



Earth Observation Payload Data Ground Systems Infrastructure Evolution 2011-2014

LTDP SAFE

SAFE Software System Specification

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1 Introduction

1.1 Purpose and Scope

The present document is the LTDP SAFE Software System Specification Document (hereafter SAFE SSS), produced as an evolution of [SAFE-SRD] and [HARM SRD] in response to the specific requirements laid down by the LTDP SAFE Consolidation Statement of Work [SAFE-SOW].

The SAFE SSS summarizes the high-level baseline requirements of the SAFE format and the associated toolset, which consists, at the date of the creation of this document, of the SAFE Toolbox, the Publisher, the SAFE I/O library, the Converters and the HARM infrastructure. This document has been created taking as a base the corresponding DRD (Document Requirements Definition) in [ECSS-E-40], and is applicable under the envelope of the EO PDGS Infrastructure Evolution Program 2011-2016 to the consolidation of the SAFE Standard and Infrastructure.

The SAFE SSS may evolve, the changes being motivated mainly by:

- The definition/removal/update of SAFE requirements as a result of the public review by the SREWG.
- Evolution of the LTDP Guidelines ([LTDP])
- Evolution of the FIRST and LAST User Requirements Documents ([FIRST] and [LAST]).
- Definition of additional requirements generated by open discussions.
- Additional requirements provided by the Agency, based on operational experience.

2 Applicable and Reference Documents

2.1 Applicable Documents

The following documents, of the exact issue shown, form part of this document to the extent specified herein:

Ref.	Title	Code	Vers.	Date
[SAFE-SRD]	SAFE Standard and Infrastructure High-level Requirements	PGSI-GSEG-EOPG-RD-11-0005	1.0	24/01/2011
[ISO-OAIS]	Space data and information transfer systems – Open archival information system – Reference model	ISO 14721:2003		01/03/2003
[OAIS]	Reference Model for an Open Archival Information System (OAIS) CCSDS Pink Book	CCSDS 650.0-P-1.1	1.1	Aug. 2009
[Primer]	SAFE "Primer"	PGSI-GSEG-EOPG-FS-010-0001		
[SAFE-Cv1]	Core Specifications Control Book Volume 1	PGSI-GSEG-EOPG-FS-05-0001		
[SAFE-Cv2]	Recommendation for Specialisations Control Book Volume 2	PGSI-GSEG-EOPG-FS-05-0002		
[HARM SRD]	HARM System Requirements Document	HA-RS-ACS-GS-0111	1.1	12/01/2005
[ECSS-E-40]	Space Engineering – Software (applicable as per tailoring in Appendix A of [SAFE-SOW])	ECSS-E-ST-40	C	06/03/2009
[IPF-SPEC]	Generic IPF Interface Specification	MMFI-GSEG-EOPG-TN-07-0003	1.8	03/08/2009
[OGC-OM]	Earth Observation Metadata profile of Observations & Measurements	OGC 10-157r3	1.0.0	1/12/2011

Table 2-1: Applicable Documents

2.2 Reference Documents

The following documents, although not part of this document, amplify or clarify its contents:

Ref.	Title	Code	Vers.	Date
[SAFE-SOW]	LTDP SAFE Consolidation Statement of Work	PGSI-GSEV-EOPG-SW-10-0008	1.0	20/01/2011

Ref.	Title	Code	Vers.	Date
[FIRST]	FIRST Long-Term Data Preservation User Requirements and Dataset Composition Study	5793-2010/FURD		
[FIRST_REP]	FIRST LTDP Program Report	5793-2010/FLPR		
[HARM-DD]	HARM Architectural Design Document	HA-DD-ACS-GS-0114		
[HARM OCD]	HARM Operational Concept Document	HA-TN-ACS-GS-0116	1.6	12/09/2005
[HARM-SUM]	HARM SUM – Software User Manual	HA-TN-ACS-GS-0117		
[LAST]	LAST Requirements Document Volume 1: Common Set of Requirements	GMV-LAST-LRD-001		
[LTDP]	European Long-Term Data Preservation Common Guidelines	GSCB-LTDP-EOPG-GD-09-0002		
[Toolbox]	SAFE Toolbox – Software User’s Manual	GAEL-P279-SUM-001		

Table 2-2: Reference Documents

3 Terms, Definitions and Abbreviated terms

3.1 Definitions

Many concepts used in this document are defined in some of the applicable and reference documents. Those not defined in those documents, are defined in the following table:

Concept / Term	Definition
Specialisation	Derivation for another format by applying different restrictions to all or some of the specification rules
Content Unit	XML Structure that contains pointers to Data Objects and associated Metadata Objects, and possibly other Content Units
Conversion	<p>In the SAFE context, conversion is a mechanism launched by a specific software component (converter) in charge of building a SAFE product (AIP) using as initial input an original mission product (SIP).</p> <p>The original product will be included inside the SAFE product, although it cannot be ensured that the original format will remain unchanged within the SAFE product. This is a fact for those products whose format is not suitable for preservation but which still needs to be preserved. The preservation rules will oblige the converter to transform the original product into a format that can be preserved.</p> <p>The conversion process will look for any other files (or any other information) needed to build the SAFE product from the places where these files (or information) are stored. Some files will be gathered to be included inside a SAFE product (such as browse images) and some others (e.g. auxiliary files) will be stored outside the product, whether in a SAFE format or another format. These external files shall be referenced from the SAFE product through appropriate links.</p>
Data screening	Data screening activity consists in the regeneration of Metadata and Browse images for an archived SAFE product, to be later delivered for data inventory and/or uploaded to AMS. The outcome of the Screening process is the input product integrated with Metadata and Browse data.
Representation Information	The information that maps a Data Object into more meaningful concepts. An example is the ASCII definition that describes how a sequence of bits (i.e. a Data Object) is mapped into a symbol.
SAFE Specialisation	A SAFE Specialisation is a restriction of the SAFE Core specifications for a more specific type of data.

Table 3-1: Definitions

3.2 Acronyms

Acronyms used in this document and needing a definition are included in the following table:

Acronym	Definition
AIP	Archival Information Package
ASCII	American Standard Code for Information Interchange
CCSDS	Consultative Committee for Space Data Systems

CRC	Cyclic Redundancy Check
EO	Earth Observation
ESA	European Space Agency
GFE	Generic Front-End, reference archive ingestion facility for ESA EO data
HARM	Historical Archives Rationalization and Management
HMI	Human Machine Interface
HTML	HyperText Markup Language
LTDP	Long-Term Data Preservation
MD5	Message-Digest Algorithm 5
OAIS	Open Archival Information System
PDF	Portable Document Format
PDGS	Payload Data Ground Segment
PS	PostScript
RHEL	Red Hat Enterprise Linux
SAFE	Standard Archive Format for Europe
SREWG	SAFE Review Expert Working Group
UTF	Unicode Transformation Format
XML	Extensible Mark-up Language

Table 3-2: Acronyms

4 General description

4.1 Product perspective

SAFE (Standard Archive Format for Europe) has been designed to act as a common format for archiving and conveying data within ESA Earth Observation archiving facilities. SAFE benefits from the experience gathered during the development of other standards related to data formats. It intends to resolve the major challenges coming from the packaging and the long-term preservation of Earth Observation data.

Special attention has been given to ensure that SAFE conforms to the ISO 14721:2003 OAIS (Open Archival Information System) reference model (see [OAIS]).

An "OAIS" (Open Archival Information System) is an archive, consisting of an organization of people and systems that has accepted the responsibility to preserve information and make it available for a Designated Community. It meets a set of such responsibilities as defined in the OAIS Reference Model, and this allows an OAIS to be distinguished from other uses of the term 'archive'. The term 'Open' in OAIS is used to imply that the OAIS Reference Model Recommendation, as well as future related Recommendations and standards, are developed in open forums, and it does not imply that access to the archive is unrestricted.

The reference model addresses a full range of archival information preservation functions including ingest, archival storage, data management, access, and dissemination.

The OAIS Reference Model is a technical recommendation of the CCSDS.

4.2 General capabilities

The primary goal of SAFE is to handle EO data with processing levels close to the usually called "level 0". However no limitation exists regarding the packaging of higher level products as well as other technical and scientific information. Experience has demonstrated that packaging and archiving higher processing levels or auxiliary data in a common format may be effective in many situations. SAFE embodies this concept by offering a single framework for packaging a large variety of information.

SAFE is defined as a format for the AIP, which is internal to the OAIS. The objective of SAFE is to enable the preservation of the products, and the AIP is the package within OAIS that takes into account the long term preservation of the information handled. According to OAIS, the original format of the products (SIP) and the format in which the products are disseminated (DIP) don't need to care about the preservation of the information, since they fall outside the archive.

This does not mean that SAFE cannot be used as a format for the SIP or DIP, if it is agreed so by the parties involved. But in this case, some rules applicable for the SAFE format at archive level should be relaxed at the producer and consumer level (for example, the conditions for compressed products).

SAFE shall make use of the latest available technologies at the moment of its specification. It is not foreseen to perform periodic updates on the format, unless strictly necessary. In other words, unless it is foreseen that

at a specific moment the information stored in the archive for the preservation of the format and associated software will be no longer valid.

SAFE provides a set of tools to generate products in SAFE format starting from products in the original mission formats.

Moreover, the SAFE format shall provide a common product structure definition and a standard metadata set (Earth Observation Metadata profile of Observations & Measurements defined by OGC). These will help to simplify the data extraction from the archive and will enhance the use of SAFE by end-users and/or processing systems.

4.3 General constraints

The constraints applicable to the SAFE Format and Infrastructure can be derived, on the one hand, from the OAIS Specifications and on the other hand, from the HARM Operational concept. See [OAIS], and [HARM OCD] for more information.

5 Specific requirements

This chapter is devoted to detailing the specific requirements for the SAFE Format and Toolset. The format used for the identification of the requirements is as follows:

SAFE-xxx-nnnn/V.v

where:

xxx is a section identifier:

GEN: GENeral specifications
FMT: ForMaT specifications
REP: REPresentation information
MTD: MeTaData specifications
AUX: AUXiliary data files specifications
BRW: BRoWse data
FIL: FILE naming convention
IO: Input/Ouput library
PUB: PUBlisher
TBOX: ToolBoX
HARM: HARM Infrastructure
CNV: CoNVerters

nnnn is the requirement number

V.v are the major and minor version numbers of this document where the requirement was created, deleted or modified for the last time.

5.1 SAFE Standard

5.1.1 General specifications

[SAFE-GEN-0010/2.0]	SAFE shall be an Archival Information Package (AIP) designed for archiving and conveying Earth Observation data within ESA Earth Observation archiving facilities.
[SAFE-GEN-0020/2.0]	SAFE shall provide two conformance classes of products: <ul style="list-style-type: none"> • LTDP class • Operational class
[SAFE-GEN-0030/2.0]	The SAFE LTDP conformance class shall comply with the OAIS reference model <i>Comments: For more information on the OAIS model, see [OAIS]</i>
[SAFE-GEN-0040/2.0]	The SAFE Operational conformance class shall not be constrained by the OAIS preservation requirements. <i>Comments: Operational products can be wrapped using SAFE format, but the preservation cannot be assured for this kind of products (this shall be stated in the SAFE core documents)</i>
[SAFE-GEN-0050/2.0]	SAFE shall define under which condition a compressed format qualifies for the LTDP conformance class

[SAFE-GEN-0060/2.0]	SAFE format shall be designed to: <ul style="list-style-type: none"> • be multi-satellite; • host different product-type level and auxiliary products; • host products with different multiple files structure;
[SAFE-GEN-0070/2.0]	SAFE shall be able to host L0, L1 and L2 data independently from compression format
[SAFE-GEN-0080/2.0]	SAFE shall facilitate the definition of specialisations for specific needs. <i>Comments: A specialisation is a restriction of the SAFE Core specifications for a more specific type of data.</i>
[SAFE-GEN-0090/2.0]	SAFE shall provide specialisations for the following missions: <ul style="list-style-type: none"> • Envisat • ERS • JERS (OPS, SAR) • LANDSAT (ETM, MSS, TM) • MOS (MESSR, VTIR) • NOAA (AVHRR) • SEASTAR (SeaWiFS) • SPOT (HRV, HRVIR) • TERRA/AQUA (MODIS) • Sentinels 1/2/3 • GOCE • SMOS • Cryosat • SWARM
[SAFE-GEN-0100/2.0]	SAFE mission specialisations shall include the list of documents which are needed to understand the products of their corresponding missions.
[SAFE-GEN-0110/2.0]	SAFE mission specialisation documents shall be archived in a format that does not require specific software to be used to assure their preservation.
[SAFE-GEN-0120/2.0]	SAFE control books and tools shall be preserved for public access.
[SAFE-GEN-0130/2.0]	SAFE products shall reference the applicable documents with a unique identifier.
[SAFE-GEN-0140/2.0]	SAFE mission specialisation documents shall be archived in a specific semantic mark-up language based on a document formatting language. <i>Comments: Document converters shall be required to adapt the existing mission documentation to assure its preservation.</i>
[SAFE-GEN-0150/2.0]	The SAFE core specification documents shall require to include in the specialisations the sensor processing chains from L0 to L2 with the following information: <ul style="list-style-type: none"> • processing steps • sources needed for each processing step • description of the input product type for each processing step • description of the output product type for each processing step

5.1.2 Format specifications

[SAFE-FMT-0010/2.0]	SAFE format shall be composed by several files which shall be archived and retrieved together.
[SAFE-FMT-0020/2.0]	SAFE format shall allow modelling the relation between the files existing within a SAFE product.
[SAFE-FMT-0030/2.0]	SAFE packaging format shall provide a flexible packaging mechanism allowing adding several types of format files to a SAFE product.
[SAFE-FMT-0040/2.0]	SAFE packaging format shall be an open source standard. <i>Comments: Possible package standard candidates shall be widely used by the Information and Communications archiving Technology community.</i>
[SAFE-FMT-0050/2.0]	SAFE packaging format shall be supported by a set of open source tools.
[SAFE-FMT-0060/2.0]	SAFE packaging format shall be able to represent EO Products using a mark-up language.
[SAFE-FMT-0070/2.0]	SAFE packaging format should restrict the use of implicit referencing among components
[SAFE-FMT-0080/2.0]	SAFE packaging format shall provide metadata information describing the package structure.
[SAFE-FMT-0090/2.0]	SAFE shall specify how the files comprised in a SAFE product, are grouped together minimizing the effort to retrieve them.
[SAFE-FMT-0100/2.0]	SAFE shall provide a manifest file containing a minimum set of core metadata providing basic information to allow an immediate understanding of the main characteristics of the product.
[SAFE-FMT-0110/2.0]	The manifest file shall include the SAFE format version used to store the data in a product.
[SAFE-FMT-0120/2.0]	SAFE shall allow the use of Schematron for making assertions about the presence or absence of patterns in a SAFE product. <i>Comments: Schematron is a rule-based validation language for making assertions about the presence or absence of patterns in XML trees.</i>
[SAFE-FMT-0130/2.0]	SAFE shall provide the necessary schemas for validation with Schematron.

5.1.3 Representation information specifications

[SAFE-REP-0010/2.0]	All data files within a SAFE product shall be complemented with their corresponding representation information to assure their preservation.
[SAFE-REP-0020/2.0]	The representation information shall allow the description of structured data up to the bit level.
[SAFE-REP-0030/2.0]	The representation information shall be based on XML Schemas. <i>Comments: The XML Schemas will establish a link between the concepts, magnitudes, physical entities, etc. represented, and the raw data stored in the package.</i>

[SAFE-REP-0040/2.0]	The use of proprietary/commercial languages to describe the physical format of a data object shall be avoided. <i>Comments: The use of proprietary languages shall be well justified among other possibilities</i>
[SAFE-REP-0050/2.0]	The language to be used for data object representation information shall have free public accessible documentation.
[SAFE-REP-0060/2.0]	The language to be used for data object representation information shall have an extensive freely available tool support.
[SAFE-REP-0070/2.0]	The language to be used for data object representation information shall be based on XML.
[SAFE-REP-0080/2.0]	Redefinition of attributes within a SAFE schema shall not be allowed.
[SAFE-REP-0090/2.0]	SAFE shall establish a metadata naming convention to represent the measurements contained in the data object of a SAFE product
[SAFE-REP-0100/2.0]	SAFE metadata naming convention shall describe how the measurements, contained in the data object of a SAFE product, have to be named in order to have a clear semantic meaning.
[SAFE-REP-0110/2.0]	SAFE shall provide a formal description of the attributes describing the measurements contained in the data object of a SAFE product: <ul style="list-style-type: none"> • Dimensions • Unit of measure • Range • Special values (e.g. no measurement or saturated) • Other attributes needed for the complete understanding of the information reported (e.g. star name for limb looking sensor).
[SAFE-REP-0120/2.0]	SAFE shall guarantee that data representation information stored in a SAFE product (if it exists) is accessible. <i>Comments: Representation information may not be available within a SAFE product for products in the SAFE Operational conformance class.</i>

5.1.4 Metadata specifications

[SAFE-MTD-0010/2.0]	SAFE shall define core mandatory metadata for an EO product.
[SAFE-MTD-0020/2.0]	SAFE shall define core optional metadata for an EO product
[SAFE-MTD-0030/2.0]	Earth Observation Metadata profile of Observations & Measurements defined by OGC (OGC-OM) shall be the base metadata model mandatory for SAFE products. <i>Comments: For more information on the OGC EO metadata profile of O&M: [OGC-OM]</i>
[SAFE-MTD-0040/2.0]	OGC-OM metadata should be stored in a dedicated file inside the SAFE product. <i>Comments: This information should be stored outside the manifest file but only if this solution is still compliant with OAIS and the package standard finally adopted</i>

[SAFE-MTD-0050/2.0]	SAFE shall be able to extend the base model metadata in order to accommodate mission specific metadata. <i>Comments: If the extension is not possible then optional metadata models could be included in the product.</i>
[SAFE-MTD-0060/2.0]	SAFE shall allow the addition of optional metadata models in a SAFE product.
[SAFE-MTD-0070/2.0]	SAFE metadata following a specific metadata model shall be stored in a single file.
[SAFE-MTD-0080/2.0]	SAFE shall provide metadata quality indicators in accordance with QA4EO project outcomes. <i>Comments: QA4EO references at http://www.qa4eo.org</i>
[SAFE-MTD-0090/2.0]	SAFE should allow the inclusion of quality reports in a SAFE product
[SAFE-MTD-0100/2.0]	SAFE shall allow restriction capability on metadata for product specialisations.
[SAFE-MTD-0110/2.0]	SAFE shall allow extension capability on metadata for product specialisations.
[SAFE-MTD-0120/2.0]	SAFE shall allow the addition of mask files in a SAFE product to specify coverage information. <i>Comment: Currently mask types in OGC-OM are SNOW, CLOUD and QUALITY (candidate for coverage description via mask files is LAND e.g. for Land or Sea Surface Temperature products).</i>
[SAFE-MTD-0130/2.0]	SAFE metadata shall allow to understand the correlation between footprint and temporal coverage information for L0, L1 and L2 products
[SAFE-MTD-0140/2.0]	SAFE metadata shall indicate the integrity check algorithm used to ensure that a product has not been altered during the retrieval, archiving or transcription operations. <i>Comments: The integrity check is assumed to be done by the SAFE I/O library</i>
[SAFE-MTD-0150/2.0]	SAFE product metadata shall provide information about the organization responsible for generating the product. <i>Comments: Aligned with the base model metadata.</i>
[SAFE-MTD-0160/2.0]	SAFE shall be able to provide World Reference System (WRS) metadata information for those native products having a WRS. <i>Comments: Metadata granularity shall be at frame level, i.e. in case the SAFE product covers multiple frames, there will be multiple metadata records.</i>
[SAFE-MTD-0170/2.0]	SAFE format shall provide information about the last metadata update time.
[SAFE-MTD-0180/2.0]	SAFE shall identify at core level the elements that must be classified as forbidden or mandatory at specialization level.
[SAFE-MTD-0190/2.0]	SAFE metadata shall provide the satellite phase information.
[SAFE-MTD-0200/2.0]	SAFE metadata shall provide an optional repeat cycle metadata for each satellite phase.
[SAFE-MTD-0210/2.0]	SAFE metadata shall provide repeat cycle information containing the local equator crossing time for sun-synchronous satellites.

5.1.5 Auxiliary/ancillary data files specifications

[SAFE-AUX-0010/2.0]	SAFE shall be able to represent auxiliary files as SAFE products. <i>Comments: The scope of SAFE should be limited to Products and Auxiliary files. Other elements like processors and ancillary information shall be considered as non-suitable formats for SAFE.</i>
[SAFE-AUX-0020/2.0]	Auxiliary files shall always be stored externally to the related SAFE EO products, independently if they are relevant for multiple products or a single product only.
[SAFE-AUX-0030/2.0]	Each SAFE EO product shall contain enough information to access related auxiliary/ancillary files inside the SAFE long-term archive. <i>Comments: It should be assumed that such information will be preserved in the LTDP archive, according to the LTDP guidelines.</i>
[SAFE-AUX-0040/2.0]	For each product level, SAFE shall preserve sufficient information to generate the next-higher product levels up to L2 at least. <i>Comments: It may be sufficient to describe the processing chain in the control book or in a separate document referred to within the control book.</i>
[SAFE-AUX-0050/2.0]	SAFE product provenance metadata shall provide auxiliary/ancillary information involved in data production. <i>Comments: This information comprises auxiliary file name, processor ID and other ancillary information identifier when available (like DEM and cal/val)</i>
[SAFE-AUX-0060/2.0]	The SAFE product shall store a reference to the algorithm, the processor software and its version (but not the algorithm itself)

5.1.6 Browse data specifications

[SAFE-BRW-0010/2.0]	SAFE shall mandate the storage of any product browse image(s) inside the SAFE product. <i>Comments: Browse image(s) will be included only if they exist in the original product.</i>
[SAFE-BRW-0020/2.0]	SAFE shall allow to store more than one browse image inside the SAFE product. <i>Comments: For example one browse for each band.</i>
[SAFE-BRW-0030/2.0]	SAFE shall be able to store browse image files and their information for georeferencing (if existing) according to the following well-known formats: <ul style="list-style-type: none"> • Bitmap • PNG • JPEG / JPEG2000 • TIFF <i>Comments: It is assumed that the algorithms to process these formats shall be part of the long-term knowledge base to ensure data preservation.</i>

5.1.7 File naming convention specifications

[SAFE-FIL-0010/2.0]	SAFE Core Specification control book shall provide a recommended file naming convention for the SAFE products
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[SAFE-FIL-0020/2.0]	SAFE specialisation control books shall provide a recommended file naming convention for that mission's SAFE products
[SAFE-FIL-0030/2.0]	The common files internal to a SAFE product shall follow a naming convention defined in SAFE core control books. <i>Comments: The number of files internal to a SAFE product may vary according to the mission specialisation but the common file set includes at least the manifest, the data and metadata files</i>
[SAFE-FIL-0040/2.0]	SAFE file naming convention shall consider case-sensitive and case-insensitive file systems.

5.2 SAFE Toolset

This section describes the high-level baseline requirements for the various SAFE tools.

[SAFE-TSET-0010/2.0]	The SAFE Toolset shall provide tools for converting the existing mission documentation from its original format to the document format chosen for document preservation.
[SAFE-TSET-0020/2.0]	The SAFE Toolset shall be able to manage SAFE products compliant with the version of SAFE anterior to the last. <i>Comment: Backward compatibility should be assured between the two last SAFE existing versions (i.e. the reference version and the immediate former)</i>
[SAFE-TSET-0030/2.0]	SAFE Toolset shall be based on an open source approach to ease long-term maintenance.
[SAFE-TSET-0040/2.0]	Toolbox, Publisher and I/O Library shall be able to work under the following platforms: <ul style="list-style-type: none"> • Windows Server 2008R2 64 bit operating system • Linux RHEL/CentOS 6.x 64bit operating system
[SAFE-TSET-0050/2.0]	SAFE Toolset shall be able to be executed on virtual machines for the supported operating systems.

5.2.1 I/O Library

The SAFE I/O library is a tool which facilitates the creation, editing, reading and validation of the SAFE products. The main use cases of this software are:

- Create a SAFE product
- Edit a SAFE product
- Read a SAFE product
- Validate a SAFE product
- Add/Remove/Browse Content Units of the Information Package
- Add/Remove/Retrieve the Metadata
- Add/Remove/Retrieve the Data Objects
- Browse/Select/Extract information from either Binary or XML objects
- Identify/Sort Quality Information to a specific part of the objects.

The following high-level requirements have been identified for the I/O library:

[SAFE-IO-0010/2.0]	The SAFE I/O library shall provide Java and C++ interfaces.
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[SAFE-IO-0020/2.0]	The library shall be backward compatible for reading and validation operations.
[SAFE-IO-0030/2.0]	The library shall be compliant with the SAFE core definition and the SAFE specialisations.
[SAFE-IO-0040/2.0]	The library shall provide a modular structure to allow the addition of SAFE specialisation modules.
[SAFE-IO-0050/2.0]	The library shall provide the capability of adding newly-defined SAFE Specialisation modules without any code rebuilding and configuration changes.
[SAFE-IO-0060/2.0]	The SAFE I/O library shall offer the possibility to create a SAFE product.
[SAFE-IO-0070/2.0]	The SAFE I/O library shall offer the possibility to edit a SAFE product.
[SAFE-IO-0080/2.0]	The SAFE I/O library shall offer the possibility to read a SAFE product.
[SAFE-IO-0090/2.0]	The SAFE I/O library shall offer the possibility to validate a SAFE product.
[SAFE-IO-0100/2.0]	The SAFE I/O library shall offer the possibility to add content units of the Information Package Map
[SAFE-IO-0110/2.0]	The SAFE I/O library shall offer the possibility to remove content Units of the Information Package Map
[SAFE-IO-0120/2.0]	The SAFE I/O library shall offer the possibility to browse content Units of the Information Package Map
[SAFE-IO-0130/2.0]	The SAFE I/O library shall offer the possibility to add the Metadata into a SAFE product.
[SAFE-IO-0140/2.0]	The SAFE I/O library shall offer the possibility to remove Metadata from a SAFE product.
[SAFE-IO-0150/2.0]	The SAFE I/O library shall offer the possibility to retrieve Metadata from a SAFE product.
[SAFE-IO-0160/2.0]	The SAFE I/O library shall offer the possibility to add the Data Objects into a SAFE product
[SAFE-IO-0170/2.0]	The SAFE I/O library shall offer the possibility to remove the Data Objects from a SAFE product.
[SAFE-IO-0180/2.0]	The SAFE I/O library shall offer the possibility to retrieve the Data Objects from a SAFE product.
[SAFE-IO-0190/2.0]	The SAFE I/O library shall offer the possibility to browse information from either Binary or XML objects in a SAFE product.
[SAFE-IO-0200/2.0]	The SAFE I/O library shall offer the possibility to select information from either Binary or XML objects in a SAFE product.
[SAFE-IO-0210/2.0]	The SAFE I/O library shall offer the possibility to extract information from either Binary or XML objects in a SAFE product.
[SAFE-IO-0220/2.0]	The SAFE I/O library shall be able to provide quality data information i.e. every detected missing and corrupted unit should be listed <i>Comments: Correct and present units checked may also be listed</i>

[SAFE-IO-0230/2.0]	<p>The SAFE I/O library shall offer the possibility to provide the list of missing elements associated to a component. The list should provide the following information:</p> <ul style="list-style-type: none"> • The missing elements location • The number of missing elements • The cause for the missing elements. (if known) <p><i>Comment: Every detected missing unit should be listed. Existing units checked may also be listed.</i></p>
[SAFE-IO-0240/2.0]	<p>The SAFE I/O library shall offer the possibility to provide the list of corrupted elements associated to a component. The list should provide the following information:</p> <ul style="list-style-type: none"> • The corrupted elements location • The number of corrupted elements • The cause for the corruption (if known) <p><i>Comment: Every detected corrupted unit should be listed. Correct units checked may also be listed.</i></p>
[SAFE-IO-0250/2.0]	The SAFE I/O library shall allow creating the manifest file of a SAFE product.
[SAFE-IO-0260/2.0]	The SAFE I/O library shall allow filling all manifest sections of a SAFE product.
[SAFE-IO-0270/2.0]	The SAFE I/O library shall follow the rules imposed by the applicable SAFE standard to fill the manifest sections of a SAFE product.
[SAFE-IO-0280/2.0]	The SAFE I/O library shall allow linking together data, metadata and <i>representation information</i> properly.
[SAFE-IO-0290/2.0]	The SAFE I/O library shall provide an integrity check functionality to ensure that a SAFE product (both at the manifest file level, and at the data sources level) has not been altered during the retrieval, archiving or transcription operations.
[SAFE-IO-0300/2.0]	The SAFE I/O library shall make use of an open source and well-known integrity check algorithm that can be centrally stored as part of the knowledge base.

5.2.2 Publisher

In order to facilitate the creation of SAFE specialisations, the user has available the Publisher. The Publisher is a tool which allows the creation of the SAFE Specialisation *Control books* based on the ESA template. The user writes the SAFE Specialisation document using the *docbook* language without taking care of the layout format, which is under the responsibility of the Publisher.

The entire set of SAFE specifications, including [SAFE-Cv1] and [SAFE-Cv2], was generated by the SAFE publisher.

The following high-level requirements have been identified for the Publisher:

[SAFE-PUB-0010/2.0]	The Publisher shall be able to generate the SAFE Control Books.
[SAFE-PUB-0020/2.0]	The Publisher shall generate all SAFE Control Books using a common template.

[SAFE-PUB-0030/2.0]	The Publisher shall provide the common template to generate the SAFE Control Books.
[SAFE-PUB-0040/2.0]	The Publisher shall take input files written in a specific semantic mark-up language based on XML.
[SAFE-PUB-0050/2.0]	SAFE Control Books shall make use of image formats which are based on bitmap representation. <i>Comment: No additional image pre-processing should be needed to ensure that the image will be understandable also in the long-term.</i>
[SAFE-PUB-0060/2.0]	The Publisher shall be able to generate the SAFE Control Book in the following formats: <ul style="list-style-type: none"> • PDF v1.7 (ISO 32000-1) • HTML v4.0.1 • PS v3
[SAFE-PUB-0070/2.0]	Each SAFE Specialisation Control Book shall be written in a specific file to be used by the Publisher as input.
[SAFE-PUB-0080/2.0]	The Publisher shall provide a directory structure by default to store all the SAFE Specialisations files.
[SAFE-PUB-0090/2.0]	The specific directory structure to store all the SAFE Specialisation files shall be configurable.
[SAFE-PUB-0100/2.0]	The Publisher shall be able to generate all the SAFE Control Books.
[SAFE-PUB-0110/2.0]	The Publisher shall make use of the available SAFE Specialisation input files previously installed, for the generation of the SAFE Control Books.

5.2.3 Toolbox

The SAFE Toolbox is an application which allows creating, browsing, editing and validating SAFE products, leveraging on the SAFE I/O Library. For a detailed view on the existing Toolbox, refer to the document [Toolbox].

The following high-level requirements have been identified:

[SAFE-TBOX-0010/2.0]	The Toolbox shall allow creating, browsing, editing and validating SAFE products
[SAFE-TBOX-0020/2.0]	The Toolbox shall allow the validation of a SAFE product, ensuring the consistency of the manifest file and the entire SAFE product
[SAFE-TBOX-0030/2.0]	The Toolbox shall allow the creation of a SAFE product, starting from a manifest template file.
[SAFE-TBOX-0040/2.0]	The Toolbox shall allow searching for identifiers of nodes and structural information within the manifest file. <i>Comments: The identifiers are those in "nodes", "IDs" and "names" within the XML manifest file.</i>
[SAFE-TBOX-0050/2.0]	The Toolbox shall allow the visualization of any metadata stored in the SAFE product.
[SAFE-TBOX-0060/2.0]	The toolbox should be able to display bitmap images stored in a SAFE product.

5.2.4 HARM Infrastructure

The Historical Archives Rationalization and Management (HARM) infrastructure allows the conversion of current Earth Observation satellite products from their original format to the specific SAFE format. HARM allows controlling and monitoring all the conversion activities.

The HARM infrastructure is intended to be used only by ESA, however it should be engineered in a way that does not preclude its utilisation by other potential users.

5.2.4.1 General specifications

[SAFE-HARM-0010/2.0]	HARM shall define a file based input and output interface file for product conversion. <i>Comments: HARM shall take the native products from an inbox and converted SAFE products shall be placed in an outbox.</i>
[SAFE-HARM-0020/2.0]	HARM shall provide an interface for the provision of metadata for product supplementation
[SAFE-HARM-0030/2.0]	HARM shall ensure integrity of product data and metadata used for the generation of the SAFE product.
[SAFE-HARM-0040/2.0]	The HARM system shall provide the environment and the automated procedures for: <ul style="list-style-type: none"> • Data Conversion • Data Screening • Monitoring & Control
[SAFE-HARM-0050/2.0]	The HARM system shall provide data conversion from native product format to SAFE format.
[SAFE-HARM-0060/2.0]	The HARM system shall provide a mechanism (filter) to allow the user to select a set of products (according a common set of characteristics) to perform a data conversion. <i>Comments: At least, the user shall be able to select a set of products of the same type.</i>
[SAFE-HARM-0070/2.0]	The HARM system shall be able to perform the regeneration of metadata and/or browse images (Data Screening) corresponding to a SAFE product for further use (e.g. catalogue).
[SAFE-HARM-0080/2.0]	The HARM system shall provide monitoring and control functionalities to coordinate several HARM activities: <ul style="list-style-type: none"> • launching and stopping processes • monitoring activity progress statuses • handling messages • managing the activities' interruptions

5.2.4.2 Performance and Operations

[SAFE-HARM-0090/2.0]	HARM shall provide two possibilities to start the data conversion and screening operations: - automatically triggered by the monitoring and control functionalities (running in background) - manually triggered by an operator
[SAFE-HARM-0100/2.0]	HARM shall perform data conversion and screening operations in a fully automatic and autonomous way by default.
[SAFE-HARM-0110/2.0]	HARM shall provide different logs for data conversion and screening processes to be used in further operational investigations.
[SAFE-HARM-0120/2.0]	HARM shall provide both interactive and automatic control for data conversion and screening operations.
[SAFE-HARM-0130/2.0]	HARM shall provide HMI interfaces for monitoring and control interactive operations.
[SAFE-HARM-0140/2.0]	Data conversion to SAFE shall have a throughput of at least 12 times real-time, where real-time means the average amount of data archived in one day during normal acquisition activities. <i>Comments: The latency time for data downloading/uploading to Legacy Archive shall not be taken into account in the requested throughput.</i>

5.2.4.3 System interface requirements

[SAFE-HARM-0150/2.0]	The HARM system shall provide standardized interfaces to interact with the legacy archive services.
[SAFE-HARM-0160/2.0]	The HARM system shall provide an HMI to support manual intervention
[SAFE-HARM-0170/2.0]	The HARM system shall provide notification means to notify the presence of corrupted/damaged native products during data conversion process. <i>Comments: Corrupted/Damaged products are for example those products with wrong or missing Main Product Header.</i>

5.2.4.4 Security requirements

[SAFE-HARM-0180/2.0]	The system monitoring and control activities shall be restricted to authorised users only.
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5.2.4.5 Reliability and availability requirements

[SAFE-HARM-0190/2.0]	The HARM system shall be able to automatically convert data with an availability figure of 95% computed over a period of two weeks on 24/7 basis.
[SAFE-HARM-0200/2.0]	The HARM system should be able to deal with corrupted data in the archive without crashing.

[SAFE-HARM-0210/2.0]	The HARM system should be able to notify the operator when a corrupted data is being processed.
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5.2.5 Converters

The SAFE converters are tools, configured under HARM environment but able to run also in stand-alone mode, which convert the EO products stored in the ESA archives from their original format to SAFE format.

The following high-level requirements have been identified for the Converters:

[SAFE-CNV-0010/2.0]	The SAFE converters shall be able to process an EO product to extract/generate the associated metadata needed for the SAFE product. <i>Comments: The needed metadata shall depend on the final standard adopted in SAFE.</i>
[SAFE-CNV-0020/2.0]	For those metadata that cannot be directly obtained from an EO product, the SAFE converters shall be able to process information coming from external sources to extract/generate the additional metadata needed for the SAFE product. <i>Comments: The needed metadata shall depend on the final standard adopted in SAFE.</i> <i>Possible external sources shall be:</i> <ul style="list-style-type: none"> - Product Auxiliary data (depending on each EO product). - Catalogue information (only available when converters are interfacing with HARM. Not used when the converters are executed in stand-alone mode)
[SAFE-CNV-0030/2.0]	The SAFE converters shall be able to include all the EO product associated metadata in the SAFE product. <i>Comments: The needed metadata shall depend on the final standard adopted in SAFE.</i>
[SAFE-CNV-0040/2.0]	SAFE converters shall be able to be executed as stand-alone applications.
[SAFE-CNV-0050/2.0]	The SAFE converters shall provide quality information (missing and corrupted elements) of a converted SAFE product. <i>Comments: The information retrieved will be further used to check the correct transcription of the data into the SAFE product.</i>
[SAFE-CNV-0060/2.0]	The SAFE converters shall make use of the I/O library quality checking functionality to obtain information on the missing and corrupted elements in a SAFE product.
[SAFE-CNV-0070/2.0]	The SAFE converters shall provide the Generic IPF Interfaces to allow integration in the product processing chain. <i>Comments: Interface details are described in "Generic IPF Interface Specification" (MMFI-GSEG-EOPG-TN-07-0003)</i>

[SAFE-CNV-0080/2.0]	<p>The SAFE converters shall be able to convert the following native L0 EO data products to the SAFE format:</p> <ul style="list-style-type: none"> • Envisat • ERS • JERS (OPS, SAR) • LANDSAT (ETM, MSS, TM) • MOS (MESSR, VTIR) • NOAA (AVHRR) • SEASTAR (SeaWiFS) • SPOT (HRV, HRVIR) • TERRA/AQUA (MODIS) • Sentinels 1/2/3 • GOCE • SMOS • Cryosat • SWARM
[SAFE-CNV-0090/2.0]	<p>The SAFE converters shall be able to convert the following native L1 EO data products to the SAFE format:</p> <ul style="list-style-type: none"> • Envisat • Sentinels 1/2/3 • GOCE • SMOS • Cryosat • SWARM
[SAFE-CNV-0100/2.0]	<p>The SAFE converters shall be able to convert the following native L2 EO data products to the SAFE format:</p> <ul style="list-style-type: none"> • Envisat • Sentinels 1/2/3 • GOCE • SMOS • Cryosat • SWARM
[SAFE-CNV-0110/2.0]	<p>Each SAFE converter will act on the products of a specific mission.</p>
[SAFE-CNV-0120/2.0]	<p>The SAFE converters shall be able to convert auxiliary files to the SAFE format for the following missions (Sensors):</p> <ul style="list-style-type: none"> • Envisat • ERS • JERS (OPS, SAR) • LANDSAT (ETM, MSS, TM) • MOS (MESSR, VTIR) • NOAA (AVHRR) • SEASTAR (SeaWiFS) • SPOT (HRV, HRVIR) • TERRA/AQUA (MODIS) • Sentinels 1/2/3 • GOCE • SMOS • Cryosat • SWARM

Appendix A Requirements ID traceability

The current SSS has been deeply modified according to the comprehensive set of requirements identified during the SRR. In order to incorporate the new requirements in this document, it was decided to group them by topic to ease readability. This modification implied a change in the original requirement IDs that has to be traced.

The following table provides traceability between the requirements ID defined for the first version of this document and the current version.

SSS v1.0 Req. ID	SSS v2.0 Req. ID	Comments
[SAFE-FMT-0010/1.0]	[SAFE-GEN-0010/2.0]	
[SAFE-FMT-0020/1.0]	[SAFE-GEN-0030/2.0]	
[SAFE-FMT-0030/1.0]	Removed	
[SAFE-FMT-0040/1.0]	[SAFE-FMT-0030/2.0] [SAFE-MTD-0110/2.0]	
[SAFE-FMT-0050/1.0]	[SAFE-GEN-0080/2.0]	
[SAFE-FMT-0060/1.0]	[SAFE-GEN-0060/2.0]	
[SAFE-FMT-0070/1.0]	[SAFE-REP-0030/2.0]	
[SAFE-FMT-0080/1.0]	[SAFE-REP-0020/2.0]	
[SAFE-FMT-0090/1.0]	Removed	
[SAFE-FMT-0100/1.0]	[SAFE-FMT-0090/2.0]	
[SAFE-FMT-0110/1.0]	[SAFE-FMT-0100/2.0]	
[SAFE-FMT-0120/1.0]	[SAFE-FMT-0110/2.0]	
[SAFE-FMT-0130/1.0]	[SAFE-MTD-0010/2.0]	
[SAFE-FMT-0140/1.0]	[SAFE-MTD-0060/2.0]	
[SAFE-FMT-0150/1.0]	[SAFE-MTD-0110/2.0]	
[SAFE-FMT-0160/1.0]	Removed	
[SAFE-FMT-0170/1.0]	[SAFE-REP-0010/2.0]	
[SAFE-FMT-0180/1.0]	[SAFE-FIL-0010/2.0]	
[SAFE-FMT-0190/1.0]	[SAFE-MTD-0140/2.0]	
[SAFE-FMT-0200/1.0]	[SAFE-IO-0360/2.0]	
[SAFE-IO-0010/1.0]	[SAFE-IO-0010/2.0]	
[SAFE-IO-0020/1.0]	[SAFE-IO-0020/2.0]	
[SAFE-IO-0030/1.0]	[SAFE-IO-0030/2.0]	
[SAFE-IO-0040/1.0]	[SAFE-IO-0040/2.0]	
[SAFE-IO-0050/1.0]	[SAFE-IO-0050/2.0]	
[SAFE-IO-0060/1.0]	Removed	This requirement has been split in several atomic requirements. See IO Library requirements for details
[SAFE-IO-0070/1.0]	[SAFE-IO-0280/2.0] [SAFE-IO-0290/2.0] [SAFE-IO-0300/2.0]	
[SAFE-IO-0080/1.0]	[SAFE-IO-0310/2.0]	
[SAFE-IO-0090/1.0]	Removed	Representation information is now external. This requirement doesn't have much sense now.
[SAFE-IO-0100/1.0]	Removed	Representation information is now external. This requirement doesn't have much sense now.
[SAFE-IO-0110/1.0]	Removed	Representation information is now external. This requirement doesn't have much sense now.
[SAFE-IO-0120/1.0]	[SAFE-IO-0350/2.0]	
[SAFE-IO-0130/1.0]	[SAFE-IO-0360/2.0]	
[SAFE-IO-0140/1.0]	[SAFE-TSET-0040/2.0]	
[SAFE-IO-0150/1.0]	[SAFE-TSET-0040/2.0]	
[SAFE-PUB-0010/1.0]	[SAFE-PUB-0010/2.0]	
[SAFE-PUB-0020/1.0]	[SAFE-PUB-0020/2.0]	
[SAFE-PUB-0030/1.0]	[SAFE-PUB-0040/2.0]	
[SAFE-PUB-0040/1.0]	[SAFE-PUB-0060/2.0]	
[SAFE-PUB-0050/1.0]	[SAFE-PUB-0070/2.0]	

SSS v1.0 Req. ID	SSS v2.0 Req. ID	Comments
[SAFE-PUB-0060/1.0]	[SAFE-PUB-0080/2.0]	
[SAFE-PUB-0070/1.0]	[SAFE-PUB-0100/2.0]	
[SAFE-PUB-0080/1.0]	[SAFE-TSET-0040/2.0]	
[SAFE-PUB-0090/1.0]	[SAFE-TSET-0040/2.0]	
[SAFE-TBOX-0010/1.0]	[SAFE-TBOX-0010/2.0]	
[SAFE-TBOX-0020/1.0]	[SAFE-TBOX-0020/2.0]	
[SAFE-TBOX-0030/1.0]	[SAFE-TBOX-0030/2.0]	
[SAFE-TBOX-0040/1.0]	[SAFE-TBOX-0040/2.0]	
[SAFE-TBOX-0050/1.0]	Removed	
[SAFE-TBOX-0060/1.0]	[SAFE-TBOX-0050/2.0]	
[SAFE-TBOX-0070/1.0]	[SAFE-TBOX-0060/2.0]	
[SAFE-TBOX-0080/1.0]	Removed	
[SAFE-TBOX-0090/1.0]	[SAFE-TSET-0040/2.0]	
[SAFE-TBOX-0100/1.0]	[SAFE-TSET-0040/2.0]	
[SAFE-HARM-0010/1.0]	Removed	
[SAFE-HARM-0020/1.0]	[SAFE-HARM-0040/2.0]	
[SAFE-HARM-0030/1.0]	[SAFE-HARM-0050/2.0]	
[SAFE-HARM-0040/1.0]	[SAFE-HARM-0060/2.0]	
[SAFE-HARM-0050/1.0]	[SAFE-HARM-0070/2.0]	
[SAFE-HARM-0060/1.0]	[SAFE-HARM-0080/2.0]	
[SAFE-HARM-0070/1.0]	[SAFE-HARM-0090/2.0]	
[SAFE-HARM-0080/1.0]	[SAFE-HARM-0100/2.0]	
[SAFE-HARM-0090/1.0]	[SAFE-HARM-0110/2.0]	
[SAFE-HARM-0100/1.0]	[SAFE-HARM-0120/2.0]	
[SAFE-HARM-0110/1.0]	[SAFE-HARM-0130/2.0]	
[SAFE-HARM-0120/1.0]	[SAFE-HARM-0140/2.0]	
[SAFE-HARM-0130/1.0]	[SAFE-HARM-0150/2.0]	
[SAFE-HARM-0140/1.0]	[SAFE-HARM-0180/2.0]	
[SAFE-HARM-0150/1.0]	[SAFE-HARM-0200/2.0]	
[SAFE-HARM-0160/1.0]	[SAFE-HARM-0190/2.0]	
[SAFE-CNV-0010/1.0]	Removed	
[SAFE-CNV-0020/1.0]	[SAFE-CNV-0010/2.0]	
[SAFE-CNV-0030/1.0]	[SAFE-CNV-0040/2.0]	
[SAFE-CNV-0040/1.0]	[SAFE-CNV-0050/2.0]	

Table 5-1: SSS requirement ID traceability

Change Record

Issue	Date	Change Status	Origin
1.0	07/12/2011	First Version	GMV
2.0	31st May 2012	<p>Changes after SRR collocation meeting:</p> <ul style="list-style-type: none"> - New document structure (sections) - All requirements have been re-labeled (traceability is provided as annex) - Requirements have been deeply modified according to the SRR RID dispositions. <p>Document track changes only kept for paragraphs within each section (not for the requirements due to the big amount of changes)</p>	GMV

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