APAF-DSID-15-03561-V1.2

October 17, 2003

Data System Interface Document

For The

Swedish Institute of Space Physics (IRF)

Mars Express
ASPERA-3 Processing
and Archiving Facility
(APAF)

SwRI® Project No. 15-03561

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SwRI® Project No. 15-03561

Approved by: _____ _____
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REVISION NOTICE

Document Revision History			
Revision	Date	Section	Description of Changes
Initial Release (V1.0)	Aug-18-2000		
Revision 1 (V1.1)	Oct-31-2001	Page i	Added REVISION NOTICE section
		Signature Page	Updates made due to personnel changes
		1.2, 2.1	Re-worded to say “acquires telemetry” instead of “accepts telemetry”
		1.4	Updated names, dates, and versions of related documents
		2.2	Update of ESOC DDID Document Reference and web site usage for IDFS information in table
		2.2.2	Re-write of paragraph describing interface between APAF data system and ESOC system for acquiring telemetry data
		2.2.3	Re-write of paragraph describing usage of the www.ASPERA-3.org web site for IDFS information
		2.2.5	Clarifications made to distribution of IDFS data sets
Revision 2 (V1.2)	Oct-17-2003	Page iii	Updated acronyms
		1.2, 2.1, 2.2.1, 2.2.2	Interface for telemetry data is no longer with ESOC via NISN – telemetry data now retrieved from IRF
		1.4	Updated related documents
		2.2.5	Updated IDFS data distribution interfaces
		2.2.7	Updated local archive information
		2.2.8	Updated web display information

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ACRONYMS

APAF	ASPERA-3 Processing and Archiving Facility
ASPERA-3	Analyzer of Space Plasma and Energetic Atoms (3rd Version)
Co-I	Co-Investigator
DDID	Data Delivery Interface Document
DDS	Data Disposition System
DPU	Data Processing Unit (of the ASPERA-3 instrument package)
DSID	Data System Interface Document
ELS	Electron Spectrometer (of the ASPERA-3 instrument package)
ESA	European Space Agency
ESOC	European Science Operations Center (Darmstadt, Germany)
FMI	Finnish Meteorological Institute (Helsinki, Finland)
GIF	Graphics Interchange Format
ICD	Interface Control Document
IDD	IDFS Design Document
IDFS	Instrument Data File Set or Instrument Description File Set
IMA	Ion Mass Analyzer (of the ASPERA-3 instrument package)
IRF	Swedish Institute of Space Physics (Kiruna, Sweden)
MEX	Mars Express
MU	Main Unit – refers to ASPERA-3 Main Unit DPU (IMA has separate DPU)
NASA	National Aeronautics and Space Administration
NPD	Neutral Particle Detector (of the ASPERA-3 instrument package)
NPI	Neutral Particle Imager (of the ASPERA-3 instrument package)
OA	Orbit/Attitude (information from the Mars Express spacecraft)
OPD	Operations Procedures Document
PDMP	Project Data Management Plan
PDS	NASA Planetary Data System
PI	Principal Investigator
PIDF	Plot Interface Definition File
PM	Project Manager
PSA	ESA Planetary Science Archive
SDDAS	Southwest Data Display and Analysis System
SDP	Software Development Plan
SPM	Software Project Manager
SU	Scanning Unit (of the ASPERA-3 instrument package)
SwRI®	Southwest Research Institute (San Antonio, Texas USA)
UMU	Umeå Univeristet (University in Umeå, Sweden)
VIDF	Virtual Instrument Description File

1.0 SCOPE

1.1 Project Identification

Project Title:	ASPERA for Mars Express
Project Number:	15-02853 / 15-03561
Contract Number:	NASW-99030 / NASW-00003
Principal Investigator:	Winningham, John D.
Project Manager:	Scherrer, John R.
Software Project Manager:	Jeffers, Sandee J.
Start Date:	June 14, 1999
End Date:	September 30, 2007

1.2 Data System Overview

The ASPERA-3 instrument package (or ASPERA-3 experiment) is flown on the Mars Express spacecraft of the European Space Agency (ESA) and was launched on June 2, 2003. ASPERA-3 contains a number of different sensors that measure particles, neutral atoms, and fields in the near Martian environment. Southwest Research Institute is providing the data system to produce data products in a form suitable for analysis and archiving. These data products are in a form known as the Instrument Data File Set (IDFS).

The ASPERA-3 Processing and Archiving Facility (APAF) is a ground data system responsible for processing all of the ASPERA-3 telemetry. The APAF data system acquires the telemetry data from IRF, processes the data into IDFS data sets, makes the IDFS data sets available to the ASPERA-3 team, provides web-based displays of the most current data for public view, stores the telemetry and IDFS data sets on a local SwRI archive, and submits ASPERA-3 data to PSA and PDS for long-term archival.

The first step in defining the IDFS data sets is to identify the physical instruments that make up the ASPERA-3 experiment and any ancillary data necessary for scientific analysis. There are six components of the ASPERA-3 package, plus the orbit and attitude data from the spacecraft:

1. Main Unit Data Processing Unit (MU or DPU)
2. Electron Spectrometer (ELS)
3. Ion Mass Analyzer (IMA)
4. Neutral Particle Detector (NPD)
5. Neutral Particle Imager (NPI)
6. Scanning Unit (SU)
7. Orbit/Attitude (OA)

Each of the physical components are divided into logical groups (called virtual instruments) in which each logical group is formatted as an IDFS data set. Each of the seven components described above has an associated IDFS Design Document (IDD) that defines and describes the data contained within each individual virtual instrument.

1.3 Document Overview

The purpose of this document is to identify and briefly describe the external interfaces necessary to develop and operate the ASPERA-3 Processing and Archiving Facility (APAF). The required internal interfaces are identified, described, and documented in the associated IDFS Design Documents.

This document is applicable only to the ASPERA-3 Processing and Archiving Facility (APAF) data system which includes the IDFS processing software and the documentation needed to develop this software. The APAF documentation includes all the requirements for the APAF data system and the definitions of each virtual instrument.

1.4 Related Documents

APAF Software Development Plan: APAF-SDP-15-02853, Version 1.3 released June 7, 2001

APAF Project Data Management Plan: APAF-PDMP-15-03561, Version 1.3 released July 10, 2003

ESA Mars Express Space / Ground Interface Control Document (SGICD): ME-ESC-IF-5001, Issue 2.0, December 20, 1999

ESOC Data Delivery Interface Document (DDID): MEX-ESC-IF-5003, Issue B5, March 27, 2003

ASPERA-3 Main Unit Software User's Guide: ME-ASP-MA-0005, Issue 3, June 21, 2003

ICA-IMA TC/TM Data Formats and Related Software Aspects, Issue 1.4a, June 19, 2003

Program-Level Requirements for the ASPERA-3 Mission of Opportunity Project: approved Nov. 1999

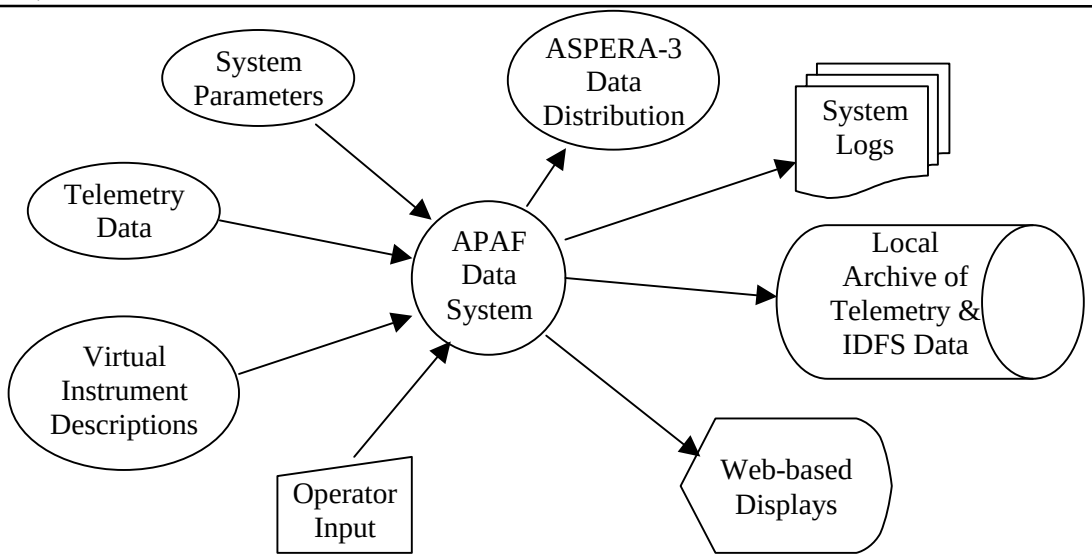
APAF Software Requirements Specifications: APAF-SRS-15-03561, Version 1.0 released April 24, 2001

APAF Operations Procedures: APAF-OPD-15-03561: www.aspera-3.org/idfs/apaf_ops.html, first online release May 30, 2003

2.0 DATA SYSTEM EXTERNAL INTERFACES

2.1 External Interfaces Overview

The APAF data system shall acquire telemetry data via IRF, process the data into IDFS data sets, make the IDFS data sets available to the ASPERA-3 team, provide web-based displays of the most current data for public view, store the telemetry and IDFS data sets on a local SwRI archive, and submit ASPERA-3 data to PSA and PDS for long-term archival. To properly develop and operate the APAF data system, various external interfaces are required. The data system interfaces are categorized either as input interfaces or output interfaces. The input interfaces refer to the information and data needed by the APAF data system to operate as required. The output interfaces refer to the information and data delivered as operational products of the APAF data system. The data system interfaces are shown in the following data flow diagram.



APAF Data Flow Diagram

2.2 External Interface Identification

The interface identifiers (ID) begin with APAF-DS to denote the APAF Data System. The next two characters refer to the category of the interface – either II for Input Interface or OI for Output Interface. Sequential numbers starting at 1 follow to uniquely identify the interfaces.

The input interfaces are identified in the table below.

Interface ID	Interface Description	Document Reference
APAF-DS-II-1	System Parameters	Programmers Guide to the ASPERA-3.org Web Server This document describes the configuration of phobos.space.swri.edu, the computer used for the development of the APAF data system
		ESOC Data Delivery Interface Document (DDID) MEX-ESC-IF-5003
APAF-DS-II-2	Telemetry Data	ME-ESC-IF-5001 Mars Express Space / Ground Interface Control Document (SGICD) (ESA Document)
		ME-ASP-MA-0005 (IRF Doc) ASPERA-3 Main Unit Software User's Guide
		ICMA-TCTM-030619a ICA-IMA TC/TM Data Formats and Related Software Aspects (IRF Document)
APAF-DS-II-3	Virtual Instrument Descriptions	APAF-SRS-15-03561 APAF Software Requirements Specifications
		Program-Level Requirements for the ASPERA-3 Mission of Opportunity Project

Interface ID	Interface Description	Document Reference
APAF-DS-II-3 (Continued)	Virtual Instrument Descriptions	The IDFS Design Documents fully document the instrument parameters, spacecraft parameters, and science information necessary for IDFS descriptions.
		The www.ASPERA-3.org web site is used for reviewing IDFS information.
APAF-DS-II-4	Operator Input	APAF-OPD-15-03561 APAF Operations Procedures Document Online: www.aspera-3.org/idfs/apaf_ops.html

The output interfaces are identified in the table below.

Interface ID	Interface Description	Document Reference
APAF-DS-OI-1	Distribution of ASPERA-3 Data	APAF-PDMP-15-03561 APAF Project Data Management Plan
		APAF-OPD-15-03561 APAF Operations Procedures Document
APAF-DS-OI-2	System Logs	APAF-OPD-15-03561 APAF Operations Procedures Document
APAF-DS-OI-3	Local Archive of Telemetry & IDFS Data	APAF-OPD-15-03561 APAF Operations Procedures Document
		Local Archive Configuration Files
APAF-DS-OI-4	Web-based Displays	www.ASPERA-3.org
		APAF-OPD-15-03561 APAF Operations Procedures Document

2.2.1 System Parameters

System parameters refer to the data items describing local time, the availability of telemetry data for retrieval, the amount of local storage available, and so forth. These parameters are concerned with the initiation, termination, and successful operation of the IDFS production process. Most are obtained through system calls or through the protocol used to acquire data files for processing, although certain parameters may be statically defined in files. Examples of static parameters are directory path names and flags controlling the level of pipelining used in the ingestion process.

The APAF Data System processes telemetry into IDFS data sets once the telemetry becomes available at IRF. Thus, the state of the data server at IRF directly determines when to start the IDFS creation process. The status variables may be explicit or implicit. Some examples of parameters originating at IRF and driving the APAF Data System are system time, telemetry availability, a reprocessing status indicator, and data quality reports (if any).

2.2.2 Telemetry Data

Telemetry data is defined as a telemetry source packet. The data structure or format of the telemetry source packet is defined within the Mars Express SGICD document. The telemetry source packet consists of a source packet header and a packet data field. The source packet header, which is a fixed length

header, defines the ESA Packet Telemetry Standard that addresses the transport of telemetry data between user applications on the ground and user-applications on-board the satellite. The packet data field, which is a variable length field, contains the data elements of the telemetry reported to the ground. Members of the ASPERA-3 flight software team at FMI and UMU are providing the definitions of the data elements reported to the ground. The data definitions indicate characteristics such as name, byte location within the variable length field, bit location within the byte for sub-commutated data, and pre-defined values (if applicable). Additional characteristics, such as units of measurement and range or enumeration of possible values are anticipated from other documents to be provided by members of the ASPERA-3 team.

The APAF data system shall acquire telemetry data via IRF. ESOC provides a means for instrument groups (IRF for ASPERA-3) to automatically receive the telemetry data as it becomes available. An automated process is being developed on the APAF data system that interfaces with the IRF system in order to properly receive the data in a timely fashion. The specifics of this process are documented in the APAF Operations Procedures.

2.2.3 Virtual Instrument Descriptions

In order to convert the telemetry data into IDFS data sets, an understanding of the data products being returned from the instruments and the spacecraft is needed. Based upon information received from various members of the ASPERA-3 team, IDFS Design Documents have been created. These documents describe the instrument parameters, spacecraft parameters and all pertinent science information that is needed for usage within the IDFS paradigm.

The IDFS Design Documents contain detailed information for each of the data items defined such as:

- the name
- measurement number (if applicable) for cross-reference
- pre-defined fill value
- units of measurement
- algorithms for unit conversion
- range or enumeration of possible values
- the format of the data item such as integer or floating point
- the size of the data (in bits)
- information pertinent to the determination of time tags
- point of contact

The goal behind the IDFS format is that the data should be self-documenting; that is, all required instrument characteristics and processing algorithms should be captured to enable high-level science analysis.

The SwRI software team makes use of the www.ASPERA-3.org web site to post the information that is extracted and inferred from the reading of the gathered information for review by the ASPERA-3 team members.

2.2.4 Operator Input

Even though the APAF data system is automated, operator input will be required on occasion. An operator shall review the system logs on a regular (usually daily) basis to ensure the IDFS data sets have been processed, locally archived, and available to the ASPERA-3 team within 24 hours of receiving the telemetry data. The operator is also responsible for reporting all problems to the SwRI ASPERA-3 software team so that timely resolutions can be made. Some events may trigger operator intervention where steps in the automated process will require manual execution. These events and associated operator actions are to be described in the APAF Operations Procedures Document.

2.2.5 Availability of IDFS Data Sets

Once the telemetry data has been processed into IDFS data sets, the data are made available to members of the ASPERA-3 team. All generated ASPERA-3 IDFS data sets are locally archived on the SwRI ASPERA-3 data server. The members of the ASPERA-3 team can retrieve the data in the following ways:

1. Web-based interface for download of predefined displays or selected IDFS data sets.
2. Web-based interface to export IDFS data to ASCII, XML, CDF, or netCDF for download.
3. Install SDDAS (www.sddas.org) on local computer to use automatic promotion of data during analysis.
4. Mirror SwRI Mars Express data server.

The www.aspera-3.org home page will have a link to the ASPERA-3 web-based data. During the 6-month validation period, this interface is to be password protected and the ASPERA-3 PI or Co-PI must approve user access.

2.2.6 System Logs

The design of the APAF system emphasizes automation of the activities to retrieve the telemetry data, process the data, and locally archive the telemetry and IDFS data sets. However, the success of automation relies on the successful completion of each intermediate step in the process. In order to help diagnose any problems encountered on unsuccessful attempts, system log files are to be maintained. The system log files are structured such that failures or problems can be identified and resolved easily. The goal in maintaining the log files is to enable the operator to re-start the failed process by intervening manually to fix the point of failure.

The system log files are in ASCII format, thereby allowing easy access and readability. These files are read-only files to all parties except the instantiator of the processes that are invoked, either manually or automatically. The names and locations of these system log files are to be documented in the APAF Operations Procedures Document.

2.2.7 Local Archive of Telemetry and IDFS Data

The telemetry data that are ingested into the APAF data system are to be stored on a dedicated RAID disk on a computer at Southwest Research Institute in San Antonio, Texas USA. The IDFS data sets that are generated from the telemetry data are archived on a data server at SwRI. The domain name of the data server is to be APAFDS.space.swri.edu. The machine will be purchased and installed before Mars encounter.

The APAF data system shall locally archive the telemetry and IDFS data within 24 hours of receiving the telemetry data. The location of the telemetry and IDFS data files are specified in a configuration file and described in the APAF Operations Procedures Document. The format of this configuration file is ASCII and the file is read-only to all parties except for the system administrator.

2.2.8 Web-based Displays

Once the newly generated IDFS data sets have been locally archived, the data are displayed on the web as GIF files in pre-defined graphical representations. A link from the www.ASPERA-3.org web site is to be provided, or direct access to these files can be gained at the MEXdata.space.swri.edu web site. The generation of the GIF files is achieved by utilizing the Southwest Data Display and Analysis System (SDDAS). SDDAS is a flexible, extensible software system that is oriented toward the examination of data that is stored in IDFS format. The details of managing the GIF files and display definition templates are to be documented in the APAF Operations Procedures.