cleaned to avoid any reference to SAFE. It only remains information related with the metadata.	4
30	1.1	S3IPF-113: section 3.1 contains a clarification on regarding sorting of packets in output vs. input	3.1
31	1.1	S3IPF-116: end of section 4.1 shows that the OLQC report is mentioned in the manifest of the L0 product	4.1
32	1.1	S3IPF-117: representation information files are added to the document	
33	1.1	S3IPF-118: section 4.2 is updated with the latest manifest	4.2

No.	Change in Issue	Description	Affected Section
34	1.1	S3IPF-119: Thresholds for missing, etc. packets are a subject for the ICD. Regarding comment on section 4.2.1"[...] complete as much as possible [...]" is reworded	4.2.1
35	1.1	S3IPF-120: beginning of section 5.2 clarifies the extra sorting beyond time ordering done on OLCI and SLSTR	5.2
36	1.1	S3IPF-121: former Table 4-3 is deleted. Additionally, section 4.2.1 includes the latest metadata specification	4.2.1
37	1.1	S3IPF-128: Section 5 is cleaned from the different XML examples provided in the previous version	5
38	1.1	S3IPF-129: OLCI CR1 product is added on section 5.2.3	5.2.3
39	1.1	S3IPF-130: representation Information Files are annexed	
40	1.1	S3IPF-132: This RID refers to section 5.3 and the ADS2. Therefore its solution is the same one as S3IPF-33	5.3
41	1.1	S3IPF-133: binX schemas are deleted (and moved to the ICD document)	
42	1.1	S3IPF-135: Appendix B and size calculation is clarified	Appendix B
43	1.1	S3IPF-137: RID de-scoped by Vega (RID description missing in Jira)	
44	1.1	S3IPF-139	
45	1.1	S3IPF-161: Section 5.2.6 clarifies that DORIS has specific packets for "reports"	5.2.6
46	1.1	S3IPF-162: Clarifications on the use of nominal and redundant data are covered by S3IPF-12	
47	1.1	S3IPF-163: Deletion of SALP in the next is covered by S3IPF-14	

No.	Change in Issue	Description	Affected Section
48	1.1	S3IPF-164: Correction on ADS2 section 5.3.1.2 does not apply anymore because it is confirmed after DR0 that SRAL ADS2 is not needed	
49	1.1	S3IPF-216: RID is closed by Vega clarification. It simply states that the original AD-19 is no longer maintained due to the existence of this product specification DI-12	
50	1.1	S3IPF-218: The CRC discarded packets are tracked with the new metadata on the manifest (section 4.2). The CRC is not anymore on ADS2 section 5.2.1. Indeed packets are discarded in the sense that they are not in the output product. This is clarified just before starting section 5.2.1	4.2, 5.2.1
51	1.1	S3IPF-219: Driver TAIL-GEN-DRV-5 deleted	
52	1.1	S3IPF-220: management of nominal and redundant covered by S3IPF-12	
53	1.1	S3IPF-221: manifest, data types, etc. have been updated (section 5.1) and checked for consistency	5.1
54	1.1	S3IPF-222: section 4.3.2 clarifies the wording for "development teams"	4.3.2
55	1.1	S3IPF-223: use of CR1 OLCI product through the document is covered by S3IPF-81	
56	1.2	S3IPF-86: section 4.3.1 is updated with a clarification on the granule contents	4.3.1
57	1.2	S3IPF-90: Section 4.2 is updated considering that the metadata is external excel document	4.2
58	1.2	S3IPF-97: PID and PCAT are in section 1.5	1.5
59	1.2	S3IPF-109: AD-19.5 is removed from the document	
60	1.2	S3IPF-116: This RID appears as not-implemented. But on section 4.3.2 DR1 delivery already clarified that the OLQC report is an annotation	4.3.2

No.	Change in Issue	Description	Affected Section
61	1.2	S3IPF-130: xsd schemas delivered as separate files	
62	1.2	S3IPF-132: Since S3IPF-256 on ADS is closed, this RID can be closed as well. But there is not yet explicit close-out by Vega	
63	1.2	S3IPF-133: Section 5.6 does not contain anymore the binX schemes	5.6
64	1.2	S3IPF-139: Reference [AD-19.5] is deleted and [AD-19.6] is an ACRI document developed by the consortium	1.3
65	1.2	S3IPF-256, S3IPF-40: ADS2 to be removed from the document	
66	1.2	S3IPF-460: ADS3 is complete to be aligned with DPM L0. Update is done on section 5.3.1.2	5.3.1.2

1. INTRODUCTION

1.1 Purpose and Scope

This document is for the Product Data Format Specification of the Level 0 Sentinel-3 Core Payload Data Ground Segment Instrument Processing Facility Implementation project, performed under VEGA Space GmbH contract, VEGA/SUB/4000101720/004.

This document aims to identify and specify the format of the Level 0 products.

1.2 Structure of the Document

Besides this introduction (first section of the document), a number of major sections are contained in this document and they are briefly described below:

Chapter Number	Title	Contents
1	INTRODUCTION	This section
2	OVERVIEW OF THE INSTRUMENTS ON-BOARD SENTINEL 3	In this section an overview of the Sentinel-3 instruments is given.
3	LEVEL 0 PRODUCT OVERVIEW	The overall L0 Product structure is described in this section along with the used definitions and terminology.
4	L0 PRODUCT FORMAT SPECIFICATION	In this section each part of the product is specified.

Chapter Number	Title	Contents
5	DETAILED DESCRIPTION OF THE PRODUCT PACKAGE	In this section each component of the product is described in great details and examples of implementations are given. As the title indicates, this section is a further development of section 4 There are a series of appendices with supporting information as follows: • Appendix A summarizes the list of APIDs for each L0 product. • Appendix B makes an estimation of the size of the products • Appendix C provides examples for the XML and schema files. These files are only provided for illustration purposes

Table 1: Document Structure

1.3 Applicable and Reference Documents

1.3.1 Applicable documents

The following table lists the applicable documents.

ID	Document	Reference
AD- 1	Sentinel 3 PDGS File Naming Convention	EUM/LEO-SEN3/SPE/10/0070 GMES-S3GS-EOPG-TN-09-0009, Issue 1.2, 05/07/2012
AD- 2	Product Data Format Specification - Product Structures	S3IPF.PDS.0012, i1r1, 18/12/2012
AD- 3	Drivers for the S3 PDGS Processing Function Implementation	EUM/LEO-SEN3/TEN/09/0183, V1E, ESA:GMES-GSEG-EOPG-TN-11-0062, Issue 1.4, 24/07/2012

ID	Document	Reference
AD- 4	Metadata Specification, Excel document	S3IPF.PDS.008, i1r10, 18/12/2012 This reference is the baseline document describing the primary and secondary metadata of the product manifests. As soon as this document is consolidated, the tables will be fully included in the present document.
AD- 5	XML Schemas.zip	S3IPF PDS 009, i1r0, 18/12/2012. Zip file containing all the schemas used to represent the metadata
AD- 6	Sentinel SAFE control book volume 1 – core specifications	GAEL-P264-DOC-0001-01-01, i1r1, 05/06/2012
AD- 7	GMES Generic PDGS-IPF Interface Specification	GMES-GSEG-EOPG-TN-09-0016, i1r1, 25/02/2011
AD- 8	System Technical Budget	S3PDGS REP 002, i3r1, 15/11/2012
AD- 9	Level 0 documentation from Optical Level 0/Level 1 CFI	S3-RS-ACR-SY-00001, i6r1, 22/07/2011
AD- 10	11 - APID Vs PDHT&SMU Packet Store Allocation	S3-TN-TAF-SC-01798, i3r0, 09/06/2012
AD- 11	12 - SLSTR Instrument Measurement Data Definition Document (IN-17)	S3-RP-GA-SL-00019, i4r0, 20/04/2012
AD- 12	External ICD Volume 2 DFEP <--> PDGS ICD	DFEP-ICD-KSAC-ESA-1066, Issue 1. 1, 02/03/2011
AD- 13	CFI-ID-09-01 Sentinel-3 Satellite to ground ICD	S3-ID-TAF-SC-00438, Issue 8.0, 21/02/2012
AD- 14	CFI-ID-09-02 Sentinel-3 appendix to the Space to Ground ICD – NAVATT packets definition	S3-ID-TAF-SC-01890, Issue 2.0, 21/02/2012
AD- 15	CFI-ID-09-03 Sentinel-3 APID definition	S3-TN-TAF-SC-00641 Issue 6.0, 13/05/2011
AD- 16	CFI-ID-09-04 Sentinel GPSR Command and Housekeeping Data Interface Specification	S1-IF-AAE-SC-0001 Issue 16.0, 15/05/2012
AD- 17	CFI-ID-09-05 Sentinel GPSR Measurement Data Interface Specification	S1-IF-AAE-SC-0002 Issue 10.0, 13/06/2012

ID	Document	Reference
AD- 18	CFI-ID-09-06 Sentinel-3 MWR Instrument Measurement Data Definition Document	S3-TN-ECE-MR-00096 Issue 4.1, 17/07/2012
AD- 19	CFI-ID-09-07 Sentinel-3 OLCI Measurement Data Definition Document	S3-DD-TAF-OL-00836 Issue 6.0, 20/10/2011
AD- 20	CFI-ID-09-08 Sentinel-3 SRAL Software Interface Control Document	CFI-ID-TAF-RA-00806 Issue 6.0, 15/04/2011
AD- 21	CFI-ID-09-09 Sentinel-3 SLSTR Science Data SW Interface Requirement Document	S3-IS-GA-SL-00003 Issue 2, 25/02/2010
AD- 22	CFI-ID-09-10 DORIS – Definition of TM Packets and TC Formats	CO-SP-D0-EA-16222-CN Issue 3, 06/01/2012
AD- 23	CFI-ID-09-11 APID Vs PDHT&SMU Packet Store Allocation	S3-TN-TAF-SC-01798 Issue 3, 09/06/2011

1.3.2 Reference documents

The following reference documents contain information supporting this document. This product format specification has been written taking into account the outcomes of the activities carried out during the prototype development and the related documents have been used as reference.

ID	Document	Reference
RD- 1	CCSDS 661.0-B-0 XFDU structure and construction rules	Issue Sept. 2008
RD- 2	S3PDGS Operations Concept Document	GMES-GSEG-EOPG-TN-09-0040, EUM-LEO-SEN3-TEN-09-0007, v2.1, 03/09/2010
RD- 3	Level 0, Level 1a/b/c Products Definition Part 2: Optical Products Volume 2: OLCI L0/L1b products	S3-RS-ACR-SY-00004, i7r0, 06/07/2012

1.4 Terms, Definitions and Abbreviated Terms

Terms, Definitions and Abbreviated Terms are identified in the common volume of the product format specifications in [AD 2].

1.5 Intellectual property rights for specific parts this document

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Section	IPR/Document Reference
Section 5.3.1.1	Document Title: Level 0, Level 1a/b/c Products Definition Part 2: Optical Products Volume 2: OLCI L0/L1b products Document Reference: S3-RS-ACR-SY-00004 Issue: i7r0 Date: 06/07/2012

2. OVERVIEW OF THE INSTRUMENTS ON-BOARD SENTINEL 3

The products specified in this document refer to the data generated by the instruments on-board Sentinel 3 satellites.

Four of them are science instruments and they are:

- SRAL : Synthetic Radar Altimeter
- MWR : MicroWave Radiometer
- OLCI : Ocean Land Colour Instrument
- SLSTR : Sea Land Surface Temperature Radiometer

There are also two more location instruments that generate telemetries to be turned into Level 0 products and they are: DORIS and GNSS.

SRAL is a redundant dual-frequency (C-band and Ku-band) instrument that measures the two-way delay of the radar echo from the Earth's surface with a precision better than a nanosecond. SRAL altimeter measurements are performed either in Low Resolution Mode (LRM) or in Synthetic Aperture Radar (SAR) mode. LRM mode is the conventional altimeter pulse limited mode with interleaved Ku-band and C-band pulses, while SAR mode is the high along track resolution mode based on Synthetic Aperture Radar processing, made of Ku-band bursts, each of them being surrounded by two C-band pulses (for ionosphere delay correction) to be also able to operate over open ocean

MWR is a dual frequency, single polarization and fully redounded radiometer whose data are used to correct SRAL measurements for atmospheric effects. The centre frequencies of each channel are 23.8 GHz and 36.5 GHz, with a channel bandwidth of 200 MHz.

SLSTR is based on Envisat's Advanced Along Track Scanning Radiometer (AATSR), to determine global sea-surface temperatures to an accuracy of better than 0.3 K.

OLCI is an imaging spectrometer based on the heritage from Envisat's MERIS but with a higher number of bands (21) for a higher resolution over all surfaces (ocean and land).

3. LEVEL 0 PRODUCT OVERVIEW

3.1 Product Tree

Within the PDGS system, the Sentinel 3 Level 0 products are generated by the Instrument Processing Facility (IPF). This Facility is called IPF L0 or also L0P. The L0P interacts with the PDGS through another component named PM, in charge, for instance, to provide the necessary input data during the processing, that is:

- Auxiliary files for L0, like the orbit scenario file. actually, by "orbit" it is necessary to understand that there can be different options to comply with the requirements of the activity (FOS orbit file, FOS restituted, predicted orbit file, IERS Bulletins)
- Configuration processing parameters, Job Order, etc.
- Binary packets from the Sentinel 3 instruments (OLCI, GNSS, SRAL, etc.) named “ISPs”. When the packets contain navigation and attitude information are called NAVATT. Another specific type is the platform and payload housekeeping, enclosed in a L0 product named HKTM

Interestingly, upon being downloaded from the satellite, the binary packets are pre-processed at PDGS level by a component named L0 pre-processor or L0PP. The role and tasks of L0PP are out of the scope of this document. Consider only that thanks to it, the packets input to L0P have been already cleaned and sorted, simplifying the work of L0P when generating L0 products.

The Level 0 products contain streams of packets that not necessarily are identical to the stream generated on-board. It can happen that some packets are simply lost (and will be detected by L0 processor as "missing"). Others could be corrupted, and when detected by L0 processor, they will be removed from the input stream (i.e., they will not be written on the output L0 product). Moreover, the packets in the L0 output product will be sorted in time (and also ordered per APID in some instruments), something that, again, not necessarily happens in the data input to the L0 processor.

The complete list of products contained in this volume is given in Table 2. From the point of view of the end users, L0 products are not available to them because their main role is to support at PDGS the processing of L1 and L2.

Table 2: Level 0 Products list. For details on naming convention refer to section 3.2

Product	Description
SR_0_SRA___	SRAL observation data
SR_0_CAL___	SRAL calibration data
MW_0_MWR___	MWR observation data and calibration
SL_0_SLT___	SLSTR ISPs including all targets (EO, black body and VISCAL)
OL_0_EFR___	OLCI Full Resolution ISPs
OL_0_CR0___	OLCI Calibration with no spectral relaxation
0L_0_CR1___	OLCI calibration with spectral relaxation.

GN_0_GNS___	ISPs Level 0 as follows: Satellites In View, Tracking State Data, Channel Status, IMT/GPST Correlation Data, Auxiliary Data Carrier Phase Data, Carrier Amplitude Data, Code phase Data, Noise Histogram Data AGC Status Data, Constellation Status, GPS Nav Almanac Data, GPS Nav Ephemeris Data, GPS NAV UTC and Ionosphere Data
DO_0_NAV___	Navigation packets including ITRF, geodetic and J2000
DO_0_DOP___	DORIS Measurements packets including doppler, datation, test packets and reports
TM_0_HKM___	Payload and Platform House Keeping telemetry packets
TM_0_NAT___	Telemetry Source packets (navigation and attitude, i.e., state vectors and quaternions). This product contains information on the manoeuvring status

3.2 Product Naming Convention

The names of all the Level 0 products comply with the Sentinel 3 file naming convention, according to [AD 1]. The specification is summarized here for completeness of this product specification document.

The file names are a series of keys concatenated using underscores:

MMM_SS_L_TTTTTT_yyyymmddThhmmss_YYYYMMDDTHHMMSS_<instanceID>_GGG_<class ID>_VV.<ext>

- MMM stands for the satellite S3A or S3B (for any practical purpose L0 is not sensible to either S3A or S3B data streams)
- SS stands for the instrument OLCI (OL), SLSTR (SL), SRAL (SR), etc.
- L is the level of processing, equal to 0 for L0P
- TTTTTT is the file type function of the instrument (EFR, CR1, NAV, etc. See the full list on Table 2)
- The fields with the date year-month-dayThour-minute-second refer to the start and stop sensing times of the instrumental acquisitions. They are in UTC scale
- The field “instance” includes several sub-fields like the relative orbit number, the cycle number, the length in time (duration) of the product or the elapsed time from ascending node.
- GGG provides the generation centre for the product
- VV is the file version (starts with 0)
- The last field “<ext>” is a hint on the product format (that is the IPF product package).

4. L0 PRODUCT FORMAT SPECIFICATION

The Sentinel 3 IPF products share a common product structure based on ad-hoc Sentinel3 formalism, which is described in the next sections. It is important to point out that all the IPF products share this approach. Then, "an IPF product" is a container (or package) with different physical files: manifest, annotation data file(s), measurement data files and, if applicable, representation files.

4.1 Level0 Package Description

In the following table the physical composition of the package is specified for Level 0 products.

The components of the package that are not part of the current operational production baseline are identified with a flag in the column N.O. (Not Operational). These components might be required to be generated at a later time during the mission lifecycle.

Table 3: Level 0 product physical composition

<table>
<tr><td colspan="2">Product Package Type
OL_0_EFR_, OL_0_CR0_, OL_0_CR1, SL_0_SLT_, SR_0_SRA_, SR_0_CAL_, MW_0_MWR_, GN_0_GNS_, DO_0_DOP_, DO_0_NAV_, TM_0_HKM_, TM_0_NAT_,</td><td colspan="4">Description
This is the generic package describing the structure of the Level 0 Products generated by Sentinel 3 PDGS</td><td></td></tr>
<tr><td>Product Level</td><td>Diss. Timeliness</td><td>Product Category</td><td>ApplicationDomain</td><td colspan="3">Spatial Resolution</td></tr>
<tr><td>0</td><td>NRT</td><td>Not Available to the user</td><td></td><td colspan="3"></td></tr>
<tr><td colspan="2">Product Dissemination Unit</td><td>Number of Package components</td><td>Number of Measurement Data Files</td><td>Number of Annotation Data Files</td><td colspan="2">Number of Representation Information Files</td></tr>
<tr><td colspan="2">N/A</td><td>5</td><td>1</td><td>1</td><td colspan="2">2</td></tr>
<tr><td colspan="7">Manifest file (see section 4.2)</td></tr>
<tr><td colspan="3">File name</td><td colspan="4">Composition</td></tr>
<tr><td colspan="3">xfdumanifest.xml</td><td colspan="4">Contains information about the product composition. Its aim is to describe the physical components of the L0 package</td></tr>
<tr><td colspan="6">Measurement Data files (section 4.3.1)</td><td>N.O.</td></tr>
<tr><td colspan="3">File name</td><td colspan="3">Composition</td><td></td></tr>
<tr><td colspan="3">ISPData.dat</td><td colspan="3">Raw ISP Packets. They are described by the information file ISPData.xsd</td><td></td></tr>
<tr><td colspan="6">Annotation Data files (section 4.3.2)</td><td>N.O.</td></tr>
<tr><td colspan="3">File name</td><td colspan="3">Composition</td><td></td></tr>
<tr><td colspan="3">ISPAnnotation.dat</td><td colspan="3">Annotation linked to the ISP stream, It is described by the information file ISPAnnotation.xsd</td><td></td></tr>
<tr><td colspan="6">Representation Information Files (section 4.3.3)</td><td>N.O.</td></tr>
<tr><td colspan="3">File name</td><td colspan="3">Composition</td><td></td></tr>
<tr><td colspan="3">ISPData.xsd</td><td colspan="3">Representation Information provided via an XML Schema annotated with SDF markups for providing the binary physical attributes of the file containing the ISP.</td><td></td></tr>
</table>

ISPAnnotation.xsd	Representation Information provided via an XML Schema annotated with SDF markups for providing the binary physical attributes of the file containing the Annotation for the ISP.	

The manifest file (section 4.2) is split into:

- A block with the information package. Here the list of components indicated on the data objects section located at the end of the manifest
- Wrapped metadata (see section 4.2.1). It contains a primary (common) part and a secondary (product specific) part
- Referenced metadata (see section 4.2.2). It focuses on metadata components (information file schemas + annotations data file). This is rather product specific, at least at L0 level

A more detailed description of the product is shown in section 5.

There is another component named the OLQC report (section 5.3.2) that is not generated by the IPF. However, due to its consideration of "annotation", it is also referenced on the manifest of the L0 IPF product.

4.2 Manifest File

4.2.1 Wrapped Metadata

The manifest file describes the different metadata for output product. It includes primary, secondary and referenced metadata.

Primary metadata is described in volume Product Data Format Specification - Product Structures [AD 2]

In *Table 4* the list of Secondary Metadata is provided.

< Complete secondary metadata is described in details in [AD-2].
The content of this table will be embedded in the document when it will be finalized>

Table 4: L0 Secondary Metadata

4.2.2 Referenced Metadata

The metadata components, referenced in the Manifest file, are (see section 5.1.2)

- the Annotations Data File that contains all the annotations relevant to the ISPs contained in the Measurement Data Files.
- the Representation Information Files (schema xsd) for
    - the Measurement Data Files (ISP binary stream)
    - the Representation Information Files of the Annotations Data File

4.3 Data Objects

4.3.1 Measurement Data Files

The *Measurement Data File* is a binary file containing the time-ordered raw data generated by the Sentinel-3 instrument in the form of the original Instrument Source Packets (ISPs) stream. The ordering in a stream is a function also of the instrument. For instance, for OLCI in earth observation mode the binary stream is a function of the camera index, but on, e.g., SRAL or GNSS there are not cameras, etc. and a different conceptual ordering is applied.

The binary data is stored in big-endian format (i.e. the byte order is from the most significant bit (MSB) to the least significant bit (LSB)). By default, the convention of big endian is applied to annotations as well.

The Measurement Data File is composed of a set of ISPs (total number n, which depends on the time window and instrument processed). The ISPs are identified with a number named APID. Note that the input data for L0 contain different APIDs in agreement with the ones L0 will write in output. In fact, the input data are prepared by another facility named L0PP or pre-processor, whose output are granules.

- An input granule is in fact a container with different physical files each one function of APID. For example: a granule for OLCI observation mode contains data for each of the five cameras. Since each camera has a different APID, the granule will contain indeed five different APIDs.

The ISP content (understood as its CCSDS definition) is the same as the ISP downlinked from the spacecraft platform to the receiving Ground Station. Not all the packets that are downlinked appear on the L0 products. If a packet is duplicated, its second appearance is removed from the stream written in the product. It is also removed if it is corrupted (CRC check fails).

At the end, ISPs with different APIDs can be found into the Measurement Data File. In theory, the Representation Data File included into the product package is to be used to decode the contents of the Measurement Data File as well as the structure of the ISPs contained inside. In practice at IPF the files with the ISP definitions are stored in external static files.

Albeit SAFE/XFDU makes possible to have several Measurement Data Files, at L0 level there will be only one per product. Consequently, the file must contain several APIDs. This decision simplifies how L1 runs (everything will arrive into one physical file). It helps also to encompass working sequences at instrument level that end up in different types of ISPs on the same stream. A typical case is OLCI, where the Earth observation ISPs follow a sequence as a function of the camera number. Other case is SLSTR stream sorted per target and spectral channel in addition of the time.

4.3.2 Annotation Data Files

Two Annotation Data Files belongs to the Level 0 package: the ISP Annotation Data File and the OLQC Report.

The ISP Annotation Data file gathers some useful information extracted from the headers of each ISP, the FEP annotations and other metadata contained into the input granule.

The ISP annotations are stored into a binary file whose format is described by a Representation Data File, which is part of the product. The annotations are managed by the L0P processor (values are assigned during the processing)

The format of the ISP Annotation File is specific to the product it refers to, i.e. each level 0 product will have an Annotation File. This dependency means that there could happen backwards feedbacks from L1 processor development teams towards L0 development teams when L1 is further refined: the end result could be to add new quality flags on some but not all L0 output products as deemed necessary by L1 teams.

The OLQC Report is generated by the OLQC Facility, added to the package and reference by a Data Object into the Data Object Section of the manifest file. Addition and generation of OLQC report is outside the duties performed by the L0P processor.

4.3.3 Representation Data Files

Two Representation Data Files are included in every Sentinel-3 Level 0 product:

- the XML schema that describes the format of the “ISPData.dat” Measurement data File.
- the XML schema that describes the format of the “ISPAnnotation.dat” Annotation Data File.

The representation data files follow the SAFE / XFDU standard. Due to its length and to ease readability, they are provided at the end of this document.

5. DETAILED DESCRIPTION OF THE PRODUCT PACKAGE

5.1 Manifest File

The structure of the Manifest element is as follows:

Table 5: Sentinel 3 Level 0 Specialization XFDU Manifest

Name	Description	Data Type	Reference	Occ.
version	Attribute containing the relative path for the *xfdu.xsd* XML schema corresponding to the product. It is based on CCSDS 661.0-B-1 standard	string	-	1
informationPackageMap	Contains a high-level textual description of the product and references to all product components	informationPackageMapType	Section 5.1.1	1
metadataSection	Contains the product Metadata	metadataSectionType	Section 5.1.2	1
dataobjectSection	Contains references to the physical information needed to get the location of each file composing the package	dataObjectSectionType	Section 5.1.3	1

5.1.1 InformationPackageMap

The Information Package Map associated to each level 0 product has a common format shown in *Table 6*.

Table 6: Common Structure of the InformationPackageMap for Level 0 products

Name				Description	Data Type	Value	Occ.
contentUnit				The information package map contains one content unit that includes the product data component included in the product.	Content Unit Type		1
	ID			Content unit Identifier	S		0..1
	unitType			Describes the type of data referenced by this	S	"Information Package"	0..1

Name				Description	Data Type	Value	Occ.
				content unit			
	textInfo			Textual description of the content unit	S	See Table 7	
	pdiID			Identifier of the Preservation Description Information applicable to this content unit	S	“processing”	
	dmdID			Identifier of the MetaData applicable to this content unit	S	In any order : “acquisitionPeriod” “platform” “generalInformation” “measurementOrbitReference” “qualityInformation”	
	anyMdID			Identifier of any other Metadata that doesn’t fit dmdID or pdiID metadata related to this contentUnit	S		
	contentUnit						
		ID			S		
		unitType			S	“Measurement Data Unit”	
		textInfo			S	“ISP Data Set”	
		repID		Identifier of the Representation Information applicable to this content unit	S	“ISPDataSchema”	
		dmdID		Attribute: Description MetaData Identifier	S	“ISPAnnotation”	
		anyMdID			S		
		dataObjectPointer				Section 5.1.2	
			ID	Data Object pointer ID	S		
			dataObj	Data Object element ID	S	“ISPData”	

Name				Description	Data Type	Value	Occ.
			ectID				
	contentUnit						
		ID			S		
		unitType			S	"Metadata Unit"	
		textInfo			S	"ISP Annotation"	
		repID		Identifier of the Representation Information applicable to this content unit	S	"ISPAnnotationSchema"	
		dmdID		Attribute: Description MetaData Identifier	S		
		anyMdID			S		
		dataObjectPointer				Section 5.1.2	
			ID	Data Object pointer ID	S		
			dataObjectID	Data Object element ID	S	"ISPAnnotation"	

The values of the tag: textInfo for informationPackageMap is specific to each product type and it is provided on *Table 7*.

Table 7: textInfo value for each L0 product

File Type	Value
SR_0_SRA___	SENTINEL-3 SRAL Level 0 observation data
SR_0_CAL___	SENTINEL-3 SRAL Calibration Level 0
MW_0_MWR___	SENTINEL-3 MWR observation data and calibration Level 0
SL_0_SLT___	SENTINEL-3 SLSTR ISPs including all targets (EO, black body and VISCAL)
OL_0_EFR___	SENTINEL-3 OLCI Level 0 (full resolution)
OL_0_CR0___	SENTINEL-3 OLCI Level 0 (calibration with no spectral relaxation)
OL_0_CR1___	SENTINEL-3 OLCI Level 0 (calibration with spectral relaxation)
GN_0_GNS___	ISPs Level 0 as follows: Satellites In View, Tracking State Data, Channel Status, IMT/GPST Correlation Data, Auxiliary Data Carrier Phase Data, Carrier Amplitude Data, Code phase Data, Noise Histogram Data AGC Status Data, Constellation Status, GPS Nav Almanac Data, GPS Nav Ephemeris Data, GPS NAV UTC and Ionosphere Data

DO_0_DOP___	SENTINEL-3 DORIS DOP Level 0 (doppler, datation, test packets and reports)
DO_0_NAV___	SENTINEL-3 DORIS NAV Level 0 (Navigation packets including ITRF, geodetic and J2000)
TM _0_HKM___	SENTINEL-3 HKTM Level 0 (Payload and Platform House Keeping telemetry)
TM _0_NAT___	SENTINEL-3 NAVATT Level 0 (navigation and attitude, i.e., state vectors and quaternions). This product contains information on the manoeuvring status)

5.1.2 Metadata Section

The Metadata Section contains a list of metadata objects (data object pointer, metadata wrap and metadata reference) that are represented in *Table 8*.

Table 8: Metadata Section

Name	Description	Data Type	Occ.
dataObjectPointer	**Data Object** Pointer is used when the metadata object is an Annotation Data set.	dataObjectPoi nter Type	1
metadataWrap	**Metadata** Wrap is used to include metadata directly in the manifest file. See Table 9 or section 4.2.1	MetadataWra p Type	1
metadataReference	**Metadata** Reference is used when the metadata object is a Representation data file. See 4.2.2	MetadataRefe rence Type	1

5.1.2.1.1 Wrap Metadata (metadataWrap)

Wrapped metadata is described in section 4.2.1. Their XFDU representation shall follow the following syntax:

Table 9: metadataObject

Name				Description	Occ.
metadataObject					
	ID			identifier	1
	classification			concrete type of metadata represented by this element of metadataObjectType	0..1
	category			type of metadata class to which this metadata belongs	0..1
	metadataWrap				*
		textInfo		a label to display to the viewer of the XFDU document identifying the	0..1

				metadata	
		vocabularyName		the name of the well-known standard vocabulary of the metadata being pointed at	1
		mimeType		the MIME type for the metadata being pointed at	0..1
			xmlData	Wrapper to contain metadata	1

5.1.3 Data Object Section (dataobjectSection)

Data Objects for the Level 0 products are listed in the following table. There is an error control proxy with a checksum on the field “checksum”, corresponding to a MD5 hash.

Table 10: Data Object

Name				Description	Data Type	Occ.	Value
	byte Stream			Pointer to the Data Component	U	1..*	
		ID		Byte stream ID	S	0..1	
		mimeType		MIME type for the referenced Data Component	E	1	"application/octetstream”
		size		Size of the Data Object File	L	1	
		fileLocation		Description of the location of the data component file	U	1	
			Locator Type	Type of the file location	URI	0..1	URL
			href	Relative path of the file (in the file system) containing the referenced Data Component (same for annotations, etc.)	URI		“ISPData.dat”
			textInfo	Textual description of the Data Component	S	0..1	“Raw ISP Packets”
		checksum		Checksum for the Data Component	U	1	
			checksumName		E	1	MD5

Name				Description	Data Type	Occ.	Value
Data Object				This element references the Data Component included in the L0 product.	U	1..*	
	byte Stream			Pointer to the Data Component	U	1..*	
		ID		Byte stream ID	S	0..1	
		mimeType		MIME type for the referenced Data Component	E	1	"application/octetstream"
		size		Size of the Data Object File	L	1	
		fileLocation		Description of the location of the data component file	U	1	
			Locator Type	Type of the file location	URI	0..1	URL
			href	Relative path of the file (in the file system) containing the referenced Data Component (same for annotations, etc.)	URI		"ISPAnnotation.dat"
			textInfo	Textual description of the Data Component	S	0..1	"Annotations"
		checksum		Checksum for the Data Component	U	1	
			checksumName		E	1	MD5
Data Object				This element references the Data Component included in the L0 product.	U	1..*	
	byte Stream			Pointer to the Data Component	U	1..*	
		ID		Byte stream ID	S	0..1	
		mimeType		MIME type for the referenced Data Component	E	1	"application/octetstream"
		size		Size of the Data Object File	L	1	
		fileLocation		Description of the location of the data	U	1	

Name				Description	Data Type	Occ.	Value
				component file			
			Locator Type	Type of the file location	URI	0..1	URL
			href	Relative path of the file (in the file system) containing the referenced Data Component (same for annotations, etc.)	URI		“OLQCReport"
			textInfo	Textual description of the Data Component	S	0..1	“OLQCReport"
		checksum		Checksum for the Data Component	U	1	
			checksumName		E	1	MD5
i							
Data Object				This element references the OLQC Report associated to the L0 product.	U	1..*	
	byte Stream			Pointer to the Data Component	U	1..*	
		ID		Byte stream ID	S	0..1	
		mimeType		MIME type for the referenced Data Component	E	1	"application/octetstream”
		size		Size of the Data Object File	L	1	
		fileLocation		Description of the location of the data component file	U	1	
			locator Type	Type of the file location	URI	0..1	URL
			href	Relative path of the file (in the file system) containing the referenced Data Component	URI		TBD
			textInfo	Textual description of the Data Component	S	0..1	“On Line Quality Control Report”
		checksum		Checksum for the Data Component	U	1	
			checksumName		E	1	MD5

For L0 processing there is another interface named QLQC report, generated by a PDGS facility outside the IPF. It is not included in the L0 IPF output product package but it is referenced in the L0 manifest.

5.2 Measurement Data Files

These are the files that contain the ISPs filtered by the L0P processing. To read this file, specific XML information is needed.

The data files in the next subsections are split per L0 products. Each one is a container with different APIDs. By default, the L0 products are sorted in time without taking into account the APID. There is an exception for OLCI and SLSTR

- On OLCI, the packets are sorted out additionally per APID. For this instrument APID = camera number, so it can be said that they are ordered by camera number It happens then that the sorting is (for example, when in Earth Observation mode): (cam1,...cam5)(t1), (cam1...cam5)(t2), ... where t1, t2, ... are times in increasing order.

- On SLSTR the situation is more complex. Besides ordering in time, there is an ordering based on channels (because for SLSTR APID means, though not always, channel) combined with the so-called target-id. These are ids that define if a packet belongs to Earth observation mode, to the (SLSTR) on-board viscal or to the (SLSTR) on-board blackbodies. Moreover, it takes into account the SLSTR view (nadir / oblique).

Additionally:

- The measurement data files do not contain packets that failed the CRC check performed by the L0 processor. To know how many packets have been discarded it is necessary to read the metadata in the manifest

- Duplicated packets detected by the L0 processor are not saved in the output product, albeit they are accounted too in the metadata of the manifest.

5.2.1 SRAL “SR_0_SRA___” and “SR_0_CAL___”

For SRAL, two Level-0 products are defined: one containing the calibration parameters and one containing all other instrument ISPs. The ISP are defined in [CFI-ID-09-08].

- The "SRA" product refers to a measurement mode, and can be LRM (low resolution mode using nadir pulses) or SAR (high resolution as a synthetic aperture radar).
- The "CAL" product refers to the calibration packets.

Regardless the mode, the measurement data file is a single data binary file, containing the following so-called parameters (note: in this context a parameter refers to the fields in the packets)

- Calibration data product SR_0_CAL___ contains the “Calibration parameters":
    - CAL1_LRM_I2Q2 – PTR calibration measurements in LRM mode for I2+Q2 configuration [optional].

  - CAL1_LRM_IQ – PTR calibration measurements in LRM mode for I,Q configuration.
  - CAL1_SAR – PTR calibration measurements in SAR mode
  - CAL2_SAR – L0 GPRW calibration measurements (SAR mode)
- Raw data product SR_0_SRA___ contains the "Measurement parameters":
  - ACQ – Acquisition mode for open and closed loop [optional]
  - ST_SAR – Self test mode [optional]. In the documentation these parameters are identified also with "SAR"
  - ECHO_LRM – L0 Tracking measurements in LRM mode (Ku and C bands)
  - ECHO_SAR – L0 Tracking measurements in SAR mode (Ku and C bands)

The L0 product contains only streams of binary packets without further processing (as done in the prototypes prior this activity). Consequently, only the packets according [AD 3] will end up into the ISPData.dat container. This is a common point with MWR (see an example for further clarification in the next section) or other instruments.

The specific packets to deal with are further explained on the next table:

Table 11: SRAL packets and associated PID/PCAT

Packet Name	Service (type, sub type)	PID	PCAT
CAL			
CAL1_LRM_I2Q2	201, 13	90	2
CAL1_LRM_IQ	201, 14	90	3
CAL1_SAR	201, 15	90	4
CAL2_SAR	201, 16	90	5
SRA			
ACQ	201, 11	90	0
ST_SAR	201, 12	90	1
ECHO_LRM	201, 17	90	6
ECHO_SAR	201, 18	90	7

The specification includes two types of streams "nominal" and "redundant", represented by two APIDs 90 and 91 respectively. Nominal and Redundant data can appear on the L0 product as long as they are provided as input to the L0P processor. There is no distinction nominal / redundant during the processing beyond the fact that each data stream have own APIDs.

5.2.2 MWR “MW_0_MWR___”

For MWR there is only a product with all the calibration and measurements included. It is split into "observation", "calibration" and "monitoring" information. The datasets are named "parameters" but they have no relation with configuration parameters for the processor. The ISP formats are available on [CFI-ID-09-06] and make possible building up:

- Calibration parameters:

  - L0_CAL - L0 MWR calibration measurements
- Monitoring parameters:
  - L0_MON - L0 MWR monitoring measurements = time, location, noise injection pulse, error voltage, physical temperature,
- Observation parameters:
  - L0_OBS - L0 MWR observation measurements

At L0P level, there is not a processing as detailed as for the former prototypes. The reason is that the IPFs do not modify or process the ISP source data unless otherwise needed by the sorting or quality assessment checks. Therefore, the product 0_MWR only contains the (sorted and cleaned) streams of packets corresponding to PID = 0x52 and PCAT=0xB (telemetry packet TM(201,21))

Let's consider an example for clarity:

- In the MWR prototype prior this activity the L0 product contains, for instance, "noise injection pulse" data. These data are calculated through the processing RAD_MAN_ISP_01 as noise_injection_pulse = function(NIPL_238), where NIPL_238 are the data on the telemetry packet TM (201, 21)
- However, on the IPF L0 product, only the packets TM (201, 21) will be included in the ISPData.dat (section 4.1 on L0 package description)
- This is necessary to comply with the IPF specifications regarding the contents on the L0 products. In this sense, on GMES side we might refer also to GMES-GSEG-EOPG-TN-11-0062 on section 2.5.1 reads:
  - According to the Level 0 requirement the same format structure shall be followed for all the Instruments. For this reason the level 0 associated to the STM mission shall implement the components in the same format used for the OPT mission

5.2.3 OLCI “OL_0_EFR___” , “OL_0_CR0___” and "OL_0_CR1___”

The OLCI instrumental flow of data ends up into ISP streams function of two main modes: earth observation and calibration (the definitions of the ISP as well as the calibration sequences are on [CFI-ID-09-07]).

- **Earth Observation mode**: one file (ISPData.dat as in section 4.1) gathering data acquired when OLCI is on ON_DUTY_NORMAL. In this case there is one ISP per camera (1…5), gathering data related to the 21 nominal bands of the instrument, complemented by the smear band (so in total there are 22 bands). This is the sequence controlled by the telemetry packet TM (201,1). The different cameras have different PIDs (66 … 70) but always with PCAT = 0
- **Calibration mode**: one file (ISPData.dat as in section 4.1) related to data acquired during a calibration sequence, composed of 1000 acquisitions with the calibration mechanism in SHUTTER position, and 500 acquisitions with one of the three diffusers. Calibration sequences are led without spectral relaxation, i.e. the 46 micro-bands are directly transmitted towards the ground. In this configuration there are 2 ISPs per camera, one with micro-bands 1-23, the second one with 24-46.This is accomplished by two telemetry packets TM(201,2) + TM(201,3). On calibration, the PCAT is equal to 1.
  - There are more than one calibration sequences (spectral and radiometric, combined with different setups). However, all follow the approach of using two packets for a given camera, writing the cameras sequentially as well

The Earth observation mode ends up into the OL_0_EFR product, while calibration ends on OL_0_CR0 or OL_0_CR1. The CR0 does not use spectral relaxation and the CR1 does. The APIDs reserved for CR0 and CR1 are the same, because they APIDs represent OLCI cameras 1...5 but do not refer to any relaxation status. The difference CR1 vs. CR0 is managed checking the ISP field Service Sub-Type in the header of the packet.

5.2.4 SLSTR "SL_0_SLT___"

The raw SLSTR instrument data are delivered in binary Instrument Source Packets (ISPs). There are many types of ISP (details on [CFI-ID-09-09]).

- Nine optical channel packets (S1 – S9) with the radiances from the different targets (see next)
- Two fire channel packets (F1, F2), again with radiances for each target
- One scan packet which tracks the scanning on-board mirrors
- One ancillary packet with housekeeping information

The targets on the SLSTR instrument are defined as follows:

- The on-board calibration BB (hot and cold blackbodies) aimed for the infrared channels

- The VISCAL calibration diffuser for the visible channels

- The NADIR earth observation and the OBLIQUE earth observation.

The series of packets are represented by the telemetry packet TM(201, 31). The PID is fixed to 74 and the PCAT rolls from 0 to 12 on the channels VIS1, VIS2, … FIRE2, SCAN, HK.

The "target type" (or more correctly, target ID field) is at the beginning of the "source data" of each packet. It fixes the source of the data (see next table), referring to any of the two blackbodies (+Y or –Y), VISCAL or Earth view when seen by the nadir (NA) view or oblique (OB) view (SLSTR is a two-view instrument). The targets are cyclically seen due to the on-board rotating and flip mirrors. This cycle is valid for each of the spectral channels.

Table 12: SLSTR target IDs

Traget	targetID(0x)	Position in the cycle
VISCAL seen by NA scan mirror	E0	1
Black Body +Y seen by NA scan mirror	E1	2
Earth view seen by OB scan mirror	E2	3
Black Body -Y seen by OB scan mirror	E3	4
Earth view seen by NA scan mirror	E4	5
VISCAL seen by OB scan mirror	E5	6
Black Body +Y seen by OB scan mirror	E6	7
Earth view seen by OB scan mirror	E2	8
Black Body -Y seen by NA scan mirror	E7	9
Earth view seen by NA scan mirror	E4	10

Therefore, the sequence of packets on .ISPData.dat corresponds to how the instrument works. Interestingly as input there are different granules per APID only. As a result, L0P will simulate scanning sequences according [CFI-ID-09-09]. It will loop on targets for each channel; putting an ancillary packet at the beginning and end of the stream (the scan packet is located at the end of the channels).

The SLSTR output stream encompasses two SCANSYNC periods for each CYCLESYNC found in the input data (for details refer to [CFI-ID-09-09])

5.2.5 GNSS “GN_0_GNS___”

The ISP packet definitions for the GNSS instrument are on [CFI-ID-09-04] and [CFI-ID-09-05] (note that the document refers to GPRS, instead of GNSS, but it also shows its compliance with Sentinel 3). The measurement data file of the GNSS Level 0 product is composed of the following information:

- OPER - L0 GNSS Operation data
- MEAS - L0 GNSS Measurement data,
- CONST - L0 GPS Constellation data.

The OPER data contain:

- Satellites In View (OPER_GNSS_GPS_Sat_In_View)
- Tracking State Data (OPER_GNSS_Track_State)
- Channel Status (OPER_GNSS_Channel_Status)
- IMT/GPST Correlation Data (OPER_GNSS_IMT/GPST_Corr)
- Satellite Auxiliary Data (or only "Auxiliary Data") (OPER_GNSS_Aux_Data)

The MEAS data contain:

- Carrier Phase Data (MEAS_GNSS_Carrier_Phase)
- Carrier Amplitude Data (MEAS_GNSS_Carrier_Ampl)
- Code phase Data (MEAS_GNSS_Code_Phase)
- Noise Histogram Data (MEAS_GNSS_Noise_Histo)
- AGC Data Status (or "AGC Status Data") (MEAS_GNSS_AGC_Status)

The CONST data contain:

- Constellation Status (CONST_GPS_Const_Status)
- GPS Nav Almanac Data (CONST_GPS_Nav_Almanach)
- GPS Nav Ephemeris Data (CONST_GPS_Nav_Ephem)
- GPS NAV UTC and Ionosphere Data (CONST_GPS_Nav_UTC_Iono)

There is an additional set of two PCATS on IPF GNSS L0 processor:

- GNSS House keeping
- GNSS Event Reporting

The telemetry packets correspond to PID = 30 and variable PCAT, corresponding to the telemetry TM (212, 1) identified as GPRS science data.

There are two possible streams of data, "nominal" and "redundant" (PID 30 or 31 respectively). Nominal and Redundant data can appear on the L0 product as long as they are provided as input to the L0P processor. There is no distinction nominal / redundant during the processing beyond the fact that each data stream have own APIDs.

Table 13: GNSS packet types and associated SID/PCAT

Packet	Service (Type, subtype)	SID	PCAT
Satellites In View	212, 1	223	6
Tracking State Data	212, 1	215	12
Channel Status	212, 1	224	12
IMT/GPST Correlation Data	212, 1	217	11
Auxiliary Data	212, 1	218	6
Carrier Phase Data	212, 1	225	6
Carrier Amplitude Data	212, 1	226	6
Code phase Data	212, 1	227	6
Noise Histogram Data	212, 1	235	12
AGC Status Data	212, 1	234	13
Constellation Status	212, 1	229	13
GPS Nav Almanac Data	212, 1	230	13
GPS Nav Ephemeris Data	212, 1	231	13
GPS NAV UTC and Ionosphere Data	212, 1	232	13
Event Reporting	5,213	N/A	3
Housekeeping - Parameters report - Time Correlation - Navigation solution	3, 25	219 214 213	4

The GPRS packets include a specific identifier "SID" named "structure ID". This is the identifier that univocally fixes the measurement data sets, since the same PCAT is used for different meanings.

- Importantly, the GNSS packets have in many cases a variable number of records. This is equivalent to say that the length in bytes indicated in the packet header changes from packet to packet on the same stream. It represents a sort of exception when compared with OLCI, SLSTR, SRAL or MWR.

- Not only the number of records is not a constant but also the record size is a function of the SID.
- Details on the record structure are shown in section 5 (table 5-1, etc.) on [CFI-ID-09-05]. Generation packets is also function of those records: sampling rates (controlled with FMT_SampleRate (see [CFI-ID-09-04] on section 5.8.4.18) can change for the same type of record (hence the variability in the number of records, and therefore on packet size; refer to table 5-5 on [CFI-ID-09-05] and table 5-43 on [CFI-ID-09-04]
- Those peculiarities for the variable length do not have an impact on the contents of the L0 product, and are properly accounted for during the L0 processing

To generate the L0 IPF GNSS product, the L0 processor will concatenate sequentially the packets described above.

5.2.6 DORIS “DO_0_DOP___” and “DO_0_NAV___”

The packet specifications are available on [CFI-ID-09-10]. Two Level 0 products are defined to store the measurement data coming from the on-board redundant DORIS instrument. One is for measurement packets (DOP = Doppler + datation + test + Report) and the other is for navigation information (NAV = ITRF + geodetic + J2000).

Incidentally: DORIS is seen as a redundant-instrument when compared with GNSS considering they have similar goals. That does not have any impact or cross link on the L0 IPF. Both instruments have individual L0 tasks that are configured with own input and configuration.

There are two possible streams of data, "nominal" and "redundant" (PID 105 or 106 respectively). Nominal and Redundant data can appear on the L0 product as long as they are provided as input to the L0P processor. There is no distinction nominal / redundant during the processing beyond the fact that each data stream have own APIDs.

Details on the products follow. Incidentally, the approach here is the same as for GNSS. The ISP packets are written sequentially on ISPData.dat without any further ordering (as for OLCI per camera, for SLSTR per channel and targetID, etc.)

The **DO_0_DOP**___ Level 0 product can contain up to 7 different types of packets (7 APIDS for the Nominal Instrument and 7 for the Redundant one). This is encompassed by the telemetry packet structure TM (201, 46)

- DORIS test packets: These packets contain test data with sampling periods of 10 seconds, time tagged with the USO (kind of "OBT" or on-board time) and TAI times at the start of the acquisition. Each packet contains a Test_type identifier which fixes the test data delivered on the packet (see next). The test packets are generated on request by TC (the request is not in the scope of the IPF)
    - o Test_type = 16 - DORIS Test Jamming Packets containing the characteristics of the RF signals inside the DORIS bandwidth
    - o Test_type = 32 - DORIS Test Dump Packets generated upon receiving a dump TC
    - o Test_type = 1,…7, 48, 64 - TBC - Other Test Packets. Note that [CFI-ID-09-10] indicates that these packets are "only used by the manufacturer". In fact, the

"attitude data packet" indicated is only linked with Jason 3 mission, not Sentinel 3.

  - When referring to a test packet, it is useful to indicate its type (e.g., "Test Dump"). But since they contain inside the Test_type field, in some circumstances they are generically presented as "Test" only.

- DORIS Datation Packets containing one *Datation Bulletin* (in TAI time) corresponding to the last Datation Pulse (and its uncertainty) received at the DORIS I/F. This corresponds to PCAT=9
- DORIS Doppler Packets that contain Doppler measurements (bias on the on-board USO (UltraStable doris Oscillator) frequency respect to the nominal one, etc.) This is PCAT = 11
- DORIS Reports have reserved two values for PCAT, namely 1 and 2.

The **DO_0_NAV___** Level 0 product contains navigation bulletins and they can be formatted in three different ways (3 APIDs for the Nominal Instrument and another 3 for the Redundant one). The telemetry packet structure is TM(220, [1,2,3]).

- DORIS ITRF Packets: each packet contains one *NAV_T Navigation Bulletin* (i.e., position and velocity of the satellite Centre of Mass at the time defined in the Data_TAI field, in the ITRF terrestrial reference frame). This is PCAT = 6
- DORIS J2000 Packets: each packet contains one *NAV_I Navigation Bulletin* (i.e., position and velocity of the satellite Centre of Mass at the time defined in the Data_TAI field, in the J2000 inertial reference frame). They correspond to PCAT = 13
- DORIS Geodetic Packets: each packet contains one *NAV_G Navigation Bulletin* (i.e., position (geodetic longitude and latitude) and vertical velocity of the satellite Centre of Mass at the time defined in the Data_TAI field, in either of the reference frames that is indicated into each packet). The PCAT is 14. The geodetic packets can be found in some documents described as geodesic navigation.
  - Reference frames can be earth surface reference or mission orbital cycle reference

A summary of the packets is shown in the next table:

Table 14: DORIS packets and associated PCAT

Packet	Service (Type, subtype)	DORIS Product	PCAT
ITRF (or NAV_T)	220, 1	NAV	6
J2000 (or NAV_I)	220, 2	NAV	13
Geodetic (or NAV_G)	220, 3	NAV	14
Datation	201, 46	DOP	9
Doppler	201, 46	DOP	11
Test Jamming (on request by TC)	201, 46	DOP	10
Test Dump (on request by TC)	201, 46	DOP	7
Test others (on request by TC)	201, 46	DOP	8
Reports	201,46	DOP	1 and 2

The packets indicated above are written sequentially, without any other ordering, on the ISPData.dat file.

5.2.7 “TM_0_HKM___”

The housekeeping encompasses data intended to check the status of the satellite. It is defined as:

- [CFI-ID-09-01]: […] Data necessary to monitor equipment health and safety (temperatures, voltages, …). All on-board units, including instruments, are concerned when the acronym HKTM is used without any prefix. Those data are all collected by the Satellite Management Unit (SMU)
- [RD 2]: All data necessary to monitor equipment health and safety […] distinguished in: Payload HKTM from the six instruments and Platform HKTM (PF HKTM) which groups all other HKTM data

Different APIDs are reserved for the HKTM product (see for example Table 16). This is a product where the full list of packets for HKTM product could be a subject of evolution along the activity. This has no impact on the Level 0 processor design because the number of APIDs in a product is managed by an external configuration file. Addition or removal of APIDs is then a trivial step.

The HKTM product follows as any other L0 product the convention of being a package with a manifest and annotations and measurement data (this is described on section 4). Moreover, the only processing necessary is a time sorting (this functionality is indeed used by the rest of the products). Other operations like CRC check or identification of duplicated packets also are applied during the generation of the housekeeping product.

5.2.8 "TM_0_NAT___”

The product TM_0_NAT belongs to the telemetry data group as it happens for TM_0_HKM. For it, the packets are rather simple to define, as shown in [CFI-ID-09-02]: they contain state vectors and attitude information (through quaternions and their derivatives in time) that are time tagged with OBT time in CUC format. They are known as NAVATT (stands for NAVigation and ATTitude).

The information comes from the on-board GNSS and Star Tracker measurements. Interestingly, output packets are nominally dumped with time steps of 1 second. This makes possible to deal with full orbit periods (around 6000 seconds) without demanding memory processing needs.

NAVATTs include some flags to indicate if the satellite is manoeuvring or not, if there is an on-going thrust and if manoeuvre is in plane or not. The L0 product flags those packets that have been generated while in manoeuvring.

Regarding the packet structure: the NAVATTs are represented by TM(3,25), with constant PID = 22 and PCAT = 9. In the file ISPData.dat the NAVATTs are merely sorted out in time (no extra ordering is applied; see [CFI-ID 01-6A]).

5.3 Annotation Data Files

Two annotation-like files are included in the Level 0 products: the ISP Annotation Data File and the OLQC Report.

5.3.1 ISP Annotation Data File

The ISP Annotation Data (whose structure is the same for all the L0 products) gathers some useful information extracted from the headers of each ISP, and the FEP annotations. These annotations are spread over two Data Sets:

- Time stamps (or ADS1) with time tags in a GPS scale
- FEP annotations (or ADS3)

5.3.1.1 ISP Time Stamps (ADS1)

This ADS is composed of as many Data Records as the number of ISPs in input raw data.

Table 15: ISP Time Stamps structure

Element Name	Variable Name	Description	Range	Unit	Data Type	Dimension	#bytes
Open Data_Set							
N_Rec	N_isp	Number of records contained within the Data Set. Here a "record" means a binary ISP packet	e.g. up to 300000 for OLCI EO mode	DI	UI	1	4
Open Record							
Time_Stamp		GPS time, corresponding to the acquisition time	-	MJD2000	sl,2ul	1	12
Close Record							
Close Data_Set							

This ADS is the same for all the IPF L0 output product.

5.3.1.2 ISP FEP Annotations (ADS3)

This ADS is directly copied as a datablock of bytes read from the annotations in the input ISIP granule and defined in section 13.5 of [AD-11]. This ADS is the same for all the IPF output product.

5.3.2 OLQC Report Annotation Data File

The OnLine Quality Control report is generated by the OnLine QC processor, which is the PDGS component in charge of checking Sentinel 3 Products before dissemination. It performs checks on a systematic basis to verify internal consistency and to provide a high-level quality flag. The report is pointed by a Data Object into the Data Object Section.

The report generation is outside the scope of the L0P processor. However, it will be a component indicated in the manifest metadata.

5.4 Representation Data Files

These files are shown in D.

Appendix A Mapping of Level 0 Products to APIDs (PID/PCAT)

The table below identifies the mapping expected between L0 products and APIDs.

Table 16: APID (split into PID and PCAT) for the L0 IPF products

L0 product	PID	PCAT	APID	Description
OL_0_EFR___	0x42	0x0	0x420	OLCI Nominal Full Resolution ISP – Camera 1
	0x43	0x0	0x430	OLCI Nominal Full Resolution ISP – Camera 2
	0x44	0x0	0x440	OLCI Nominal Full Resolution ISP – Camera 3
	0x45	0x0	0x450	OLCI Nominal Full Resolution ISP – Camera 4
	0x46	0x0	0x460	OLCI Nominal Full Resolution ISP – Camera 5
OL_0_CR0___	0x42	0x1	0x421	OLCI Calibration with no spectral relaxation ISPs – Camera 1
	0x43	0x1	0x431	OLCI Calibration with no spectral relaxation ISPs – Camera 2
	0x44	0x1	0x441	OLCI Calibration with no spectral relaxation ISPs – Camera 3
	0x45	0x1	0x451	OLCI Calibration with no spectral relaxation ISPs – Camera 4
	0x46	0x1	0x461	OLCI Calibration with no spectral relaxation ISPs – Camera 5
OL_0_CR1___	as CR0	s CR0	as CR0	OLCI Calibration with spectral relaxation. Same APIDs are shared with CR0 product. To know the relaxation status it is necessary to check the IPF field "Service Sub-Type" in the main header
SL_0_SLT___	0x4A	0x0	0x4A0	SLSTR Full Resolution ISPs – Vis1 Channel
	0x4A	0x1	0x4A1	SLSTR Full Resolution ISPs – Vis2 Channel
	0x4A	0x2	0x4A2	SLSTR Full Resolution ISPs – Vis3 Channel
	0x4A	0x3	0x4A3	SLSTR Full Resolution ISPs – SWIR1 Channel
	0x4A	0x4	0x4A4	SLSTR Full Resolution ISPs – SWIR2 Channel
	0x4A	0x5	0x4A5	SLSTR Full Resolution ISPs – SWIR3 Channel
	0x4A	0x6	0x4A6	SLSTR Full Resolution ISPs – MWIR1 Channel
	0x4A	0x7	0x4A7	SLSTR Full Resolution ISPs – LWIR1 Channel
	0x4A	0x8	0x4A8	SLSTR Full Resolution ISPs – LWIR2 Channel
	0x4A	0x9	0x4A9	SLSTR Full Resolution ISPs – FIRE1 Channel
	0x4A	0xA	0x4AA	SLSTR Full Resolution ISPs – FIRE2 Channel
	0x4A	0xB	0x4AB	SLSTR Full Resolution ISPs – ScanP Channel
	0x4A	0xC	0x4AC	SLSTR Full Resolution ISPs - HK (TBC)
SR_0_SRA___	0x5A	0x6	0x5A6	SRAL LRM observation ISPs from DPU Nominal
	0x5A	0x7	0x5A7	SRAL SAR observation ISPs from DPU Nominal
	0x5B	0x6	0x5B6	SRAL LRM observation ISPs from DPU Redundant
	0x5B	0x7	0x5B7	SRAL SAR observation ISPs from DPU Redundant

L0 product	PID	PCAT	APID	Description
	0x5A	0x0	0x5A0	Acquisition mode for open and closed loop nominal
	0x5A	0x1	0x5A1	Self test mode nominal
	0x5B	0x0	0x5B0	Acquisition mode for open and closed loop redundant
	0x5B	0x1	0x5B1	Self Test mode redundant
SR_0_CAL___	0x5A	0x0	0x5A0	SRAL calibration ISPs from DPU Nominal
	0x5A	0x1	0x5A1	SRAL calibration ISPs from DPU Nominal
	0x5A	0x2	0x5A2	SRAL calibration ISPs from DPU Nominal
	0x5A	0x3	0x5A3	SRAL calibration ISPs from DPU Nominal
	0x5A	0x4	0x5A4	SRAL calibration ISPs from DPU Nominal
	0x5B	0x1	0x5B1	SRAL calibration ISPs from DPU Redundant
	0x5B	0x2	0x5B2	SRAL calibration ISPs from DPU Redundant
	0x5B	0x3	0x5B3	SRAL calibration ISPs from DPU Redundant
	0x5B	0x4	0x5B4	SRAL calibration ISPs from DPU Redundant
	0x5B	0x5	0x5B5	SRAL calibration ISPs from DPU Redundant
MW_0_MWR___	0x52	0xB	0x52B	MWR Calibration, monitoring and observation ISPs
GN_0_GNS___	0x30	0x6	0x306	GNSS ISP from Nominal Instrument
	0x30	0xC	0x30C	GNSS ISP for Support of Signal Processing from Nominal Instrument
	0x30	0xD	0x30D	GNSS ISP Science Data Events from Nominal Instrument
	0x31	0x6	0x316	GNSS ISP from Redundant Instrument
	0x31	0xC	0x31C	GNSS ISP for Support of Signal Processing from Redundant Instrument
	0x30 0x31	3	0x303 0x313	Nominal and redundant Disabled Event Packets Report
	0x30 0x31	4	0x304 0x314	Housekeeping, Parameter report, time correlation, navigation solution for nominal and redundant chainsGNSS
	0x31	0xD	0x31D	GNSS ISP Science Data Events from Redundant Instrument
DO_0_DOP___	0x69	0x7	0x697	DORIS Test Dump packets – Nominal Instrument
	0x69	0x8	0x698	DORIS Test packets – Nominal Instrument
	0x69	0x9	0x699	DORIS Datation packets – Nominal Instrument
	0x69	0xA	0x69A	DORIS Test Jamming packets – Nominal Instrument
	0x69	0xB	0x69B	DORIS Doppler packets – Nominal Instrument
	0x6A	0x7	0x6A7	DORIS Test Dump packets – Redundant Instrument
	0x6A	0x8	0x6A8	DORIS Test packets – Redundant Instrument
	0x6A	0x9	0x6A9	DORIS Datation packets – Redundant Instrument
	0x6A	0xA	0x6AA	DORIS Test Jamming packets – Redundant Instrument

L0 product	PID	PCAT	APID	Description
	0x6A	0xB	0x6AB	DORIS Doppler packets – Redundant Instrument
	0x69 0x6A	1, 2	0x691 0x692 0x6A1 0x6A2	DORIS reports
DO_0_NAV___	0x69	0x6	0x696	DORIS ITRF Navigation ISPs - Nominal Instrument
	0x69	0xD	0x69D	DORIS J2000 Navigation ISPs - Nominal Instrument
	0x69	0xE	0x69E	DORIS Geodetic Navigation ISPs - Nominal Instrument
	0x6A	0x6	0x6A6	DORIS ITRF Navigation ISPs - Redundant Instrument
	0x6A	0xD	0x6AD	DORIS J2000 Navigation ISPs - Redundant Instrument
	0x6A	0xE	0x6AE	DORIS Geodetic Navigation ISPs - Redundant Instrument
TM_0_HKM___	0x69	0x1	0x691	DORIS HouseKeeping packets – Nominal Instrument
	0x69	0x2	0x692	DORIS HouseKeeping packets – Nominal Instrument
	0x6A	0x1	0x6A1	DORIS HouseKeeping packets – Redundant Instrument
	0x6A	0x2	0x6A2	DORIS HouseKeeping packets – Redundant Instrument
	0x30	0x1	0x301	Test Service - Nominal Instrument
	0x30	0x3	0x303	GPS Parameters Report from Nominal Instrument
	0x30	0x4	0x304	GPS Housekeeping from Nominal Instrument
	0x30	0x7	0x307	GPS Event Report from Nominal Instrument
	0x30	0x9	0x309	GPS Memory Service from Nominal Instrument
	0x31	0x1	0x311	Test Service - Redundant Instrument
	0x31	0x3	0x313	GPS Parameters Report from Redundant Instrument
	0x31	0x4	0x314	GPS Housekeeping from Redundant Instrument
	0x31	0x7	0x317	GPS Event Report from Redundant Instrument
	0x31	0x9	0x319	GPS Memory Service from Redundant Instrument
	0x4A	0xC	0x4AC	SLSTR Full Resolution ISPs – HK
	TBC	TBC	TBC	(other housekeeping)
TM_0_NAT___	0x16	0x9	0x169	NAVATT Telemetry Source packets (navigation and attitude

Appendix B Size of the L0 Products

In this section it is evaluated the final size of the L0 products. The rule of thumb is that the product size can be calculated as the number of packets in a fixed period (for example an orbit) times the packet size in bytes. The rule is applied under the next list of considerations.

- Each Level 0 Measurement Data File in this section contains data for one orbit. An orbit represents a time span of two consecutive crossings of the Ascending Node (ANX). For S3 it means ≈ 6060 seconds
- Duty cycles are for scenario MOS 1 described on [AD 8]. This scenario assumes that the complete sensing data of the satellite is received and processed. On it, OLCI works on full resolution mode. OLCI calibration case is based on the OLCI sequences envisaged, where the number of frames is fixed most of the cases to 1500. The duty cycle represents the percent of time that the instrument will be gathering data; it is then an important scaling factor.
- Note that by "packet size" it is considered its header, the data block (radiances, etc. corresponding to the instrument data) and the CRC
- In some L0 products the specification includes packets that have variable number of records (hence, a non-constant packet-size). To avoid complex evaluations, averages are used instead.
- The L0 IPF product package, as any other IPF product, contains different physical files. In this section, only the size due to the ISPData.dat component is considered.
- There is an additional amount of bytes on the L0 product due to the other components (manifest, annotations and representation files; section 4.1). Estimated sizes on those components are such that (A) Annotation Data Files can be ≈ 40 times the number of packets and (B) The size of the (manifest + representation data) files is ≈ 0.5 MB

The Table 17 includes several columns whose meaning is explained next:

- L0 product – this is an id that unambiguously identify the product in the IPF context
- Packet Size in bytes – this is an estimation of the packet size. If the product contains packets with variable size (as in GNSS), averages are done. The column shows all the packets envisaged for a product (for example, OLCI EFR contains packets for camera 1, ... camera 5, each one with size 33582
- Rate – these are the number of IPS per second. When not clear in the documentation it is assumed one packet per second
- Duty cycle – the percent of time that an instrument is working along an orbit. Thus, the final size of a product for "an orbit" is equivalent to a temporal window equal to duty_cycle * orbital_period (=6060 seconds)
- Size – this is the final size in Mbytes. It is akin to have an order of magnitude, rather than to be too accurate. Numbers are rounded upwards.

Table 17: Estimated size of the L0 products for one orbit

L0 product	Packet size in bytes	Rate (ISP/s)	Duty Cycle for scenario MOS-1	Size (MB/Orbit)
OL_0_EFR	EO – 33582 per camera 1 frame = cam1,…cam5	1 frame = 0.044	44%	22053 * 0.44 = 9703
OL_0_CR0 (OLCI ISPs for CR1 are 95% size of a CR0 ISP packet)	CAL – 35090 1 frame = [cam1,cam2…]	N/A 1500 frames except S06 which are 10000	Upper limit assuming 100%	502 3346 (S06)
SL_0_SLT	Function of targetID. VIS1, …, VIS3 - 25622 SWIR1,…,SWIR3 - 51222 MWIR - 6422 LWIR1, LWIR2 - 6422 FIRE1, FIRE2- 6422 SCAN -12822 ANCILLARY -1019 Total Max = 276483	CYCLESYNC= 0.6s Sequence of channels and targets on [AD9] ≈ 2.8 * MaxSize using TPT scaling	100%	≈ 7400
SR_0_SRA	ACQ - 458 ST_SAR - 16926 ECHO_LRM - 588 ECHO_SAR – 17484 Total = 35456	1	25 (LRM) % 75 (SRM) %	≈ 35456 bytes * 6060 ≈ 200 Mbytes
SR_0_CAL	CAL1_LRM_I2Q2 - 566 CAL1_LRM_IQ - 25142 CAL1_SAR - 16950 CAL2_SAR – 16946 Total = 59604	1	25 (LRM) % 75 (SRM) %	≈ 59604 bytes * 6060 ≈350 Mbytes
MW_0_MWR	58	1 / 0.153	100%	2.2
GN_0_GNS	Record size: - Satellites In View - 28 - Tracking State Data- 12 - Channel Status - 8 - IMT/GPST Correlation - 20 - Auxiliary Data - 4 - Carrier Phase Data - 16 - Carrier Amplitude Data- 8 - Code phase Data - 12 - Noise Histogram Data - 36 - AGC Data Status - 12 → Average size = 16 → Assume 10 record on average (table 5-5, in S1-IF-AAE-SC-0002_10_00-1) Size (table 4-1, [CFI-ID-09-05]) = 36 + n_record * size_record ≈ 36 +10*16 = 196	Variable per packet type [CFI-ID-09-04] but to have a first guess on size it is assumed equal to 1	100%	1.1
DO_0_DOP	Datation - 36 Doppler - 256 Tst. Jamming - 256 Test Dump - 256 Test others – 256	1 Assumed 1/10 N/A (on request) N/A (on request) N/A (on request)	100%	0.4

DO_0_NAV	ITRF - 64 J2000 - 64 Geodetic – 64 64*3 = 192	1 / 10 1 / 10 1 / 10	100%	0.1
TM_0_HKM	TBC - Whole list of APIDs not frozen	assume one	100%	TBC
TM_0_NAT	246	1	100%	1.5

Appendix C XML /Schema Files

To avoid duplication, XML schemas are kept in separate files delivered along with the product specification documents (see AD 5).

Appendix D Representation Information File

This section describes the xsd schema used to describe the fine structure of the ISP by means of sdf markups.

```
<xs:schema xmlns:sdf="http://www.gael.fr/2004/12/drb/sdf"
xmlns:xs="http://www.w3.org/2001/XMLSchema"
xmlns="http://www.esa.int/safe/sentinel-1.0/"
targetNamespace="http://www.esa.int/safe/sentinel-1.0/">
	<xs:element name="measurements" type="measurements" maxOccurs="1"
minOccurs="1">
		<xs:annotation>
			<xs:documentation xml:lang="en"/>
		</xs:annotation>
	</xs:element>
	<xs:complexType name="measurements">
		<xs:sequence>
			<xs:element minOccurs="1" name="isp" type="ispType">
				<xs:annotation>
					<xs:appinfo>
						<sdf:block>

	<sdf:encoding>BINARY</sdf:encoding>

	<sdf:occurrence>unbounded</sdf:occurrence>
						</sdf:block>
					</xs:appinfo>
				</xs:annotation>
			</xs:element>
		</xs:sequence>
	</xs:complexType>
	<xs:complexType name="ispType">
		<xs:sequence>
			<xs:element name="primaryHeader" type="mainHeaderType"/>
			<xs:element name="secondaryHeader"
type="dataFieldHeaderType"/>
			<xs:element name="sourceData">
				<xs:annotation>
					<xs:documentation xml:lang="en">Stream of
binary packets after dataFiieldHeader</xs:documentation>
					<xs:appinfo>
						<sdf:block>
							<sdf:array>
								<sdf:occurrence
query="packetDataLength - 64" constant="false"/>
								<sdf:length>1</sdf:length>
							</sdf:array>
						</sdf:block>
					</xs:appinfo>
				</xs:annotation>
				<xs:simpleType>
					<xs:list itemType="xs:unsignedByte"/>
				</xs:simpleType>
			</xs:element>
			<xs:element name="errorControl" type="errorControlType"/>
		</xs:sequence>
	</xs:complexType>
	<!--The main header covers 6 bytes. It is also named "primary header" or
simply "packet header"-->
	<!--
========================================================================= -->
```

```
	<xs:complexType name="mainHeaderType">
		<xs:sequence>
			<xs:element name="packetVersionNumber"
type="packetVersionNumberType" fixed="0"/>
			<xs:element name="packetType" type="packetTypeType"
fixed="0"/>
			<xs:element name="dataFieldHeaderFlag"
type="dataFieldHeaderFlagType" fixed="0"/>
			<xs:element name="PID" type="PIDType"/>
			<xs:element name="PCAT" type="PCATType"/>
			<xs:element name="groupingFlags" type="groupingFlagsType"
fixed="3"/>
			<xs:element name="sequenceCount" type="sequenceCountType"/>
			<xs:element name="packetLength" type="packetLengthType"/>
		</xs:sequence>
	</xs:complexType>
	<xs:simpleType name="packetVersionNumberType">
		<xs:annotation>
			<xs:documentation>constant value = 000 (3
bits)</xs:documentation>
			<xs:appinfo>
				<sdf:block>
					<sdf:encoding>BINARY</sdf:encoding>
					<sdf:length unit="bit">3</sdf:length>
				</sdf:block>
			</xs:appinfo>
		</xs:annotation>
		<xs:restriction base="xs:unsignedByte"/>
	</xs:simpleType>
	<xs:simpleType name="packetTypeType">
		<xs:annotation>
			<xs:documentation>constant value = 0 (1
bit)</xs:documentation>
			<xs:appinfo>
				<sdf:block>
					<sdf:encoding>BINARY</sdf:encoding>
					<sdf:length unit="bit">1</sdf:length>
				</sdf:block>
			</xs:appinfo>
		</xs:annotation>
		<xs:restriction base="xs:unsignedByte"/>
	</xs:simpleType>
	<xs:simpleType name="dataFieldHeaderFlagType">
		<xs:annotation>
			<xs:documentation> constant value = 0 (1
bit)</xs:documentation>
			<xs:appinfo>
				<sdf:block>
					<sdf:encoding>BINARY</sdf:encoding>
					<sdf:length unit="bit">1</sdf:length>
				</sdf:block>
			</xs:appinfo>
		</xs:annotation>
		<xs:restriction base="xs:unsignedByte"/>
	</xs:simpleType>
	<xs:simpleType name="PIDType">
		<xs:annotation>
			<xs:documentation>function of instrument / mode (7
bits)</xs:documentation>
			<xs:appinfo>
				<sdf:block>
					<sdf:encoding>BINARY</sdf:encoding>
```

```
                        <sdf:length unit="bit">7</sdf:length>
                    </sdf:block>
                </xs:appinfo>
            </xs:annotation>
            <xs:restriction base="xs:unsignedByte"/>
        </xs:simpleType>
        <xs:simpleType name="PCATType">
            <xs:annotation>
                <xs:documentation>function of instrument / mode (4
bits)</xs:documentation>
                <xs:appinfo>
                    <sdf:block>
                        <sdf:encoding>BINARY</sdf:encoding>
                        <sdf:length unit="bit">4</sdf:length>
                    </sdf:block>
                </xs:appinfo>
            </xs:annotation>
            <xs:restriction base="xs:unsignedByte"/>
        </xs:simpleType>
        <xs:simpleType name="groupingFlagsType">
            <xs:annotation>
                <xs:documentation> constant value = 3 (2
bit)</xs:documentation>
                <xs:appinfo>
                    <sdf:block>
                        <sdf:encoding>BINARY</sdf:encoding>
                        <sdf:length unit="bit">2</sdf:length>
                    </sdf:block>
                </xs:appinfo>
            </xs:annotation>
            <xs:restriction base="xs:unsignedByte"/>
        </xs:simpleType>
        <xs:simpleType name="sequenceCountType">
            <xs:annotation>
                <xs:documentation>variable value = 0 to 16383 (wraps to 0)
(14 bits)</xs:documentation>
                <xs:appinfo>
                    <sdf:block>
                        <sdf:encoding>BINARY</sdf:encoding>
                        <sdf:length unit="bit">14</sdf:length>
                    </sdf:block>
                </xs:appinfo>
            </xs:annotation>
            <xs:restriction base="xs:unsignedShort"/>
        </xs:simpleType>
        <xs:simpleType name="packetLengthType">
            <xs:annotation>
                <xs:documentation> number of forthcoming bytes till the end
of the packet -1 (2 bytes)</xs:documentation>
                <xs:appinfo>
                    <sdf:block>
                        <sdf:encoding>BINARY</sdf:encoding>
                        <sdf:length>2</sdf:length>
                    </sdf:block>
                </xs:appinfo>
            </xs:annotation>
            <xs:restriction base="xs:unsignedShort">
                <xs:minInclusive value="0"/>
                <xs:maxInclusive value="2"/>
            </xs:restriction>
        </xs:simpleType>
        <!--  === End of mainHeaderType === -->
```

```
	<!--dataField is sometimes called secondary header, just before the 
source data (12 bytes)-->
	<!--It also is named PUS (Packet Utilization Standard)-->
	<!--
=========================================================================-->
	<xs:complexType name="dataFieldHeaderType">
		<xs:sequence>
			<xs:element name="spareBit" type="spareBitType" fixed="0"/>
			<xs:element name="PUSversion" type="PUSversionType" 
fixed="1"/>
			<xs:element name="spare4Bit" type="spare4BitType" 
fixed="0"/>
			<xs:element name="servicePacketType" 
type="servicePacketTypeType"/>
			<xs:element name="servicePacketSubType" 
type="servicePacketSubTypeType"/>
			<xs:element name="destinationID" type="destinationIDType" 
fixed="0"/>
			<xs:element name="coarseTime" type="coarseTimeType"/>
			<xs:element name="fineTime" type="fineTimeType"/>
			<xs:element name="timeStatus" type="timeStatusType"/>
		</xs:sequence>
	</xs:complexType>
	<xs:simpleType name="spareBitType">
		<xs:annotation>
			<xs:documentation>constant value = 0 (1 
bit)</xs:documentation>
			<xs:appinfo>
				<sdf:block>
					<sdf:encoding>BINARY</sdf:encoding>
					<sdf:length unit="bit">1</sdf:length>
				</sdf:block>
			</xs:appinfo>
		</xs:annotation>
		<xs:restriction base="xs:unsignedByte"/>
	</xs:simpleType>
	<xs:simpleType name="PUSversionType">
		<xs:annotation>
			<xs:documentation>constant value = 1 (1 
bit)</xs:documentation>
			<xs:appinfo>
				<sdf:block>
					<sdf:encoding>BINARY</sdf:encoding>
					<sdf:length unit="bit">3</sdf:length>
				</sdf:block>
			</xs:appinfo>
		</xs:annotation>
		<xs:restriction base="xs:unsignedByte"/>
	</xs:simpleType>
	<xs:simpleType name="spare4BitType">
		<xs:annotation>
			<xs:documentation>constant value = 0 (4 
bit)</xs:documentation>
			<xs:appinfo>
				<sdf:block>
					<sdf:encoding>BINARY</sdf:encoding>
					<sdf:length unit="bit">4</sdf:length>
				</sdf:block>
			</xs:appinfo>
		</xs:annotation>
		<xs:restriction base="xs:unsignedByte"/>
	</xs:simpleType>
```

```
	<xs:simpleType name="servicePacketTypeType">
		<xs:annotation>
			<xs:documentation>function of instrument / mode (8 
bits)</xs:documentation>
			<xs:appinfo>
				<sdf:block>
					<sdf:encoding>BINARY</sdf:encoding>
					<sdf:length unit="bit">8</sdf:length>
				</sdf:block>
			</xs:appinfo>
		</xs:annotation>
		<xs:restriction base="xs:unsignedByte"/>
	</xs:simpleType>
	<xs:simpleType name="servicePacketSubTypeType">
		<xs:annotation>
			<xs:documentation>function of instrument / mode (8 
bits)</xs:documentation>
			<xs:appinfo>
				<sdf:block>
					<sdf:encoding>BINARY</sdf:encoding>
					<sdf:length unit="bit">8</sdf:length>
				</sdf:block>
			</xs:appinfo>
		</xs:annotation>
		<xs:restriction base="xs:unsignedByte"/>
	</xs:simpleType>
	<xs:simpleType name="destinationIDType">
		<xs:annotation>
			<xs:documentation>this is fixed to 0 by S3-SC-IF5-REQ-016 (8 
bits)</xs:documentation>
			<xs:appinfo>
				<sdf:block>
					<sdf:encoding>BINARY</sdf:encoding>
					<sdf:length unit="bit">8</sdf:length>
				</sdf:block>
			</xs:appinfo>
		</xs:annotation>
		<xs:restriction base="xs:unsignedByte"/>
	</xs:simpleType>
	<!-- here comes TIME, which has format CUC = coarse (32bit), fine (24 
bits) = 7 bytes (56 bits) -->
	<xs:simpleType name="coarseTimeType">
		<xs:annotation>
			<xs:documentation>coarse, over-second, interger seconds (32 
bits)</xs:documentation>
			<xs:appinfo>
				<sdf:block>
					<sdf:encoding>BINARY</sdf:encoding>
					<sdf:length>4</sdf:length>
				</sdf:block>
			</xs:appinfo>
		</xs:annotation>
		<xs:restriction base="xs:unsignedInt"/>
	</xs:simpleType>
	<xs:simpleType name="fineTimeType">
		<xs:annotation>
			<xs:documentation> fine time, sub-seconds (24 
bits)</xs:documentation>
			<xs:appinfo>
				<sdf:block>
					<sdf:encoding>BINARY</sdf:encoding>
					<sdf:length>3</sdf:length>
```

```
                        </sdf:block>
                </xs:appinfo>
            </xs:annotation>
            <xs:restriction base="xs:unsignedShort"/>
    </xs:simpleType>
    <xs:simpleType name="timeStatusType">
            <xs:annotation>
                <xs:documentation>0 or 1 if in OBT is in sync or not with
GPS (8 bits)</xs:documentation>
                <xs:appinfo>
                        <sdf:block>
                            <sdf:encoding>BINARY</sdf:encoding>
                            <sdf:length unit="bit">1</sdf:length>
                        </sdf:block>
                </xs:appinfo>
            </xs:annotation>
            <xs:restriction base="xs:unsignedByte"/>
    </xs:simpleType>
    <!--  === End of dataFieldHeaderType === -->
    <!-- errorControl is the CRC.  See ECSS-E-70-41A on its Annex A for
details-->
    <!-- ========================================================= -->
    <xs:simpleType name="errorControlType">
            <xs:annotation>
                <xs:documentation> CRC (primaryHeader + secondaryHeader +
sourceData) [ (2 bytes)</xs:documentation>
                <xs:appinfo>
                        <sdf:block>
                            <sdf:encoding>BINARY</sdf:encoding>
                            <sdf:length>2</sdf:length>
                        </sdf:block>
                </xs:appinfo>
            </xs:annotation>
            <xs:restriction base="xs:unsignedShort"/>
    </xs:simpleType>
    <!--  === End of packet definition === -->
</xs:schema>
```

End of Document