SAAPS

Satellite Anomaly Analysis and Prediction System

Test Plan

Version 1.0

ESA/ESTEC Contract No. 11974/96/NL/JG(SC)

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February 28, 2001

Document status sheet

Test Plan, SAAPS		
Version	Date	Comment
0.1	1 November 2000	Created
0.2	14 November 2000	Major revision
1.0	February 28, 2001	All tests documented

Contents

Chapter 1

Introduction

SAAPS consists of three parts: the database and database tools (DB&T), the satellite anomaly analysis module (SAAM), and the satellite anomaly prediction module (SAPM). The DB&T runs both automatically by updating the database and manually from requests from the SAAM or SAPM. The SAAM and SAPM only runs manually and are connected to a user interface.

In the SAAPS Manual [*Wintoft,* 2000c] are described how the DB&T, SAAM, and SAPM are operated. There are also examples of how two perform various operations.

This document describes how SAAPS shall be tested for all the functions described in the URD's. The test plan is divided to test the three subsystems: DB&T, SAAM, and SAPM.

1.1 Abbreviations

The abbreviations used in this document are listed in Table 1.1.

Table 1.1: Abbreviations used in the text

`SAAPS_DATA`	The base directory of the SAAPS database
`SAAPS_MODELS`	The base director of the SAAPS models database
`SAAPS_HOME`	The base director of the compiled SAAPS code (`.class` files)
`SAAPS_TEST`	The base director of the test files to be used for the testing of SAAPS
`GUI`	Graphical User Interface
`DataInspector`	A GUI to inspect the data in the database

Chapter 2

Test plan for database and database tools

The test of the database routines can only be performed on the SAAPS server as these are not accessible from the outside.

2.1 Check available data

DB&T.CAP.1

The database consists of a number of files under the SAAPS home database directory, which we hereafter call `SAAPS_DATA`. The data files ends with the suffix `.data` and the meta data files with `.meta`. In Tables 1 and 2 in the database URD [*Wintoft,* 2000a] the data are listed.

2.1.1 Test

At the prompt do

```
cd $SAAPS_HOME
ls
```

The files listed in Table 2.1 shall exist with suffixes `.data` and `.meta` in `SAAPS_DATA`. Listing the directory shall verify this.

2.2 Check latest available data

DB&T.CAP.2

Part of the database is updated in real time with between 10 minutes and 1 hour intervals. The real time data are listed in Table 2 in the database URD [*Wintoft,* 2000a]. In Table 2.2 the real time data files are shown together with the update frequency.

Table 2.1: The files in the database. Each file exists in two versions: `.data` and `.meta`.

OMNIDB	OMNI data
LANLDB	LANL particle data
GOES08partDB	GOES-08 particle data
GOES08xrayDB	GOES-08 x-ray data
GOES10partDB	GOES-10 particle data
GOES10xrayDB	GOES-10 x-ray data
ACEmagDB	ACE magnetic field data
ACEsweDB	ACE plasma data
KpDB	Estimated Kp
KpPredDB	Predicted Kp
DstDB	Predicted Kp
AEDB	Predicted Kp

Table 2.2: The files of the real time data with updating frequencies

GOES08partDB	10 min
GOES08xrayDB	10 min
GOES10partDB	10 min
GOES10xrayDB	10 min
ACEmagDB	10 min
ACEsweDB	10 min
KpEstDB	1 hour
KpPredDB	1 hour

2.2.1 Test

At the prompt do

```
ExportAscii <name> yyyy.mm.dd 00:00:00 1440
```

where `<name>` is replaced by the names in Table 2.2. The `yyyy`, `mm`, and `dd` are replaced by the current year, month, and date, respectively. The command above will export the all data for the current day, more precisely it will export 1440 minutes (=24 hours) of data starting from hour 00UT.

2.3 Inspect meta data

DB&T.CAP.3

The meta data shall contain the name of the database object, the start and end times, the time resolution, the field names and units, and a short description of the data.

2.3.1 Test

At the prompt type

```
ShowMetaData <file>
```

where `<file>` is replaced by the names in Table 2.1. The meta data should now be listed on the screen.

2.4 Add a new database object

DB&T.CAP.4
DB&T.CAP.7

To add a new database object the (system) user must create two Java classes. The classes are created by copying two template classes available on the SAAPS server. The user must then add the necessary information of the database object, such as the name of the object, the data fields, and the field units. The creation of the database object is described in the SAAPS Manual [*Wintoft,* 2000c].

After the creation of the Java source code for the new database object the two classes must be compiled.

Finally, the database objects are added to the database by executing the `AddDatabaseObject` command. This step will create the `.data` and `.meta` files in the database. The new object will automatically appear in any of the tools in SAPM or SAAM.

2.4.1 Test

The compilation of the Java source code and the adding of the new database object is done with the command `AddDatabaseObject`. There exist a dummy database object for which this can be done. Do the following steps:

```
ls $SAAPS_DATA
AddDatabaseObject DummyDB
ls $SAAPS_DATA
ShowMetaData DummyDB
```

The first `ls` command should show that there are no `DummyDB.*` files. If they do exist, remove them by typing `rm DummyDB.*`. After `AddDatabaseObject` has been run the `DummyDB.*` files should now exist. Two new class files have also been created at

```
$SAAPS_HOME/saaps/dbt/Dummy.class
$SAAPS_HOME/saaps/dbt/DummyDB.class
```

Finally, the contents of the meta data are explored with `ShowMetaData`.

2.5 Updating of the meta data

DB&T.CAP.5

Every time new data are added to an existing database object the meta data will be updated with new end time.

2.5.1 Test

Examine the meta data with `ShowMetaData`. Then run the `DummyUpdate1` program that will add new data to the DummyDB database. Run `ShowMetaData` again, and inspect and verify that the meta data has been updated.

2.6 Updating the database

DB&T.CAP.8

When new data are appended to existing data there can arise different situation as described in Section 2.4.2.12 in the SAAPS SRD [*Wintoft,* 2000b].

The program `DummyUpdate2` appends data for the situation when there is overlap in time between the SAAPS data and the new data.

The program `DummyUpdate3` appends data for the situation when there is a gap in time between the SAAPS data and the new data.

2.6.1 Test

Export the data using

```
ExportAscii DummyDB 2001.01.01 00:00:00 1440
```

This should show all available data for one day. Note that the data ends at 03:59:00.

Run `DummyUpdate2` followed by

```
ExportAscii DummyDB 2001.01.01 00:00:00 1440
```

The `DummyUpdate2` has overlapping data for hour 03 with new values which should show up in the exported data. The data now also continues through hour 06.

Finally, run `DummyUpdate3` and again followed by the `ExportAscii`. The `DummyUpdate3` contain data from hour 08, while the data in the database ends at hour 06. The data for hour 07 should thus be filled in with NaNs representing data gaps.

2.7 Read meta data

DB&T.CAP.9

The meta data can be read either locally on the SAAPS server or over the Internet using a web browser.

2.7.1 Test

The previous tests where `ShowMetaData` have been used should already have verified the the reading of the meta data works.

The reading of the meta data over the internet can be tested using a web browser. Launch the SAAPS models from a web browser. Select the data plotter tool. The database objects should be shown in one of the list windows. Select one object and click the Inspect button. The meta data should now be displayed in a new window.

2.8 Read data

DB&T.CAP.10

The data can be read either locally on the SAAPS server or over the Internet using a web browser.

2.8.1 Test

The previous tests where `ExportAscii` have been used should already have verified the the reading of the data works.

The reading of the data over the internet can be tested using a web browser. Launch the SAAPS models from a web browser. Select the data plotter tool. The database objects should be shown in one of the list windows. Select one object and click the Get Data button. Verify that the data have been read by creating a plot.

2.9 Export SAAPS data to ASCII

DB&T.CAP.12

The data in the SAAPS database can be exported to ASCII files.

2.9.1 Test

The previous tests using `ExportAscii` should have verified this function.

2.10 Import ASCII data to the SAAPS database

DB&T.CAP.13

For an existing database object new data can be added by importing it from an ASCII file. The ASCII data must have the following format:

```
YYYY MM DD hh mm ss field_1 field_2 ... field_n
```

where the six first fields are the year, month, date, hour, minute, and second. The following `n` fields are the data fields. The number of data fields must match the number of fields defined in the database object definition, e.g. the `Dummy.java` file.

What can go wrong for continuous data? 1) ASCII data not continuous, 2) ASCII data not time ordered, 3) first data in ASCII data before the first date in the SAAPS database.

2.10.1 Test

A prepared ASCII file called `DummyData.txt` exist at `SAAPS_TEST`. Execute

```
ImportAscii DummyDB $SAAPS_TEST/DummyData.txt
```

which should add new data to the `DummyDB` object. Verify that the data has been added to the database with `ExportAscii`.

2.11 Meta data user interface

DB&T.CAP.14

Web browser?

2.12 Data user interface

DB&T.CAP.15

Web browser?

2.13 Remove data and meta data

DB&T.CAP.6
DB&T.CAP.11

A database object is removed by simply deleting the `.data` and `.meta` files in the database with the UNIX command `rm`. The Java classes need not to be removed.

If there is an automatic update that is still running after the database object that has been removed it will be created automatically again.

2.13.1 Test

Start a web browser and visit the SAAPS user page. Start the data plotter tool and verify that the DummyDB item appears in the database objects list.

Remove the `DummyDB.data` and `DummyDB.meta` files by executing

```
rm DummyDB.*
```

at the command prompt. Reload the web page and verify that the object has disappeared from the list.

2.14 Short interrupts in network communication

DB&T.CON.2

Short interrupts in network communication shall not affect the database more than that the latest data will not be available. An interrupt is considered short when it lasts for a time period shorter than the time extent of the original ftp data. This means that when the interrupt has passed the missing data in SAAPS shall be filled with the data available at the source.

2.14.1 Test

The test is performed by physically disconnecting the SAAPS server from the network for one hour. During this hour the data in the database shall be examined. This verifies that the server is still running but the latest data are missing. The SAAPS server is the reconnected to the network and the database is examined again. The data for the period when SAAPS was disconnected shall now exist in the database.

2.15 Long interrupts in network communication

DB&T.CON.2

Long interrupts in network communication will affect the SAAPS database. The database will contain data gaps for the time period for which the interrupt lasted. An interrupt is considered long if the interrupt lasts for a time period that is longer than the time period for which the data at the source extends over.

2.15.1 Test

This test is carried out by physically disconnecting the SAAPS server from the network for four hours. This will affect the ACE and GOES data as the data sources only contain the latest two hours of data. After SAAPS has been reconnected with the network the database shall be examined. The data will show a two hour long period for which the data fields are set to NaNs.

2.16 Data gaps in source data

DB&T.CON.2

Occasionally there will be data gaps in the source data from the ftp site. The description of the data gaps varies from the different sources. In the SAAPS database the gaps shall always be described with NaNs (Not a Number). Sometimes the last data in the source contain a data gap while a few minutes later this gap has been replaced by a value.

2.16.1 Test

The propagation of the data gaps are tested by searching the data source for periods with data gaps, and exploring the data in the SAAPS database for the same period.

Chapter 3

Test plan for the satellite anomaly analysis module

There are two aspects of the testing of the user interface. Firstly, there is the test of the expected behaviour of the tool when the user proceeds along the right steps. Secondly, there is the test of when the user misses some essential step and tries to proceed. The different tools usually contain several items that need to be specified by the user to be able to produce expected action. If the items in the interface have not been correctly set the user shall be notified.

3.1 SAAPS database connection

SAAM.CAP.1

The satellite anomaly analysis module (SAAM) shall make use of the SAAPS database. SAAM is run from a web browser on a client machine and the data in the database at the SAAPS server shall be loaded over the Internet to the web browser.

3.1.1 Test

Launch the data plotter tool from the web browser and inspect that the database items listed in Table 2.1 appears in the database list window. Use the Inspect button on each item to see the details.

3.2 2-D data plotter

SAAM.CAP.2
SAAM.CAP.3
SAAM.CAP.4

From the web browser the user can plot lines or points of 2-D data. The user can select what data to plot and select the time periods. Situations when the user uses the tool in the wrong way may appear and the user should be notified.

3.2.1 Test

The first part of the test tests the situation when the tool is used in the wrong way.

No data selected Reload the data plotter tool in the web browser such that no item in the database list is selected. Push the Get Data button. A dialog shall appear informing that the user must first select a database item.

Dates outside range Select an item from the database list. Then select start and end dates that are outside the database range, e.g. select data for next year. Push the Get Data button. The user shall be notified that the selected dates are outside the available range.

No field selected Select an item from the database and valid start and end dates. Push Get Data button. A dialog shall appear that informs the user data are loading. The x- and y-axis fields are set with the available data fields. Do not select any fields. Push the Plot Data button. A dialog shall appear that informs the user the fields must be selected to be able to plot.

Create a plot Now select one field for the x-axis, it is only possible to select one field for the x-axis. Select one or more fields for the y-axis. Push the Plot button. A window with the plot shall appear. Inspect the x- and y-axis labels and verify the the field names and units are present.

Resize window The size of the window can be changed and the plot surface will fill the available space. Verify this.

Zoom in plot It is possible to zoom in and out in the plot, and to restore it to the original zoom. In the plot surface place the cursor and click-and-drag with the mouse downwards and to the right. A rectangle shall appear that indicates the part of the plot that will fill the window. Release the mouse button and the new plot shall appear. Repeat the above steps but move the mouse upwards and to the left. Two rectangles shall now appear. The innermost indicates the size of the current plot, while the outermost indicates the size of the new plot. Finally, the original plot can be restored by selecting the Fill item from the Axis menu.

Logarithmic scaling The scaling of the axes can be linear or logarithmic (base 10). Try using logarithmic scaling for both the x-axis and the y-axis. Any negative values shall be ignored.

Line style Verify that the data points can be plotted with connected lines or points or both. The items are available under the Lines menu.

Close the plot window Verify that the window disappears when the windows close button is pushed.

3.3 Coordinate transformations

SAAM.CAP.5

For spacecraft with positional information the user can select to plot in different coordinate system. The positional information either comes from the data in the SAAPS database or from input from the user. The supported coordinate systems are: geographic (GEO) and magnetic (B-L).

3.3.1 Test

Launch the coordinate transformation tool from the web browser.

Database list Select one item from the database list that consists of spacecraft data with positional information, e.g. `GOES08DB`. Select a valid time period and transform from GEO to BL.

User list Enter positional information in GEO-R-PHI coordinates in the user list:

```
3.0  0.0
4.0 15.0
5.0 30.0
6.0 45.0
7.0 60.0
```

Select the transformation to go from `GEO-R-PHI` to `B-L` coordinates and push Plot.

3.4 Interpolation

SAAM.CAP.6

Interpolation is useful when data are missing (data gaps). This is especially true for data that should be used for superposed epoch analysis.

3.4.1 Test

The test is performed under Section 3.6.

3.5 Time averages

SAAM.CAP.7

To restrict the amount of data that are retrieved over the Internet form the SAAPS server to the client time averaging is useful. Time averaging also

comes in to use when different data with different samplings are to be used in a model.

3.5.1 Test

Launch the data plotter tool from the web browser.

High resolution data Select the `ACEmagDB` data and get the data for the last three days. This will load the one minute resolution data. Select `Time` on the x-axis and `Bt` and then push Plot. This will create a plot with the one minute data.

One hour data Again, Select the `ACEmagDB` data and get the data for the last three days. Click the Average check box and set the time resolution to one hour. Then push the Get Data button. The loading of the data should be quicker, but the same data fields shall appear. Select the Time and Bt fields and push Plot. Compare the two plots to ensure that they are related.

3.6 Superposed epoch analysis tool

SAAM.CAP.6
SAAM.CAP.8

The superposed epoch analysis (SEA) tool is used to study how a parameter varies around selected events. A list of events is given together with the event window time extent. The data for the selected parameter will then be loaded for each event extending over the time window size. To reduce the amount of data transmitted over the Internet the tool will work differently depending on whether the number of events is less than or equal to 5, or greater than 5. Any data gaps that are present in one or several events will also appear as data gaps when the average is calculated. The user may choose to remove data gaps with linear interpolation.

3.6.1 Test

Launch the SEA tool from a web browser.

Five or less events Enter the following events in the event list window:

```
2001 01 01 00 00
2001 01 02 00 00
2001 01 03 00 00
2001 01 04 00 00
2001 01 05 00 00
```

Select the `GOES08partDB` item and the `E>2.0 MeV` field. Set the event window size to ±12 hours (NB hours not days!). Then push the Plot Events button. A new window with five different curves should now be displayed. Select the Y Log from the Axis menu item. The daily variation of the electron flux should be seen. The average from these five curves can be obtained from the Display menu selecting Average.

More than five events Add another event to the event list above by entering `2001 01 06 00 00`. Then push the Plot Events button. Only a single curve should appear now. The curve represents the average of the six events.

Interpolation Note that there is a data gap at around hours -9 and -8. This data gap is caused by a data gap in one of the events. The gap can be removed with interpolation. Check the Interpolate check box and push the Plot Events again.

Average Extend the event window to cover ±10 days. Check the Average check box and set the averaging to 1 hour. Push Plot Events. The window that appears should display one hour average data. Select the Points item from the Lines menu to verify this.

Random events Set the number of random events to 10, then push the Generate Random List button. The Random List window should now contain ten events with dates between the first data in the events list plus the start window time, and the last date in the events list plus the end window time. Push the Plot Random Events should produce the curve with the random events.

3.7 Correlation measures

SAAM.CAP.9

To support the tools for estimating the best prediction models, to find relations between different parameters, and to do pattern search correlation measures are used.

3.7.1 Test

See Section 3.9 and Section 3.11.

3.8 Cluster analysis

SAAM.CAP.10

With cluster analysis we mean the possibility to plot data with choice of physical parameters against each other, and for spacecraft with given locations to plot in different coordinate systems. The data plotter tool shall support these options.

3.8.1 Test

See Section 3.2.

3.9 Pattern search

SAAM.CAP.11

3.10 Guide lines

SAAM.CAP.12

3.11 Estimate best model

SAAM.CAP.13

3.12 The Jonathan test

gvgshsgfshdhwhxhd xcccjndcn sjddgsgdgxsgdcgddc dd fd f d d fdt jj j j jj j j jjj j j j j j . KJHh dxjhdjkgkttf r deg g g r r erb rer rtr 222 4wew . hffdrrgj gsassxhv v aabbdhd dd bzxold fkdfdfkkwffrggrk trthkhy5ko t tttyyy.

Chapter 4

Test plan for the satellite anomaly prediction module

4.1 Anomaly prediction tool

SAPM.CAP.1

The anomaly prediction tools are accessible from a web browser. When the web page is opened a list of available models shall be displayed. The user can then select one model and run it.

4.1.1 Test

In the web browser select one of the models and run it. Verify that it produces predictions based on the current time.

4.2 Add new prediction models

SAPM.CAP.2

New models are added to SAAPS by putting the model file in the directory `SAAPS_MODELS`. The new model will automatically appear in the SAAPS window.

4.2.1 Test

Copy the the dummy model file into the model database by executing

```
cp $SAAP_TEST/Dummy.model $SAAPS_MODEL
```

Launch the web browser and verify that the `Dummy` item has appeared.

4.3 Model database

SAPM.CAP.3

The directory `SAAPS_MODEL` shall contain one `.model` file for each model that exist in SAAPS.

4.3.1 Test

Verify that the `SAAPS_MODEL` directory contain several `.model` files by listing the contents.

4.4 Web access

SAPM.CAP.4

Each model in SAAPS should be available from a web browser.

4.4.1 Test

Start a web browser and verify that a list of SAAPS models appears. Select each model in turn and verify that it produces an output.

4.5 SAAM access

SAPM.CAP.5

The analysis module (SAAM) shall have access to the models in the model database. This is trivially fulfilled as both SAAM and SAPM have access to the files under `SAAPS_MODELS`.

4.6 Plot predictions

SAPM.CAP.6

It shall be possible to plot the predictions based on the models in the model database. Two modes shall be available: real time operation and predictions for selected time intervals.

4.6.1 Test

Launch the web browser and start the prediction tool.

Inspect Select one model in the model list. Push the Inspect button. A window should appear that describes the model.

Real Time Operation Select one model that updates frequently, e.g. every 10 minutes. Check the real time check box. Push the Plot button. A new window with the predictions should appear. Verify that the plot is updated with time intervals indicated by the model description.

Selected Time Interval Uncheck the Real Time check box. The Start Time and End Time choice boxes now become enabled. Select one model. Select different star and end times. Verify that the plot window for the selected times appears. Verify also, that if the time are outside the valid range a dialog should appear informing the user about this.

4.7 List predictions

SAPM.CAP.7

Should it be implemented?

4.8 Real time operation

SAPM.CAP.8

See Section 4.6

4.9 Select time period

SAPM.CAP.9

See Section 4.6

4.10 Manuals

SAPM.CAP.11

4.11 Help pages

Chapter 5

URD reference tables

5.1 Database and database tools

Test id	URD id	Test reference
1	DB&T.CAP.1	2.1
2	DB&T.CAP.2	2.2
3	DB&T.CAP.3	2.3
4	DB&T.CAP.4	2.4
5	DB&T.CAP.5	2.5
6	DB&T.CAP.6	2.13
7	DB&T.CAP.7	2.4
8	DB&T.CAP.8	2.6
9	DB&T.CAP.9	2.7
10	DB&T.CAP.10	2.8
11	DB&T.CAP.11	2.13
12	DB&T.CAP.12	2.9
13	DB&T.CAP.13	2.10
14	DB&T.CAP.14	2.11
15	DB&T.CAP.15	2.12
15.1	DB&T.CON.1	**??**
15.2	DB&T.CON.2	2.14, 2.15, 2.16

5.2 Satellite anomaly analysis module

Test id	URD id	Reference
16	SAAM.CAP.1	3.1
17	SAAM.CAP.2	3.2
18	SAAM.CAP.3	3.2
19	SAAM.CAP.4	3.2
20	SAAM.CAP.5	3.3
21	SAAM.CAP.6	3.4
22	SAAM.CAP.7	3.5
23	SAAM.CAP.8	3.6
24	SAAM.CAP.9	3.7
25	SAAM.CAP.10	3.8
26	SAAM.CAP.11	3.9
27	SAAM.CAP.12	3.10
28	SAAM.CAP.13	3.11

5.3 Satellite anomaly prediction module

Test id	URD id	Reference
29	SAPM.CAP.1	4.1
30	SAPM.CAP.2	4.2
31	SAPM.CAP.3	4.3
32	SAPM.CAP.4	4.4
33	SAPM.CAP.5	4.5
34	SAPM.CAP.6	4.6
35	SAPM.CAP.7	4.7
36	SAPM.CAP.8	4.8
37	SAPM.CAP.9	4.9
38	SAPM.CAP.10	4.10
39	SAPM.CAP.11	4.11

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