HERSCHEL

SCIENCE GROUND SEGMENT

INTEGRATION & TEST PLAN

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Change Record

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1.0 draft	18th November	- Added additional pre-integration tests for HSC-ICCa and HSC-MOC to deal with installation & testing of the transfer mechanisms to be used between these sites. - Updated System test section to take into account the three test themes - Added test schedules at the end
1.0 final draft	28th November 2005	- Email – G.Di Girolamo – 30th Nov 05 - Email – N.Dean – 21st Dec 05 - Email – N.Dean – 22nd Dec 05 - Email – S.Ott – 15th Jan 06 - Email – T.Lock – 26th Jan 06 - Email – D.Clements – 31st Jan 06 - Email – K.Galloway – 1st Feb 06 - Email – G.Gienger – 28th Feb 06 - Email – P.Roelfsema – 7th April 06 - Email – B. Vandenbussche – 7th April 06

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1. Introduction

1.1 Purpose

This document is the Herschel Science Ground Segment Integration & Test plan. It provides an in-depth overview of all testing events to be carried out for the verification and validation of the SGS System.

This document represents a lower level plan document derived from the requirements defined in the Herschel/Planck Ground Segment System Test Plan [AD 10]. The GSSTP document covers test and validation activities conducted at system level and in addition provides references to lower level test and validation activities as far as these constitute pre-requisites for system level activities. In general, the GSSTP covers all activities involving more that one major ground segment element, to the level of interface validation between elements.

Where integration & higher-level tests are addressed in this document, then these shall be fed into the GSSTP.

This document supersedes the "Herschel Ground Segment End-To-End Test Plan" [RD 3]. It takes into account the contents of this "never issued and without reference" Technical Note. As such [RD 3] can be considered to be an obsolete document.

1.2 Scope

What is included in this document

This Plan provides the following information:

- A detailed overview of the test strategy being applied for the Science Ground Segment Test Programme and the concept of the 3 Test Themes
- Descriptions of all Science Ground Segment System components and their test strategies
- Descriptions of all Science Ground Segment System Integration Tests
- Descriptions of all Science Ground Segment System Tests to be carried out

What is NOT included in this document

In-depth details of the planning for each test including procedure definition are not provided in this document. These details may be found in the test plan that shall be written for each test by the appropriate Integration & Test Team.

1.3 Document Overview

The document is organised as follows:

Chapter 1 – Introduction
This chapter describes the scope & purpose of this document

Chapter 2 – References
Provides a list of the Applicable & Reference Documentation

Chapter 3 – Herschel System Definition
This chapter gives a broad overview of the Herschel Ground Segment and its constituent elements.

Chapter 4 – SGS Integration & Test Overview
This chapter provides an in-depth view of the verification & validation approach being applied within the Science Ground Segment. Details such as naming conventions, test teams, test responsibilities can all be found in this chapter.

Chapter 5 – SGS Component Test Phase
This chapter provides details on the components that make up the Science Ground Segment and how they are to be tested. Their links to Functional Deliveries are addressed in particular.

Chapter 6 – SGS Compatibility & Integration Test Phase
This chapter provides details on each of the integration tests that need to be performed to ensure that the system is ready for start of the system tests.

Chapter 7 – SGS System Test Phase
This chapter describes the various system tests planned to be performed to ensure that the Science Ground Segment is ready for launch.

Chapter 8 – Overall Ground Segment Test Phase
This chapter provides details of the scope & contents of the SVTs and the Spacecraft End to End test campaigns.

As can be seen in the above breakdown, the concept of each chapter of this document is to effectively show to the reader what tests are required to be performed before the tests in the next chapter can begin i.e. component tests => Integration tests => System tests.

1.4 List of acronyms

ADC	Attitude Determination & Control
AO	Announcement of Opportunity
AOT	Astronomical Observing Template
CC	Configuration Control
CCB	Configuration Control Board
CI	Configuration Item
COTS	Commercial Off-The-Shelf
CSG	Computer Support Group (ESAC)
CUS	Common Uplink System
DDS	Data Disposition System
DP	Data Processing
DTCP	Daily TeleCommunication Period
E2E	End-to-End
ESAC	European Space Astronomy Centre
FDS	Flight Dynamics
FTS	File Transfer System
GS	Ground Segment
G/S	Ground Station
GSSTP	Ground Segment System Test Plan
GT	Guaranteed Time
HAB	Herschel Archive Browser
HCSS	Herschel Common Science System
HGS	Herschel Ground Segment
HIFI	Heterodyne Instrument for the Far Infrared
HK	HouseKeeping
HOTAC	Herschel Observing Time Allocation Committee
HSC	Herschel Science Centre
HSCDT	HSC Development Team
HSPOT	Herschel SIRTF Planning Observation tool
IA	Interactive Analysis
ICC	Instrument Control Centre
ICC@MOC	ICC at MOC (workstations at MOC)
ICD	Interface Control Document
ITT	SGS Integration & Test Team
KP	Key Programme
LDAP	Lightweight Directory Access Protocol
LEOP	Launch and Early Operations Phase
MCS	Mission Control System
MOC	Mission Operations Centre
MPS	Mission Planning System
MTL	Mission TimeLine
NHSC	NASA Herschel Science Center
OBSM	On-Board Software Maintenance
OD	Operational Day
OD	Orbit Determination (by Flight Dynamics)
ODB	(MOC) Operational Data Base
ODBMS	Object DataBase Management System
OPMD	Orbit Prediction & Manoeuvre Design
PACS	Photodetector Array Camera and Spectrometer
PV	Performance Verification
PSF	Planning Skeleton File
QCP	Quality Control Pipeline
QLA	Quick Look Analysis
RTSI	Real Time Science Interface
S/C	SpaceCraft
SCOS	(ESOC) SpaceCraft Operations System
SCR	Software Change Request
SDS	Secure Distribution System
SGS	Science Ground Segment
SOV	System Overall Verification Test
SPG	Standard Product Generation
SPIRE	Spectral and Photometric Imaging Receiver
SPR	Software Problem Report
SSO	Solar System Objects
SSMM	Solid State Mass Memory
SVT	System Validation Test
S/W	SoftWare
TBC	To Be Confirmed
TBD	To Be Determined
TC	TeleCommand
TM	TeleMetry

2. Applicable & Reference Documentation

2.1 Applicable Documents

[AD 3], [AD 4], [AD 7], [AD 8], [AD 11], [AD 12], [AD 15] => [AD 18] Deleted in Issue 1.0 of the document

[AD 1] Herschel Space Observatory Science Management Plan (SMP), Herschel/HSC/DOC/0019, 2.1, 22/04/2005

[AD 2] Herschel Space Observatory Operations Scenario Document, HERSCHEL/HSC/DOC/0114, 1.2, 17/03/2002

[AD 5] Herschel Ground Segment Design Description, FIRST/FSC/DOC/0146, 1.5, 03/04/2006

[AD 6] Herschel Ground Segment Interface Requirements Document, FIRST/HSC/DOC/0117, 2.5, 03/04/2006

[AD 9] Herschel/Planck Ground Segment MOC System Architecture Document, PT-CMOC-SYS-ADD-7101-OPS-ONV, 1.0, 01/07/2006

[AD 10] Herschel/Planck Ground Segment System Test Plan (GSSTP) Document, PT-CMOC-MGT-PL-1201-OPS-ONV, 1.1, 21/03/2006

[AD 13] Herschel HCSS Software Project Management Plan – FIRST/FSC/DOC/0116, 7.0, 01/06/2006

[AD 14] Herschel DP Software Project Management Plan - HERSCHEL-HSC-DOC-0555, 1.0, 23/05/2005

[AD 19] Herschel Ground Segment List of ICDs – FIRST/FSC/DOC/0150, 1.9, 03/04/2006

2.2 Reference Documents

[RD 1], [RD 2], [RD 4], [RD 6] & [RD 7]Deleted

[RD 3] Herschel Ground Segment End-to-End Test Plan – TN draft 18th December 2001, no issue number

[RD 5] Herschel/Planck Ground Segment Integration & Test Schedule and Status Report, PT-CMOC-SYS-SCH-7302-OPS-ONV

[RD 8] Science Ground Segment System Data Flow TN – HSCDT-TN052, 1.1, 07/07/2006

[RD 9] HCSS Actor Descriptions – FIRST/FSC/DOC/0157 , 2.4, 11/05/2006

[RD 10] DP End to End Test Plan – Issue 1.1, 09/05/2006

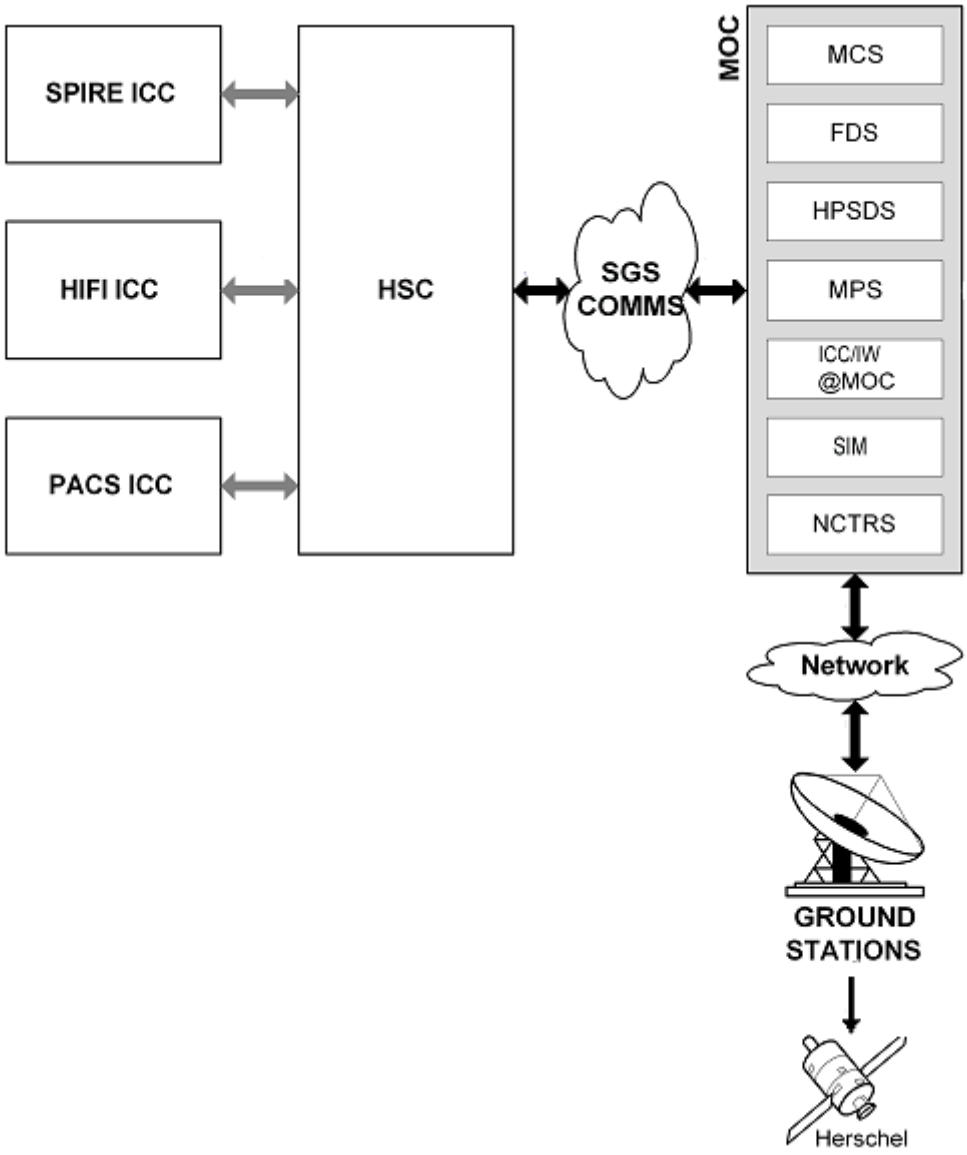
3. Understanding the Herschel Ground Segment

3.1 Herschel Ground Segment System Overview

The Herschel Ground Segment can be broken into two main constituents:

- Mission Operations Centre (MOC) - consisting of the MOC, the ground stations and the network infrastructure
- Herschel Science Ground Segment (SGS) – consisting of the HSC, ICCs and the NHSC.

The drawing below (extracted from the GSSTP – [AD 10] shows a top-level block diagram of the centres and their interconnections.

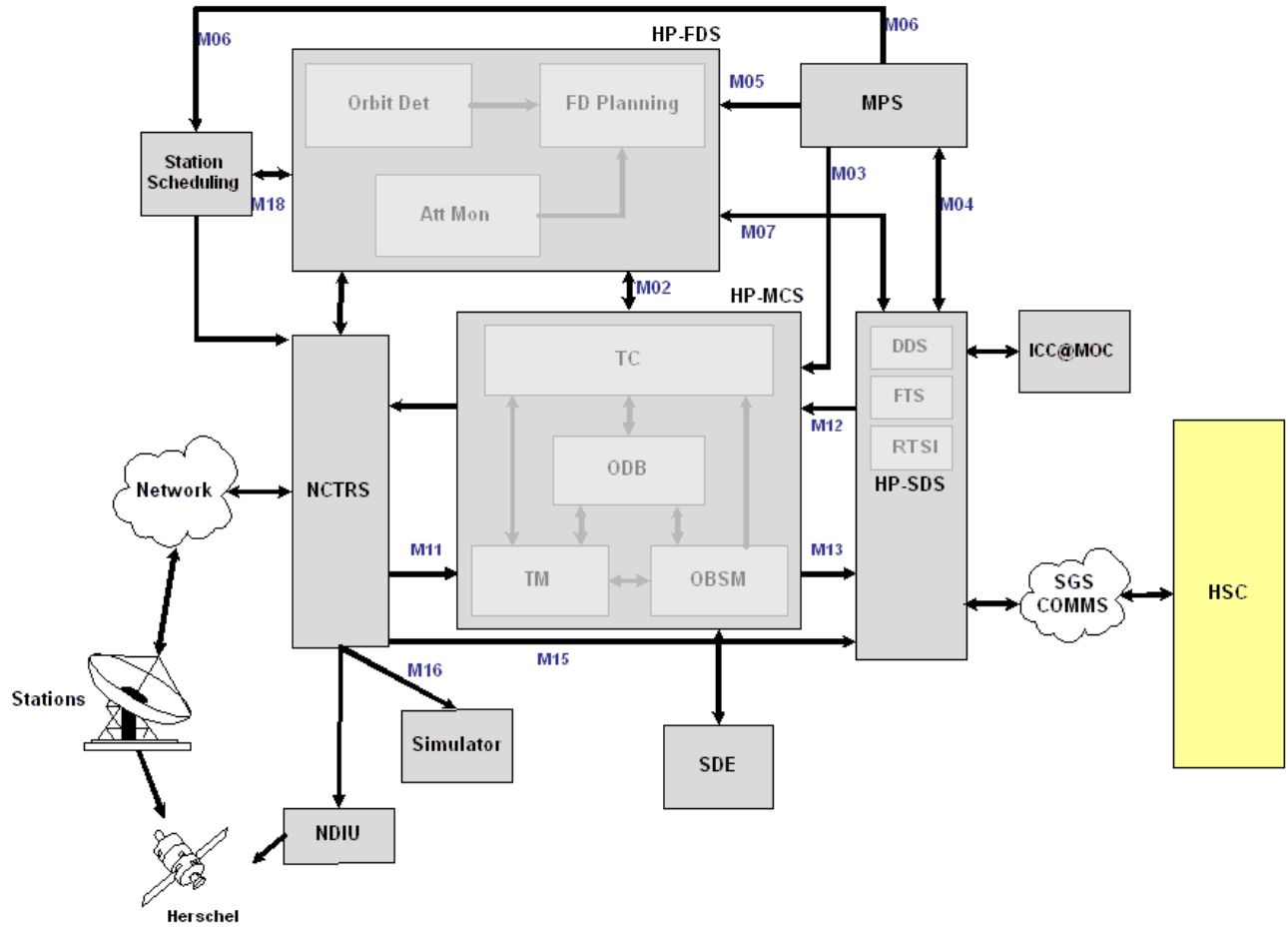


3.1.1 Mission Operations Centre (MOC) Overview

The Mission Operations Centre is outlined below showing the set up of the HERSCHEL MOC and its interfaces with its external sites i.e. HSC, ICCs. It consists of 5 lower level subsystems [AD 9]:

- **MCS** - TM/TC Mission Control System & MPS (shown separately in the drawing below)
- **FDS** – The Flight Dynamics System has 4 main subsystems with numerous internal interfaces i.e. ADC (Attitude Determination & Control), MPS (Mission Planning Subsystem), OD (Orbit Determination) & OPMD (Orbit Prediction & Manoeuvre Design)
- **Ground Stations** – New Norcia, Vilspa, Kourou, Cebreros and Perth
- **Simulator** – Ground Model Simulator, Satellite Service Module & Payload Module simulator
- **Interface**s – SDS (RTSI, FTS, DDS)[1], NCTRS and NDIU

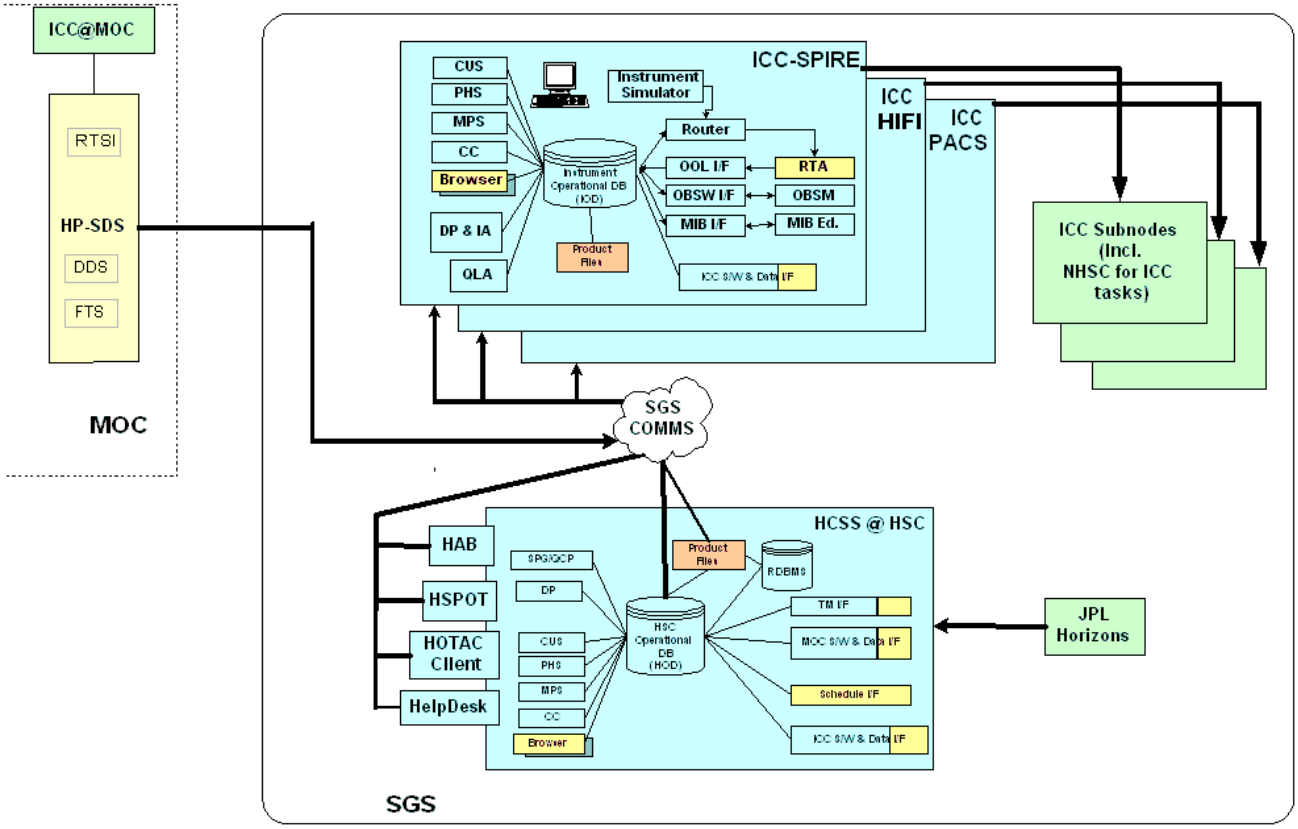
The interface numbers shown in the drawing are described in detail in the GSSTP [AD 10]. The Interface numbering e.g. M1, are MOC specific. The SGS interface numbering shall be introduced in section 4.3.3.



[1] In the drawing above, several connections from SDS to various MOC elements (MPS, HP FDS HP MCS) are shown, however it should be noted that these are logical connections only. Physically there will be only one connection between SDS and a node on the OPSLAN acting as gateway and responsible to take care of proper file forwarding in/out

3.1.2 Science Ground Segment (SGS) Overview

The Herschel Science Ground Segment is shown below showing the Herschel Science Centre (HSC) & the Instrument Control Centres (ICCs), and the interfaces both between each other, the MOC, JPL Horizons and the scientific community.



Important Note: Herschel ICC at MOC :

There will also be an ICC set-up at the MOC, called the **ICC@MOC**. It will be used during the commissioning phase, PV phase, and potentially for the remainder of the mission during instrument emergencies. The testing of this interface is considered to be a MOC responsibility and is therefore not dealt with any further in this document.

4. SGS Integration & Test Overview

4.1 The SGS Test Strategy – The Three Test Themes explained

4.1.1 Background to the Three Test Themes

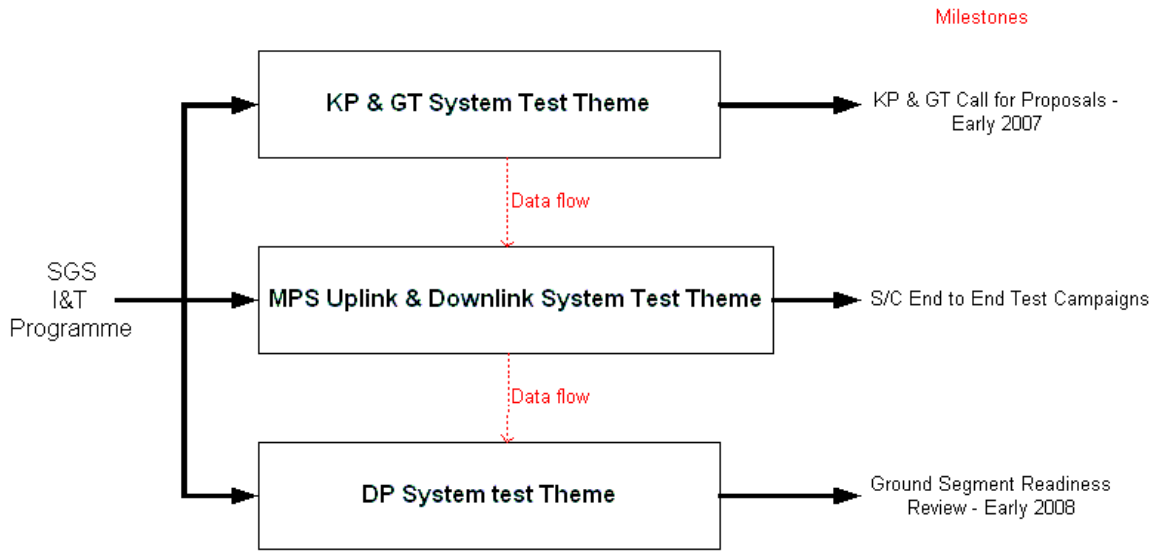
The strategy being applied to test the Science Ground Segment has been generated based upon a review of the nominal set of activities that will be followed by the SGS after launch, namely that the science ground segment shall be able to schedule proposals received from the scientific community, send such schedules to the MOC for uplink to the spacecraft and be able to process the data that results from execution of these schedules by the instruments on board.

Analysing in greater detail these activities, one can observe that there are in fact three different scenarios involved in this process. The first is the reception & use of proposals from the scientific community, the second is the scheduling of these proposals, execution of these proposals on the spacecraft and downlink of the data and the third and final scenario is the processing of the resultant data.

These three scenarios have led to the definition of three associated test themes called the KP & GT System Test Theme, the MPS Uplink & Downlink System Test Theme and the Data Processing System Test Theme.

While it is obvious that there is a major link between each of these test themes, it became clear when putting together the test strategy that although they are linked, they do in fact represent three distinct chains within the overall ground segment which from an Integration & Test Perspective can be tested separately but of course ensuring that advantage is taken of any data flow that exists between each one.

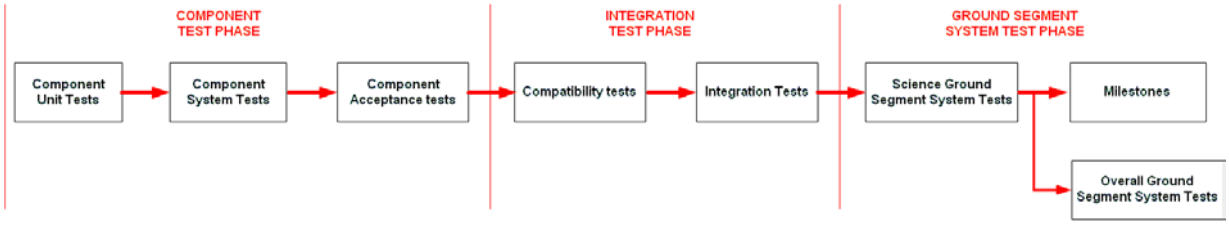
The test strategy then proceeded to identify the milestones that would drive the schedule of these three different test themes. These milestones and the link to the test themes can be seen in the drawing below.



Once the test themes and the milestones were identified, the focus then turned to the inner set up of the three test themes.

The inner workings of the test themes shall follow the standard integration & test approach as defined below.

The Standard Integration & Test approach is that the system is built from the bottom up whereby software components must pass through unit, system and acceptance tests before being utilised in integration tests followed by their validation within the ground segment system test phase. These steps are linked therefore to three main test phases i.e. Component test phase, the integration test phase and the ground segment system test phase. The drawing below clearly highlights these phases and the links between them.



Each of the SGS System Test Themes shall be described in detail in the coming subsections.

Note: In the coming pages the concept of software components being delivered as part of a "**Functional release**" is introduced. A **functional release** corresponds to a system level release of a number of different software subsystems e.g. 0.SCI.1 = HCSS, Helpdesk, Web, LDAP.

4.1.2 KP & GT System Test Theme

The drawing overleaf provides a good overview of the KP & GT System Test Theme.

Component Test Phase

The following SGS components are required to allow support of this test phase :

- HCSS (PHS, HSPOT, HOTAC)
- Kayako Helpdesk
- Web Server
- LDAP

In the drawing below one can see the "Functional Release"[2] within which these components are included.

- 0.SCI.1 release consisting of HCSS, Helpdesk, Web server and LDAP components

- 0.SCI.2 release consisting of HCSS only

- 0.SCI.3 release consisting of HCSS only

It is expected that each of these releases will be acceptance tested by the Project Scientist Team at ESAC. Delta Acceptance tests refer more to delta releases of the HCSS software that shall include additional functionality required to support this test theme. Further details can be found in section 5.2.

Integration Test Phase

There are no specific integration tests required to be performed for this test theme.

Ground Segment System Test Phase

There are two system tests planned to be performed for this test theme. The second shall be a repeat of the first to verify closure of previously identified system problems.

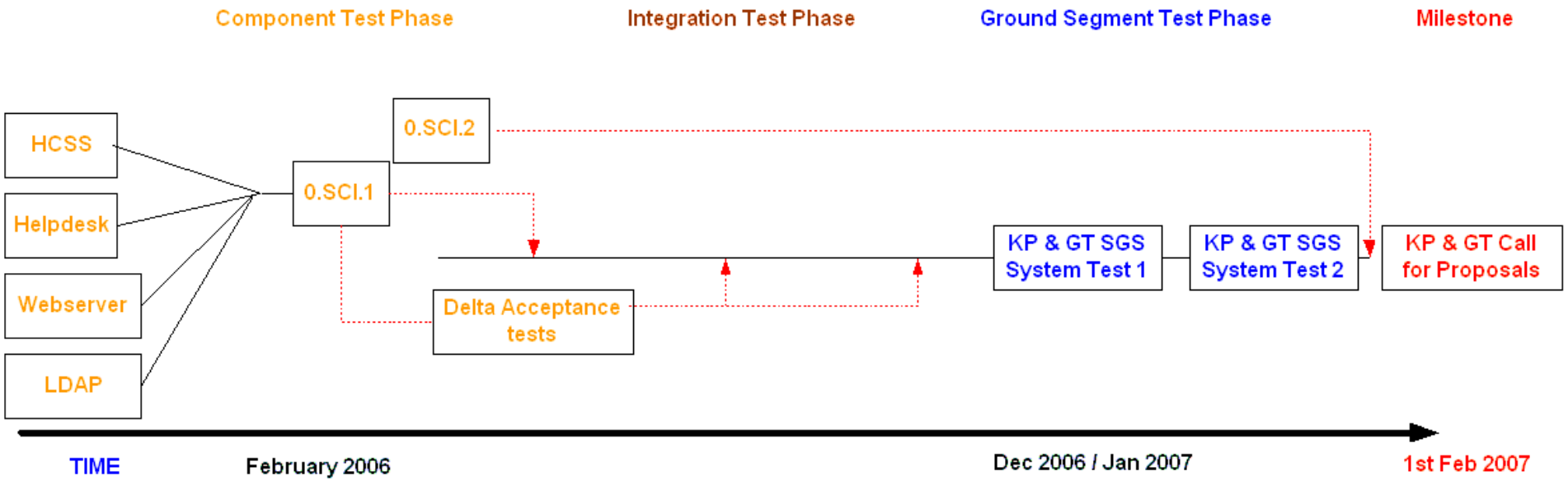
- KP & GT System Test #1

- KP & GT System Test #2

Details of these tests can be found in section 7.2.

[2] The term "Functional Release" is taken from the HCSS SPMP and describes a combined delivery of a number of different software subsystems e.g. 0.SCI.1 = HCSS, Helpdesk, Web, LDAP.

The KP & GT System Test Theme



4.1.3 MPS Uplink & Downlink System Test Theme

The drawing overleaf provides a good overview of the MPS Uplink & Downlink System Test Theme.

Component Test Phase

The following SGS components are required to allow support of this test phase:

- HCSS
- FTS interface Software
- I-OBSM – ICC On Board Software Maintenance Tool

In addition to the I-OBSM subsystem, one can see in the drawing the functional releases within which particular components are included i.e.

- 0.EE.1 release consisting of HCSS (MPS, PHS, CUS, DDS & FTS interface) components
- 0.EE.2 release
- 0.EE.3 release

It is expected that the 0.EE.x releases will be acceptance tested by the Project Scientist Team and Integration & Test Team. Each ICC shall test the OBSM subsystem. Further details in section 5.1.

Integration Test Phase

The following integration tests shall be performed for this test phase, details of which can be found in chapter 6: (Note that the HSC-ICC propagation set-up test and HSC-MOC FTS & DDS Set-up tests shown in the drawing are subsets of the corresponding HSC-ICC and HSC-MOC Integration test programmes).

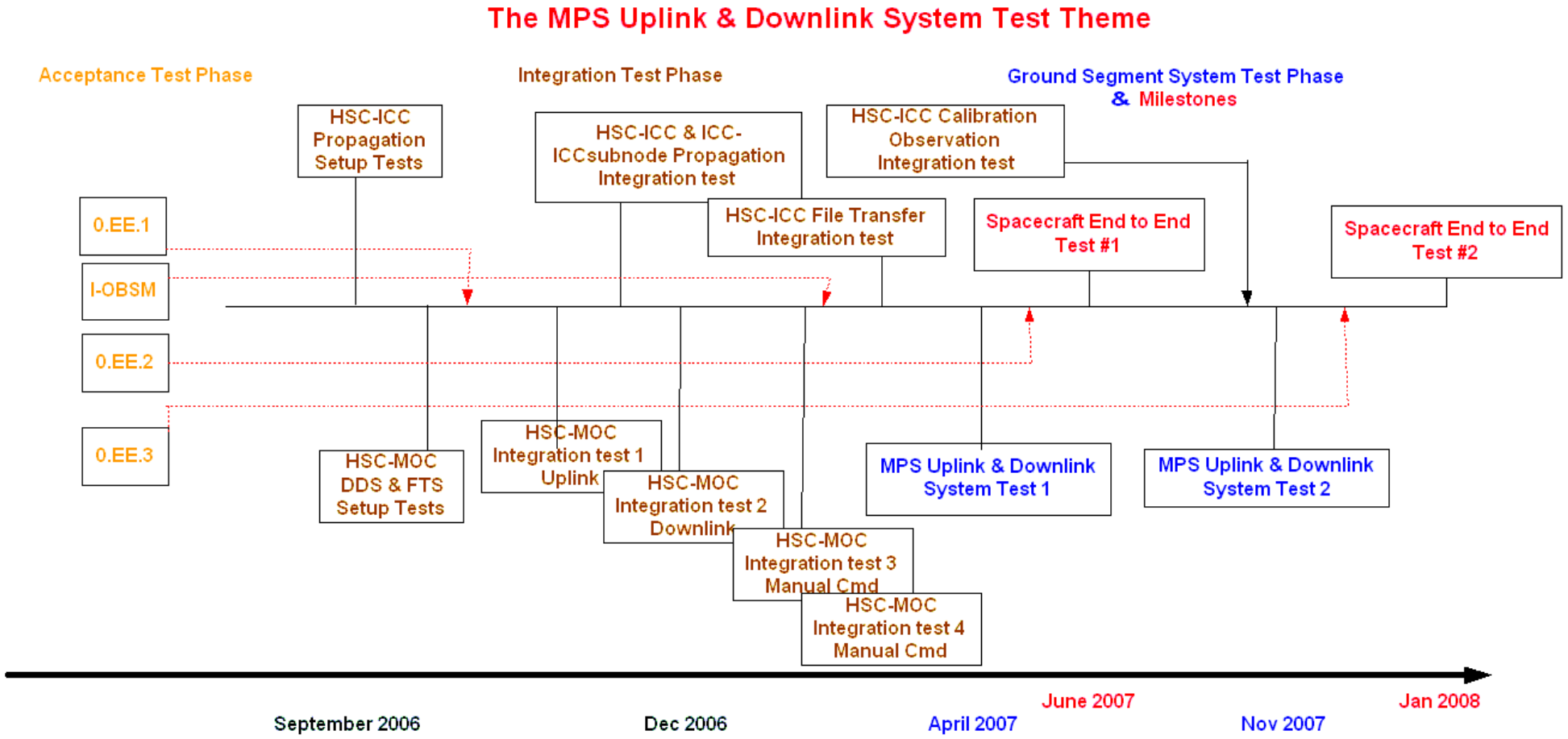
- HSC-MOC Integration Test 1 – Uplink (includes HSC-JPL Horizons test)
- HSC-MOC Integration Test 2 – Downlink
- HSC-MOC Integration Test 3 – Manual Commanding Scenario with HSC TPF
- HSC-MOC Integration Test 4 – Manual Commanding Scenario without HSC TPF or POS
- HSC-ICC & ICC-ICC(Subnode) Propagation Integration Tests
- HSC-ICC File Transfer Integration test
- HSC-ICC Calibration Observation transfer Integration Test

Ground Segment System Test Phase

A Science Ground Segment System test shall be performed prior to each of the two Spacecraft End to End tests. As a result, there shall be two Science Ground Segment System tests performed, details of which can be found in section 7.4.

- SGS Uplink & Downlink System Test #1
- SGS Uplink & Downlink System Test #2

The overall ground segment shall be tested in the scope of the formal Spacecraft End-to-End test campaign. Details of these tests can be found in chapter 8.2.


The MPS Uplink & Downlink System Test Theme
Acceptance Test Phase
Integration Test Phase
Ground Segment System Test Phase & Milestones
HSC-ICC Propagation Setup Tests
HSC-ICC & ICC-ICCsubnode Propagation Integration test
HSC-ICC Calibration Observation Integration test
HSC-ICC File Transfer Integration test
Spacecraft End to End Test #1
Spacecraft End to End Test #2
0.EE.1
I-OBSM
0.EE.2
0.EE.3
HSC-MOC DDS & FTS Setup Tests
HSC-MOC Integration test 1 Uplink
HSC-MOC Integration test 2 Downlink
HSC-MOC Integration test 3 Manual Cmd
HSC-MOC Integration test 4 Manual Cmd
MPS Uplink & Downlink System Test 1
MPS Uplink & Downlink System Test 2
September 2006
Dec 2006
April 2007
June 2007
Nov 2007
Jan 2008

4.1.4 Data Processing System Test Theme

The drawing overleaf provides a good overview of the Data Processing System Test Theme.

Component Test Phase

The following SGS components are required to allow support of this test phase :

- HCSS Data Processing (DP)
- Herschel Archive Browser (HAB)

In the drawing one can see the specific software releases i.e. HAB, and indeed functional releases i.e. 0.DP.x corresponding to these components:

- HCSS 0.DP.9.x, 0.DP.10.x and 0.DP.11.x

- HAB 1.0 & 2.0

Details of the testing to be performed on these releases can be found in sections 5.1 and 5.2

Integration Test Phase

The following integration tests are required to be performed for this test phase: (Note that the HSC-ICC Propagation set-up shown in the drawing is a subset of the propagation integration test).

- HSC-ICC Propagation Integration test
- HSC-ICC Product Transfer Integration Test

Details of these tests can be found in section 6.2

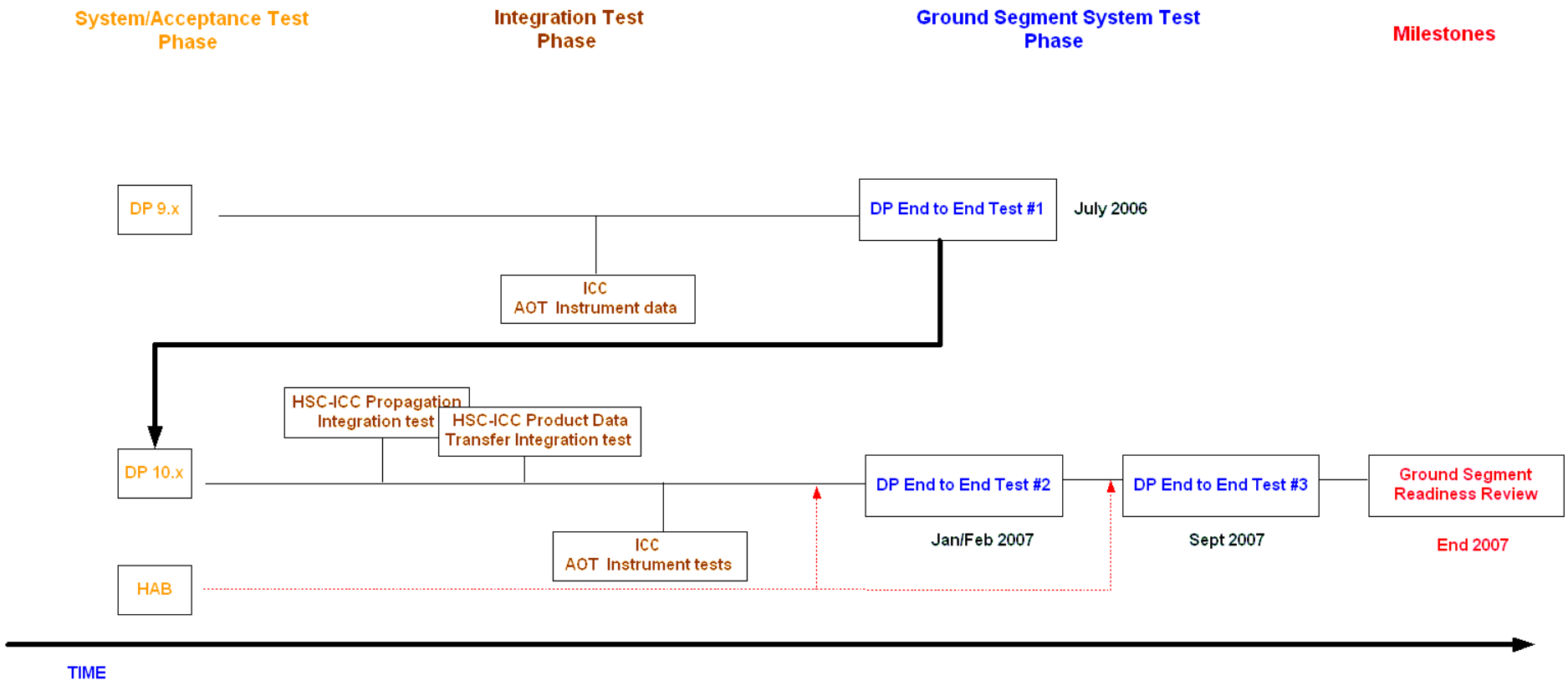
Ground Segment System Test Phase

There shall be 3 DP System Test campaigns consisting of 3 end to end tests to be performed per ICC.

- HIFI, PACS, SPIRE DP End to End Test #1
- HIFI, PACS, SPIRE DP End to End Test #2
- HIFI, PACS, SPIRE DP End to End Test #3

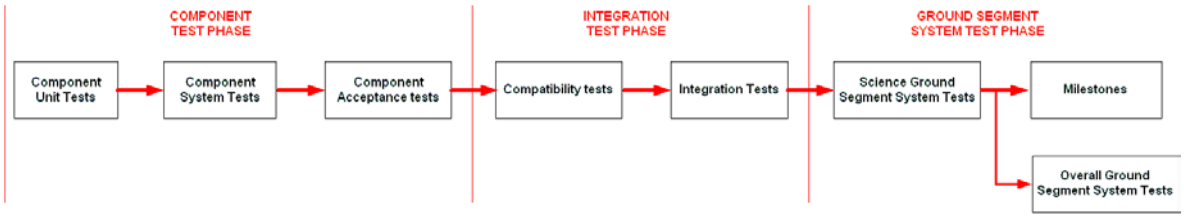
Details of these tests can be found in section 7.3.

Data Processing System Test Theme



4.2 Components, Integration & System Test Phases – Summary

The drawing below introduced in section 4.1.1 presents the three major test phases of the SGS test programme, namely the Component Test Phase, the Integration Test Phase and the Ground Segment System Test Phase.



The following subsections shall identify the constituent parts of the Science Ground Segment that fall within these test phases.

4.2.1 Components in the Component Test Phase

The following list of components have been identified in the previous pages as being part of the "Component test phase" of the SGS test programme.

- HCSS (including Data Processing, PHS, MPS, CUS, HSPOT, HOTAC)
- Kayako Helpdesk
- Webserver
- LDAP Interface
- Herschel Archive Browser
- Instrument OBSM

See chapter 5 for more information on the component test phase.

4.2.2 Integration Tests within the Integration Test Phase

The following list of Integration tests have been identified in the previous pages as being part of the "Integration Test Phase" of the SGS Test programme.

HSC-MOC
- HSC-MOC Integration Test 1 – Uplink (includes HSC-MOC FTS Set-up and HSC-JPL Horizons test)
- HSC-MOC Integration Test 2 – Downlink (includes HSC-MOC DDS Set-up test)
- HSC-MOC Integration Test 3 – Manual Commanding scenario **with** HSC TPFs
- HSC-MOC Integration Test 4 – Manual Commanding scenario **without** HSC TPFs or POS

HSC-ICC
- HSC-ICC Product Transfer Integration test
- HSC-ICC Propagation Integration Tests (includes HSC-ICC Propagation Set-up tests)
- HSC-ICC File Transfer Integration test
- HSC-ICC Calibration Observation Transfer Integration test

ICC-ICC Sub node
- ICC-ICC Subnode Propagation tests
- ICC-ICC Subnode Product Transfer integration tests

Note that Compatibility tests which form the first part of the integration test phase shall be carried out prior to and indeed in parallel with all the integration tests planned to be carried out in the SGS test programme.

See chapter 6 for more information on the Integration Test Phase.

4.2.3 System Tests in the Ground Segment Test Phase

SGS System tests

The following list of SGS System tests have been identified in the previous pages as being part of the "Ground Segment System Test Phase" of the SGS Test programme

- KP & GT System Test #1
- KP & GT System Test #2
- SGS Uplink & Downlink System Test #1
- SGS Uplink & Downlink System Test #2
- HIFI, PACS, SPIRE DP End to End Test #1
- HIFI, PACS, SPIRE DP End to End Test #2
- HIFI, PACS, SPIRE DP End to End Test #3

See chapter 7 for more information on the SGS System Test phase.

Overall Ground Segment System Tests

The following Overall Ground Segment tests linked to the execution of the three system test themes are described in this test plan:

- Spacecraft End to End Test #1
- Spacecraft End to End Test #2

Also addressed in this test plan at a very high level and for information purposes only are the System Validation Tests (SVTs).

See chapter 8 for more information on the Overall Ground Segment System Test phase.

4.3 SGS Integration & Test Programmatics

4.3.1 SGS Test Schedule

The SGS Test Schedule generated as an outcome of this document shall be produced on a bi-monthly basis. It shall be fed into the higher-level ground segment test schedule [RD 5] that is issued on a regular basis.

Impacts on the test schedule due to a launch delay will be addressed by the Integration & Test Steering Group.

4.3.2 Test Responsibilities & Organisation

Test Responsibilities

The responsibilities for testing of the Herschel Science Ground Segment are defined in detail in AD[10].

Test Organisation & Evaluation

The preparation, execution and evaluation activities for each test are defined in section 5.3 of the GSSTP document [AD 10].

4.3.3 Test Naming Conventions

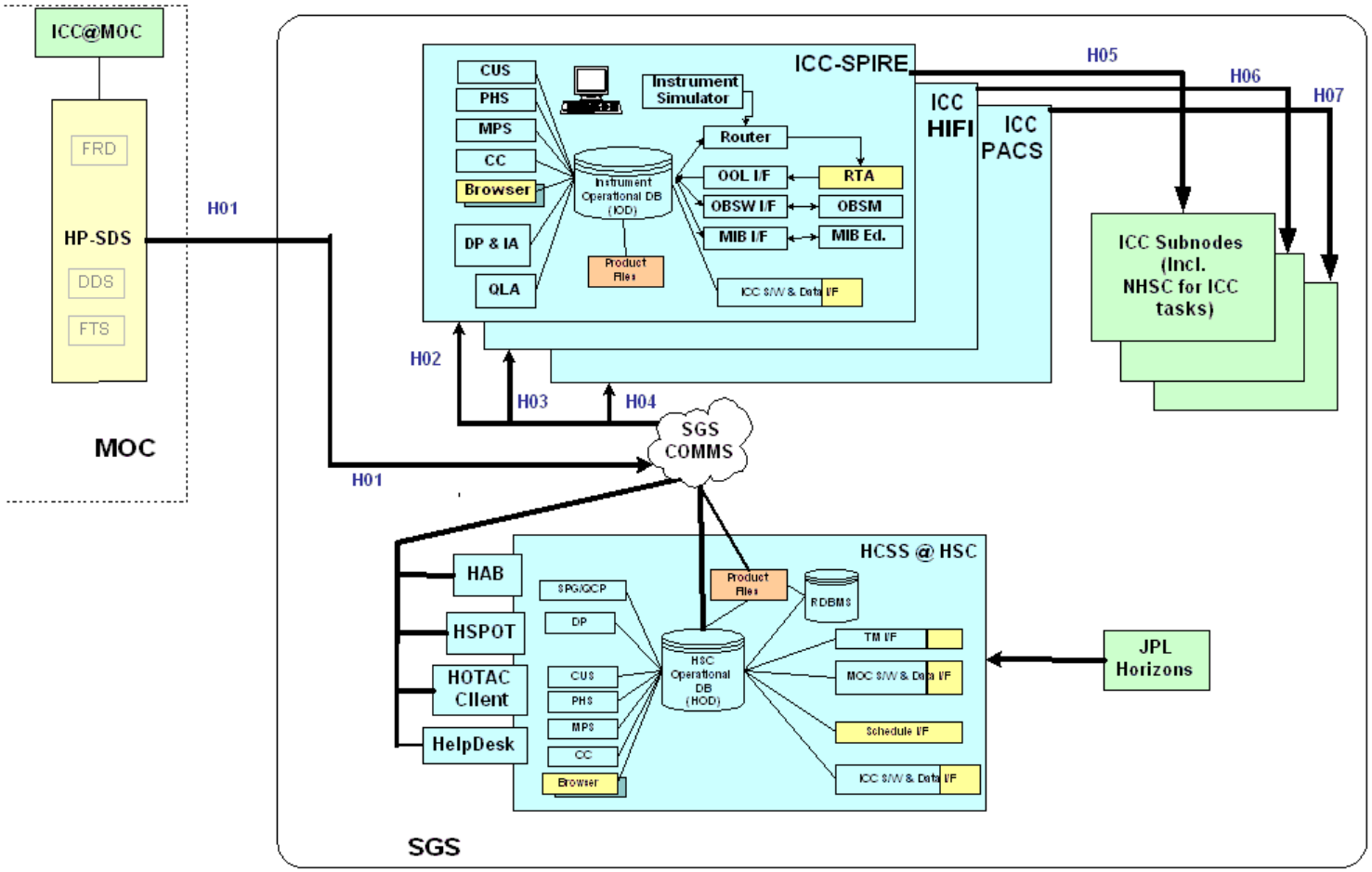
Each of the interfaces described in section 4.2.2 has an "SGS Interface identifier" which is used in the test naming convention described below and which can be seen in the SGS system level drawing overleaf. This drawing was presented in chapter 3 except now it has the interface numbers added.

Interface Group	Interface Components		Description
H01	MOC	HSC	MOC to/from SGS Comms network
H02	HSC	ICC-S	HSC to/from SPIRE ICC
H03	HSC	ICC-H	HSC to/from HIFI ICC
H04	HSC	ICC-P	HSC to/from PACS ICC
H05	ICC-S	ICC-Sub-S	SPIRE ICC to SPIRE ICC Subnodes
H06	ICC-H	ICC-Sub-H	HIFI ICC to HIFI ICC Subnodes
H07	ICC-P	ICC-Sub-P	PACS ICC to PACS ICC Subnodes

The test naming convention used in this document i.e. HGS-xT-iii-n.m, is described in the GSSTP document [AD 10], and is not repeated here. For information purposes however, some examples of how this format has been applied in this document are provided below:

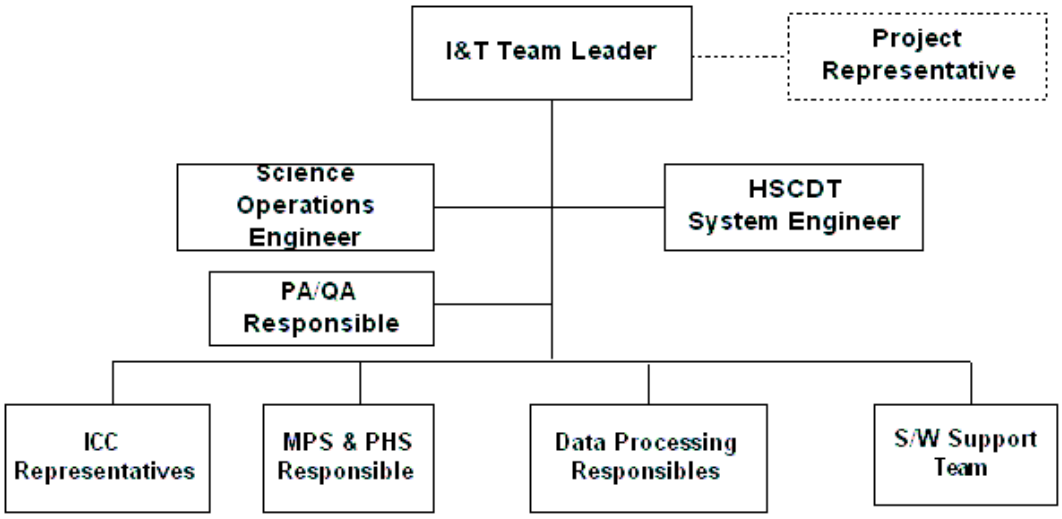
HGS-AT-HSC-0.EE.2	*Acceptance Test of HSC Software version 0.EE.2*
HGS-CT-H02-1.0	*First compatibility test between HSC and the SPIRE ICC*
HGS-IT-H01-3.0	*3rd integration test between HSC and MOC*

Science Ground Segment and its interfaces – numbered



4.3.4 The SGS Integration & Test Team

Team Structure



The Integration & Test Team functions only during the development phase of the mission. The following roles are envisaged to be performed by this team (as ITT Actors [RD 9]) :

Permanent Members

These members shall always be part of the ITT.

- **I&T Team Leader** – This individual will be selected when setting up of the relevant I&T team e.g. DP End to End test team.

- **Science Operations Engineer** – This is the representative of the Science Ground Segment on the Herschel/Planck Ground Segment Integration & Test Steering group.

- **HSCDT System Engineer** – The contribution of this individual to the I&T activities is considered to be extremely beneficial to ensure all system level requirements are taken into account during the testing.

- **Project Representative** – This person shall participate in the various tests with the purpose of providing a monitoring role

- **PA/QA Responsible** – This person shall participate in the various tests with the purpose of ensuring that the tests are run consistent with the PA & QA Procedures.

Non-Permanent Members

- **ICC Representatives** – where tests involve the ICCs, then it is requested that representatives of the ICCs shall participate as members of this group.

- **MPS, PHS, Data Processing Actors/Responsibles** – these individuals may represent people from the HSCDT or individuals already selected for this role during operations.

- **Software Support Team** – For the HSCDT, until approximately Launch minus 6 months, this support shall be provided from ESTEC as a remote interface. During larger system tests, on-site support will be required. For tests involving the ICCs then their software support would also be required.

Main Activities of the SGS ITT

The integration and test (ITT) team are responsible for performing the Herschel ground segment end-to-end tests [RD-9]. These tests ensure that:

- Individually each component of the Herschel ground segment correctly implements all functions within its respective scope.

- All relevant components of the Herschel ground segment communicate with each other and the satellite as required.

- Together these components provide the end-to-end functionality the operational system has to exhibit.

An end-to-end test consists of several test scenarios. In these scenarios the I&T team actor plays the role of other actors when testing the system. A single I&T team actor can play several sequential roles in a test scenario (session). Alternatively, a test scenario can involve several I&T team actors acting out roles in parallel.

The ITT team is also responsible for integrating the HCSS with the other components of the ground segment.

The ITT team shall follow the guidelines for test preparation & conduction as defined in the GSSTP document [AD 10]

5. SGS Component Test Phase

This chapter introduces in greater detail the list of SGS components expected to support the SGS Integration & Test programme. Details of the lower level testing (unit, module & system) and higher level testing (acceptance) are provided for each of the components in question.

As the SGS Functional releases are made up of SGS components then a description of the link between the two is also provided in this chapter.

5.1 List of SGS Components & their Testing approach

In Section 4.2.1 the complete list of components required to be delivered to support the science ground segment system test phase was provided. These are as follows:

(a) HCSS (including Data Processing)

(b) Kayako Helpdesk

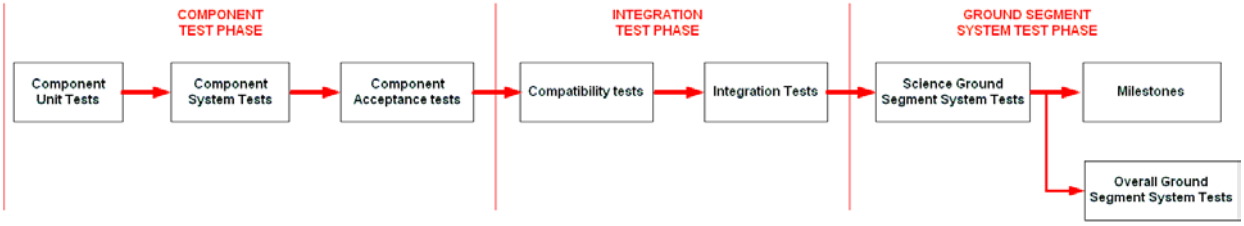
(c) Webserver

(d) LDAP Interface

(e) Herschel Archive Browser (HAB)

(f) Instrument OBSM

To understand how each of these software are tested, one must take into account the standard integration & test approach which was introduced earlier (section 4.1). It can be summarised by the following diagram:



Each of the above components shall now be studied from a test perspective to see how it adheres to this standard test model.

(a) HCSS (including DP) Testing Approach

The HCSS is made up of many different software subsystems namely MPS, PHS and CUS. It also includes the Data Processing System that again can be broken up into lower level constituents such as QLA, SPG, QCP, IA and TA.

To understand how the HCSS is tested one must first understand how the releases of the software are made.

HCSS Software Releases

Three types of software releases are made during the course of each year. These are Developer Releases, User Releases and System Releases. Each of these shall now be outlined in detail.

Developer Releases
Developer Releases (build #xyz) are made automatically every night if any developer has tagged updated/new code during the day. They are unit tested by automatically running test harnesses on each package. Using these ensures that the latest functionality is always available but it doesn't guarantee that things work exactly the same way as the previous days build. The PST & ICCs often make use of developer releases however.

ICC Specific Builds
In addition to the software generated by the CSDT (developers from HSC & ICCs), additional software specific to the ICCs is under development at the ICCs. An agreement has been reached between the ICCs and the HSCDT that this additional software shall be submitted to ESTEC and the HSCDT shall produce the relevant ICC specific build taking into account the most recent HCSS developer release. Software that would be included in the ICC build could include the instrument simulator and the QLA. This approach is being applied for SPIRE & HIFI builds. PACS have decided to perform their own builds in-house

User Releases:
User Releases (v0.x.y) are made every ~6-8 weeks apart. They are system tested by the development team and provide a stable system to end-users. The ICCs generally access and use these user releases and perform acceptance testing on them.

Functional Releases:
Functional Releases (v0.SCI.x, v0.EE.x, v0.DP.x) are *Management Milestones* and made ~1 year apart. They are formally system tested by the development team and acceptance tested by the final users e.g. ICCs, PST.

HCSS Software Testing

Based upon the above different set of releases, the test approach can now be outlined. It can be seen that if follows clearly the drawing from the previous page.

Unit/Module Testing:
Unit/Module Tests are run on developer releases with the results displayed on the HSCDT website.

System Testing:
System Tests are performed on both user and system releases and they include the following activities:

- The System Test Plan is written reflecting use cases and functionality required for the release exercised
- The end-to-end test is performed on a local test bed
- All resultant SPRs are recorded and the following reports are generated :
  - System Test Report
  - Unit test coverage report
  - Metrics report generated versus previous 'User Release'

As with the unit/module test phase, the results are published on the HSCDT Website.

Acceptance Testing of HCSS system releases :
In general, acceptance testing is performed by the customers (e.g. ICCs, PS team, etc.) on an agreed successfully system tested HCSS build. For the case of acceptance testing by the Project Scientist Team, it is agreed with the HSCDT manager beforehand, which of the HCSS User releases shall be included in the overall SGS functional release e.g. 0.SCI.x.

Acceptance testing by the PST is performed according to the acceptance test plan and acceptance test specification documents that are written by them. Acceptance testing by the ICCs is normally performed through the use of the system release in instrument testing.

(b) Kayako Helpdesk

The Kayako Helpdesk is an off-the-shelf software that has been purchased by the HSC to be used primarily for the support of the astronomer community prior to and during the mission.

It shall be acceptance tested by the PST as part of the formal SGS Functional release 0.SCI.1 and test cases are included in the PST written Acceptance test plan and Acceptance test specification documents.

(c) Web Server

This corresponds to the creation of a website for the HSC where links shall be made to the relevant call for proposals. In addition, it will contain information about the HSC and the Herschel programme.

It shall be acceptance tested by the PST as part of the formal SGS functional release 0.SCI.1 and test cases are included in the PST written Acceptance test plan and Acceptance test specification documents. It shall also be tested as part of the KP & GT System Tests

(d) LDAP

This represents a copy of the ESTEC LDAP system being made available at ESAC and configured for the Herschel system. Where a user registration is made an update is made to the ESTEC LDAP which is then replicated to the ESAC system to allow the user to then login and take advantage of the Herschel software that can be downloaded from the ESAC site.

It shall be acceptance tested by the PST as part of the formal SGS Functional release 0.SCI.1 and test cases are included in the PST written Acceptance test plan and Acceptance test specification documents. It shall also be tested as part of the KP & GT System Tests

(e) Herschel Archive Browser

The Astronomers that make up the Herschel Scientific community will have access to the Herschel Data located at ESAC. Access to data is dependent on the restrictions in place e.g. confidentiality etc. The Herschel Archive browser is a standard interface in use by many missions in ESAC and as such its adaptation for Herschel will not lead to a big change in its architecture. This means that the testing involved here does not need to be very detailed.

System Tests of the HAB shall be performed by the ESAC Archive Group. The Acceptance Test shall be performed by representatives of the HSC and representatives of the Astronomy Actors.

The tests shall focus on the verification (with respect to requirements) of the HAB software and in addition shall validate the operational interface required to allow astronomy actors to input and retrieve data from the Herschel Science Centre using the HAB clients.

(f) Instrument OBSM

HFI (Planck Instrument Team) are in the process of producing their own OBSM tool which can convert the software images output from the various compilers of the Herschel & Planck Instruments, into the SCOS 2000 File format. Such a tool could then be used in conjunction with the ESOC OBSM system provided to the Herschel ICCs to allow further processing of their images.

HFI has responsibility to test its OBSM system before delivering it to the ICCs (TBC). Each ICC has responsibility to test the above software and confirm that their functionality is consistent with the appropriate ICDs.

5.2 SGS Functional Releases 0.EE.x, 0.SCI.x, 0.DP.x - Explained

Section 4.1 introduced the concept of functional releases e.g. 0.EE.1, 0.SCI.1, 0.DP.x, which can (although not always) contain various components within them e.g. HCSS & Helpdesk, all of which have been discussed in section 5.1 from the perspective of their test approach.

The HCSS SPMP [AD 13] provides a high level overview of the reasoning behind these functional releases, an extract of which is now provided. Note that specific dates have been updated as of the current issue date of this test plan.

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Because of different delays in various areas (launch delay at the H/P Program level, delay in the development of AOT "engines", delay in the AO for Key and Guaranteed Time Programs, etc.), and starting with Issue 6 of this document, it has become necessary to introduce new nomenclature for some of the later HCSS versions. While it is necessary to maintain a single HCSS development line, the final phases of HCSS development have to acknowledge that the HCSS has different end users, including

- The Herschel Project Scientist Team,
- The Herschel Science Ground Segment Integration & Test Team,
- The HSC Operations Team,
- The ICCs,
- The astronomical end user,

and that these different users have different schedules that translate into milestones at which they expect a particular set of HCSS functionalities. It is these functionalities that the new nomenclature identifies and as different elements of the schedule shift relative to each other we may have to adjust the mapping of these identifiers to "real" HCSS version numbers.

HCSS 0.EE.x releases

The "EE" stands for "end-to-end" and functionally HCSS v0.EE.x releases relate to use of the system at various stages in Herschel Ground Segment Integration & Test activities which later phase over into training activities for the operations team. Three v0.EE.x releases have been identified:

- HCSS v0.EE.1: With SVT-1/ EE-1 scheduled for mid 2007, informal interface tests to validate the format and then the contents of files that are exchanged between the Herschel MOC and the HSC are planned to start in the second half of 2006. HCSS v0.EE.1 will support this activity. Because start of these tests is not far in the future, we believe that HCSS v0.EE.1 should map onto user release HCSS v0.3.6 or perhaps v0.4, with the latter being the same release that is subjected to full acceptance testing by the PST prior to issuing the KP/GT AO.

- HCSS v0.EE.2: This version is to support the actual EE-1 scheduled for May 2007. In terms of data, it needs to be populated with some "observations" in instrument modes of operation for which we have real AOT "engines" that generate instrument commands. In terms of functionality, it has to be able to process orbit files, schedule observations based on PSFs, produce POS and ICPs, etc. Because of limitations in the support equipment (e.g. on ISO all observations used in actual EE tests had to be constrained to a very small area of sky) there will be certain tests that have to be carried out outside (or in preparation of the) EE tests, e.g. validating that observations scheduled by the scientific mission planning system never violate attitude constraints

- HCSS v0.EE.3: This version is to support the actual EE-2 scheduled for early 2008

HCSS V0.SCI.X Releases

One of the main responsibilities of the Project Scientist Team is to "optimise the scientific return from the Herschel mission". In this task, one of their foremost concerns is which instrument observing modes are sufficiently advanced in their definition to be offered to Key Program/ Guaranteed Time proposers with sufficiently stable AOT engines such that they can actually be scheduled starting in the science demonstration phase.

Similar to HCSS versions 0.EE.x, we can identify a number of 0.SCI.x releases, the first of which has already been delivered:

- HCSS v0.SCI.1: This is the release which will be provided to the PST at the start of their Proposal Submission Acceptance Tests. This includes to HCSS v0.3.3 that has been released in early February 2006

- HCSS v0.SCI.2: This is the release which will support the entry of Key Program and Guaranteed Time Proposals in early 2007. According to current plans, HCSS v0.SCI.2 would include HCSS v0.4.1.

- HCSS v0.SCI.3: In the absence of any formal distinction between supporting software for phase 1 and phase 2 proposal submission, it is TBD whether or not such a version needs to exist. It is possible, however, that after delivery of the instrument Flight Models to industry additional instrument operational or satellite pointing modes are introduced which need to be included in the HCSS and supported by the time of launch. Such changes would be accommodated in HCSS v0.SCI.3.

HCSS V0.DP.X Releases

HCSS functionality that is of particular interest to the ICCs, the astronomical community that wants to scientifically process Herschel data and the HSC which plans to build up a legacy archive of Herschel observations, has been in the past and will continue to be delivered in the future as Data Processing iterations (DP #x/y) that form an integral part of each HCSS user release. The content of these DP #x/y releases is described in a separate Software Project Management Plan [AD 14].

The table overleaf links the SGS Functional releases with the components contained within them, their expected functionality and the SGS Test reference number assigned to each one.

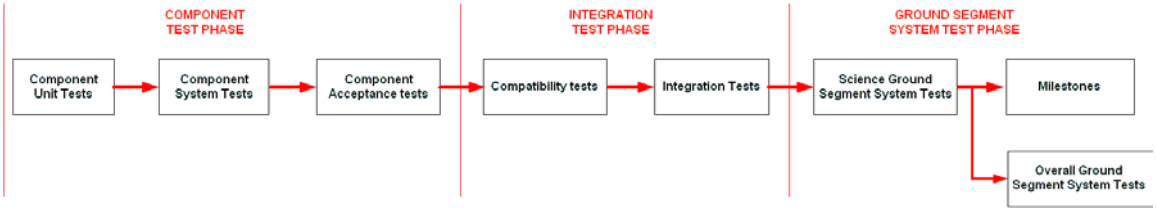
Functional Release Name	This release supports ….	Need Date	Test Reference
0.SCI.1	Project Scientist Team Acceptance Testing of - HCSS (Proposal Submission, HSPOT) - Helpdesk, Web, LDAP	Delivered February 2006	HGS-AT-HSC-0.SCI.1
0.SCI.2	Key Program/ Guaranteed Time proposal submission	February 2007	HGS-AT-HSC-0.SCI.2
0.SCI.3	TBD	TBD	HGS-AT-HSC-0.SCI.3
0.EE.1	EE1 preparatory activities: Validate format and, later, contents of files exchanged between the HSC and the MOC	Q4 2006	HGS-AT-HSC-0.EE.1
0.EE.2	- Support EE1 (full MOC/HSC Interface) - Support exchange of operational data with the ICCs - Partial support for validating operational procedures	Q2 2007	HGS-AT-HSC-0.EE.2
0.EE.3	- Support EE2. - Support training of operational staff. - Full support for validating operational procedures	Q4/2007	HGS-AT-HSC-0.EE.3
0.DP.x	Cf. [AD-14]	Every 6 months	HGS-AT-HSC-0.DP.x
1.0	Launch Version	Mar. 2008	HGS-AT-HSC-1.0

6. SGS Compatibility & Integration Test Phase

6.1 Compatibility & Integration Tests in the SGS I&T Plan

6.1.1 Background to Compatibility & Integration Tests

This chapter deals specifically with the Integration test phase of the ground segment test programme, which was introduced in section 4.1 and can be seen in the following drawing:



The Integration Test phase shown above can be divided into two main parts:

(a) Compatibility tests
(b) Integration Tests

(a) Compatibility Tests

Compatibility tests are the first step in ground segment testing They correspond to stand-alone tests involving only two elements. Their main purpose is to test the compatibility for the exchange of data on facility level between different GS elements, centre/stations, and facilities. It is not required to validate the interface on both sides of a data exchange during the same test. Their main goal is verification of ICDs with respect to data structure, file syntax, etc.

(b) Integration Tests

Integration tests are a second step in ground segment testing involving increased complexity. Integration tests involve at two or more elements connected with each other to enable functional testing and data exchange. They have 4 main purposes:

1. Test of communication protocols and synchronisation
2. Syntax check of data structures exchanged on the interface
3. Test of the functionality of the facilities
4. Test of operations procedures

6.1.2 Compatibility & Integration tests in the SGS Test Programme

Section 4.2.2 provided a list of the integration tests to be held between the HSC and the MOC, between the HSC and the ICCs and indeed between the ICCs and their sub-nodes, in order to support the three SGS System Test Themes. These are as follows:

HSC-ICC
- HSC-ICC Propagation Integration test
- HSC-ICC File Transfer Integration test
- HSC-ICC Product transfer Integration test
- HSC-ICC Calibration Observation Transfer Integration test

ICC-ICC Subnode
- ICC-ICC(Sub node) Propagation Integration Tests
- ICC-ICC(Sub node) Product transfer Integration test

HSC-MOC
- HSC-MOC FTS & DDS Setup Tests
- HSC-MOC Integration Test 1 – Uplink (includes HSC-JPL Horizons test)
- HSC-MOC Integration Test 2 – Downlink
- HSC-MOC Integration Test 3 – Manual Commanding scenario with HSC TPFs
- HSC-MOC Integration Test 4 – Manual Commanding scenario without HSC TPFs or POS

Prior to and in parallel with these integration tests, compatibility tests shall be performed to validate the data syntax.

Each of the above tests shall be dealt with in the coming subsections.

6.2 HSC ⇔ ICC Integration Tests

Test Overview & Objectives

This section defines the compatibility & Integration tests that shall be performed between the HSC and the three ICCs.

Interface Mechanisms

(a) **Science & HK TM Object data transfer** – this is transferred from the HSC to the ICCs through the nominal ODBMS Propagation process. These interfaces will be object based. Objects created in any of the HSC or ICC (e.g. as a result of the archiving of telemetry in HSC) will be (when relevant) accessible in a transparent manner to any of the other centres. The HSC-ICC interfaces are intrinsic to the HCSS and rely on the ODBMS remote access or propagation mechanism.

(b) **Product Cache & Transfer mechanism** – this is based upon a mechanism whereby products are transferred from the HSC to the ICCs only if not already present at the ICCs. Storage would be in a product storage pool. It is envisaged (although it remains TBC) that the product transfer mechanism shall also be used transfer calibration objects.

(c) **File transfer** – the mechanism for transfer of specific non TM files shall be via the File Transfer Mechanism (TBC).

(d) **CUS DB Script updates** – This makes use of the existing pre-launch interface whereby the CUS Scripts are delivered to the CVS server in ESTEC

(e) **Expert HSPOT interface** – Calibration Observations are delivered to the HSC during the mission via the HSPOT interface. The exact mechanism remains TBD but it is envisaged that the calibration observations AORs shall be sent to the HSC via the standard AOR delivery process.

Test Description & Methodology

A compatibility test shall be performed with each ICC where data and files in the correct format according to the ICDs are available. This data would not be provided via the operational interface but rather would be provided via email (for example). It must be mentioned here however that in general data to be transferred to the ICCs is already in use by the ICCs on a daily basis thus the need for compatibility tests is reduced.

Four integration tests shall be performed between the HSC and each of the three ICCs. Each test shall focus on the validation of the operational interface and for the verification of correct file format of the relevant data being transferred. These tests are as follows :

- HSC-ICC Propagation Integration test
- HSC-ICC File Transfer Integration test
- HSC-ICC Product Cache & transfer Mechanism Integration test
- HSC-ICC Calibration Observation Delivery Integration Test

Test Responsibilities

Responsibility for testing this interface falls to the DB Admin & Operations Group for the Propagation & Product data transfer tests and to the SGS I&T group for the file transfer tests.

Integration Test data Table

The contents of the tables below have been extracted from [RD 8].

HSC => SPIRE/HIFI/PACS ICC

Files being transferred	File Description	Generation Details	Transfer Mechanism
S/C TM	Spacecraft HK TM Objects	ESOC DDS provided data	Propagation
HK TM	Instrument HK TM Objects	ESOC DDS provided data	Propagation
SCIENCE TM	Instrument Science TM Objects	ESOC DDS provided data	Propagation
Data Frames	Instrument Science TM Data Frames[3]	Generated at HSC	Propagation
IIMG	Instrument Image File from MOC	ESOC FTS provided data	FTS (TBC)
Orbit file	Auxiliary Data File from MOC	ESOC FTS provided data	FTS (TBC)
SIAM	Spacecraft Instrument Alignment	ESOC FTS provided data	FTS (TBC)
SSO Ephem	SSO Ephemerides file	ESOC FTS provided data	FTS (TBC)
PSF	Planning Skeleton file	ESOC FTS provided data	FTS (TBC)
HCSS S/W	HCSS Software releases	CSDT software	Web interface

SPIRE/HIFI/PACS ICC => HSC

Files being transferred	File Description	Generation Details	Transfer Mechanism
ICSCH	ICC Mission Planning Schedule File	Generated using MPS at ICCs	FTS (TBC)
IIMG	OBSM Image File	ICC OBSM Export tool output	FTS (TBC)
CAL – Uplnik	Calibration object update	Calibration software	Product transfer
CAL Downlink	Calibration object update	Calibration software	Product transfer
CUS	CUS DB Script update	CUS Software	CVS Server
DP S/W	Data Processing Scripts & S/W	Generated at ICCs	CVS Server (TBC)
CALOBS	Calibration Observations	Generated at ICCs	HSPOT

[3] SPIRE & HIFI ICCs only

Test Characterisation Table

HSC-ICCs Compatibility Tests

The following table analyses the data transfers expected to be made between the HSC and the ICCs and determines which data should be realistically tested as part of a compatibility test.

The data in such a test is envisaged to be exchanged by email or FTP as part of a compatibility test between the HSC and the ICCs. The data contents do not need to be correct but rather the format of the data within the file should be consistent with the relevant ICD.

The test references for these tests shall be as follows: HGS-CT-H02-1.0, HGS-CT-H03-1.0 and HGS-CT-H04-1.0

File Type	Test in Compatibility Test
HK TM	No – not required as data is in format as exists in ICC database
SCIENCE TM	No – not required as data is in format as exists in ICC database
IIMG	Yes – both image file from MOC and image file from ICC
AUX Data	No – compatibility test of MOC with HSC will demonstrate compatibility with ICCs.
ICSCH	Yes – Verify correct format of file input provided by ICCs

HSC-ICCs Propagation Integration Test

Test Name	HSC to ICCs Propagation Integration Test
Test Objectives	- Configure the servers on the HSC and each of the ICCs to support the Propagation mechanism - Configure the ISDN line (TBC) to support data transfer between the nodes - Verify basic data transfer works via this method - Verify that standard data set to be transferred by Propagation can be successfully transferred.
Integration Test Prerequisites	Servers purchased or made available for data transfer by propagation DB Propagation approach ready for implementation
Test Data Required	**Basic data** to be transferred across shall be standard TM Pkts & Frame objects to verify the connection & the approach. **Standard data set** = All TM Pkts & Frames required by each ICC
SGS Test Reference	HGS-IT-H02-1.0 (Propagation Integration tests – SPIRE) HGS-IT-H03-1.0 (Propagation Integration tests – HIFI) HGS-IT-H04-1.0 (Propagation Integration tests – PACS)

HSC-ICCs – File Transfer Mechanism Integration test

Test Name	HSC to ICCs File Transfer Mechanism Test
Test Objectives	- Configure the servers on the HSC and each of the ICCs to support the File Transfer mechanism i.e. FTS (TBC) - Configure the ISDN line (TBC) to support data transfer between the nodes - Verify basic data transfer works via this method - Verify standard data transfer works via this method
Integration Test Prerequisites	Servers purchased or made available for FTS data transfer HSC-MOC Integration test #1 completed
Test Data Required	**Basic data set** = example of each file type i.e. PSF, Orbit, SIAM, OBSM Image file, MPSF file, SSO Ephemeredes file **Standard data set** = Sending of each file but testing of configuration control issues, data access issues etc
SGS Test Reference	HGS-IT-H02-2.0 (File transfer tests – SPIRE) HGS-IT-H03-2.0 (File transfer tests – HIFI) HGS-IT-H04-2.0 (File transfer tests – PACS)

HSC-ICCs Product Cache & Transfer Mechanism Integration Test

Test Name	HSC to ICCs Product Cache Mechanism Integration Test
Test Objectives	- Configure the servers on the HSC and each of the ICCs to support the Product cache & transfer mechanism - Configure the ISDN line (TBC) to support data transfer between the nodes - Verify basic product transfer works via this method - Verification of the successful transfer of product files to the ICCs - Verification of the cache mechanism whereby files not existing in the ICC product store are retrieved from the product DB located at the HSC - Verification of the transfer of Calibration products from ICCs to the HSC (TBC).
Test Data Required	Products generated at HSC during DP end to end tests Calibration products generated at the ICCs
SGS Test Reference	HGS-IT-H02-3.0 (Product transfer integration test – SPIRE) HGS-IT-H03-3.0 ((Product transfer integration test – HIFI) HGS-IT-H04-3.0 (Product transfer integration test – PACS)

HSC-ICCs – Calibration Observation Delivery Integration test

Test Name	HSC to ICCs Calibration Observation Delivery Integration Test
Test Objectives	- Validate the generation of Calibration Observations by the ICCs using the Expert HSPOT version - Validate the delivery of these observations to the JBOSS Application Server and confirm placement in the DB Temporary Repository - Validate the use by the MPS of these observations based upon the reception of a related Mission Planning Scheduling Summary File.
Integration Test Prerequisites	Mission Planning Summary File software developed & tested Expert HSPOT software developed & tested HSC to ICCs File transfer mechanism Integration Test completed
Test Data Required	Calibration Observation Requests Mission Planning Schedule Summary File
SGS Test Reference	HGS-IT-H02-4.0 (Calibration Observation test – SPIRE) HGS-IT-H03-4.0 (Calibration Observation test – HIFI) HGS-IT-H04-4.0 (Calibration Observation test – PACS)

Test Summary Tables

(a) Compatibility tests

Test Sites	Test Name	Test Referemce	Test Team
HSC & SPIRE	HSC-SPIRE Compatibility test	HGS-CT-H02-1.0	To be created in early 2007
HSC & HIFI	HSC-HIFI Compatibility test	HGS-CT-H03-1.0	
HSC & PACS	HSC-PACS Compatibility test	HGS-CT-H04-1.0	

(b) Integration Tests

Test Sites	Test Name	Test Referemce	Test Team
HSC & SPIRE	HSC-SPIRE Propagation Integration test	HGS-IT-H02-1.0	DB Admin & Ops group
	HSC-SPIRE File Transfer Integration test	HGS-IT-H02-2.0	TBD in 2007
	HSC-SPIRE Product Cache & transfer Integration test	HGS-IT-H02-3.0	DB Admin & Ops group
	HSC-SPIRE Cal. Observation Delivery Integration Test	HGS-IT-H02-4.0	TBD in 2007
HSC & HIFI	HSC-HIFI Propagation Integration test	HGS-IT-H03-1.0	DB Admin & Ops group
	HSC-HIFI File Transfer Integration test	HGS-IT-H03-2.0	TBD in 2007
	HSC-HIFI Product Cache & transfer Integration test	HGS-IT-H03-3.0	DB Admin & Ops group
	HSC-HIFI Cal. Observation Delivery Integration Test	HGS-IT-H03-4.0	TBD in 2007
HSC & PACS	HSC-PACS Propagation Integration test	HGS-IT-H04-1.0	DB Admin & Ops group
	HSC-PACS File Transfer Integration test	HGS-IT-H04-2.0	TBD in 2007
	HSC-PACS Product Cache & transfer Integration test	HGS-IT-H04-3.0	DB Admin & Ops group
	HSC-PACS Cal. Observation Delivery Integration Test	HGS-IT-H04-4.0	TBD in 2007

6.3 ICC⇔ ICC Sub Node Integration Tests

Test Overview & Objectives

This section defines the Integration tests that shall be performed between the ICCs and their sub-nodes. It should be noted that these tests will be performed between each ICC and a pre-selected ICC sub-node to test the interface. It is assumed that following a successful test, the interface mechanism may then be used for the other ICC sub-nodes to transfer data with the ICC primes.

Interface Mechanism

(a) **Science & HK TM Object data transfer** – this is transferred from the HSC to the ICCs through the nominal ODBMS Propagation process. These interfaces will be object based. Objects created in any of the HSC or ICC (e.g. as a result of the archiving of telemetry in HSC) will be (when relevant) accessible in a transparent manner to any of the other centres. The HSC-ICC interfaces are intrinsic to the HCSS and rely on the ODBMS remote access or propagation mechanism.

(b) **Product Cache & Transfer mechanism** – this is based upon a mechanism whereby products are transferred from the ICCs to the ICC sub-nodes. It is envisaged (although it remains TBC) that the product transfer mechanism shall also be used transfer calibration objects.

Test Description & Methodology

Two integration tests shall be performed between the ICC and a pre-defined ICC subnode to test the various transfer mechanisms planned to be used during operations. These tests are as follows :

- ICC-ICC sub-node Propagation Integration test
- ICC-ICC sub-node Product Cache & transfer Mechanism Integration test

Test Responsibilities

Responsibility for testing this interface falls to the DB Admin & Operations Group.

Integration Test data Table

The contents of the tables below have been extracted from [RD 8].

Important Note: The data to be provided by the ICC prime to the ICC Sub Node may be a subset of what the HSC makes available to the ICC prime. The tests to be performed shall demonstrate however that the mechanism works for all the various types of data that "could" be made available to the ICC sub-nodes. Whether they receive or not this data type is an internal ICC policy issue.

SPIRE/HIFI/PACS Prime ICC sites - ICC Sub-nodes

Files being transferred	File Description	Generation Details	Transfer Mechanism
S/C TM	Specific Spacecraft HK TM Files	Provided to ICC from HSC	Propagation
HK TM	Specific Instrument HK TM Files	Provided to ICC from HSC	Propagation
SCIENCE TM	Specific Science TM Files	Provided to ICC from HSC	Propagation
Data Frames	Specific Science TM Data Frames[4]	Provided to ICC from HSC	Propagation

SPIRE/HIFI/PACS ICC Sub-nodes => ICC Prime sites

Files being transferred	File Description	Generation Details	Transfer Mechanism
CAL – Uplink	Calibration table update	Calibration software	Product transfer - TBC
CAL - Downlink	Calibration table update	Calibration software	Product transfer

[4] SPIRE & HIFI ICCs only

Test Characterisation Table

ICC Prime –ICC Sub-node Propagation Integration Test

Test Name	HSC to ICCs Propagation Integration Test
Test Objectives	- Configure the servers on the ICC prime and each of the ICC sub-nodes to support the Propagation mechanism - Verify basic data transfer works via this method
Integration Test Prerequisites	Servers purchased or made available for data transfer by propagation DB Propagation approach ready for implementation
Test Data Required	**Basic data** to be transferred across shall be basic TM Pkts & Frames to verify the connection & the approach.
SGS Test Reference	HGS-IT-H05-2.0 (Propagation test with ICC sub-node – SPIRE) HGS-IT-H06-2.0 (Propagation test with ICC sub-node – HIFI) HGS-IT-H07-2.0 (Propagation test with ICC sub-node – PACS)

ICC Prime-ICC Sub-node Product Cache & Transfer Mechanism Integration Test

Test Name	ICC prime to ICC sub-node Product Cache Mechanism Integration Test
Test Objectives	- Configure the servers on the ICC prime and each of the ICC sub-nodes to support the Product cache & transfer mechanism - Verify basic product transfer works via this method - Verification of the successful transfer of product files to the ICCs - Verification of the transfer of Calibration products from ICC subnodes to the ICC prime (TBC).
Test Data Required	Products generated at HSC during DP end to end tests Calibration products generated at the ICC sub-nodes
SGS Test Reference	HGS-IT-H05-2.0 (Product transfer test with ICC sub-node – SPIRE) HGS-IT-H06-2.0 ((Product transfer test with ICC sub-node – HIFI) HGS-IT-H07-2.0 (Product transfer test with ICC sub-node – PACS)

Test Summary Table

Test Sites	Test Name	Test Referemce	Test Team
SPIRE	SPIRE –SubICC Propagation Integration test	HGS-IT-H05-1.0	DB Admin & Ops group
	SPIRE –SubICC Product Cache & transfer test	HGS-IT-H05-2.0	DB Admin & Ops group
HIFI	SPIRE –SubICC Propagation Integration test	HGS-IT-H06-1.0	DB Admin & Ops group
	SPIRE –SubICC Product Cache & transfer test	HGS-IT-H06-2.0	DB Admin & Ops group
PACS	SPIRE –SubICC Propagation Integration test	HGS-IT-H07-1.0	DB Admin & Ops group
	SPIRE –SubICC Product Cache & transfer test	HGS-IT-H07-2.0	DB Admin & Ops group

6.4 HSC ⇔ MOC Integration Tests

Test Overview & Objectives

This section defines the compatibility & Integration tests that shall be performed between the HSC and the MOC.

The data that flows between the two sites is described in more detail later but can be considered to fall into two different categories (a) FTS Data Transfer and (b) DDS data transfer.. Both of these categories and the operational mechanism for their transfer will be validated in the integration test between the two sites.

The testing of the interface between the HSC & the JPL Horizons system shall also be addressed within this section.

Interface Mechanism

(a) **DDS Data Transfers** – This interface is used for Science & HK TM retrieval by the HSC for incorporation into the HSC Database
(b) **File Transfer System data transfers** – the mechanism for transfer of specific non TM files shall be via the ESOC based File Transfer System.
(c) **Email/FTP** – The mechanism for transfer of SSO Ephemerides files from JPL Horizons to HSC

Test Description & Methodology

Compatibility tests shall be performed with the MOC where data and files in the correct format according to the ICDs are exchanged. This data would not be provided via the operational interface but rather would be provided via email (for example). Such a test will include checking for file syntax & format.

Two transfer mechanism installation, set-up & data verification tests shall be performed between the HSC and the MOC. These tests just focus on verifying that a correct set-up and configuration of the transfer mechanisms at the HSC and the MOC has been made.

Four formal integration tests shall be performed between the HSC and the MOC.

- HSC-MOC Integration Test #1 – Uplink – Nominal Mission Planning test
- HSC-MOC Integration Test #2 – Downlink – Nominal Mission Planning test
- HSC-MOC Integration Test #3 – Manual commanding with HSC TPFs – test of the commissioning phase interface between HSC & MOC
- HSC-MOC Integration Test #4 – Manual Commanding without HSC TPFs – test whereby commands of instruments are sent by MOC using procedures i.e. no POS, no HSC TPFs. This is to ensure that the uplink & downlink chains can be linked in the HSC.

Test Responsibilities

Responsibility for testing this interface falls to the HSC and the MOC Integration & Test responsible who form part of the SGS Integration & Test Team.

Integration Test data Table

In general all files sent via the FTS are also made available by the DDS. Those that are only DDS specific are highlighted below. The contents of the tables below have been extracted from [RD 8].

MOC => HSC

Files being transferred	File Description	Generation Details	Transfer Mechanism
PSF_	Planning Skeleton File	Generated by FDS	FTS
TSF_	Mission Timeline Summary	Generated by MCS	FTS
ORBI	Spacecraft orbit data (reconstituted)	Generated by FDS	FTS
AHF_	Attitude History File	Generated by FDS	FTS
OEF_	Orbit Event File	Generated by FDS	FTS
IOBS	Instrument Memory Image	Generated by MCS	FTS
SDB_	Spacecraft Database (bridge files)	Generated by MCS	FTS
ORBS	S/C attitude constraints algorithm	Generated by FDS	FTP
ORBS	S/C slew time and path predictor	Generated by FDS	FTP
N/A	Consolidated S/C HK TM	All output from the MCS and archived in the DDS for retrieval by the HSC	DDS
N/A	Consolidated Instrument HK TM		DDS
N/A	Consolidated Science TM		DDS
N/A	Instruments derived parameters		DDS
N/A	Telecommand History file		DDS
N/A	Out of Limit Data		DDS
N/A	Time Correlation File		DDS

HSC => MOC

Files being transferred	File Description	Generation Details	Transfer Mechanism
POS_	Preferred Observation Sequence	Generated by HSC	FTS
ICP_	Instrument Command Parameter	Generated by HSC	FTS
IOBS	Instrument Memory Image	Generated by ICCs	FTS
SIAM	Instrument Misalignment (SIAM)	Generated by HSC/ICCs	FTS
SSO_	SSO Ephemerides file	Generated by JPL Horizons	FTS
TPF_	Task Parameter File	Generated by HSC	FTS

Test Characterisation Table

HSC-MOC Compatibility Tests

The following data is envisaged to be exchanged by email or FTP as part of a compatibility test between the HSC and the MOC. The data contents do not need to be correct but rather the format of the data within the file should be consistent with the relevant ICD.

The test reference for these tests shall be as follows: HGS-CT-H01-1.0 (FTS file tests) HGS-CT-H01-2.0 (DDS File tests)

File Type	Test in Compatibility Test
PSF_ TSF_ ORBI AHF_ OEF_ IOBS SDB_ ORBS ORBS	Yes – Verify correct format of file input from MOC
Consolidated S/C HK TM Consolidated Instrument HK TM Consolidated Science TM Instruments derived parameters Telecommand History file Out of Limit Data Time Correlation File	Yes – retrieve representative files from the DDS archive
POS_ ICP_ IOBS SIAM SSO_ TPF_	Yes – Verify correct format of file input from HSC

HSC-MOC– HFTS Transfer Mechanism Set-up & verification

Test Name	HSC to MOC FTS Transfer Mechanism Set-up & Test
Test Objectives	- Configure the servers on the HSC and the MOC to support the FTS data transfer mechanism - Configure the lease line (TBC) to support data transfer between the nodes - Verify basic data transfer works via this method
Integration Test Prerequisites	- SDS Server configured at MOC for data transfer by FTS to HSC - HFTS Server machine at HSC ready for FTS installation & tests - MCS D2 FTS S/W acceptance tested - HCSS software updated to support FTS data transfers
Test Data Required	Data to be transferred across shall be basic data files to verify the connection & the approach
SGS Test Reference	HGS-IT-H01-0.1 (SGS FTS Configuration & verification)

HSC-MOC – DDS Transfer Mechanism Set-up & verification

Test Name	HSC to MOC DDS Transfer Mechanism Set-up & Test
Test Objectives	- Configure the servers on the HSC and the MOC to support the DDS data transfer mechanism - Configure the lease line (TBC) to support data transfer between the nodes - Verify basic data transfer works via this method
Integration Test Prerequisites	- Servers configured at MOC for data transfer by DDS to HSC - MCS D2 DDS S/W acceptance tested - HCSS software updated to support DDS data processing
Test Data Required	Data to be transferred across shall be basic TM files to verify the connection & the approach
SGS Test Reference	HGS-IT-H01-0.2 (SGS DDS Configuration & verification)

HSC to MOC Integration Test 1 – Uplink Test

NOTE: This test includes also the validation of the HSC⇔JPL Horizons interface. :

Test Name	HSC to MOC Integration Test 1 – Uplink test
Test Objectives	- Verification of the successful reception of SSO Ephemerides files from the JPL Horizons system - Verification of the successful transfer of HSC specific "uplink" files to the MOC via the FTS - Verification of the successful transfer of MOC Specific "Uplink" files to the HSC via the FTS - Validation of the correct transfer mechanisms expected to be used in operations - Validation of the HSC internal systems processing of these files
Integration Test Prerequisites	HCSS vs. 0.EE.1 System Tested MOC Delivery 2 Acceptance Tested FTS Transfer Mechanism Set-up & verification completed HSC-SPIRE/PACS/HIFI File transfer tests[5]
Test Data Required	The files defined in the Interface data tables above relating to the Ground segment uplink that are transferred via FTS shall be tested in this integration test
SGS Test Reference	HGS-IT-H01-1.0 (Integration Test)

HSC to MOC Integration Test 2 – Downlink Test

Test Name	HSC to MOC Integration Test 2 – Downlink test
Test Objectives	- Verification of the successful processing of MOC Specific "downlink" files provided to the HSC via the FTS and via the DDS - Validation of the correct transfer mechanisms expected to be used in operations - Validation of the HSC and the MOC internal systems processing of these files
Integration Test Prerequisites	HCSS vs. 0.EE.1 System Tested MOC Delivery 2 Acceptance Tested DDS Transfer Mechanism Set-up & verification completed HSC-MOC Integration Test 1
Test Data Required	The files defined in the Interface data tables above relating to the Ground segment downlink that are transferred via FTS & DDS shall be tested
SGS Test Reference	HGS-IT-H01-2.0 (Integration Test)

[5] For the case of the OBSM images to be transferred to the MOC

HSC to MOC Integration Test 3 – Manual Commanding Scenario with HSC TPFs

Test Name	HSC to MOC Integration Test 3 – Manual Commanding with HSC TPFs
Test Objectives	- Validation of the successful processing of TPFs sent by the HSC - Validation of the loading of sequences (based upon these TPFs) on the manual stack and generation of a manual stack printout to be sent to the HSC via FTS - Validation of the correct transfer mechanisms expected to be used in operations - Validation of the HSC and the MOC internal systems processing of these files
Test Prerequisites	HCSS vs. 0.EE.2 System Tested MOC Delivery 2 Acceptance Tested 1 Sequences existing on the MOC linked to TPFs
Test Data Required	TPF files, Manual Stack printout file
Test Steps & Features (for information purposes)	**HSC** - The HCSS shall generate & send to MOC 3 TPF files corresponding to three different sequences in the MOC DB **MOC** - The MOC shall receive the TPF files and load each one onto the manual stack and add commands e.g. DTCP s/c commands - The SPACON shall generate a manual stack printout file and this shall be sent via FTS to the HSC **HSC** - The Manual Stack printout file shall be opened and its contents confirmed to be consistent with the TPF's sent previously
SGS Test Reference	HGS-IT-H01-3.0 (Integration Test)

HSC to MOC Integration Test 4 – Manual Commanding Scenario without HSC TPFs

Test Name	HSC to MOC Integration Test 4 – Manual Commanding without HSC TPFs
Test Objectives	- Validation of the successful link by the HSC of manual commanding by the MOC with the downlink data that is produced and sent to the HSC - Validation of the procedures to be followed for this interface
Test Prerequisites	HSC-MOC Integration test #1 & 2 completed
Test Data Required	TC History, DDS TM data linked to TC history
Test Steps & Features (For information purposes)	This test will be run to validate the procedures that will exist to allow the HSC to process downlink data whereby the MOC has performed manual commanding of the instruments without HSC TPF or POS input. This test can be run off-line after a SVT-1 has been performed with the instruments in the loop.
SGS Test Reference	HGS-IT-H01-4.0 (Integration Test)

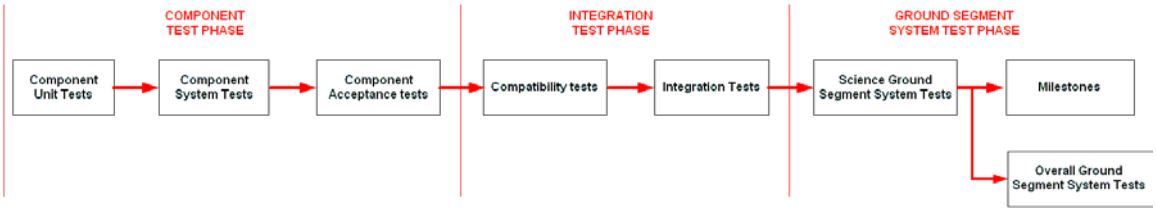
Test Summary Table

Test Sites	Test Name	Test Referemce	Test Team
HSC & MOC & JPL Horizons	HSC-MOC– HFTS Transfer Mechanism Set-up & verification	HGS-IT-H01-0.1	Test Team to be established September 2006
	HSC-MOC– DDS Transfer Mechanism Set-up & verification	HGS-IT-H01-0.2	
	HSC-MOC Integration Test #1 – Uplink – Nominal Mission Planning test	HGS-IT-H01-1.0	
	HSC-MOC Integration Test #2 – Downlink	HGS-IT-H01-2.0	
	HSC-MOC Integration Test #3 – Manual commanding with HSC TPFs	HGS-IT-H01-3.0	
	HSC-MOC Integration Test #4 – Manual Commanding without HSC TPFs	HGS-IT-H01-4.0	

7. Science Ground Segment System Test Phase

7.1 Science Ground Segment System Tests - Overview

This chapter deals specifically with the Science Ground Segment test phase of the ground segment test programme, which was introduced in section 4.1 and can be seen in the following drawing:



A number of different System tests are planned to be performed by the Science Ground Segment to ensure its readiness to support (see also section 4.2.3):

(a) The KP & GT Call for proposals
(b) The Processing of science data from the spacecraft
(c) The Ground Segment End To End Tests 1 & 2

(a) KP & GT Call for Proposals

The following Ground Segment System test shall be performed to_verify readiness of the system to support the KP & GT Call for proposal phase that is expected to begin in early 2007.

- SGS SOV 1.1 - KP & GT Science Ground Segment System Test 1
- SGS SOV 1.2 - KP & GT Science Ground Segment System Test 1

(b) The Data Processing System of the Science Ground Segment

The following Ground Segment System test shall be performed to test the data processing chains :

- SGS SOV 2.H1/S1/P1- Science Ground Segment DP End to End Test #1 – Mid 2006
- SGS SOV 2.H2/S2/P2 - Science Ground Segment DP End to End Test #2 – Mid 2006\
- SGS SOV 2.H3/S3/P3 - Science Ground Segment DP End to End Test #3 – End 2006

Whereby SOV2.H1 corresponds to the 1st HIFI DP end to end test, .S1 = SPIRE, .P1 = PACS

(c) Preparing for the Ground Segment End to End Tests 1 & 2 (chapter 8)

The following Ground Segment System test shall be performed **in preparation** for the first Herschel Ground Segment End to End test.

- SGS SOV 3.1 - Uplink/Downlink Ground Segment System Test 1

The following Science Ground Segment System test shall be performed **in preparation** for the second Herschel Ground Segment End to End test.

- SGS SOV 3.2 – Uplink/Downlink Ground Segment System Test 2

Each of the above tests shall be dealt with in turn in this section.

7.2 SGS SOV 1 - KP & GT Science Ground Segment System Test

Scope & Contents of these tests

Two tests will be performed end 2006 and early 2007 to ensure readiness to support the call for Key Programme proposals that shall be made February 2007.

The first test shall be 3 days long (as described below) with the second being between 1-2 days depending on how much retesting due to problem fixing is required. This test will involve all of the PST team members as well as the science operations engineer and a number of HSCDT team members.

To be able to say that the HSC system is ready to support the AO call for proposals, it needs to be demonstrated that it can support the opening of the AO, the closing of the AO and finally the TAC process. Based upon this, here are the steps to be followed for the first test:

DAY #1 - OPENING THE AO & FIRST STEPS - includes:
- Going through the steps involved in making the software & documentation visible to the community (well actually using internal HSC website)
- Opening the Proposal handler reception tool at HSC
- Downloading to various platforms of the PST the different versions of HSPOT & indeed of all required documentation
- Confirming correct start-up and running of different specific performance tests e.g. all making use of visualisation tool, all running time estimator, all logging into LDAP & registering at once etc.
- This day would also include sending in questions to the helpdesk.
- All HSC specific steps involved should make use of the relevant procedures defined in the HFOM document

DAY #2 - CLOSING THE AO - includes:
- All PST to generate test proposals during this day using their specific HSPOT version (note 1).
- Again sending Helpdesk questions & receiving answers, accessing the website, registering with LDAP for new users as required, shall be performed during this day.
- All proposals will be delivered at the same time of the day (note 2).
- The HFOM procedures on monitoring the HSC system shall be followed for all HSC specific activities

DAY#3 - POST AO - includes PST using the HFOM procedures relevant to the activities to be performed by them for preparing the HOTAC package. For example :
- Performing batch printing of all proposals
- Filling in the proposal analysis sheets to be made available to the HOTAC
- Preparing & making documentation available to the HOTAC e.g. using FTP or website for delivery of all proposals & justifications & "half-empty' documentation sets to the HOTAC,
- Performance of a representative HOTAC meeting whereby the proposals will be quickly categorised and updated with appropriate times allocations etc.
- The final step shall be access by the PHS of these proposals to confirm that the status that has been assigned is correct and the attempt to plan basic revolutions with some of them using the MPS that exists at that time (note 3)

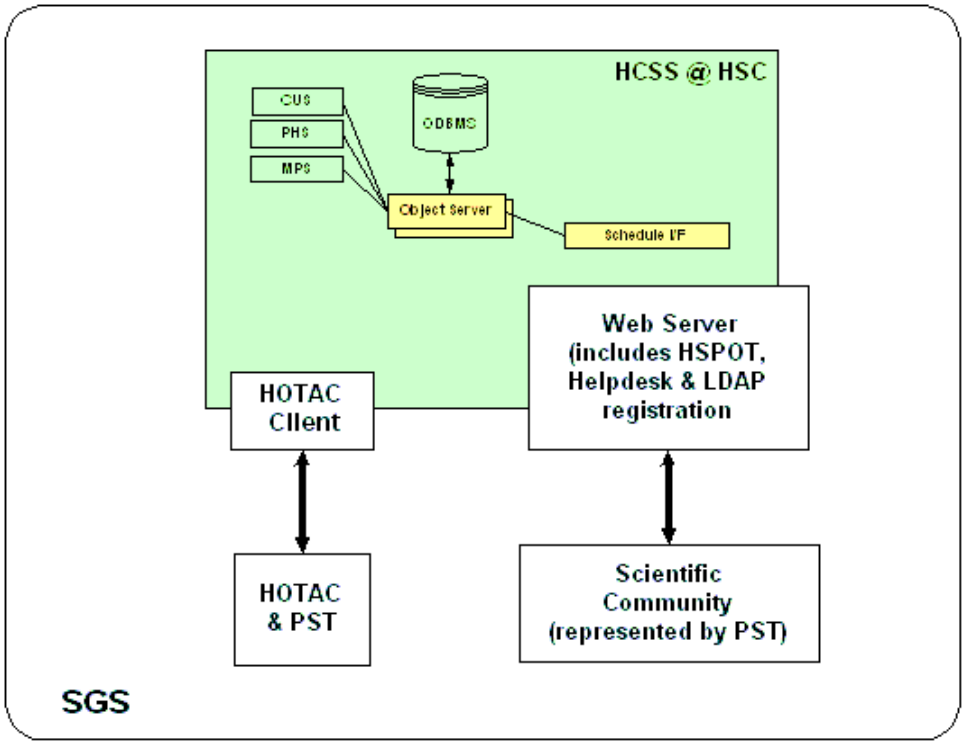
Note 1 - Previously generated test data shall not be used as the HSPOT version will not be the user release version being acceptance tested but a version which includes closure of major PST Acceptance test problems that have been raised before then.

Note 2 - While the load tests that the HSCDT shall perform will test certain aspects of the proposal delivery, in this particular test different proposals will be delivered from different platforms and from different users with different settings etc etc.

Note 3 – Both PHS & MPS are involved as these applications represent the final "user software" of the proposals. With their involvement, then and only then can it be confirmed that the proposals as generated by the astronomer have not been changed/altered in any way up to the point where they can be scheduled.

System Test Overview

This drawing provides a good overview of the interfaces that are involved in this system test.



KP & GT SGS System Test

SOV Preliminary tests

The following tests must be carried out prior to this SOV taking place

Test Type	Test Name
SGS Acceptance Tests	0.SCI.1 Acceptance tests completed

Data Transfer Tables

The following tables show the type of data that will be exchanged during this SOV.

Scientific Community Actors ⇔ HSC

From HSC to Scientific Community	From Scientific Community to HSC
Access to Website where they can - Download HSPOT Client - Access the Helpdesk - Register to LDAP	- Test Proposals - Questions, emails to the Helpdesk

HSC (PST) ⇔ HOTAC

From HSC to HOTAC	From HOTAC to HSC
Set of Proposals including Abstract, Justification and scientific analysis from PST	Update to proposal rate/rank criteria

Herschel SGS SOV 1 Test Scenarios

Test Name	KP & GT Science Ground Segment System Tests #1 and #2
Test Objectives	To demonstrate: - That the HSC (HSPOT) can function when receiving proposals from different users & different platforms at the same time. - That these proposals can be correctly stored and archived within the HSC database - That these proposals can be assessed by the Project Scientist Team and correctly analysed such that the relevant information expected by the HOTAC team members is available - That the Helpdesk & web server can be used by a wide audience and that the required interfaces with the PST e.g. responding to questions, functions as expected - That the procedures in place at the HSC are correct and cover all scenarios (nominal & contingency) expected to occur during the call for proposals
Test Sites involved	HSC @ ESAC PST @ ESAC and at ESTEC
Test Steps & Features	The test steps involved in this system test shall be defined in a dedicated SOV1 Test Plan document. An overview has been provided earlier in this subsection.
Additional Test Requirements	Testing of different computer platform configurations to ensure full redundancy is ensured and supported during the call for proposals
SGS Test Reference	HGS-VT-SGS-SOV1.0 and HGS-VT-SGS-SOV1.1

7.3 SGS SOV 2 - Science Ground Segment DP End-to-End Tests

Scope & Contents (extracted from [RD 10])

Data Processing End-to-End tests shall be organised with each ICC to verify that the Herschel science ground segment is capable of processing and distributing, to product levels 0, 1 & 2, all science data generated by the instruments during the Herschel Mission. There shall be a minimum therefore of three major test campaigns[6] comprising of a minimum of nine tests in total, three per ICC. These are as follows:

- **DP End to End Test campaign #1** – this test campaign consists of three separate tests i.e. HIFI DP End to End test #1, SPIRE DP End to End test #1 & PACS DP End to End test #1. Each test shall be performed using DP version 9.x. This test is envisaged to take place using test data from previously concluded instrument tests. The scope of this test is based upon whatever DP software, DP test data and pipelines are available at the expected date of the test i.e. July 2006. Code in the proto area is acceptable.

- **DP End to End Test campaign #2** – this test campaign consists of three separate tests i.e. HIFI DP End to End test #2, SPIRE DP End to End test #2 & PACS DP End to End test #2. Each test shall be performed using DP version 10.x. This DP software version shall have the capability to validate a **subset of the AOTs** defined (pre-launch) to be used in the mission. This test is envisaged to take place using test data from AOT tests performed on the actual instrument Flight Model hardware. Code in the proto area should be avoided.

- **DP End to End Test campaign #3** – this test campaign consists of three separate tests i.e. HIFI DP End to End test #3, SPIRE DP End to End test #3 & PACS DP End to End test #3. Each test shall be performed using DP version. 11.x. This DP software version shall have the capability to validate **all of the AOTs** defined (pre-launch) to be used in the mission.[7] This test is envisaged to take place using test data from AOT tests performed on the actual instrument Flight Model hardware. No code in the proto area is accepted.

The purpose of separating the DP End to End tests such that there are a minimum of three per ICC relates to the fact that test organisation and test data delivery shall be easier if handled on an ICC per ICC basis.

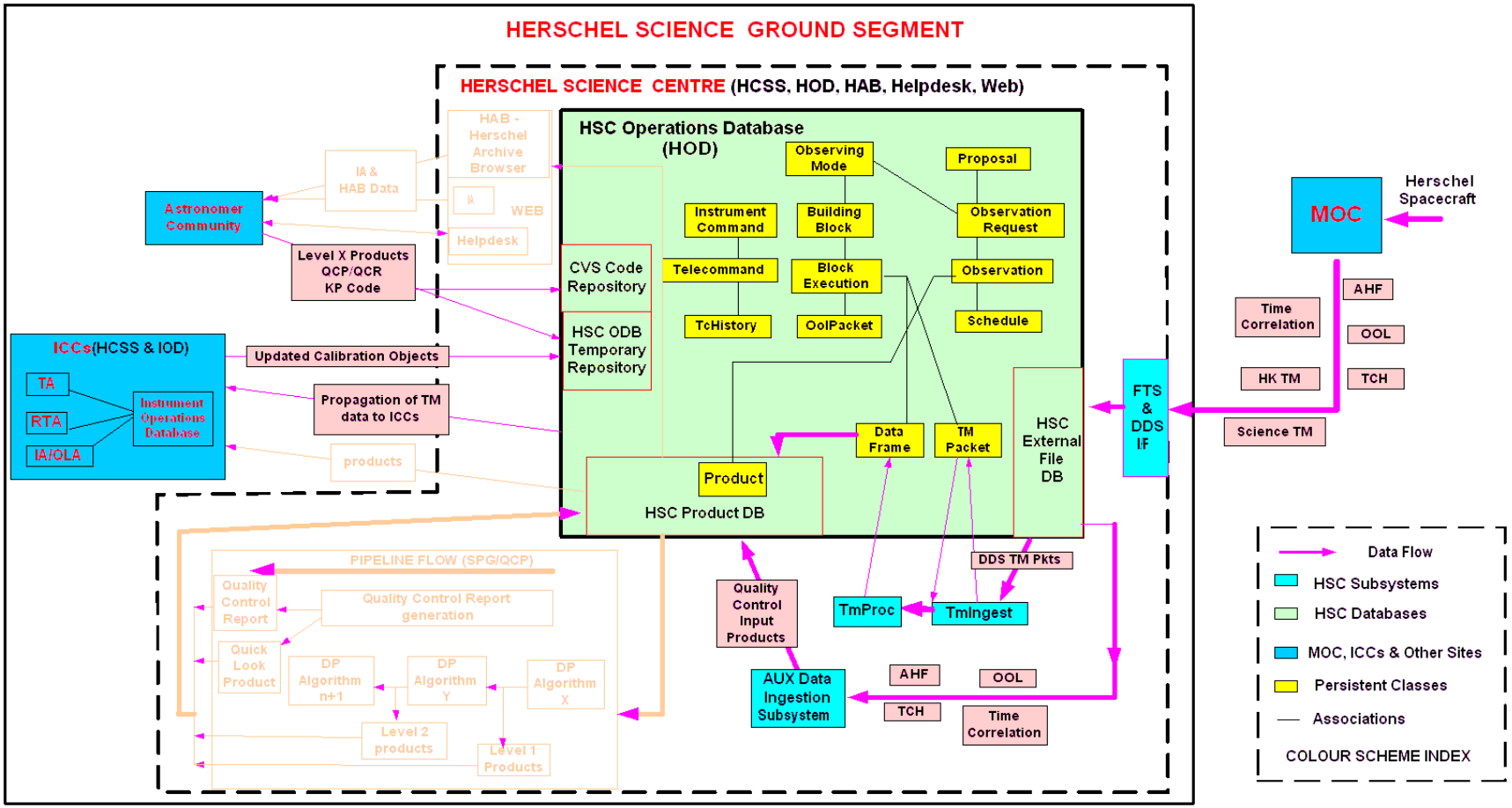
System Test Overview:

The following drawings (extracted from [RD 8]) provide a good overview of the interfaces & data flows that are involved in this system test.

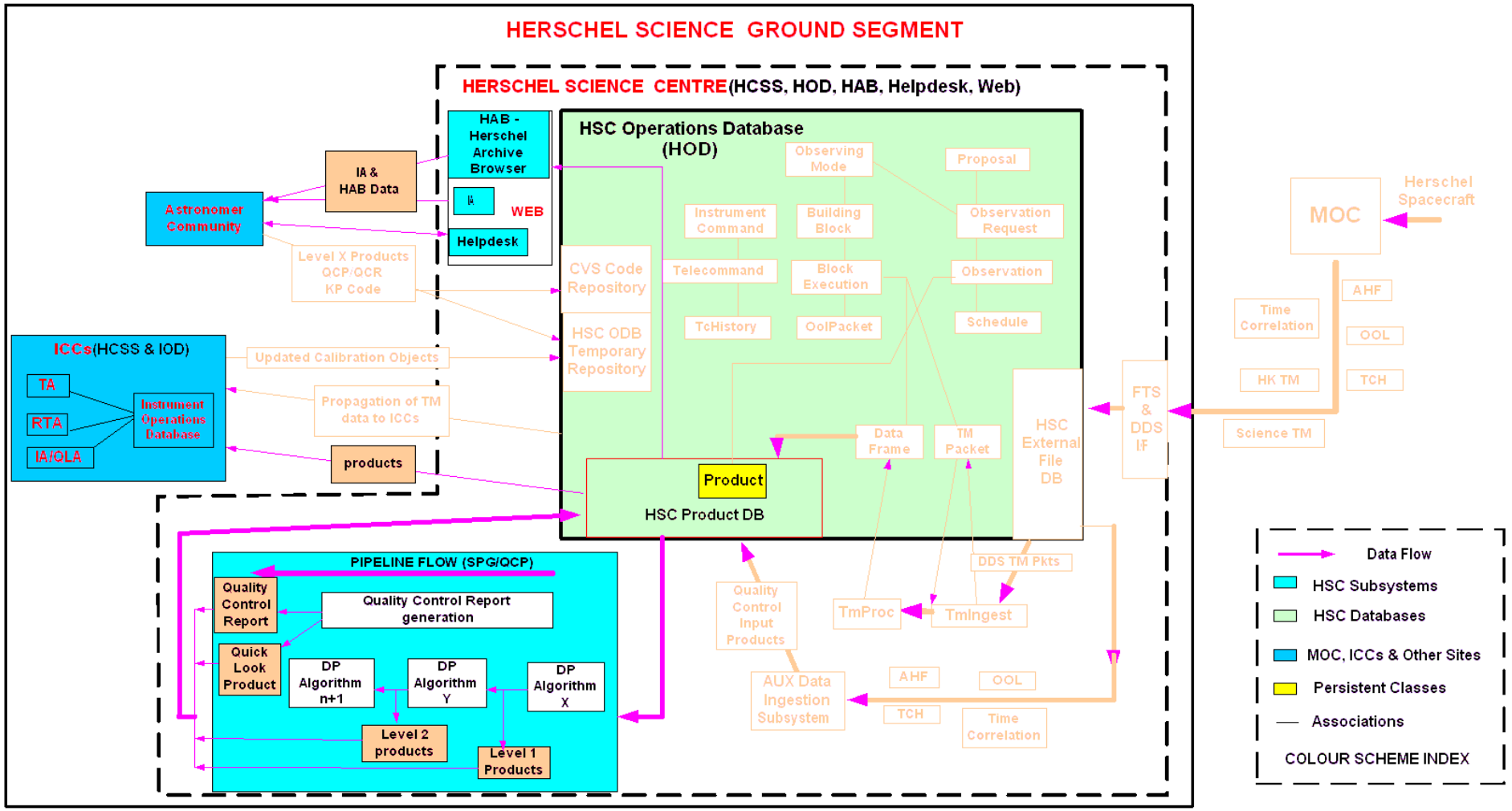
[6] Originally there were two major test campaigns defined. As the launch date moves then more tests shall be added to allow validation of those subsystems or software that could not be tested in the previous test campaign. Testing of closure of problem reports would also be covered.

[7] In addition, an understanding of the post-launch hardware requirements should result.

Downlink Chain 1 (Highlighted part = Inputs to Data Processing)



Downlink Chain 2 (Highlighted part = Output from Data Processing)



Herschel SGS SOV 2 Test Scenario

Data Processing End to End Test Campaign #1

Test Name	Data Processing End to End Tests #1 for HIFI, PACS & SPIRE - using DP Vs. 9.x
Test Objectives	The following reduced set of objectives shall be applied for DP End to End test campaign #1: (a) Validate the Input file generation process - Validate the generation of the Quality control input products (by the Aux data ingestion subsystem) - Validate the generation of Pointing products for the SPG (b) Validate the DP pipeline process for a pre-defined subset of AOTs (where possible, based upon test data availability) existing in DP vs. 9.x - Validate the correct processing of the science TM by the SPG and the production of the following types of files – All Level 0 data[9] (PACS/HIFI) & products (SPIRE) specific to the AOT in question – All Level 1 products specific to the AOT in question
Test Description	These are system tests that shall be performed to verify the capabilities of the DP chain at ESAC to process a limited set of science data using the Pipeline software existing at the time of performing the test.
SGS I&TP Reference	HPGS-VT-SGS-SOV2.H1 – HIFI DP End to End Test #1 HPGS-VT-SGS-SOV2.P1 – PACS DP End to End Test #1 HPGS-VT-SGS-SOV2.S1 – SPIRE DP End to End Test #1

Data Processing End to End Test Campaign #2

Test Name	Data Processing End to End Tests #1 for HIFI, PACS & SPIRE - using DP Vs. 10.x
Test Objectives	The following objectives shall be applied for DP End to End test campaign #2: (a) Validate the Input file generation process - Validate the generation of the Quality control input products(by the Aux data ingestion subsystem) (c) Validate the DP pipeline process for a pre-defined subset of AOTs existing in DP vs. 9.x - Validate the correct processing of the science TM by the SPG and the production of the following types of files – All Level 0 data[10] (PACS/HIFI) & products (SPIRE) specific to the AOT in question – All Level 1 products specific to the AOT in question – All Level 2 products specific to the AOT in question (PACS/SPIRE only)[11] (c) Validate the Interfaces involved - Validate the interface with the Herschel Archive Browser - Validate the interface for the reception of Calibration Objects from the ICCs and the HSC - Validate the interface for the reception of DP S/w Updates from the DP team.

[9] SPIRE will have level 0 products while for the other ICCs Level 0 shall represent Data Frames only
[10] SPIRE will have level 0 products while for the other ICCs Level 0 shall represent Data Frames only
[11] It remains TBC whether HIFI SPG shall be able to generate level 2 products

	- Validate the provision of IA software to the Astronomer community via the WEB (d) Validate the DP pipeline "update & re-run" process: - Reception of updated DP S/W routines & running of the appropriate CCB procedures - Reception of new Calibration Objects with a timeframe relevant to the previously processed data set & running of the appropriate CCB procedures - Issue of new DP software and re-run of previously processed data using new pipeline version - Update on Herschel Web the downloadable IA software version based upon these changes (e) Procedures Verification – All procedures relevant to the SPG/QCP shall be tested in these tests (f) Performance Verification : When all three tests have been completed then: - Process HIFI & PACS data on the GRID in parallel with the SPIRE data to verify performance capabilities
SGS I&TP Reference	HPGS-VT-SGS-SOV2.H2 – HIFI DP End to End Test #2 HPGS-VT-SGS-SOV2.P2 – PACS DP End to End Test #2 HPGS-VT-SGS-SOV2.S2 – SPIRE DP End to End Test #2

Data Processing End-to-End Test Campaign #3

Test Name	3rd Data Processing SOV Tests for HIFI, PACS & SPIRE - Using DP Vs. 11.x
Test Objectives	The following objectives shall be applied to DP End to End test campaign #3: (a) Closeout any open Anomaly Reports raised during the three End to End 2 subtests (b) Repeat failed or non-runs tests output from End to End test Campaign #2 (c) Perform the following additional tests: - Validate the full set of AOTs defined by the ICCs and implemented in DP vs. 11.x - Perform a stress test running TBD hours of AOT test data through the system - Verify increased quality & representativity of the test data - Run parallel processing of the three ICC data sets to verify system performance - Ensure that the pipelines can also work in the case where TM gaps exist - Validate the distribution of products via the Herschel Archive Browser (d) Test the feedback mechanism from the community of level-X products back into the archive (e) Define the Hardware requirements for the post-launch phase (f) Run through all SPG & QCP procedures (this includes manual checking steps)
Test Description	These are system tests that shall be performed to verify the capabilities of the DP chain at ESAC and at the ICCs to process Science data and to produce HAB useable data products.
SGS I&TP Reference	HPGS-VT-SGS-SOV2.H3 – HIFI DP End to End Test #3 HPGS-VT-SGS-SOV2.P3 – PACS DP End to End Test #3 HPGS-VT-SGS-SOV2.S3 – SPIRE DP End to End Test #3

7.4 SGS SOV 3 - Uplink/Downlink Ground Segment System Tests

Scope & Contents

Two spacecraft End-to-End tests are to be performed prior to launch. These End-to-End tests shall validate (among other things) the Mission Planning chain of the Herschel Ground Segment. Further details of the Spacecraft End to End tests are provided in chapter 8.

To ensure that the Science Ground Segment is capable of supporting these tests, two SGS Uplink/Downlink System tests shall be carried out – one before each of the spacecraft end to end tests.

It is envisaged that the MOC shall take an active involvement in both SGS system tests, as it is only with such an involvement that useful uplink/downlink connections can be tested. It is understood however that the system test may take place over separate time periods in order to take into account the nominal workload at each centre i.e. MOC activities can be performed a number of days.

The HK & Science TM data generated by MOC from their simulator shall be inherently linked (by OBSID & BBID) to the uplink data files provided by the HSC and should be consistent with the CUS files & Calibration objects provided by the ICC in preparation for the test.

A test of the **OBSM interface** shall also be included in these SGS system tests as a change to the instrument configuration will lead to a change to the system existing at the ICCs.

Where possible, these SGS System Tests shall be run in **Future Time.**

SOV Preliminary tests

The following tests must be carried out prior to this SOV taking place

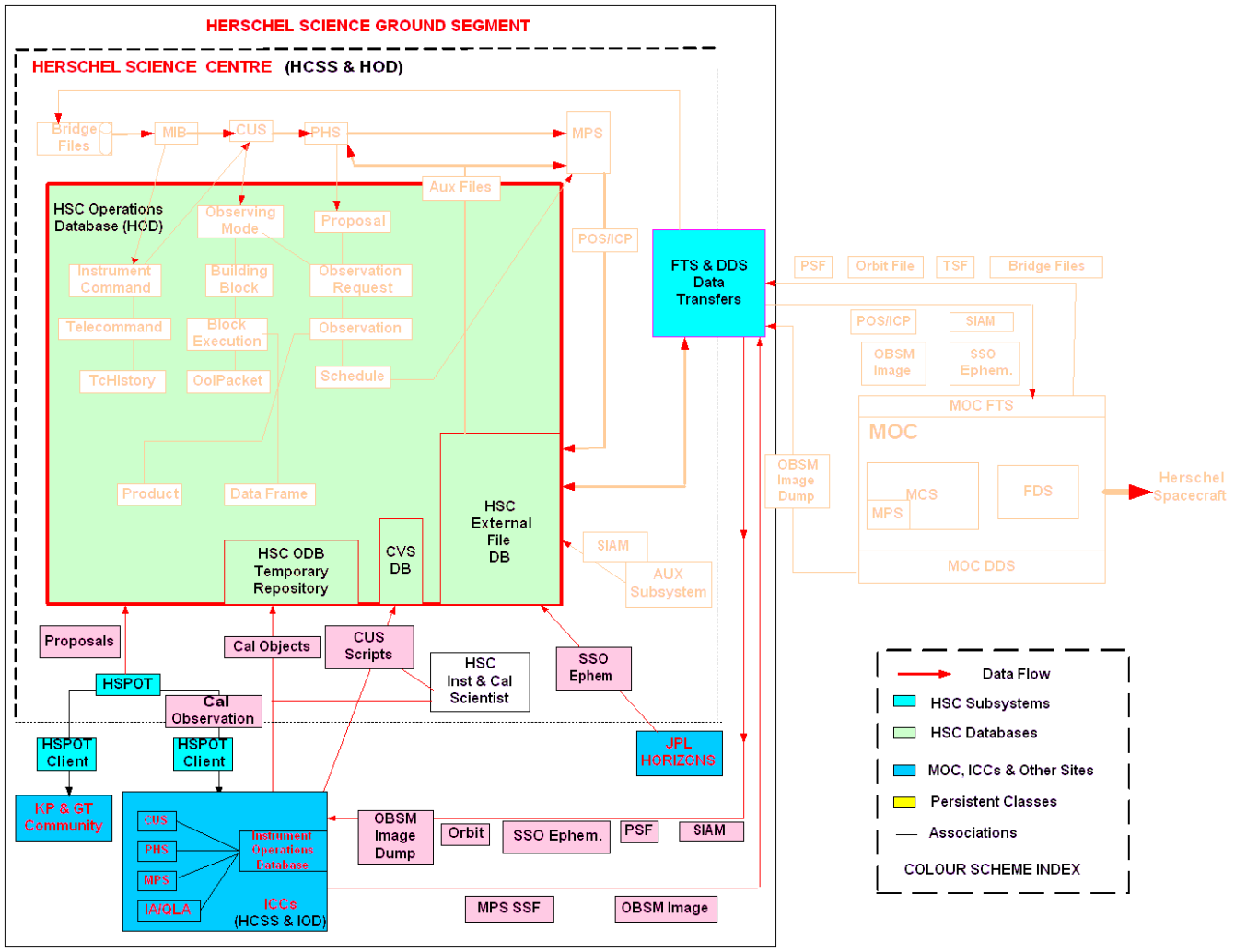
Test Type	Test Name
SGS Acceptance Tests	HCSS 0.EE.1/HCSS 0.EE.2
Integration Tests	HSC-ICC File Transfer Integration test
	HSC-ICCs data propagation Integration test
	HSC-ICCs data propagation Integration test
	HSC-MOC Integration test 1 – Uplink test
	HSC-MOC Integration Test 2 – downlink test
SGS SOV Tests	SOV 1 - KP & GT System Test

System Test Overview:

The following drawings (extracted from [RD 8]) provide a good overview of the interfaces & data flows that are involved in this system test.

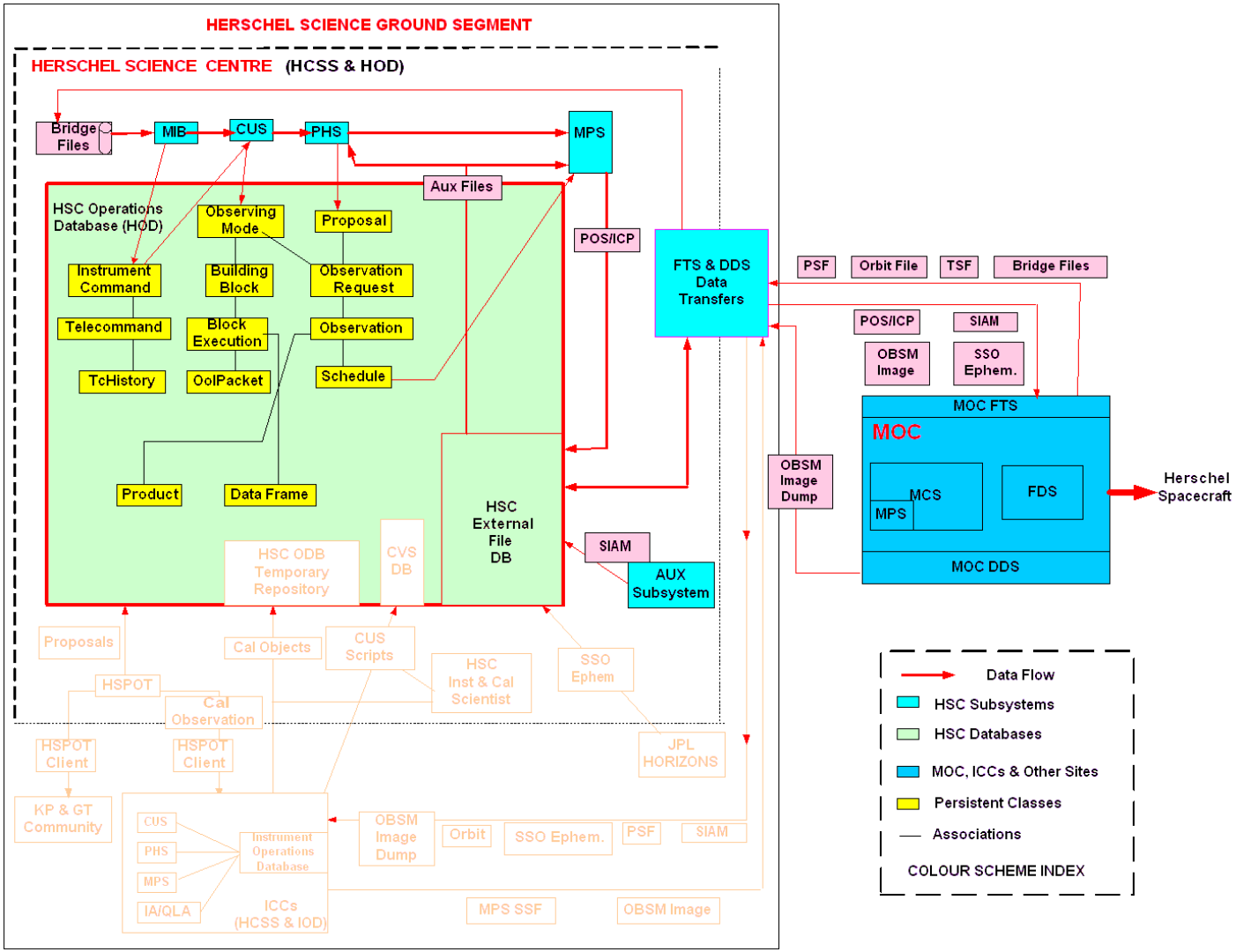
[12] In addition, an understanding of the post-launch hardware requirements should result.

SGS SOV 3 - Drawings #1 -Uplink Chain – HSC interactions with ICCs highlighted[13]

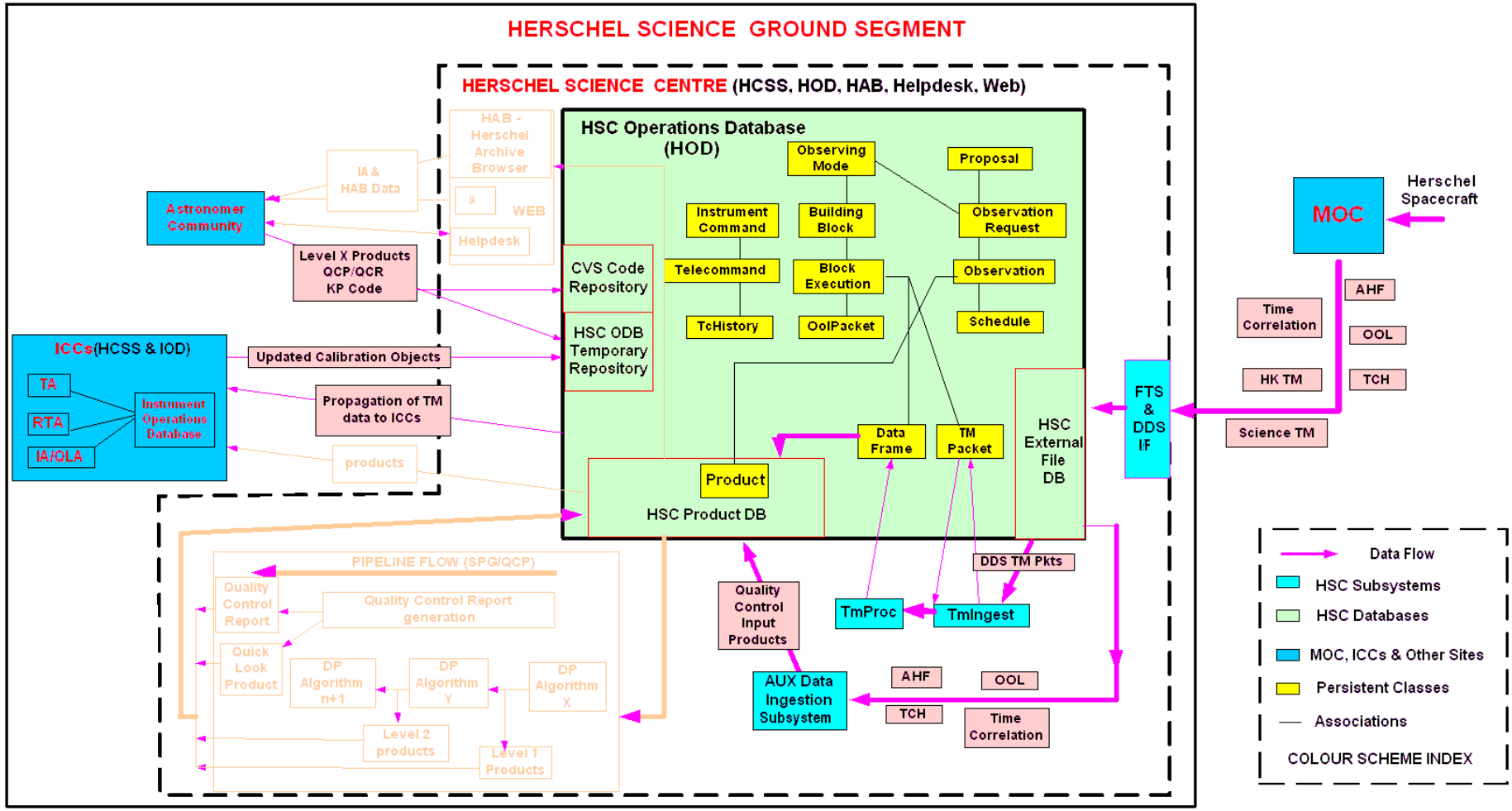


[13] Note that the HSPOT interface will not be tested in this system test.

SGS SOV 3 - Overview Drawing #2 -Uplink Chain – HSC interactions with MOC highlighted



SGS SOV 3 - Overview Drawing #3 -Downlink Chain – Inputs to the Data Processing Chain Highlighted only



Data Transfer Tables

The following tables show the type of data that will be exchanged during this SOV.

HSC ⇔ JPL Horizons (Uplink only)

From HSC to JPL Horizons	From JPL Horizons to HSC
Email/FTP request	SSO Ephemeredes file

HSC ⇔ ICCs

From HSC to ICCs	From ICCs to HSC
Uplink Only - Spacecraft orbit data (reconstituted) - Planning Skeleton File - SIAM file - SSO Ephemerides file **Downlink only** - Instrument HK TM - Spacecraft HK TM - Science TM - Data Frames (HIFI/SPIRE only) - Auxiliary Data – See MOC table below	**Uplink Only** - ICC Mission Planning Schedule File - OBSM Image - CUS Scripts - Calibration Products - Calibration observations **Downlink Only** - Calibration Products

HSC ⇔ MOC – Uplink Only

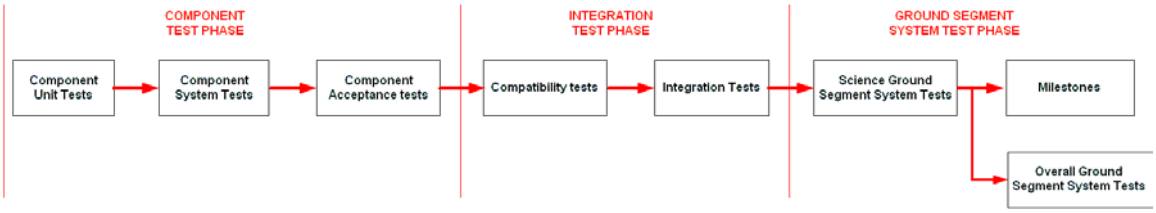
From HSC to MOC	From MOC to HSC
Uplink Only - Preferred Observation Sequence (POS) - Instrument Command Parameter (ICP) - Instrument Misalignment (SIAM) - SSO Ephemerides file - OBSM Image from ICCs **Downlink Only** N/A	**Uplink Only** - Planning Skeleton File - Bridge files - Spacecraft orbit data (reconstituted) - Timeline Summary File - Orbit Event File **Downlink Only** - Consolidated S/C HK TM - Consolidated Instrument HK TM - Consolidated Science TM - Spacecraft orbit data (reconstituted) - Attitude History File - Orbit Event File - Telecommand History file - Out of Limit Data - Time Correlation File

Herschel SGS SOV 4 Test Scenario

Test Name	SGS SOV3.1 and 3.2 – Uplink/Downlink System Tests 1 & 2
Test Objectives	**SGS SOV 3.1 Objectives** **To Demonstrate:** - The nominal uplink chain of events that are followed by the HSC, the ICCs and the MOC (use of ESOC simulator envisaged) - The nominal downlink chain of events that are followed by the MOC, HSC and the ICCs (use of ESOC simulator envisaged) - The SGS can run in future time throughout this system test - On-board Memory Image transfer **To Verify:** - The correct process in updating the Operational system at the HSC with data inputs provided by the ICCs and the MOC - The correct linking of the uplink & downlink chains via the OBSID concept - The correct timing of events in performing the processing of data received from the ICCs and the MOC **SGS SOV 3.2 Objectives** **To Demonstrate:** - The nominal uplink chain of events that are followed by the HSC, the ICCs and the MOC + additional test involving MPS Schedule summary file & calibration observations from ICCs. (use of ESOC simulator envisaged) - The nominal downlink chain of events that are followed by the MOC, HSC and the ICCs (use of ESOC simulator envisaged) - The SGS can run in future time throughout this system test - The impact on the ICCs resulting from a change in the On-board Memory Image - That the problems identified during End to End test 1 have been fixed **To Verify:** - The correct process in updating the Operational system at the HSC with data inputs provided by the ICCs and the MOC - The correct linking of the uplink & downlink chains via the OBSID concept - The correct timing of events in performing the processing of retrieved data - That the system is ready to support End to End test 2 & the commissioning phase e.g. Hardware redundancy tests - The procedures to be used for operating the various SGS systems - HCSS Performance Requirements are met
Test Sites involved	HSC, PACS/SPIRE/HIFI ICCs, MOC
Test Steps & Features	The test steps & features of each test shall be defined in a dedicated test plan.
SGS Test Reference	HGS-VT-SGS-SOV3.1 and HGS-VT-SGS-SOV.3.2

8. Overall Ground Segment System Tests – SVT & E2E

This chapter deals specifically with the Ground Segment System tests that form part of the Ground Segment test phase, which was introduced in section 4.1 and can be seen in the following drawing:



Full details of the Herschel Ground Segment System tests can be found in [AD 10]. An extract is provided below however to allow the readers to understand where the Herschel Science Ground Segment System Test Programme fits within the scope of these tests.

8.1 Spacecraft Listen In Tests (For information only)

Scope & Objectives

These tests are not Ground segment system tests but are included here for information.

They have the main objective to demonstrate connectivity and proper configuration of the MCS to the test site, including correct processing, display and archiving of real TM data. As these are Listen-In tests i.e. TM reception, they do not involve commands being sent from the MOC to the spacecraft.

These are ESOC Specific tests and they do **NOT** involve the Science ground Segment.

The SGS can of course connect to the DDS and retrieve the recorded data (if stored in the archive) after the event.

8.2 SVT and End to End Tests - Involvement of Science Ground Segment

What is the difference between an SVT and an End to End test?

There are three System Validation Tests to be performed between ESOC and the Spacecraft. SVT-0 is Service Module specific while both SVT-1 and SVT-2 involve, among other tests, manual commanding of the instruments according to predefined procedures.

At the end of SVT-1 and SVT-2, the spacecraft End-to-End test shall be performed which shall primarily focus on validating the mission planning chain. In this case the full science ground segment is involved.

In the case of SVT-1 and SVT-2, the Science Ground Segment is only involved in that the ICCs are located at the MOC (ICC@MOC and at the spacecraft site to monitor the performance of their instrument). It is envisaged that for SVT-1, only the PACS ICC@MOC shall be used.

8.2.1 SVTs

Scope & Objectives

As far as the scope of the SVTs concerns system-level interface validation, the objectives, interfaces and tests are presented in the GSSTP [AD10].

SVTs **do** involve the Science Ground Segment but only from the perspective that the instruments procedures are being run at the MOC and thus the ICC@MOC shall be setup and listening in to verify correct performance of the instruments upon running of those procedures.

SVTs do **NOT** involve the mission planning chain as this is tested in the scope of the End-to-End tests. The HSC can connect to the DDS and retrieve the TM and TC history during & after the event if so required and if agreed with the MOC.

Three SVTs shall be performed prior to launch i.e. SVT-1, SVT-2 and SVT-3. The top-level objectives for the SVT campaigns are as follows:

- To confirm the ability of the ground station equipment (NDIUs) to correctly decode the TM data.
- To confirm the ability of the MCS (and ground station back-end equipment) to receive, process and display
- TM for all the different data rates and data transmission scenarios.
- To verify the data is correctly extracted from TM packets and interpreted correctly.
- To verify the functionality of the MCS telecommanding subsystem, operating in a closed loop with the satellite, in AD and BD modes with either decoder, including directives.
- To verify MCS manual telecommanding functionality.
- To verify the MCS automatic telecommanding functionality.
- Verify the modelling of on-board systems used for telecommanding/display (MTL, SSMM)
- To verify, as far as is possible, the correctness of the operational database (calibration, validity, limits, mode dependency, status consistency, derived parameters, PTV command verification, etc.).
- To confirm the ability of the ground station equipment (NDIU) to correctly encode TCs
- To confirm the ability of the telecommand and telemetry router equipment (NCTRS) to correctly exchange all required data types.
- To confirm the ability of the Flight Dynamics (FDS) systems to retrieve, process and display TM correctly.
- To verify that commands generated by FDS are correctly encoded. This requires modelling of the orbital environment to stimulate the attitude sensors according to the actuator outputs.

- To verify all functionality is in place in the MCS to support nominal and contingency operational flight procedures (e.g. redundancy switching, recovery from safe modes).

- To confirm that the spacecraft response to commands is as expected by the procedures and timelines as defined in the FOP.

- To verify that the final product of the mission planning process (i.e. time-tagged command schedules, the onboard Mission Timeline) can be correctly executed by the satellites.

- To verify, for all on-board memories accessible to maintenance processes, that the products of the OBSM function can be correctly loaded on-board the satellites.

- To verify that the contents of the on-board memories can be correctly dumped, stored, interpreted and displayed by the OBSM function.

- To verify that OBCPs can be generated, loaded, executed and controlled from the ground.

- To confirm that the spacecraft launch configuration is as expected, and is fully compatible with the ESOC post-launch initial acquisition Flight Control Procedures (SVT-1 or SVT-2 – TBC).

- To provide reference data useful for the verification of the spacecraft simulator.

8.2.2 Spacecraft End To End tests

The End-End tests for both missions have the following top-level objectives:

- Validation of the mission planning cycle as applicable to each mission

- Validation of the data exchange interfaces in an operational context

- Validation of operational procedures

- Demonstration of end-end integration of subsystems and their system-level interfaces

- Identification of timing constraints and data product processing issues

- Familiarisation of the routine operational scenario for participating teams

There are two Spacecraft End to End tests planned, the first at the end of SVT-1 and the second at the end of SVT-2. Both have 5 days duration.

The set of activities to be performed during these tests shall be recorded in a dedicated test plan to be produced by the Integration & Test Steering Group.