User Requirements Document (URD)
Open Data Interface (ODI)
ESTEC/Contract No. 21964/08/NL/AT

September 22, 2009

Prepared by:

Peter Wintoft
Swedish Institute of Space Physics

Daniel Heynderickx
DH Consultancy

Approved by:

Lars Eliasson
Swedish Institute of Space Physics

Hugh Evans
ESA/ESTEC

Annika Tenho
ESA/ESTEC

Document status sheet

Version	Date	Comment
0.1	2009-01-07	First draft.
1.0	2009-04-07	Updated the contract number. Major revision.
1.1	2009-09-22	Major revision.

Contents

1 Introduction

ESA has several systems for evaluating and analysing the effects of the space environment on spacecraft, principally: SAAPS, SEDAT, and SPENVIS. Each of these systems fulfils a unique requirement in the analysis of the environment and makes use of the available data on the environment, such as radiation monitor fluxes and geomagnetic indices. Many of the datasets included in these systems are common to them all and require regular updates. To simplify the database requirements of these systems and their maintenance a common database infrastructure is required.

The Satellite Anomaly Analysis and Prediction System (SAAPS) provides an analysis and prediction service to be used by spacecraft operators and engineers to mitigate the effects of space weather related anomalies, in particular from spacecraft charging. SAAPS uses a specially developed database that is updated in real time with space environment data. SAAPS contains a set of routines that can read, write, delete and update data in the database. Data in ASCII format can be imported to and exported from SAAPS. SAAPS is written in Java.

Space Environment Data Analysis Tool (SEDAT) provides a java client interface through which the user can write and initiate his own analysis routines in the ITT/IDL language using the datasets loaded into the SEDAT system. These routines interface to the SEDAT datasets via a set of 5 interface routines, for opening datasets, reading datasets, writing datasets and closing datasets. The user's client interface communicates with a server via HTTP, and the analysis is performed entirely on the server. Users can download the data contained in the SEDAT system in either ASCII or CDF format. Datasets that the users create from their analyses are stored as CDF files on the system and are not to be included in the system's SQL dataset but remain on the SEDAT server in this format.

The Space Environment Information System(SPENVIS) provides a web based interface to a series of well known space environment and effects models. In addition to these models, it provides plotting and limited data download functionality for a subset of space environment datasets.

The objective of this project is to create an MySQL database and populate it with data common to SAAPS, SEDAT, and SPENVIS. Routines shall also be developed so that the database is automatically updated for live data sets. Interface routines shall be developed so that SAAPS, SEDAT, and SPENVIS can access the data in the database.

This document captures the user requirements.

2 Applicable and reference documents

SOW SOW ESTEC/Contract No. 21964/08/NL/AT

E401B ECSS-E40 Part 1B

E402B ECSS-E40 Part 2B

PRBEM/Guide Bourdarie, S., et al., Panel on radiation belt environment modeling – Standard file format guidelines, http://craterre.onecert.fr/prbem/Standard_File_Format.pdf

ODI/TN ODI Technical Note

3 Terms, definitions and abbreviated terms

ODI Open Data Interface

PRBEM Panel on Radiation Belt Environment Modeling

SAAPS Satellite Anonmaly Analysis and Prediction System

SEDAT Space Environment Data Analysis Tool

SOW Statement of Work

SPENVIS Space Environment Information System

SSS Software System Specification

TSO Time Series Object

4 General description

4.1 Product perspective

The ODI software system shall be developed to form a common data platform for SAAPS, SEDAT, and SPENVIS. The SAAPS/SEDAT/SPENVIS systems will be updated in order to access the ODI database. Figure 1 illustrates the realation between the ODI database and the SAAPS/SEDAT/SPENVIS systems.

Another requirement is that the ODI database shall be compliant with the PRBEM standard. Therefore it is important to analyse the PRBEM data definition and compare it to the SAAPS/SEDAT/SPENVIS databases. This is done in ODI/TN.

4.2 General capabilities

The metadata and variables that are stored in the ODI database must be the superset of metadata and variables for each stored dataset. The datasets comply with the ISTP standard that defines a complete list of metadata. The PRBEM standard ads a set of variables to be used for radiation belt data.

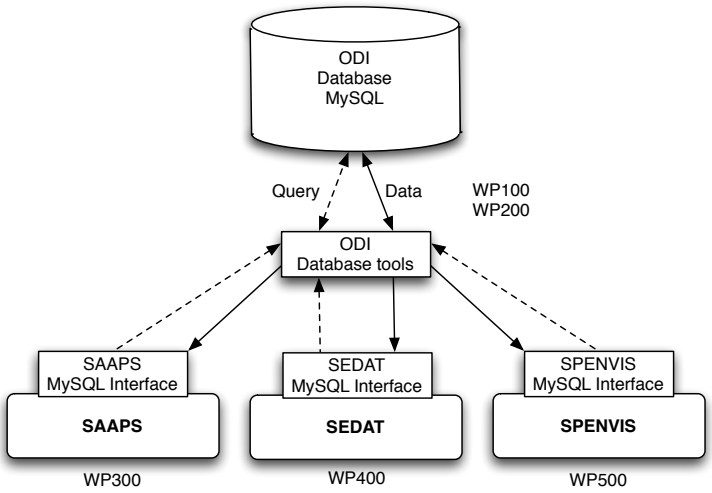

Figure 1: **Illustration of the ODI system and the related SAAPS/SEDAT/SPENVIS systems.**

4.2.1 Data in the ODI database

According to SOW:A.1 the ODI database shall be populated with the contents of the ESTEC SEDAT database as it stands at kick-off. There is considerable overlap between the data sets contained in SAAPS, SEDAT, and SPENVIS. We will therefore populate the ODI database with the data listed in ODI/TN. The data will be acquired from either the existing SAAPS, SEDAT, and SPENVIS databases, or from the original sources. When new datasets become available they shall be manually stored into the ODI database using a script. Live data sets shall also be automatically updated with frequencies suitable for the respective data sets. Several datasets will be downloaded over the Internet and the system must thus be connected using TCP/IP.

4.2.2 CDF, ISTP/IACG and PRBEM standard file format

The PRBEM format builds on the ISTP/IACG guidelines by adding another layer of variables. The set of additional variables depend on the instrument generating the data. The space physics guide lines for CDF[1] state:

> A CDF data set using ISTP/IACG guidelines, by definition forms a logically complete and self-sufficient whole (data and descriptions). The goal is to make the resulting CDF data set correctly and independently usable by the science community and accessible through the CDAWeb Display and Retrieval system. These guidelines have been adopted by a wide SEC community.

[1] http://spdf.gsfc.nasa.gov/sp_use_of_cdf.html

Both the data and the metadata are contained in one file following the CDF standard.

The CDF file contains *global attributes*, *variables*, and *variable attributes*. The variables are further divided into *data variables*, *support_data variables*, and *metadata variables*. One CDF file contains one day of data and the file name is constructed from the source_name, data_type, descriptor, date, and data_version, e.g. GE_K0_MGF_-19920923_V01. The storage of metadata is analysed and described in ODI/TN.

4.2.3 ODI interface

To simplify the process of accessing data from the ODI database an interface shall be defined. This interface shall be used by the SAAPS/SEDAT/SPENVIS systems and may also be used for other applications like Matlab. The required parameters to access data are

- ODI data table name,
- one or several field names,
- time interval, which could be one of the following:
  - all records between a start time and an end time,
  - all records after a given time,
  - all records before a given time,
  - or all records.

The output from the query on the database shall be either an ASCII file or a CDF file. The ASCII file is constructed as a table with one record for each row. The first column is always the epoch and the following columns contain the data fields.

It shall also be possible to explore the metadata in the ODI database using a set of standard functions. These functions shall return at minimum the following:

- Get the epoch range of a specific dataset.
- Get the number of records in a dataset.
- Get the field names of a dataset.

4.2.4 SAAPS-ODI

The SAAPS interface to the ODI database shall be restricted to read access. As SAAPS has been implemented in Java the SAAPS-ODI interface shall also be coded in Java using the JDBC. SAAPS uses the TSO for all its modules (plotting, analysis, forecasting), where the TSO is created from the data in the database. The SAAPS-ODI interface needs to implement the following functions:

1. Get a list of the datasets in the database.

2. Get the field names of each variable in a selected dataset.
3. Get the metadata of a selected dataset.
4. Get the metadata of a selected field in a selected dataset.
5. Get the data from a selected dataset, data fields, and start and end epochs.

4.2.5 SEDAT-ODI

The SEDAT interface to the ODI database shall be restricted to read access.

4.2.6 SPENVIS-ODI

The SPENVIS interface to the ODI database shall be restricted to read access.

4.2.7 User characteristics

We identify the users of the ODI system as given in Table 1.

Table 1: The ODI system users.

Id.	Name	Description
U.1	User 1	The user at this level has complete control over the ODI database. This is typically a system administrator.
U.2	User 2	The user at this level is allowed to update and add new data to the existing database, but not allowed to change the structure of the database or to remove data. This user is typically used by automatic processes to update the database with real time data.
U.3	User 3	The user at this level is only allowed to retrieve data from the database. This is the normal end user and also used by the SAAPS, SEDAT, and SPENVIS systems.

4.3 General constraints

To minimise the possibility of accidentally changing the ODI database it is only a user at the administration level that are allowed to delete and update the data. Other levels of user may be added that have only read access.

The ODI system shall build on an MySQL database system and all software used shall be freeware unless agreed with the Agency.

The performance of the system is not crucial as there are no applications that require real-time operation. The SAAPS system requires live data sets, but the cadence is at maximum one minute and the amount of data accessed is small. But to still ensure a

smooth operation of the system it is required that at least 50 000 data records could be read in less than one second. It is assumed that this is performed directly in MySQL on a new standard desktop computer with no other jobs running.

4.4 Operational environment

The ODI database will run at the ESTEC TEC-EE Electromagnetics Computing Facility operated by engineers. The system will be connected to the Internet (TCP/IP) and run behind the ESA/ESTEC firewall and the protocols used to access servers external to ESA must be limited to the protocols accepted by the firewall (HTTP, HTTPS, FTP, TELNET). For other connections SSH shall be used.

The SAAPS/SEDAT/SPENVIS systems are run independently from the ODI system but shall automatically connect to the ODI database to retrieve data.

The ODI software shall run on an OpenSuse Linux Cluster. However, the ODI system will build on software that run on many different platforms.

For the operation of ODI the following software are needed: MySQL, PHP, IDL, and IDL/Dataminer. These will be paid for and installed by ESA/ESTEC on the ESA/ESTEC server.

5 Specific requirements

5.1 Capabilities requirements

ODI.CAP.1	The system shall provide a common database infrastructure for SAAPS/SEDAT/SPENVIS.
Source	Section 4.1
Criticality	Mandatory
Verification	Test the functionality of SAAPS/SEDAT/SPENVIS.

ODI.CAP.2	The system shall contain all data that are used by SAAPS, SEDAT, and SPENVIS.
Source	Section 4.2.1
Criticality	Mandatory
Verification	Check the contents of the ODI database against Table **??**.

ODI.CAP.3	The system shall contain all metadata that are used by SAAPS, SEDAT, and SPENVIS.
Source	Section **??**
Criticality	Mandatory
Verification	Check the contents of the ODI database against Section **??**.

ODI.CAP.4	The system shall be able to store data compliant with CDF/ISTP/PRBEM.
Source	Section 4.1
Criticality	Mandatory
Verification	Store PRBEM data.

ODI.CAP.5	The system shall be able to store metadata compliant with CDF/ISTP/PRBEM.
Source	Section 4.1 and Section **??**
Criticality	Mandatory
Verification	Store PRBEM metadata.

ODI.CAP.6	The system shall allow the ingestion of new data sets.
Source	Section 4.2.1
Criticality	Mandatory
Verification	Add a new dataset to the system.

ODI.CAP.7	The system shall provide for automatic updates of live data.
Source	Section 4.2.1
Criticality	Mandatory
Verification	Monitor the update of live data sets.

ODI.CAP.8	The system shall return the epoch range of datasets.
Source	Section 4.2.3
Criticality	Mandatory
Verification	Execute function to get epoch range.

ODI.CAP.9	The system shall return the number of data records in each dataset.
Source	Section 4.2.3
Criticality	Mandatory
Verification	Execute function to get number of records.

ODI.CAP.10	The system shall return the field names of the data records in each dataset.
Source	Section 4.2.3
Criticality	Mandatory
Verification	Execute function to get field names.

ODI.CAP.11	The system shall return the contents of a dataset query as an ASCII file.
Source	Section 4.2.3
Criticality	Mandatory
Verification	Export to ASCII file and examine the file contents using a text editor.

ODI.CAP.12	The system shall return the contents of a dataset query as a CDF file, compliant with ISTP/IACG and COSPAR PRBEM guidelines.
Source	Section 4.2.3
Criticality	Mandatory
Verification	Export to CDF file and examine the file using CDF software.

ODI.CAP.13	The system shall return the metadata of a dataset.
Source	Section 4.2.3
Criticality	Mandatory
Verification	Export the metadata for a dataset and examine.

ODI.CAP.14	A standard interface shall be defined for the reading of the data and metadata from the system.
Source	Section 4.2.3
Criticality	Mandatory
Verification	Use the interface to read a selected dataset.

ODI.CAP.15	The SAAPS access shall follow the standard interface.
Source	Section 4.2.3
Criticality	Mandatory
Verification	Perform an action using SAAPS on a selected dataset.

ODI.CAP.16	The SEDAT access shall follow the standard interface.
Source	Section 4.2.3
Criticality	Mandatory
Verification	Perform an action using SEDAT on a selected dataset.

ODI.CAP.17	The SPENVIS access shall follow the standard interface.
Source	Section 4.2.3
Criticality	Mandatory
Verification	Perform an action using SPENVIS on a selected dataset.

ODI.CAP.18	The SAAPS system shall be updated to the SAAPS-ODI system that connects to the ODI database.
Source	Section 4.2.4
Criticality	Mandatory
Verification	Test the SAAPS system.

ODI.CAP.19	The SEDAT system shall be updated to the SEDAT-ODI system that connects to the ODI database.
Source	Section 4.2.5
Criticality	Mandatory
Verification	Test the SEDAT system.

ODI.CAP.20	The SPENVIS system shall be updated to the SPENVIS-ODI system that connects to the ODI database.
Source	Section 4.2.6
Criticality	Mandatory
Verification	Test the SPENVIS system.

5.2 Constraints requirements

ODI.CON.1	The database shall be implemented in MySQL.
Source	Section 4.3
Criticality	Mandatory
Verification	Access the database using mysql software.

ODI.CON.2	The database shall be implemented on Open Suse Linux.
Source	Section 4.4
Criticality	Mandatory
Verification	Install and run the system at ESTEC.

ODI.CON.3	The system shall be connected to the Internet using TCP/IP.
Source	Section 4.2.1 and Section 4.4
Criticality	Mandatory
Verification	Connect to the Internet from the ODI server.

ODI.CON.4	The system shall provide an interface to ITT/IDL.
Source	Section 4.4
Criticality	Mandatory
Verification	

ODI.CON.5	The system shall provide on average at least 50 000 data records in less than a second using a direct MySQL connection locally on the system.
Source	Section 4.3
Criticality	Mandatory
Verification	Load 50 000 data records using mysql software.

ODI.CON.6	Access from the ODI system to external servers shall be limited to protocols permitted by the ESA firewall (HTTP, HTTPS, FTP, TELNET).
Source	Section 4.4
Criticality	Mandatory
Verification	Execute ODI code that accesses data external to the ESA/ESTEC firewall.

ODI.CON.7	The system shall make use of freeware. Third party software is to be agreed with the Agency.
Source	Section 4.3
Criticality	Mandatory
Verification	Check the licences of all used software.

ODI.CON.8	IDL and IDL/DataMiner will be payed for and installed by ESTEC.
Source	Section 4.3
Criticality	Mandatory
Verification	Run IDL and Dataminer on the ESA/ESTEC server.

ODI.CON.9	The system shall allow read only access from the SAAPS system.
Source	Section 4.2.4
Criticality	Mandatory
Verification	Inspect the mysql grant setting for SAAPS.

ODI.CON.10	The system shall allow read only access from the SEDAT system.
Source	Section 4.2.5
Criticality	Mandatory
Verification	Inspect the mysql grant setting for SEDAT

ODI.CON.11	The system shall allow read only access from the SPENVIS system.
Source	Section 4.2.6
Criticality	Mandatory
Verification	Inspect the mysql grant setting for SPENVIS.

ODI.CON.12	Only the database administrator account (U.1) shall have complete control over the database.
Source	Section 4.2.7
Criticality	Mandatory
Verification	Inspect the mysql grant settings for the U1 user.

ODI.CON.13	The U.2 user shall have read, write, and update premissions to the database.
Source	Section 4.2.7
Criticality	Mandatory
Verification	Inspect the mysql grant settings for the U2 user.

ODI.CON.14	Normal end users (U.3) shall have read only access to the database.
Source	Section 4.2.7
Criticality	Mandatory
Verification	Inspect the mysql grant settings for the U3 user.

ODI.CON.15	SSH must be installed.
Source	Section 4.4
Criticality	Mandatory
Verification	Connect to the ODI systems running at ESTEC using SSH.

ODI.CON.16	A MySQL server must be installed.
Source	Section 4.4
Criticality	Mandatory
Verification	Start a mysql session.

ODI.CON.17	The IDL software must be installed.
Source	Section 4.4
Criticality	Mandatory
Verification	Start an IDL session.

ODI.CON.18	The PHP software must be installed.
Source	Section 4.4
Criticality	Mandatory
Verification	Run a PHP script.

ODI.CON.19	The PHP software must be configured to allow connections to the MySQL server.
Source	Section 4.4
Criticality	Mandatory
Verification	Connect to the mysql database usning a PHP script.