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HERSCHEL GROUND SEGMENT

INTERFACE REQUIREMENTS DOCUMENT

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CHANGE LOG

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- Draft 0 by ESA/HSC (SV)	0	0	10/29/99
- Update after HGSSE meeting #1, 15-16/11/99, ESTEC, ref. FIRST/HSC/MOM/0097	0	1	12/02/99
- Update after HGSSE meeting #2, 20-21/12/99, ESOC , ref. FIRST/HSC/MOM/0101 and after Herschel Ground Segment Scenario meeting #4, 11-14/01/00 Vilspa Re-structure of the document	0	2	21/01/00
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- Update after HGSSE group internal review, see [HGSSE#4]	0	4	17/03/00
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- Issue 1.0. This Herschel issue is to be used as the baseline for the elaboration phase of the HSC System, see [RD-9]. This Herschel issue includes a number of TBC and TBW, especially in the area of control flows, that cannot be solved at this point in time. They are however not deemed a problem w.r.t. the HSC System elaboration phase.	1	0	09/05/00
- Complement the issue 1.0 for interface requirements between FGS systems in in-orbit phase, ILT and IST.	1	1	23/08/00
- Update of the ILT section (section 4)	1	2	05/10/00
- Update after the EGSE/HGSSE meeting on the 09/10 October 2000 and additional comments from ICCs, ESOC and Project	1	3	03/11/00
- Update after the HCSS SRR at ESTEC and follow-up HGSSE meetings #11, #12 , #13, #14 and #15.	2	0 draft	02/11/01
- See change record below.	2	1	12/12/03
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CHANGE RECORD

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reason for change/*raison du changement*	page(s)/*page(s)*	paragraph(s)/*paragraph(s)*
FIRST replaced by Herschel	Allp3	
Signature list modified according to H/P project memo SCI-PT/8410		
The Herschel Operation document and design description document are listed as applicable documents following HCSS SRR recommendation R03-2		1.5
Update to make the IRD in line with the SIRD v1.0 following SRR recommendation R05-3, see details in HGSSE#11 MoM		3.1.15 (comment only) 3.4-130 (modified) 3.7-170 3.4-80/100(modified) 3.4-80/100 (modified) 3.7-10/20 (modified) 3.7-200 (new)
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SRR RID SR-CCB-43		3.5-70 (new) 3.7-200 (new)
SRR RID SR-CCB-45		3.7-48 (new) 3.7-80 (comment only)
SRR RID SR-CCB-47		3.7-130 (TBC added)
SRR RID SR-CCB-50		3.7-125 (new)
Resolutions of TBCs, TBDs and TBWs in the IRD following HCSS SRR recommendation R07-1. The details of discussion leading to the resolution of TBCs, TBDs and TBWs are recorded in the HGSSE#12 and HGSSE#13 MoM.		3.1-75 (new) 3.1-110 (TBC removed) 3.1-130 (TBC removed) 3.1-145 (modified + TBD removed) 3.1-160 (TBC removed) 3.1-190 (TBC removed) 3.1-220 (modified + TBC removed) 3.1-240/250 (deleted) 3.1-260 (modified) 3.1-265 (new) 3.1-295 (added) 3.1-320 (modified + TBC removed) 3.1-360 (TBC removed) 3.1-390 (modified +TBC removed) 3.1-410 (TBC removed) 3.1-435/436 (new)

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		3.1-455 (new) 3.1-475 (new) 3.1-495/496/498 (new) 3.1-505/506 (new) 3.1-515/516 (new) 3.1-525/526 (new) 3.1-535/536 (new) 3.1-545/548 (new) 3.2-15/18 (new) 3.4-40 (deleted) 3.4-50 (modified) 3.4-60/70 (deleted) 3.4-90 (deleted) 3.4-100 (modified) 3.4-110 (TBC removed) 3.4-115 (new) 3.4-125 (new) 3.4-130 (modified) 3.4-135 (new) 3.4-145 (new) 3.5-15 (new) 3.5-40 (TBC removed) 3.5-45 (new) 3.5-160 (TBC removed) 3.5-165 (new) 3.7-30 (deleted) 3.7-47 (new) 3.7-65 (new) 3.7-75 (new) 3.7-85 (new) 3.7-90 (TBC removed) 3.7-127 (new) 3.7-155 (new) 3.7-165 (new) 3.7-175 (new) 3.7-185 (new) 3.7-190 (deleted) 3.8-25/26 (new) 3.9-10/20 (new) 3.10-10/20 (new) 3.11-10/20 (new) 4.2-50 (TBD removed)
HGSSE#14		3.3-35 (new)
HGSSE#15		4.9.1 deleted

CHANGE RECORD

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reason for change/*raison du changement*	page(s)/*page(s)*	paragraph(s)/*paragraph(s)*

• Editorial changes
  • Herschel GS → HGS
  • S/C → spacecraft
  • TM → telemetry
  • TC → telecommand
  • HK → housekeeping
  • I/F → interface
  • SW → software
  • & → and
  • on board → on-board
  • center → centre
	All pages	n/a

• Syntax and typos	All pages	See changebars
• Figure 1 updated (no actual change to logic)		1.2
• Figure 2 updated to include EGSE-IST		1.2
• Figure 3 updated (arrow direction corrected)		2.2.4
• GSRQR-RID-119: Change maximum on-board rate from 400 to 300 kbps		FGS-IR-3.3-350 FGS-IR-4.2-50
• Remove ICC simulator delivery requirement as spacecraft and instrument simulator development is now the sole responsibility of ESOC/ MOC.		2.2.3 FGS-IR-3.7-90
• Extended section 4 for IST mission phase		4.13 4.14

CHANGE RECORD

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• Telecommand history/ out of limit interfaces to HCSS during IST phase updated.		4.4.2
• Time correlation: s/c time and UTC synchronization updated.		3.1.11.1

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• Orbit prediction performance requirement FGS-IR-3.1-145 updated as a result of HGSSE#25 AI#110309/9.	23	3.1.2.3
• Orbit reconstitution performance requirement FGS-IR-3.1-375 added as a result of HGSSE#25 AI#110309/9.	27	3.1.9.3
• New interface: Derived parameter definitions added as a result of HGSSE#26 AI#090604/6	17 42 54	1.5.3 3.4.7 3.7.13
• Introduced mission planning concepts document as a reference document (HGSSE AI#041203/12)		1.5.2 3.1.5 3.1.6 3.4.1

CHANGE RECORD

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reason for change/*raison du changement*	page(s)/*page(s)*	paragraph(s)/*paragraph(s)*
• Removed TBDs associated with FGS-IR-3.1-145 and 375 (HGSSE#28 AI#030205/15)		1.5.2 3.1.2 3.1.9
• Clarification of schedule status information requirements (HGSSE#28 AI#030205/33)		3.1.6
• Remove derived parameter TM interface requirements (HSGSSE#5 AI#220205/6)		3.1.12

CHANGE RECORD

ISSUE: 2 REVISION: 5

reason for change/*raison du changement*	page(s)/*page(s)*	paragraph(s)/*paragraph(s)*
• HSGSSE#25 AI#220205/6: Added text clarifying the consolidated telemetry interface as agreed in FCT – HSC Telecon #1 (HERSCHEL-HSC-MOM-0617)	23	3.1.1.3

• HGSSE#29 AI#240505/10: Handling of SSOs updated to reflect agreed data/ information flow
  • Section 3.1.17 deleted
  • Section 3.4.3 updated
		Section 3.1.17
		Section 3.4.3

• HGSSE#30 AI#130905/1: Handling of consolidated data updated in line with MS recommendations.		Section 3.1.1.3
• HGSSE#30 AI#130905/5: Clarify the 2 aspects of the commanding [mission] timeline interface.		Section 3.1.7
• HGSSE#30 AI#130905/7: Include orbit events interface.		Section 3.1.20 (new)
• HGSSE#30 AI#130905/11: Address manual commanding interfaces.		Section 3.4.8 (new) Section 3.7.14 (new)
• HGSSE#31 AI#071205/10: Introduce instrument avoidance angles interface.		Section 3.4.9 (new) Section 3.7.15 (new)

CHANGE RECORD

ISSUE: 2 REVISION: 6

reason for change/*raison du changement*	page(s)/*page(s)*	paragraph(s)/*paragraph(s)*
• HSGSSE #6: Removed requirements on the storage in the HCSS and distribution from the HCSS of on-board software .		Section 3.10 Section 3.11 Section 4.1.3 Section 4.5
• Action item 150605/6: Update IRD requirement to FGS-IR-3.5-20.		Section 3.5.1.3
• Action item 130905/8: Update control requirements to more accurately reflect the use of the FTS and DDS		Section 3.1.1.2 Section 3.1.8.2 Section 3.1.11.2 Section 3.1.13.2

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Objective

The objective of this document is to define the interface requirements between the different elements of the Herschel Ground Segment (HGS).

The HGS mandate is defined in the FIRST Science Management Plan [AD-1]and is elaborated upon in the Herschel Space Observatory Operations Scenario Document [AD-2].

The interface requirements in this document are applicable to the design, development and operation of the different systems or centres supporting the HGS. It is complementary to the user requirements documents on these systems, see [RD-5] [RD-15], [RD-16] and [RD-17].

1.2 Scope

This document defines the functional, control flow and performance requirements applicable to the interfaces between the different elements of the HGS.

The HGS elements are the HGS operational centres and the HGS systems.

The different centres of the HGS considered in this document are the following, see [AD-2]section 4:
- The Herschel Mission Operations Centre (MOC)
- The Herschel Science Centre (HSC)
- The Herschel Instruments Control Centres (ICCs):
  - The SPIRE Instrument Control Centre
  - The PACS Instrument Control Centre
  - The HIFI Instrument Control Centre.

In the rest of the document, no distinction is made between the different ICCs. It is assumed that the interface requirements will not differ from one ICC to another.

In line with [AD-2] section 4.3.2, this document makes the distinction between the ICCs set-up at their home institute, referred to as ICC@ICC, and the ICCs set-up at MOC, referred to as ICC@MOC. ICC refers to both ICC@ICC and ICC@MOC.

Information flows requirements related to IPAC shall be included at a later stage (TBC).

The different systems of the HGS considered in this document are the following, see [AD-3].
- The Herschel Common Science System (HCSS) which with the Real Time Analysis (RTA) and the On-board software Management (OBSM) systems supports the HSC and ICC operations as well as the instrument teams in the instrument level testing (ILT) and integrated system testing (IST) phases of the Herschel mission.

- The RTA system which supports the real time analysis of the instrument housekeeping data.
- The OBSM system which supports the instrument on-board software maintenance.
- The ILT Electrical Ground Segment Equipment (EGSE-ILT) which supports the test executions in ILT.
- The Central Checkout system (CCS) which, together with the EGSE-IST (derived from the EGSE-ILT), supports the test executions in IST.
- The Mission Control system (MCS) which supports the MOC operations.

Note: Although the CCS is addressed, see sections 4.8 and 4.9, this document does not put any formal requirements on the CCS. This document is indeed not applicable to the Herschel/ Planck industrial contractor in charge of supplying the CCS.

The different test and operational phases covered in this document are the following:
- Instrument Level Test (ILT)
- Integrated System Test (IST)
- Ground system tests (SVT/ EE)
- In-orbit phase including:
  - Launch and early operations phase (LEOP)
  - Commissioning phase (CP)
  - Performance Verification phase (PV)
  - Routine phase (Routine)
- Post-operational phase (Post-Ops) including:
  - Run-down phase
  - Mission consolidation phase
  - Active archive phase
  - Archive consolidation phase

The ground system tests are not further addressed in this document, it is not expected to yield any new requirements with respect to the in-orbit phase.

During LEOP, the Herschel science ground segment (SGS) will be in “listening” mode only.

The document does not cover any requirements related to the reliability (error rate), availability, maintenance and security of the interfaces between the different elements of the HGS. These requirements can be added at a later stage if needed.

The two following figures (Figure 1 and Figure 2) illustrate the interfaces covered by this IRD. These interfaces are marked with a solid bar (|).

Note: In the in-orbit phase, the HCSS will support the operation of the HSC and the ICCs, collectively referred to as the science ground segment (SGS).

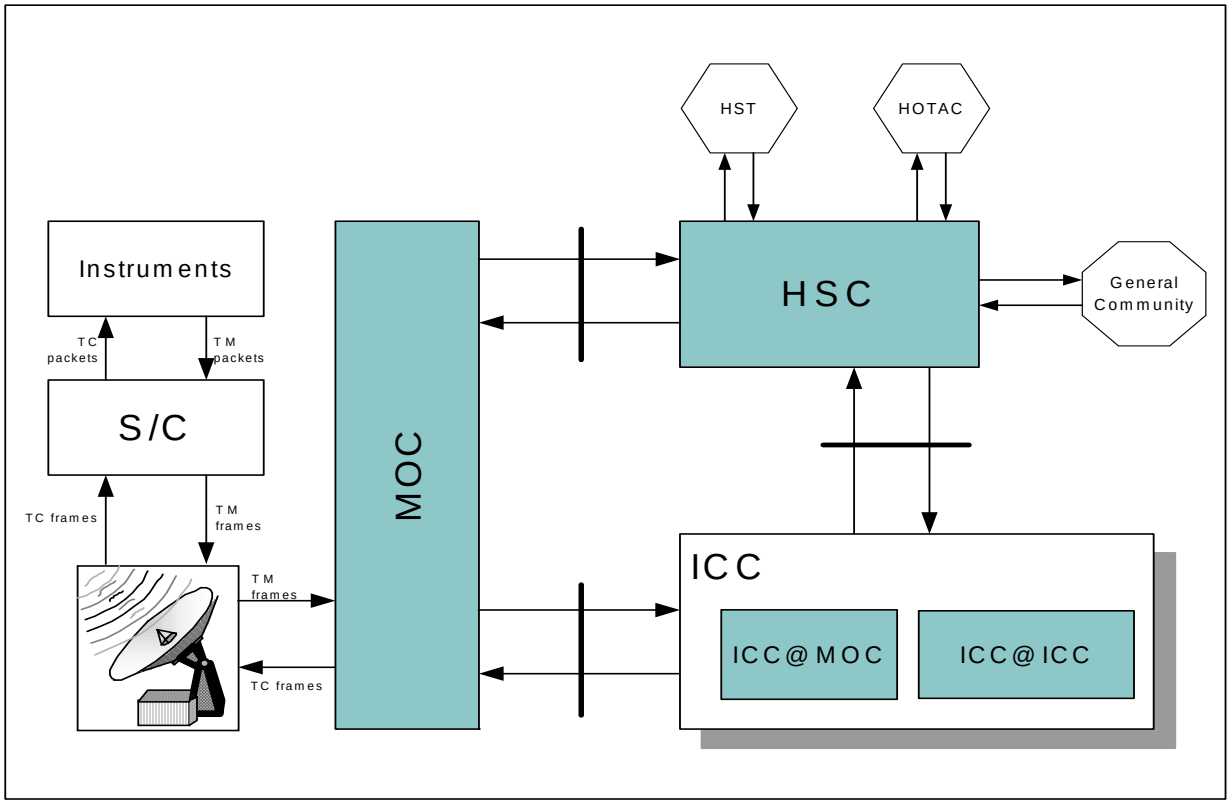

Figure 1: HGS operational centres interfaces

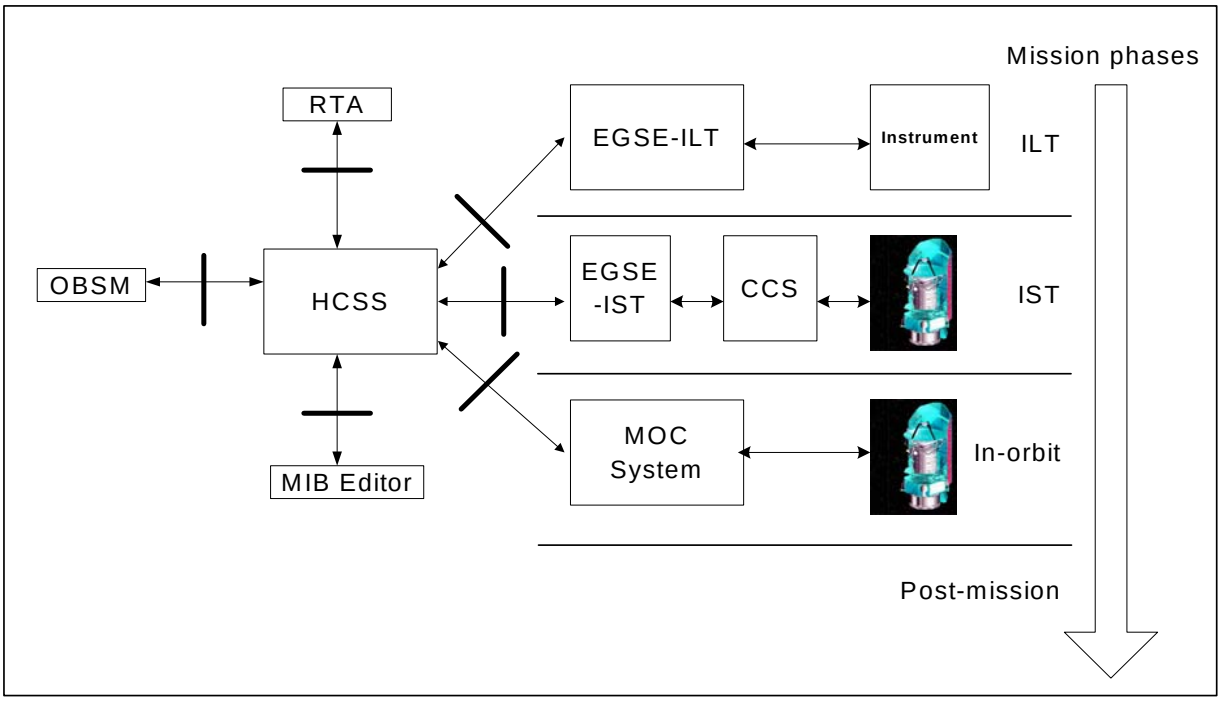

Figure 2: HGS Systems Interfaces

1.3 Structure of the document

Section 2 of this document gives an overview of the information flow between the different HGS centres and systems based on the information contained in [AD-2] and [AD-3].

Sections 3 and 4 constitute the core of this document. Section 3 defines the interface requirements between the HGS centres and systems for the in-orbit and post operation phases while section 4 defines the interface requirements between the HGS systems during ILT and IST.

In in-orbit phase, as mentioned above, the MCS will support the MOC operation and the HCSS will support the HSC and ICCs operation. The interfaces between the HCSS and the MCS are then the same as the ones between the MOC and the HSC or ICCs and are therefore not specifically addressed.
Sections 3 and 4 are structured at the highest level along the main interfaces between the centres or systems. Each main interface section is then divided up into as many subsections (information subsection) as there are types of information exchanged as part of this interface. Each information subsection is further divided up into the following sub-subsections, grouping the requirements related to:
- the definition of the information exchanged
- the control over the exchange of information (when applicable)
- the performance associated with the exchange (when applicable)

When relevant, the reference document being the source of a requirement is indicated. In addition, non-obvious requirements are commented. Both source information and comments are written in *italics*.

1.4 Definitions, acronyms and abbreviations

1.4.1.1 Acronyms and abbreviations

The list of acronyms for the HGS can be found in [RD-8].

1.4.1.2 Definitions

The definition of terms for the HGS can be found in [RD-8].

1.5 References

1.5.1 APPLICABLE DOCUMENTS

[AD-1] Herschel Science management plan (SMP), ESA/SPC(97)22, 20 August 1997
[AD-2] Herschel Operation Scenario Document, FIRST/FSC/DOC/0114, Issue 1.2, 17 March 2003
[AD-3] Herschel Ground Segment Design Document, FIRST/FSC/DOC/0146 , Issue 1.2, xx August 2003

1.5.2 REFERENCE DOCUMENTS

[RD-1] *Deleted.*

[RD-2] Herschel Science Implementation Requirements Document (SIRD), SCI-PT-03646
[RD-3] Mission Implementation Requirements Document (MIRD), SC-PT-8818
[RD-4] Herschel Operations Interface Requirements Document (OIRD), SCI-PT-RS-07360
[RD-5] HCSS URD, FIRST/FSC/DOC/0115
[RD-6] Deleted.
[RD-7] Herschel-PLANCK Packet Structure ICD, PP-IS-F-07527
[RD-8] Glossary document, FIRST/FSC/DOC/0120
[RD-9] HCSS SPMP, FIRST/FSC/DOC/0116, issue 2
[RD-10] *Deleted.*
[RD-11] Instrument Interface Document-Part A, SCI-PT-IIDA/ , issue 1.0
[RD-12] HIFI Instrument Interface Document-Part B, SCI-PT-IIDB/HIFI-02125, issue 1.0
[RD-13] PACS Instrument Interface Document-Part B, SCI-PT-IIDB/PACS-02126, issue 1.0
[RD-14] SPIRE Instrument Interface Document-Part B, SCI-PT-IIDB/SPIRE-02124, issue 1.0
[RD-15] EGSE-ILT URD, FIRST-SPI-DOC-000127, draft 1
[RD-16] RTA and MIB editor URD, HICC-2000/01, draft 2
[RD-17] OBS Maintenance URD, TBW
[RD-18] Herschel mission planning concept, PT-MP-TN-1001-TOS-OGH, Issue 2.0.

1.5.3 MINUTES OF MEETINGS

[HGSSE#1] Herschel Ground Segment System Engineering Group meeting #1, FIRST/FSC/MOM/0097
[HGSSE#2] Herschel Ground Segment System Engineering Group meeting #2, FIRST/FSC/MOM/0101
[HGSSE#3] Herschel Ground Segment System Engineering Group meeting #3, FIRST/FSC/MOM/0104
[HGSSE#4] Herschel Ground Segment System Engineering Group meeting #4, FIRST/FSC/MOM/0107
[HGSSE#5] Herschel Ground Segment System Engineering Group meeting #5, FIRST/FSC/MOM/0129
[HGSSE#6] Herschel Ground Segment System Engineering Group meeting #6, FIRST/FSC/MOM/0132
[HGSSE#7] Herschel Ground Segment System Engineering Group meeting #7, FIRST/FSC/MOM/0142
[HGSSE#8] Herschel Ground Segment System Engineering Group meeting #8, FIRST/FSC/MOM/0150
[HGSSE#9] Herschel Ground Segment System Engineering Group meeting #9, PACS-KL-MM-010
[HGSSE#10] Herschel Ground Segment System Engineering Group meeting #10, FIRST/FSC/MOM/0165
[HGSSE#11] Herschel Ground Segment System Engineering Group meeting #11, FIRST/FSC/MOM/0171
[HGSSE#12] Herschel Ground Segment System Engineering Group meeting #12, FIRST/FSC/MOM/0179

[HGSSE#13] Herschel Ground Segment System Engineering Group meeting #13, FIRST/FSC/MOM/0190
[HGSSE#14] Herschel Ground Segment System Engineering Group meeting #14, FIRST/FSC/MOM/0206
[HGSSE#15] Herschel Ground Segment System Engineering Group meeting #13, Herschel/FSC/MOM/0213
[HGSSE#25] Herschel Ground Segment System Engineering Group meeting #25, Herschel/HSC/MOM/0383.
[HGSSE#26] Herschel Ground Segment System Engineering Group meeting #26, Herschel/HSC/MOM/0404.
[HGSSE#28] Herschel Ground Segment System Engineering Group meeting #28, Herschel/HSC/MOM/0545.
[FGSSW#2] Herschel Ground Segment Workshop#2, Vilspa 13-15 October 1999.
[HSC-FCT#1] FCT – HSC Teleconference #1 MoM, HERSCHEL-HSC-MOM-0617.

2 GENERAL DESCRIPTION

2.1 Assumptions

This document takes into consideration a number of high-level design assumptions in-line with [AD-2].

1. During routine phase, the HGS will only provide guaranteed high data rate communication links (e.g. >= 256 kbps) between the MOC and the HSC and between the HSC and the ICC@ICC.
   [Source: [AD-2] section 4]

2. Real time commanding to the spacecraft can only be performed from the MOC.
   [Source: [AD-2] section 4]

3. The MOC-HSC interface is a non-real time interface.
   [Source: [AD-2] section 4]

2.2 Information flow general description

This section gives an overview of the different information flows. The information flows between the different centres of the HGS are driven by the operational mandate of these centres as defined in [AD-2], section 4.3.

2.2.1 INFORMATION FLOW RELATED TO THE MOC

The MOC is responsible for all aspects of spacecraft operation as well as the safety of the instruments. This includes the following responsibilities vis-à-vis the HSC and ICCs:

- Generating the commands to be uplinked to the satellite from the commanding requests originating from the HSC and ICCs and reporting to the HSC and ICCs on the satellite commanding.
  [Source: [AD-2] section 4.3.3].
- Making the satellite telemetry data available to the HSC and ICCs (including ICC@MOC).
  [Source: [AD-2] sections 4.3.3, 5.7.8 and 5.7.9].
- Making the instrument and spacecraft databases reference available to the HSC and ICCs.
  [Source: [AD-2] section 4.3.3].
- Making available software and data to support instrument and spacecraft commanding requests by HSC and ICCs, e.g.:
  - Spacecraft predicted orbit data *[Source: [AD-2] section 5.7.9]*.
  - Spacecraft attitude constraints *[Source: [AD-2] sections 5.3.1.1 and 5.3.1.3]*.
  - Spacecraft slew time and path *[Source: [AD-2] section 5.3.1.3]*.
  - Observations scheduling constraints (planning skeleton) *[Source: [AD-2] section 5.3.1.1]*.
- Making available software and ancillary data to support science and calibration data processing by the HSC and ICCs, e.g.:
  - Spacecraft reconstituted orbit data *[Source: [AD-2] section 5.7.9]*.
  - Spacecraft attitude history *[Source: [AD-2] section 5.7.9]*.

- Making available instrument safety information to support instrument operation by ICCs., e.g.:
  - Flagging satellite malfunctions or operational problems to the HSC and ICCs for them to take appropriate actions *[Source: [AD-2] sections 4.3.3 and 5.5]*.

The MOC will make available telemetry data and ancillary data to the rest of the HGS; it will not distribute them. *[Source: [AD-2]section 5.7.8]*.

2.2.2 INFORMATION FLOW RELATED TO THE HSC

The HSC is the single-point interface to the outside world for all Herschel observatory matters *[Source:[AD-2] section 4.3.1]*. As such, it acts as a single point of contact in particular for:
- Providing information on the observatory.
- Observation proposal handling.
- Observation scheduling (referred in [AD-2] as scientific mission planning).
- Observation products and observation quality control data generation.
- Providing observatory related software to the observatory users.

The HSC also acts, except for the ICC@MOC set-up, as the interface between the ICCs and the MOC. *[Source:[AD-2] section 4. 1]*. However, this does not exclude some direct information flow between the ICC@ICC and MOC.

These overall HSC responsibilities lead to the following responsibilities in terms of interface vis-à-vis the ICCs and MOC:
- Receiving engineering and calibration observations and associated scheduling constraints from ICCs for inclusion in the scientific mission planning *[source [AD-2] section5.2.1]*.
- Delivering to MOC the observations schedule commanding requests for each scheduling period resulting from the scientific mission planning process *[Source [AD-2] section 5.3.3]*.
- Retrieving from MOC telemetry and ancillary data for permanent storage and for making this data available to the ICC@ICC *[Source [AD-2] section 5.7.10]*.
- Making engineering and calibration observational data available to the ICCs together with any observational data needed by ICCs for calibration purposes *[Source [AD-2] section 5.2]*.
- Receiving from the ICCs and transmitting to the MOC (after PS approval) the instrument on-board software memory updates *[Source [AD-2] section 5.11.1]*.
- Receiving instrument and spacecraft information and software from respectively the ICCs and MOC which is of interest to the Herschel observatory users and making such information available to these users *[Source [AD-2] section 4.3.1]*.

2.2.3 INFORMATION FLOWS RELATED TO THE ICCS

The ICCs are responsible for the successful operation of their instruments and for making possible the processing of telemetry into resulting data. This leads to the following responsibilities vis-à-vis the HSC and the MOC:
- Delivering instrument user manuals to HSC and MOC *[Source [AD-2] section 4.3.2]*.
- Delivering instrument IA software and documentation to HSC to be made available to astronomers *[Source [AD-2] section 4.3.2]*.

- Delivering instruments procedures and commands to MOC for commanding and monitoring of their instruments *[Source [AD-2] section 4.3.2]*.
- Delivering the instruments on-board software update to MOC (via HSC) for uplink *[Source [AD-2] sections 4.3.2 and 5.11.1]*.
- Delivering the instrument modes scientific validation status information to the HSC *[Source [HGSSE#4]]*.
- Delivering instruments engineering observations to the HSC *[Source [AD-2] section 5.2]*.
- Delivering instruments calibration observations to the HSC *[Source [AD-2] section 5.2]*.
- Delivering to the HSC available science observation quality data. *[Source [AD-2] section 4.3.2]*. Note: Not all the ICCs commit to perform systematic quality control of observations.
- Delivering to the MOC (via HSC) instrument database updates *[Source [AD-2] section 4.3.2]*.
- Delivering instrument specific software and data updates to support proposal handling and scientific mission planning at the HSC; this includes:
  - Instrument observation time estimator software and data (including calibration data) *[Source [AD-2] section 4.3.2]*.
  - Commanding requests generation software *[Source [AD-2] section 4.3.2]*.
- Delivering instrument specific software and data (including calibration data) updates to support data processing and evaluation at the HSC *[Source [AD-2] section 4.3.2]*.
- Bullet deleted.

2.2.4 SUMMARY OF INFORMATION FLOWS BETWEEN HGS CENTRES

Figure 3 summarises the discussion on the information flow between the different HGS centres:

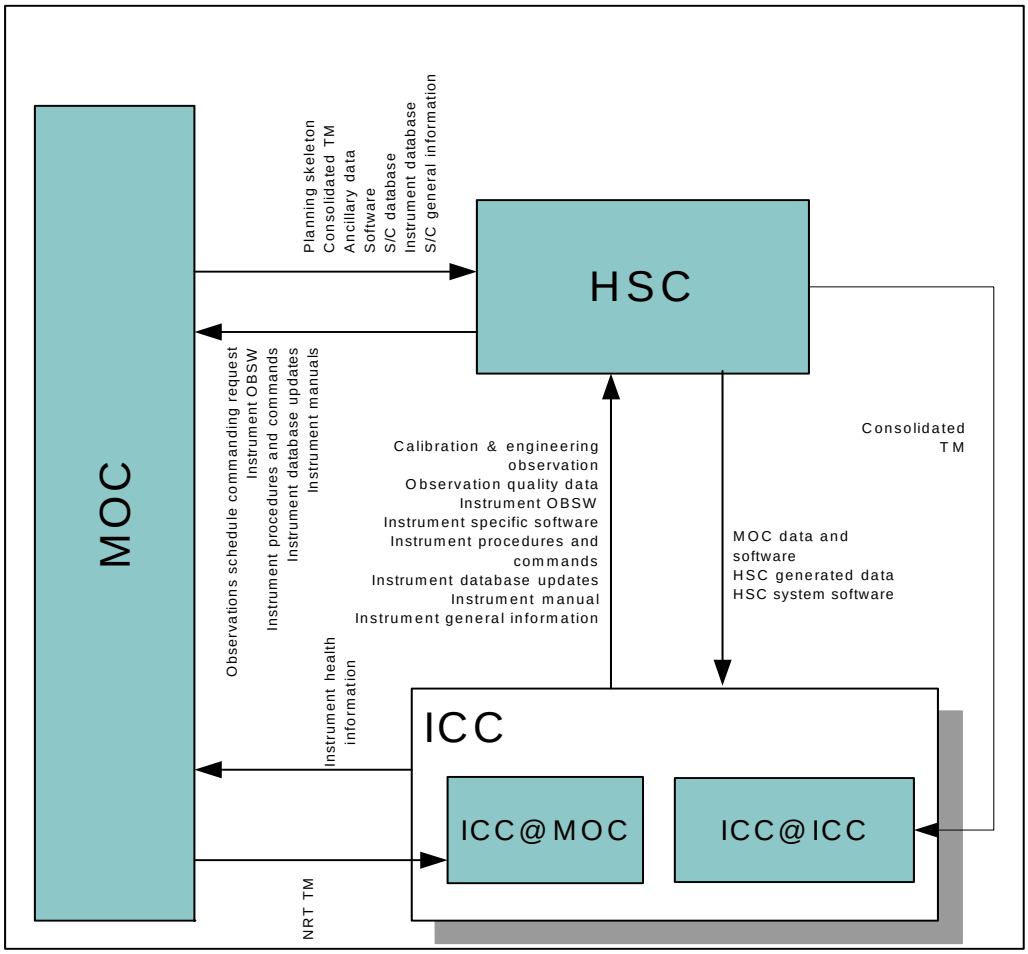

Figure 3: Information flow between HGS centres

2.2.5 INFORMATION FLOW IN THE ILT AND IST PHASES

This section introduces the information flow between the FGS systems in ILT and IST. In ILT and IST, respectively the EGSE-ILT and the EGSE-IST and CCS will simulate to a large extent the functions carried out by the MCS in routine phase and consequently the interfaces between the EGSE-ILT and the EGSE-IST and CCS can be seen to a large extent as a subset of the interfaces between the MOC and the HSC or ICCs during routine operations (see also the concept of smooth transition in [AD-3]).

In essence, in ILT and IST, the HCSS will generate command sequences which will be passed over to the EGSE-ILT or CCS for execution on-board the instrument or by the test environment. The HCSS will then retrieve the resulting telemetry for analysis and storage. As in in-orbit phase, the command sequences will originate from observations.

3 INTERFACE REQUIREMENTS FOR IN-ORBIT AND POST-MISSION PHASES

3.1 *MOC to HSC interfaces*

3.1.1 CONSOLIDATED TELEMETRY

3.1.1.1 Information flow requirements

FGS-IR-3.1-10 The MOC shall make available all spacecraft and instrument telemetry data to the HSC.

[Source: [AD-2] section 5.7.10]
Important: In operations, telemetry packets lost during space-ground transmission will not be recovered.

FGS-IR-3.1-20 The MOC shall make available telemetry data to the HSC as consolidated telemetry data.

[Source: [AD-2] section 5.7.10]

FGS-IR-3.1-30 The MOC shall make available telemetry data (spacecraft and instruments) to the HSC in a format from which the source telemetry packets generated on-board can be extracted.

[Source: [AD-2] section 5.8]
The MOC is not processing the scientific telemetry packets, see [RD-4]. Therefore the science telemetry data and by extension all instrument housekeeping telemetry data will be delivered as produced on-board in the format of ESA standard packets. However, the MOC may add additional header and trailer information to the source packets.

FGS-IR-3.1-40 *Deleted.*

FGS-IR-3.1-50 *Deleted.*

FGS-IR-3.1-60 *Deleted.*

FGS-IR-3.1-70 *Deleted.*

Note that this section does not cover the requirements the HSC may have with respect to the content of a telemetry packet, as this is not relevant to the HSC interface with MOC. These requirements are expected to be covered in the OIRD, see [RD-4]. This shall be the case, in particular, for the following requirements:

1. *It shall be possible for the HSC to detect missing consolidated telemetry data.*
   The intention is that the source sequence counter of a telemetry packet header can be used to detect missing data. This implies that the different types of instrument telemetry data can be distinguished by

APID (at least science and housekeeping) to avoid having to search different streams of telemetry for all the sequence counter values.

2. *It shall be possible for the HSC to associate telemetry data with observations and observations measurements. The intention here is that instrument telemetry packets will be tagged with an observation and measurement id. spacecraft telemetry will be related to observations by time.*

3.1.1.2 Control flow requirements

FGS-IR-3.1-75 The HSC shall request the MOC to make available consolidated telemetry data for a given operational period.

FGS-IR-3.1-80 The MOC shall make available to the HSC the consolidated telemetry data separately according to the following categories:

- Event telemetry data per APID
- telecommand verification data per APID
- housekeeping telemetry data per APID
- science telemetry data per APID
- spacecraft telemetry data

[Source: [AD-2] section 5.7.10]
This should allow the early retrieval of consolidated event, verification and housekeeping telemetry data that represents a small proportion of the overall telemetry data, see [AD-2] section 5.7.8.

FGS-IR-3.1-90 The MOC shall indicate the availability of consolidated telemetry data on a time period basis.

FGS-IR-3.1-100 The MOC shall push the consolidated telemetry data to the HSC.

[Source: [AD-2] section 5.7.8]

3.1.1.3 Performance requirements

FGS-IR-3.1-110 The MOC shall make available to the HSC any sequence of any category of consolidated telemetry data from dump telemetry not later than 10 minutes after the last “bit” of this sequence has been received by the MOC.

To be related to performance requirement FGS-IR-3.5-20
This requirement is not applicable to consolidation of live telemetry. Live telemetry received by MOC is only consolidated after all telemetry generated on-board prior to the DTCP has been consolidated, see HGSSE#4. This may take several hours; e.g. it is expected that MOC will need 16 hours to retrieve the dump telemetry corresponding to an OD.
This requirement covers only the consolidation process by MOC, not the transfer of telemetry from the MOC to the HSC.

Consolidation will be performed in sequences of configurable periods and, if complete, these sequences can then be made available. For special operations (e.g. commissioning, PV) consolidation can be declared "early" to allow quicker access to dumped data. The time period can be of the order of minutes to tens of minutes.
Manual intervention will have to be performed if a sequence is incomplete. This will impact the availability of that sequence of consolidated telemetry [Source: [FCT-HSC#1] section 3].

3.1.2 SPACECRAFT PREDICTED ORBIT DATA

3.1.2.1 Information flow requirements

FGS-IR-3.1-120 The MOC shall make available the spacecraft orbit predicted data to the HSC.

[Source: [AD-2] section 5.7.9]
The HSC will use this data in scientific mission planning to assess the relative velocity of the spacecraft vis-à-vis a celestial source. Indeed, the relative velocity may impact the selection of the frequency band of an instrument needed in the observation of this celestial source.
The data is expected to be provided in the same format as for reconstituted orbit data, see section 3.1.9

3.1.2.2 Control flow requirements

FGS-IR-3.1-130 The MOC shall notify the HSC of the availability of spacecraft predicted orbit data updates for a given operational period.

It is agreed [HGSSE#12] that MOC would notify the HSC of the availability of non-regular data.

FGS-IR-3.1-140 The HSC shall pull spacecraft predicted orbit data updates from the MOC.

3.1.2.3 Performance requirements

FGS-IR-3.1-145 The position and velocity of the spacecraft shall be predicted to an accuracy of not worse that 72.5 km and 1 m/s.

Source: [HGSSE#13], [HGSSE#26] and [HGSSE#28].

3.1.3 SPACECRAFT ATTITUDE CONSTRAINT ALGORITHM AND DATA

3.1.3.1 Information flow requirements

FGS-IR-3.1-150 The MOC shall make available to the HSC the spacecraft attitude constraints algorithm (with test data) and data updates.

[Source: [AD-2] sections 5.3.1.1 and 5.3.1.3]
The HSC will use the algorithm and data to check that a scheduled observation does not violate the spacecraft attitude constraints. The spacecraft attitude constraints can be due to astronomical constraints (e.g. solar aspect angle) or to spacecraft engineering constraints (e.g. pointing of high gain antenna to earth during space-ground communication).
From past experience (e.g. XMM), delivery of algorithm and test data are preferable to delivery of software.

3.1.3.2 *Control flow requirements*

FGS-IR-3.1-160 The MOC shall notify the HSC of the availability of spacecraft attitude constraint algorithm and data updates for a given operational period.

It is agreed [HGSSE#12] that MOC would notify the HSC of the availability of non-regular data.

FGS-IR-3.1-170 The HSC shall pull spacecraft attitude algorithm and data updates from the MOC.

3.1.3.3 Performance requirements

N/A

3.1.4 SPACECRAFT SLEW TIME AND PATH PREDICTOR ALGORITHM AND DATA

3.1.4.1 Information flow requirements

FGS-IR-3.1-180 The MOC shall make available to the HSC the spacecraft slew time and path predictor algorithm and data updates.

[Source: [AD-2] section 5.3.1.4]
The HSC will use the algorithm and data in scientific mission planning to predict slew durations and to check that the slew path is compatible with the spacecraft attitude constraints.

3.1.4.2 *Control flow requirements*

FGS-IR-3.1-190 The MOC shall notify the HSC of the availability of spacecraft slew time and path predictor algorithm and data updates.

It is agreed [HGSSE#12] that MOC would notify the HSC of the availability of non-regular data only

FGS-IR-3.1-200 The HSC shall pull spacecraft slew time and path predictor algorithm and data updates from the MOC.

3.1.4.3 Performance requirements

N/A

3.1.5 PLANNING SKELETON DATA

[RD-18] describes the planning skeleton data within the context of mission planning.

3.1.5.1 Information flow requirements

FGS-IR-3.1-210 The MOC shall make available to the HSC the planning skeleton information for any given scheduling period.

[Source: [AD-2] section 5.3.1.1]
The HSC will use this information for scientific mission planning to identify the time windows where observations can be scheduled as well as the DTCP periods.

3.1.5.2 Control flow requirements

FGS-IR-3.1-220 The HSC shall poll the MOC to know of the availability of a new planning skeleton for a given scheduling period.

FGS-IR-3.1-230 The HSC shall pull planning skeleton information from the MOC.

3.1.5.3 Performance requirements

FGS-IR-3.1-240 *Deleted.*

FGS-IR-3.1-250 *Deleted.*

The timing for the availability of the planning skeletons from MOC shall be part of the detailed operational plan covering the end-to-end scheduling activities.

3.1.6 SCHEDULE STATUS INFORMATION

[RD-18] describes the schedule status information within the context of mission planning.

3.1.6.1 Information flow requirements

FGS-IR-3.1-260 The MOC shall make available to the HSC the acceptance/ rejection status of a schedule.

Note however that in the case of rejection section 3.1.19 applies.

3.1.6.2 Control flow requirements

FGS-IR-3.1-265 Requirement deleted.

N/A. Procedural interface [HGSSE#25].

3.1.6.3 Performance requirements

N/A

3.1.7 MISSION TIMELINE SUMMARY

3.1.7.1 Information flow requirements

FGS-IR-3.1-270 The MOC shall make available to the HSC the mission timeline summary corresponding to any given operational period.

See [HGSSE#1]. The mission timeline summary will include the list of all telecommands uplinked to the satellite for autonomous execution during this operational period. The HSC will use this information to verify the translation by MOC of an observations schedule into the corresponding timeline. ICCs may use this information to follow on-board operation during the commissioning and in general to help in diagnosing instrument malfunctions.

There will be 2 components to this interface. The summary provided for manual commanding and the summary provided for scheduled commanding [HGSSE#30].

3.1.7.2 Control flow requirements

FGS-IR-3.1-280 The HSC shall poll the MOC to know of the availability of a new mission timeline summary.

FGS-IR-3.1-290 The HSC shall pull the new mission timeline summary from MOC.

3.1.7.3 Performance requirements

FGS-IR-3.1-295 The MOC shall make available the mission timeline summary before the uplink of the corresponding mission timeline to the spacecraft.

This requirement is justified for commissioning phase and when diagnosing instrument malfunctions, see comments in section 3.1.7.1.

3.1.8 TELECOMMAND HISTORY

3.1.8.1 Information flow requirements

FGS-IR-3.1-300 The MOC shall make available to the HSC the telecommand history information for any given operational period.

See [HGSSE#1]. The telecommand history information will include the uplink and execution status of all the telecommands uplinked for execution during the operational period. The telecommand history is made available to the ICCs in addition to the telecommand verification reports that are part of the instrument housekeeping telemetry. The HSC will use this information to flag observations that were not commanded as scheduled. It will make it available to the ICCs. An ICC will use the telecommand history for instrument command verification purpose.

FGS-IR-3.1-310 The telecommand history data shall include the necessary information for the HSC to be able to associate (when relevant) the telecommand to the instrument or spacecraft commanding requests in the corresponding observations schedule.

[Source [AD-3] section 3.1.8.4.1]

3.1.8.2 Control flow requirements

FGS-IR-3.1-320 The HSC shall request the MOC to make available telecommand history data for a given operational period.

FGS-IR-3.1-330 The MOC shall push the telecommand history data to the HSC.

3.1.8.3 Performance requirements

FGS-IR-3.1-340 The MOC shall make available to the HSC the telecommand history for a given operational period at the same time as the consolidated housekeeping telemetry for this period.

See [HGSSE#4]. See 3.1.1.3 for performance requirements on consolidated housekeeping telemetry.

3.1.9 SPACECRAFT ORBIT DATA (RECONSTITUTED)

3.1.9.1 Information flow requirements

FGS-IR-3.1-350 The MOC shall make available the spacecraft reconstituted orbit data to the HSC.

[Source: [AD-2] section 5.7.9]
The HSC and ICCs may use this information for scientific data processing.

3.1.9.2 Control flow requirements

FGS-IR-3.1-360 The MOC shall notify the HSC of the availability of new spacecraft reconstituted orbit data for a given operational period.

It is agreed [HGSSE#12] that MOC would notify the HSC of the availability of non-regular data.

FGS-IR-3.1-370 The HSC shall pull spacecraft reconstituted orbit data from the MOC.

3.1.9.3 Performance requirements

FGS-IR-3.1-375 The position and velocity of the spacecraft shall be reconstructed to an accuracy of not worse that 36.3 km and 1 m/s.

[HGSSE#25] and [HGSSE#28].

3.1.10 SPACECRAFT ATTITUDE HISTORY

3.1.10.1 *Information flow requirements*

FGS-IR-3.1-380 The MOC shall make available the spacecraft attitude data corresponding to a given operational period.

[Source: [AD-2] section 5.7.9]
The HSC and the ICCs will use this data for scientific data reduction and for calibration on top of the raw attitude data included in the spacecraft housekeeping telemetry. The spacecraft attitude history will allow to reconstitute the pointing of the spacecraft at any given time of the operational period (including slew and SSO tracking periods).

The HSC and the ICCs will have to reconstruct instrument pointing from the spacecraft attitude data and instrument misalignment against the spacecraft pointing reference (e.g. STR).

3.1.10.2 Control flow requirements

FGS-IR-3.1-390 The HSC shall poll the MOC to know of the availability of new attitude history data for a given operational period .

FGS-IR-3.1-400 The HSC shall pull attitude history data from the MOC.

3.1.10.3 Performance requirements

FGS-IR-3.1-410 The MOC shall make available the attitude history data for an OD not later than 8 hours after the actual reception by the MOC of the related telemetry packets.

See [FGSSW#2] and [HGSSE#13]

3.1.11 TIME CORRELATION

See [HGSSE#15].

3.1.11.1 Information flow requirements

FGS-IR-3.1-420 The MOC shall make available to the HSC the time correlation data.

The HSC and ICCs will use the time correlation data for the purpose of scientific data processing and for calibration. This data will allow to unambiguously correlate the spacecraft on-board time with the UTC time.

FGS-IR-3.1-430 The time correlation data shall allow to correlate the spacecraft time and UTC time with a precision of better than 500 ms at any time of the spacecraft mission.

[See HGSSE#24 and action item 041203/15]
It is noted that there is a top level requirement (SINT-075 H/P) in the system requirements specification (SCI-PT-RS-05991) relating to the correlation of attitude information and science data.

3.1.11.2 Control flow requirements

FGS-IR-3.1-435 The HSC shall request the MOC to make available time correlation data for a given operational period.

FGS-IR-3.1-436 The MOC shall push the time correlation data to the HSC.

3.1.11.3 Performance requirements

FGS-IR-3.1-440 The MOC shall make available to the HSC the time correlation data for a given operational period at the same time as the spacecraft consolidated housekeeping telemetry for this period.

See [HGSSE#4]. See 3.1.1.3 for performance requirements on consolidated housekeeping telemetry.

3.1.12 DERIVED PARAMETERS

3.1.12.1 Information flow requirements

FGS-IR-3.1-450 Requirement deleted.

It was agreed in HGSSE#28 and specifically HSGSSE#5 that the derived parameter telemetry interface is not required.

3.1.12.2 Control flow requirements

FGS-IR-3.1-455 Requirement deleted.

It was agreed in HGSSE#28 and specifically HSGSSE#5 that the derived parameter telemetry interface is not required.

3.1.12.3 Performance requirements

FGS-IR-3.1-460 Requirement deleted.

It was agreed in HGSSE#28 and specifically HSGSSE#5 that the derived parameter telemetry interface is not required.

3.1.13 OUT OF LIMITS INFORMATION

3.1.13.1 Information flow requirements

FGS-IR-3.1-470 The MOC shall make available the instruments parameters OOL information for a given operational period.

The HSC may be using this data for the purpose of observation quality control. It will make it available to the ICCs. An ICC will use OOL information for monitoring their instruments. The MOC will make available the list of instrument parameters out of limits (soft and hard) for a given operational period.
OOL data are only relevant for housekeeping telemetry parameters including derived parameters.

3.1.13.2 Control flow requirements

FGS-IR-3.1-473 The HSC shall request the MOC to make available OOL data for a given operational period.

FGS-IR-3.1-475 The MOC shall push the OOL data to the HSC.

The OOL *data will be delivered with the flow of consolidated telemetry as separate packets, see [HGSSE#1]*

3.1.13.3 Performance requirements

FGS-IR-3.1-480 The MOC shall make available to the HSC the instrument parameters OOL for a given operational period at the same time as the instrument consolidated housekeeping telemetry for this period.

See [HGSSE#4]. See section 3.1.1.3 for performance requirements on consolidated housekeeping telemetry.

3.1.14 INSTRUMENT MEMORY IMAGE

3.1.14.1 Information flow requirements

FGS-IR-3.1-490 The MOC shall make available to the HSC the instrument memory image corresponding to an instrument memory dump requested by an ICC.

The HSC is not using this information. It will make it available to the ICCs. The instrument memory image comes in addition to the memory dump telemetry data included within the housekeeping telemetry.

3.1.14.2 Control flow requirements

FGS-IR-3.1-495 The MOC shall notify the HSC of the availability of dumped instrument memory images.

[Source: [HGSSE#12]]

FGS-IR-3.1-496 The HSC shall pull dumped instrument memory images from the MOC.

3.1.14.3 Performance requirements

FGS-IR-3.1-498 The MOC shall make the image of an instrument memory at the latest one hour after the last telemetry data of the memory dump has been received by MOC.

This requirement is only justified for memory dump request following an instrument alert.[Source: [HGSSE#12]]

3.1.15 SPACECRAFT AND INSTRUMENTS DATABASES

3.1.15.1 Information flow requirements

FGS-IR-3.1-500 The MOC shall make available to the HSC the spacecraft and instruments reference databases.

[Source: [AD-2] section 4.3.3]
The MOC is responsible for maintaining the spacecraft and instruments reference databases for the HGS, see [HGSSE#1].
The HSC will make the spacecraft and instrument reference databases available to the ICCs.
Updates to the instruments reference databases originate from the ICCs and are forwarded by the HSC to the MOC.
The HSC and ICCs will use the spacecraft and instrument databases to decode the telemetry. It is not clear at this stage whether or not the HSC will use the spacecraft database.

Instrument database is to include at least the definition of instrument telecommand, telemetry (housekeeping and science header only), parameter monitoring and calibration/ de-calibration as well as instrument command sequences.

3.1.15.2 Control flow requirements

FGS-IR-3.1-505 The MOC shall notify the HSC of the availability of new instruments reference databases.

FGS-IR-3.1-506 The HSC shall pull new instruments reference databases from the MOC.

3.1.15.3 Performance requirements

N/A
The delivery of instrument databases shall be subject to a detailed operational scenario in line with the scheduling cycle [HGSSE#12]

3.1.16 INSTRUMENT APERTURES POINTING MISALIGNMENT

3.1.16.1 Information flow requirements

FGS-IR-3.1-510 The MOC shall make available to the HSC the instruments (virtual) aperture misalignment reference data w.r.t. the spacecraft attitude reference.

See [HGSSE#4]. The MOC is responsible for maintaining the instruments apertures pointing misalignment reference data for the HGS. The MOC is not performing the measurement. The measurement values are provided by the ICC via the HSC, see sections 3.4.6 and 3.7.10.
The HSC will make these reference data available to the ICCs.
Updates to these reference data originate from the ICCs and are forwarded by the HSC to the MOC.
The HSC and ICCs will use this data to reconstitute the instrument (aperture) pointing from the spacecraft pointing information delivered by MOC.

3.1.16.2 Control flow requirements

FGS-IR-3.1-515 The MOC shall notify the HSC of the availability of new instruments aperture pointing misalignment data.

[Source:[HGSSE#12]]

FGS-IR-3.1-516 The HSC shall pull new instruments aperture pointing misalignment data from the MOC.

3.1.16.3 Performance requirements

N/A
To be subject to a detailed operational scenario [HGSSE#12].

3.1.17 SSO DATABASE

The HSC is responsible for maintaining the SSO database and supplying the MOC (see section 3.4.3).

3.1.17.1 Information flow requirements

FGS-IR-3.1-520 Requirement deleted.

3.1.17.2 Control flow requirements

FGS-IR-3.1-525 Requirement deleted.

FGS-IR-3.1-526 Requirement deleted.

3.1.17.3 Performance requirements

N/A

3.1.18 SPACECRAFT GENERAL INFORMATION

3.1.18.1 Information flow requirements

FGS-IR-3.1-530 The MOC shall make available to the HSC the spacecraft information of interest to the Herschel observers.

[Source: [AD-2] section 4.3.1]
E.g. spacecraft pointing accuracy
The HSC will post this information for Herschel observers to consult.

3.1.18.2 Control flow requirements

FGS-IR-3.1-535 The MOC shall notify the HSC of the availability of new spacecraft general information.

[Source: [HGSSE#12]]

FGS-IR-3.1-536 The HSC shall pull new spacecraft general information from the MOC.

3.1.18.3 Performance requirements

N/A

3.1.19 INSTRUMENTS MALFUNCTIONS OR OPERATION PROBLEMS INFORMATION

3.1.19.1 Information flow requirements

FGS-IR-3.1-540 The MOC shall make available to the HSC the malfunctions or operation problems information related to the instruments.

[Source: [AD-2] sections 4.3.3 and 5.5]

3.1.19.2 Control flow requirements

FGS-IR-3.1-545 The MOC shall notify the HSC of instruments malfunction or operation problems.

[Source:[HGSSE#12]]

3.1.19.3 Performance requirements

FGS-IR-3.1-548 The MOC shall notify the HSC of any instrument malfunction or operation problem within one hour of the detection of the problem.

3.1.20 ORBIT EVENTS

3.1.20.1 *Information flow requirements*

FGS-IR-3.1-550 The MOC shall make available the orbit events corresponding to a given operational period.

[Source: HGSSE#30].

3.1.20.2 Control flow requirements

FGS-IR-3.1-560 The HSC shall poll the MOC to know of the availability of new orbit event data for a given operational period .

FGS-IR-3.1-570 The HSC shall pull the orbit event data from the MOC.

3.1.20.3 Performance requirements

N/A.

3.2 MOC to ICC interfaces

3.2.1 INSTRUMENTS MALFUNCTIONS OR OPERATION PROBLEMS INFORMATION

3.2.1.1 Information flow requirements

FGS-IR-3.2-10 The MOC shall make available to the ICCs the malfunctions or operation problems information related to their instruments.

[Source: [AD-2] sections 4.3.3 and 5.5]

3.2.1.2 Control flow requirements

FGS-IR-3.2-15 The MOC shall notify the ICCs of any malfunctions or operation problems related to their instruments.

3.2.1.3 Performance requirements

FGS-IR-3.2.18 The MOC shall notify the ICCs of any malfunctions or operation problems related to their instruments within one hour of the detection of the malfunction or problem.

3.2.2 TELEMETRY IN COMMISSIONING AND FOR EMERGENCIES

During commissioning phase and for emergencies, ICC members in ICC@ICC will carry out activities in close cooperation with ICC@MOC. ICC@ICC therefore needs telemetry data to be available at nearly the same time as ICC@MOC, in fact within 20 minutes after reception by MOC, see [HGSSE#2]. For this purpose, as described in the FGSDD [AD-3] section 3.6.2, ICC@ICC will receive telemetry directly from ICC@MOC. The ICC@MOC ICC@ICC link is considered internal to ICC and is not subject to any interface requirements in this document. It is expected that the NRT telemetry flow from MOC to ICC@ICC will be routed via the ICC@MOC and that the flow between ICC@MOC and ICC@ICC will be under ICC responsibility.

3.2.2.1 Information flow requirements

FGS-IR-3.2-20 *Deleted.*

FGS-IR-3.2-30 *Deleted.*

3.2.2.2 Control flow requirements

N/A

3.2.2.3 Performance requirements

FGS-IR-3.2-40 Deleted.

3.3 MOC to ICC@MOC interfaces

3.3.1 TELEMETRY IN COMMISSIONING AND FOR EMERGENCIES

3.3.1.1 Information flow requirements

FGS-IR-3.3-10 The MOC shall make available to an ICC@MOC its instrument telemetry in NRT during the commissioning phase and for instrument emergencies.

[Source: [AD-2] section 4.3.3]

FGS-IR-3.3-20 The MOC shall make available the telemetry data to the ICC@MOC in a format from which the source telemetry packets generated on-board can be extracted.

3.3.1.2 Control flow requirements

FGS-IR-3.3-30 The MOC shall push the NRT telemetry data to the ICC@MOC.

FGS-IR-3.3-35 It shall be possible for the ICC@MOC to fetch telemetry data from the MOC DDS.

[Source: [HGSSE#14]]. This requirement is to cover the cases where MOC fails for technical reasons to deliver telemetry data to ICC@MOC in NRT. In these cases , ICC@MOC should have the possibility to retrieve these telemetry from the DDS.

3.3.1.3 Performance requirements

FGS-IR-3.3-40 During the commissioning phase and for instrument emergencies, the MOC shall make available to an ICC@MOC its instrument telemetry not later than one minute after the telemetry packet has been received by MOC.

[Source: [AD-3] section 3.6].

FGS-IR-3.3-50 The MOC ICC@MOC interface shall support a data rate equivalent to the maximum instrument on-board data rate (300 kbps).

3.4 HSC to MOC interfaces

3.4.1 OBSERVATIONS SCHEDULE

[RD-18] describes the observation schedule within the context of mission planning.

3.4.1.1 Information flow requirements

FGS-IR-3.4-10 The HSC shall make available to the MOC the observations schedule corresponding to any given scheduling period.

[Source: [AD-2] section 5.3.3]
The observations schedule exported to the MOC will include the sequence of UTC time tagged spacecraft commanding requests (e.g. pointing) and instrument commanding requests for this schedule.
Instrument commanding is expected to be in the form of telecommand mnemonics, see [AD-3] section 3.1.2.1.
The MOC will use the observations schedule to generate the mission timeline to be uplinked to the satellite for the given scheduling period.

FGS-IR-3.4-20 Deleted.

FGS-IR-3.4-30 An observations schedule made available to the MOC by the HSC shall be compatible with the spacecraft operational and design constraints.

[Source: [AD-2] section 5.3.13]
E.g. the observations schedule shall be compatible with:
- *the observation windows as defined in the planning skeleton*
- *the spacecraft attitude constraints (e.g. the ones linked to DTCP)*
- *the commanding rate between the spacecraft DHSS and the instruments*
- *the amount of data which can be uplinked by MOC during a DTCP*
- *the amount of instrument telemetry which can be stored on-board between two consecutive DTCPs.*

3.4.1.2 Control flow requirements

FGS-IR-3.4-40 *Deleted.*

FGS-IR-3.4-50 The HSC shall push observations schedules to the MOC.

3.4.1.3 Performance requirements

FGS-IR-3.4-60 *Deleted.*

FGS-IR-3.4-70 *Deleted.*

The timing for the availability of the schedule from HSC shall be part of the detailed operational plan covering the end-to-end scheduling activities.

3.4.2 INSTRUMENT ON-BOARD SOFTWARE AND ON-BOARD CONTROL PROCEDURES UPDATES

3.4.2.1 Information flow requirements

FGS-IR-3.4-80 The HSC shall make available to the MOC instrument on-board software and on-board control procedures (OBCP) updates

[Source: [AD-2] section 5.11.1]
The HSC will receive the on-board software and OBCP updates from the ICCs for approval before the HSC passes it over to MOC for uplink.
For on-board software, it is expected that the entire memory image be delivered to MOC for each on-board software update. It will then be up to MOC on-board software management to define the part of the image to be uplinked, see [AD-3] section 3.1.8.7.
For OBCP, the entire procedure will be delivered.

3.4.2.2 Control flow requirements

FGS-IR-3.4-90 *Deleted.*

FGS-IR-3.4-100 The HSC shall push On-board software and OBCP updates to the MOC.

3.4.2.3 Performance requirements

N/A

3.4.3 SSO EPHEMERIDES INFORMATION.

3.4.3.1 Information flow requirements

FGS-IR-3.4-110 The HSC shall make SSO ephemerides information available to the MOC SSO database.

[Source: HGSSE#28 and HGSSE#29]
The requests to observe SSOs will come from observers or ICCs.
Note that the HSC shall provide the first set of SSO ephemerides to the MOC based on predicted SSO observations. Subsequent updates will be made as additional SSOs are identified or as the ephemerides information of an SSO is updated.

3.4.3.2 Control flow requirements

FGS-IR-3.4-115 The HSC shall push SSO ephemerides to the MOC.

3.4.3.3 Performance requirements

N/A

3.4.4 INSTRUMENTS DATABASE UPDATES

3.4.4.1 Information flow requirements

FGS-IR-3.4-120 The HSC shall make available to the MOC the ICC instruments database updates.

[Source: [AD-2] section 4.3.3]
Instruments database updates originate from the ICCs and are forwarded by the HSC to the MOC.
The MOC is responsible for maintaining the instruments reference databases for the HGS.

3.4.4.2 Control flow requirements

FGS-IR-3.4-125 The HSC shall push instrument databases updates to the MOC.

3.4.4.3 Performance requirements

N/A

3.4.5 INSTRUMENTS USER MANUALS

3.4.5.1 Information flow requirements

FGS-IR-3.4-130 The HSC shall make available to the MOC the instrument user manuals (including the instrument procedures) necessary for MOC to operate the instruments

[Source: [AD-2] section 4.3.2]
Instruments procedures originate from the ICCs and are forwarded by the HSC to the MOC.
MOC will use the instrument procedures in manual commanding of the instruments.

3.4.5.2 Control flow requirements

FGS-IR-3.4-135 The HSC shall push instrument user manuals to the MOC

3.4.5.3 Performance requirements

N/A

3.4.6 INSTRUMENT APERTURES POINTING MISALIGNMENT UPDATES

3.4.6.1 Information flow requirements

FGS-IR-3.4-140 The HSC shall make available to the MOC the updates of the instrument (virtual) apertures misalignment data w.r.t. the spacecraft attitude reference.

[Source: [AD-3] section 3.1.8.7]
Misalignment data originate from the ICCs and are forwarded by the HSC to the MOC. The MOC is responsible for maintaining the misalignment data reference for the overall HGS.

3.4.6.2 Control flow requirements

FGS-IR-3.4-145 The HSC shall push instrument apertures pointing misalignment updates to the MOC.

3.4.6.3 Performance requirements

N/A

3.4.7 INSTRUMENT DERIVED PARAMETER DEFINITIONS

3.4.7.1 Information flow requirements

FGS-IR-3.4-150 The HSC shall make available to the MOC the instrument derived parameter definitions.

[Source: HGSSE#26]
Instrument derived parameter definitions originate from the ICCs and are forwarded by the HSC to the MOC for inclusion in the MOC control system.

3.4.7.2 Control flow requirements

FGS-IR-3.4-155 The HSC shall push instrument derived parameter definitions to the MOC.

3.4.7.3 Performance requirements

N/A

3.4.8 INSTRUMENT PROCEDURES FOR MANUAL COMMANDING

3.4.8.1 Information flow requirements

FGS-IR-3.4-160 The HSC shall make available to the MOC the instrument procedures that are to be manually executed.

The instrument procedures to be manually executed at MOC must be delivered to the MOC well in advance of their actually execution [HGSSE#30]. The ICCs will define these instrument procedures and deliver them to the HSC (see section 3.7.14).

3.4.8.2 Control flow requirements

FGS-IR-3.4-170 The HSC shall push the instrument procedures for manual commanding to the MOC.

3.4.8.3 Performance requirements

N/A.

3.4.9 INSTRUMENT SSO AVOIDANCE ANGLES

3.4.9.1 Information flow requirements

FGS-IR-3.4-180 The HSC shall make available to the MOC the instrument SSO avoidance angles.

The pointing and slewing avoidance angles for SSOs will be provided by the ICCs for use in both the HSC and the MOC. [HGSSE#31].

3.4.9.2 Control flow requirements

FGS-IR-3.4-190 The HSC shall push the instrument SSO avoidance angles to the MOC.

3.4.9.3 Performance requirements

N/A.

3.5 HSC to ICC interfaces

The ICCs and HSC are expected to have a common data repository, see [AD-2] section 4.2.2. In this context, requirements on pushing/ pulling the data between the HSC and the ICCs are N/A as HSC and ICCs will store/ retrieve data from the HCSS.
HSC data to be accessed by ICCs include the data generated at the HSC (e.g. proposal, observation, schedule data) and data imported from MOC (telemetry and ancillary data). This section differentiates between these data as they are expected to be associated with different control flow and performance requirements.
The HSC shall notify the ICCs for the availability of non regular HSC data.

3.5.1 CONSOLIDATED TELEMETRY DATA

3.5.1.1 Information flow requirements

FGS-IR-3.5-10 The HSC shall make available to the ICC@ICC all the spacecraft and instrument consolidated telemetry received from the MOC.

[Source: [AD-2] section 5.7.10]
The ICC@MOC gets the telemetry directly from the MOC, see section 3.3.1 above.

3.5.1.2 Control flow requirements

FGS-IR-3.5-15 The HSC shall notify the ICC@ICC of the availability of new consolidated telemetry data.

3.5.1.3 Performance requirements

FGS-IR-3.5-20 An ICC@ICC shall be able to access consolidated telemetry with the following performance:

Delay includes consolidation by MOC, physical transfer from MOC to HSC, ingestion into the HSC system and transfer from HSC to ICC.	Housekeeping telemetry	Science telemetry
Commissioning + PV	20 minutes after MOC has received the last bit belonging to the consolidation period	2 hours after MOC has received the last bit belonging to the consolidation period
Routine	20 minutes after MOC has received the last bit belonging to the consolidation period	32 hours after MOC has received the last bit belonging to the consolidation period

In routine phase, an overall delay of 48 hours between the reception of science telemetry at the ground station and the availability of this data at ICCs is acceptable. This leads to a 32 hours acceptable delay from MOC to ICCs (the spacecraft to MOC transfer of science telemetry data is expected to take 16 hours (200 kbps link). Consequently, in routine phase, science telemetry data can be consolidated and retrieved by HSC on an OD basis (i.e. once every 24 hours).

In PV phase, the operation cycle (including: analysis of science telemetry data from previous cycle, generation of new calibration uplink data, scheduling of next cycle) will have to be performed within a few days. A 32 hours delay to get the science data is therefore not acceptable.

In commissioning phase, ICC@ICC will receive non-consolidated telemetry in NRT from ICC@MOC to cover NRT activities. Consolidated telemetry will be made available by the HSC in the same manner as during PV phase See [AD-3] section 3.6.

This requirement is meant to be applicable also in the case of a missed pass. The requirement is on the elapsed time between a last telemetry bit of a given period being received by MOC and this telemetry bit being received by an ICC, it does not consider the elapsed time between on-board generation of the telemetry and its reception by MOC, where the missed pass will have an effect.
Note: This requirement places performance requirements on both the MOC and the Herschel science ground segment (HSC and ICCs). For the purposes of performance testing of the MOC the MIRD requirement MPER-245 is relevant. It states:

***MPER-245**: The MOC shall make available to the HSC (Herschel) and to the PSO and/or DPCs (Planck) any sequence of any category of consolidated TM data from dump TM (i.e. TM dumped from the SSMM during the DTCP) not later than 10 minutes after the last "bit" of this sequence has been received by the MOC.*

The performance requirements placed on the Herschel science ground segment can then be calculated and will be captured in the HCSS user requirements document

3.5.2 MOC DATA

This section specifies ICC requirements for retrieval from HSC of software and data originating from MOC, see 3.1 above (with the exception of telemetry that has been addressed above).

3.5.2.1 Information flow requirements

FGS-IR-3.5-30 The HSC shall make available to the ICCs the spacecraft orbit predictor data updates received from the MOC.

FGS-IR-3.5-40 The HSC shall make available to the ICC@ICC the mission timeline summary data received from the MOC .

FGS-IR-3.5-50 The HSC shall make available to the ICC@ICC the telecommand history data received from the MOC.

FGS-IR-3.5-60 The HSC shall make available to the ICC@ICC the reconstituted spacecraft orbit data received from the MOC.

FGS-IR-3.5-70 The HSC shall make available to the ICC@ICC the spacecraft attitude history data received from the MOC.

FGS-IR-3.5-80 The HSC shall make available to the ICC@ICC the time correlation data received from the MOC.

FGS-IR-3.5-90 The HSC shall make available to the ICC@ICC the instrument derived parameters of their respective instrument received from the MOC.

FGS-IR-3.5-100 The HSC shall make available to the ICC@ICC the OOL information of their respective instrument received from the MOC.

FGS-IR-3.5-110 The HSC shall make available to the ICC@ICC the spacecraft and instruments reference databases received from the MOC.

FGS-IR-3.5-120 The HSC shall make available to the ICC@ICC the SSO reference database received from the MOC.

FGS-IR-3.5-130 The HSC shall make available to the ICC@ICC the instrument memory images of their respective instruments received from the MOC.

3.5.2.2 Control flow requirements

FGS-IR-3.5-135 The HSC shall notify an ICC of the availability of new MOC data when relevant to the ICC.

3.5.2.3 Performance requirements

N/A

3.5.3 HSC GENERATED DATA

3.5.3.1 *Information flow requirements*

FGS-IR-3.5-140 The HSC shall make available to the ICCs the data generated by the HSC.

[Source: [AD-2] section 4.2.2]
HSC generated data include proposal data, observation data (except telemetry) and schedule data.
Note that ICCs may not have the access right to all HSC generated data.

3.5.3.2 *Control flow requirements*

FGS-IR-3.5-145 The HSC shall notify an ICC of the availability of new HSC generated data when relevant to the ICC.

3.5.3.3 *Performance requirements*

N/A

3.5.4 HSC SYSTEM SOFTWARE

3.5.4.1 *Information flow requirements*

FGS-IR-3.5-150 The HSC shall make available to the ICCs the necessary proposal submission software updates to be able to define their calibration AOT observations.

The ICCs will use the HSC system to generate calibration AOT observations. The HSC system software will not support the generation of non-AOT observations.

FGS-IR-3.5-160 The HSC shall make available to the ICCs all the necessary scientific mission planning software updates to be able to check the schedulability of their engineering and calibration observations.

[Source: [AD-2] section 5.2.1]

3.5.4.2 *Control flow requirements*

FGS-IR-3.5-165 The HSC shall notify an ICC of the availability of new HSC system software when relevant to the ICC.

3.5.4.3 Performance requirements

N/A

3.5.5 HELPDESK QUERIES

3.5.5.1 Information flow requirements

FGS-IR-3.5-170 It shall be possible for the HSC to transfer helpdesk queries to the relevant ICCs

Note: This is for queries from the community that the HSC cannot answer directly. This includes queries on instrument-related software.

3.5.5.2 Control flow requirements

N/A

3.5.5.3 Performance requirements

N/A

3.6 *ICC to MOC interfaces*

There will be no direct information flow between the ICC@ICC and MOC. Information which is logically flowing from ICC@ICC to MOC (e.g. instrument database updates, instrument procedures and commanding sequences) will physically flow through the HSC.

Information flow from ICC@MOC to MOC will be mostly of informal nature and cannot be captured in forms of requirements into this document.

3.7 ICC to HSC interfaces

The ICCs and HSC are expected to have a common data repository, see [AD-2] section 4.2.2. In this context, requirements on pushing/ pulling the data between the HSC and the ICCs are N/A as HSC and ICCs will store/ retrieve data from the HCSS..
The ICCs shall notify the HSC for the availability of non regular ICC data.

3.7.1 INSTRUMENT ON-BOARD SOFTWARE AND ON-BOARD CONTROL PROCEDURES UPDATES

3.7.1.1 Information flow requirements

FGS-IR-3.7-10 The ICCs shall make available to the HSC instrument on-board software and on-board control procedures (OBCP) updates and associated information.

[Source: [AD-2] sections 4.3.2 and 5.11.1]
The HSC will receive an on-board software and OBCP update from an ICC for approval by the PS before passing it over to MOC for uplink.
The associated information shall help the PS to assess the impact of the update on the scientific operation of the instrument and resulting observation scientific data, see [HGSSE#4].

3.7.1.2 Control flow requirements

FGS-IR-3.7-20 The ICCs shall notify the HSC of the availability of an instrument on-board software and OBCP update to be validated.

FGS-IR-3.7-30 *Deleted.*

3.7.1.3 Performance requirements

N/A

3.7.2 INSTRUMENT HEALTH REPORT

3.7.2.1 Information flow requirements

FGS-IR-3.7-40 The ICCs shall make available to the HSC their information on the health of their instruments.

See [HGSSE#1]. After processing of their instrument telemetry using RTA, QLA or IA, or following a report from the MOC on a potential instrument anomaly, any findings relevant to observation scheduling (e.g. abnormal functioning of a particular instrument mode) should be sent by the ICCs to the HSC.
The HSC will use this information to guide the scientific mission planning (e.g. to prevent all observations using a non-functioning instrument observing mode from being scheduled).

FGS-IR-3.7-45 The ICCs shall make available to the HSC their instrument trend analysis reports.

3.7.2.2 Control flow requirements

FGS-IR-3.7-47 The ICCs shall notify the HSC of the availability of new information on the health of their instruments.

3.7.2.3 Performance requirements

FGS-IR-3.7-48 The ICC shall make available to the HSC any information regarding an anomaly on their instruments within one working hour after the detection of the anomaly according to agreed procedures.

Concerning the above requirement, it should be noted that severe instrument anomalies would already have been dealt within the on-board by the instrument itself or the DCMS (resulting in the instrument being switched-off) or the MOC (leading to the execution of n instrument procedure). Instrument anomalies that can only be detected by ICCs would most likely result from trend analysis exercises, which requires data to be accumulated over a possibly very substantial time period.

3.7.3 ENGINEERING AND CALIBRATION OBSERVATIONS AND SCHEDULING CONSTRAINTS

3.7.3.1 Information flow requirements

FGS-IR-3.7-50 The ICCs shall make available to the HSC their instrument engineering and calibration observations to be scheduled.

[Source: [AD-2] section 5.2.1]
The HSC will schedule the instrument engineering and calibration observations as part of the scientific mission planning process on the basis of the associated scheduling constraint information.

FGS-IR-3.7-60 The ICCs shall make available to the HSC the scheduling constraints information associated with engineering and calibration observations.

[Source: [AD-2] section 5.2.1]

3.7.3.2 Control flow requirements

FGS-IR-3.7-65 The ICCs shall notify the HSC of the availability of new instrument engineering and calibration observations to be scheduled .

3.7.3.3 Performance requirements

N/A

3.7.4 INSTRUMENT MODE VALIDATION STATUS

3.7.4.1 Information flow requirements

FGS-IR-3.7-70 The ICCs shall make available to the HSC their instrument modes validation status.

The HSC will use this information to release science observations for scheduling. Only observations using instrument modes that have been scientifically validated can normally be released for scheduling.

3.7.4.2 Control flow requirements

FGS-IR-3.7-75 The ICCs shall notify the HSC of a new validation status of their instrument modes.

3.7.4.3 Performance requirements

N/A

3.7.5 OBSERVATION ANALYSIS REPORT

3.7.5.1 Information flow requirements

FGS-IR-3.7-80 The ICCs shall make available to the HSC their information on quality of executed observation.

[Source: [AD-2] section 4.3.2]
This shall allow feedback from ICCs to HSC (and beyond to observers) concerning observation quality information. Note that not all ICCs commit to performing systematic quality control of observations.

3.7.5.2 Control flow requirements

FGS-IR-3.7-85 The ICCs shall notify the HSC of the availability of new information on observation quality

3.7.5.3 Performance requirements

N/A
No performance requirement can be added here as the ICCs will generate observation quality report on a best effort basis with no commitment.

3.7.6 INSTRUMENT SPECIFIC SOFTWARE AND DATA

3.7.6.1 Information flow requirements

FGS-IR-3.7-90 Deleted.

FGS-IR-3.7-100 The ICCs shall make available to the HSC their instrument time estimator software and data updates.

[Source: [AD-2] section 4.3.2]
The HSC will use the instrument time estimator software as part of the HSC proposal submission process and scientific mission planning.

FGS-IR-3.7-110 The ICCs shall make available to the HSC their instrument commanding software and data updates.

[Source: [AD-2] section 4.3.2]
The instrument commanding software and data include calibration uplink data and updates to observing modes.
The HSC will use the instrument commanding software and data as part of the HSC scientific mission planning

FGS-IR-3.7-120 The ICCs shall make available to the HSC their instrument observation data processing software and data updates.

[Source: [AD-2] section 4.3.2]
The instrument observation data processing software and data updates includes the calibration downlink data.
The HSC will use the instrument data processing software and data updates as part of the HSC data processing and evaluation process (including quality control processing and observation product generation).
The HSC will also make available this software to observers.

FGS-IR-3.7-125 The ICCs shall make available to the HSC the information substantiating the scientific validation of their observation data processing software for any given AOT.

3.7.6.2 Control flow requirements

FGS-IR-3.7-127 The ICCs shall notify the HSC of the availability of new instrument specific software or data when relevant to the HSC

3.7.6.3 Performance

N/A

3.7.7 INSTRUMENT OBSERVER MANUALS AND GENERAL INFORMATION

3.7.7.1 Information flow requirements

FGS-IR-3.7-130 The ICCs shall make available to the HSC their instrument observer manual updates (TBC).

[Source: [AD-2] section 4.3.2]
The instrument observer manual may not be subject to an interface as their elaboration could be a collaborative effort between the PST and the ICCs.

FGS-IR-3.7-140 The ICCs shall make available to the HSC the instruments scientific data analysis recipes manuals.

The HSC will post this information for Herschel observers to consult.

FGS-IR-3.7-150 The ICCs shall make available to the HSC general instruments information of relevance to the Herschel observers.

[Source: [AD-2] section 4.3.2]
The HSC will post this information for Herschel observers to consult.

3.7.7.2 Control flow requirements

FGS-IR-3.7-155 An ICC shall notify the HSC of the availability of a new update to its instrument observer manuals or any other information of relevance to the Herschel observers.

3.7.7.3 Performance requirements

N/A

3.7.8 INSTRUMENTS DATABASE UPDATES

3.7.8.1 Information flow requirements

FGS-IR-3.7-160 The ICCs shall make available to the HSC their instruments database updates.

[Source: [AD-2] section 4.3.3]
The HSC will not make direct use of the instruments database updates. The HSC will forward them to the MOC.

3.7.8.2 Control flow requirements

FGS-IR-3.7-165 An ICC shall notify the HSC of the availability of a database update for its instrument.

3.7.8.3 Performance requirements

N/A

3.7.9 INSTRUMENTS USER MANUALS

3.7.9.1 Information flow requirements

FGS-IR-3.7-170 The ICCs shall make available to the HSC the instrument user manuals (including instrument procedures) necessary for the operation of their instruments by MOC.

The HSC will not make use of the instrument procedures. The HSC will forward them to MOC.

3.7.9.2 Control flow requirements

FGS-IR-3.7-175 An ICC shall notify the HSC of the availability of a new update of its instrument user manual.

3.7.9.3 Performance requirements

N/A

3.7.10 INSTRUMENT APERTURES POINTING MISALIGNMENT UPDATES

3.7.10.1 Information flow requirements

FGS-IR-3.7-180 The ICCs shall make available to the HSC the updates of their instrument (virtual) aperture misalignment data w.r.t. the spacecraft attitude reference.

The HSC will not directly use this data. The HSC will forward it to the MOC.

3.7.10.2 Control flow requirements

FGS-IR-3.7-185 An ICC shall notify the HSC of the availability of an update of its instrument aperture pointing misalignment data.

3.7.10.3 Performance requirements

N/A

3.7.11 INSTRUMENT MANUALS

3.7.11.1 Information flow requirements

FGS-IR-3.7-190 *Deleted.*

See instrument user manuals, section 3.7.9

3.7.11.2 Control flow requirements

N/A

3.7.11.3 Performance requirements

N/A

3.7.12 HELPDESK QUERIES

3.7.12.1 Information flow requirements

FGS-IR-3.7-200 The ICCs shall make available to the HSC (helpdesk) replies to specific instrument related queries.

Note: This is for queries from the community that the HSC cannot answer directly. This includes queries on instrument-related software.
It is anticipated that this is only a punctual, low-level activity. Interaction is with the HSC not directly with the originator of the query

3.7.12.2 Control flow requirements

N/A

3.7.12.3 Performance requirements

N/A

3.7.13 INSTRUMENT DERIVED PARAMETER DEFINITIONS

3.7.13.1 Information flow requirements

FGS-IR-3.7-210 The ICCs shall make available to the MOC the instrument derived parameter definitions.

[Source: HGSSE#26]

Instrument derived parameter definitions originate from the ICCs and are forwarded by the HSC to the MOC for inclusion in the MOC control system.

3.7.13.2 Control flow requirements

FGS-IR-3.7-215 An ICC shall notify the HSC of the availability of instrument derived parameter definitions.

3.7.13.3 Performance requirements

N/A.

3.7.14 INSTRUMENT PROCEDURES FOR MANUAL COMMANDING

3.7.14.1 Information flow requirements

FGS-IR-3.7-220 An ICC shall make available to the HSC the instrument procedures that are to be manually executed from the MOC.

The instrument procedures to be manually executed at MOC must be delivered to the MOC well in advance of their actually execution [HGSSE#30]. The ICCs will define these instrument procedures and deliver them to the HSC for subsequent distribution to the MOC (see section 3.4.8).

3.7.14.2 Control flow requirements

FGS-IR-3.7-230 An ICC shall notify the HSC of the availability of instrument procedures for manual commanding.

3.7.14.3 Performance requirements

N/A.

3.7.15 INSTRUMENT SSO AVOIDANCE ANGLES

3.7.15.1 Information flow requirements

FGS-IR-3.7-240 An ICC shall make available to the HSC the instrument SSO avoidance angles.

The pointing and slewing avoidance angles for SSOs will be provided by the ICCs for use in both the HSC and the MOC. [HGSSE#31].

3.7.15.2 Control flow requirements

FGS-IR-3.7-250 An ICC shall notify the HSC of the availability of instrument SSO avoidance angles.

3.7.15.3 Performance requirements

N/A.

3.8 HCSS to RTA interfaces

3.8.1 TELEMETRY DURING OPERATIONS

3.8.1.1 Information flow requirements

FGS-IR-3.8-10 The HCSS shall make instrument housekeeping telemetry available to RTA.

Housekeeping telemetry includes telecommand verification packets and event packets.

FGS-IR-3.8-20 The HCSS shall make the telemetry available to the RTA system as source packets as provided by MOC.

3.8.1.2 Control flow requirements

FGS-IR-3.8-25 The RTA shall trigger the telemetry data reception from the HCSS

FGS-IR-3.8-26 The HCSS shall allow to select telemetry according to the following criteria:

- Generation time
- APIDs
- Test procedure execution
- Observation execution

3.8.1.3 Performance requirements

FGS-IR-3.8-30 The instrument telemetry shall arrive at the RTA system at a rate up to 10 times the on-board data rate.

With the current on-board data rate for housekeeping, this would amount to about 40 kbps.

3.9 RTA to HCSS interfaces

3.9.1.1 Information flow requirements

FGS-IR-3.9-10 The RTA shall make available to the HCSS its logs for any given testing period.
[Source: [AD-3] section 3.2.8].
E.g. OOL data.

3.9.1.2 Control flow requirements

FGS-IR-3.9-20 The HCSS shall pull the RTA logs data from the RTA.

3.9.1.3 Performance requirements

N/A

3.10 HCSS to OBS Maintenance interfaces

3.10.1 INSTRUMENT ON-BOARD MEMORY IMAGE

Agreed in HSGSSE#6 that this interface is not required.

3.10.1.1 Information flow requirements

FGS-IR-3.10-10 Deleted.
[Source: [AD-3] section 3.2.9].

3.10.1.2 Control flow requirements

FGS-IR-3.10-20 Deleted.

3.10.1.3 Performance requirements

N/A

3.11 OBS Maintenance to HCSS interfaces

Agreed in HSGSSE#6 that this interface is not required.

3.11.1.1 Information flow requirements

FGS-IR-3.11-10 Deleted.

3.11.1.2 Control flow requirements

FGS-IR-3.11-20 Deleted.

3.11.1.3 Performance requirements

N/A

4 INTERFACE REQUIREMENTS FOR ILT AND IST PHASES

4.1 HCSS to EGSE-ILT interfaces (ILT only)

4.1.1 TESTS PROCEDURE INPUTS

4.1.1.1 Information flow requirements

FGS-IR-4.1-05 The HCSS shall make available to the EGSE-ILT available (test) observing modes and associated parameters definitions.

[Source: [AD-3] section 3.2.7.1].
Observing modes are used by the EGSE-ILT (Test Control) in the definition of test procedures

FGS-IR-4.1-10 It shall be possible to import command mnemonic sequences from the HCSS to the EGSE-ILT by specifying observing modes and associated parameters values.

[Source: [AD-3] section 3.2.7.1].
The observation command mnemonic sequence exported to the EGSE-ILT will include the sequence of relative time tagged instrument and test equipment commanding requests for this observation.
Commanding is expected to be in the form of telecommand mnemonics, see [AD-3] section 3.2.2].

FGS-IR-4.1-20 An observation command mnemonic sequence made available to the EGSE-ILT by the HCSS shall be compatible with the test operational and design constraints.

E.g. the observations schedule shall be compatible with:
- *the commanding rate between the CDMS interface and the instruments*

4.1.1.2 Control flow requirements

FGS-IR-4.1-25 The EGSE-ILT shall pull observing modes from the HCSS.

FGS-IR-4.1-30 The EGSE-ILT shall trigger the reception of the observation command mnemonic sequences from the HCSS.

4.1.1.3 Performance requirements

FGS-IR-4.1-40 The elapsed time between the request by the EGSE-ILT to the HCSS of the generation of an observation command mnemonic sequence and the reception of this sequence by the EGSE-ILT shall not exceed 5 seconds.

During ILT the Test Control component will (automatically) request observation command mnemonic sequences to be generated on the fly by directly calling HCSS functions out of an available (pre-defined) test observation mode and parameters. The elapsed time will largely depend on the complexity of the observation.

FGS-IR-4.1-50 *Deleted.*

4.1.2 INSTRUMENT DATABASE UPDATES

Instrument databases include the definition of the instrument telecommands and telemetry as well as the telecommands and telemetry related to the TEIs.

4.1.2.1 Information flow requirements

FGS-IR-4.1-60 The HCSS shall make instruments databases updates available to the EGSE-ILT.

[Source: [AD-3] section 3.2.10].

FGS-IR-4.1-70 Instruments databases updates shall be made available in the form appropriate for the RTA system (SCOS-2000 based)

[Source: [AD-3] section 3.1.6].

4.1.2.2 Control flow requirements

FGS-IR-4.1-80 The EGSE-ILT shall pull instruments databases updates from the HCSS.

4.1.2.3 Performance requirements

N/A

4.1.3 INSTRUMENT MEMORY IMAGE

Agreed in HSGSSE#6 that this interface is not required.

4.1.3.1 Information flow requirements

FGS-IR-4.1-90 Deleted.

FGS-IR-4.1-100 IDeleted

4.1.3.2 Control flow requirements

FGS-IR-4.1-110 Deleted.

4.1.3.3 Performance requirements

N/A

4.2 EGSE-ILT to HCSS interfaces (ILT only)

4.2.1 TELEMETRY

4.2.1.1 Information flow requirements

FGS-IR-4.2-10 The EGSE-ILT shall make available to the HCSS all instrument and test equipment telemetry data generated during tests.

[Source: [AD-3] section 3.2.7.3].

FGS-IR-4.2-20 The EGSE-ILT shall make available the telemetry data to the HCSS in a format from which the TEI and instrument source telemetry packets can be extracted.

Similar to FSG-IR-3.1-30. telemetry format is expected to be the same in ILT/ IST as in operation.

FGS-IR-4.2-21 The test equipment telemetry data shall include the necessary information for the HCSS to be able to associate, when relevant, each telemetry data to the context of an observation and observation measurement

[Source: [AD-3] section 3.2.7.3].
This requirement also applies to instrument telemetry, however this is out of the scope of this document. See also comment in section 3.1.1.1.

4.2.1.2 Control flow requirements

FGS-IR-4.2-25 The HCSS shall trigger the telemetry data reception from the EGSE-ILT.

FGS-IR-4.2-30 The telemetry data shall be received from the EGSE-ILT as one single telemetry data stream.

It would be desirable to have the same protocol for the telemetry data stream in ILT as in operation between MOC and ICC@MOC.

4.2.1.3 Performance requirements

FGS-IR-4.2-40 The instrument telemetry shall be available in the HCSS not later than 5 seconds after the EGSE-ILT has received/ generated it.

This performance requirement is derived from the need for QLA to analyse instrument telemetry on line.

FGS-IR-4.2-50 The EGSE-ILT HCSS telemetry interface shall support a data rate equivalent to the addition of the maximum instrument on-board data rate (300 kbps) and the maximum TEIs data rate (400 kbps).

4.2.2 TESTS PROCEDURES

4.2.2.1 Information flow requirements

FGS-IR-4.2-60 It shall be possible to store (retrieve) test procedures definitions from (into) the EGSE-ILT into (from) the HCSS.

[Source: [AD-3] section 3.2.7.1].

FGS-IR-4.2-70 It shall be possible to store test procedures execution logs from the EGSE-ILT into the HCSS.

[Source: [AD-3] section 3.2.7.1].

FGS-IR-4.2-80 It shall be possible to store (retrieve) autonomy procedures definitions from (into) the EGSE-ILT into (from) the HCSS.

[Source: [AD-3] section 3.2.7.1].

4.2.2.2 Control flow requirements

FGS-IR-4.2-90 The storage (retrieval) of test procedures definition and execution logs into (from) the HCSS shall be triggered from the EGSE-ILT.

4.2.2.3 Performance requirements

N/A

4.3 HCSS to RTA interfaces (ILT and IST)

4.3.1 TELEMETRY

4.3.1.1 Information flow requirements

FGS-IR-4.3-10 The HCSS shall make instrument housekeeping telemetry available to RTA.

[Source: [AD-3] section 3.2.8].
Housekeeping telemetry includes telecommand verification packets and event packets

FGS-IR-4.3-20 The HCSS shall make the telemetry available to the RTA system as source packets as provided by the EGSE-ILT or the CCS.

Similar to FSG-IR-3.1-30. telemetry format is expected to be the same in ILT/ IST as in operation.

4.3.1.2 Control flow requirements

FGS-IR-4.3-25 The RTA shall trigger the telemetry data reception from the HCSS.

FGS-IR-4.3-26 The HCSS shall allow to select telemetry according to the following criteria:

- Test or instrument configuration
- Generation time
- APIDs
- Test procedure execution
- Observation execution

With respect to the test or instrument configuration: The possibility exists, especially in the test phases, that independent HCSS nodes will be ingesting telemetry data simultaneously.
An example is IST tests on the QM running in parallel with ILT test on the FM.
If the resulting telemetry packet objects originate from the same instrument (albeit different models) they can bear the same APIDs, time tags, etc, making it difficult or impossible to use these criteria to identify them uniquely.

4.3.1.3 Performance requirements

FGS-IR-4.3-30 *Deleted.*

In ILT and IST, RTA will interface with the HCSS for the telemetry retrieval only for off-line assessment of telemetry (play back mode).

FGS-IR-4.3-35 The HCSS RTA telemetry interface shall support a data rate equivalent to 10 times the maximum instrument housekeeping on-board data rate (4 kbps).

4.3.2 INSTRUMENT DATABASE UPDATES

4.3.2.1 Information flow requirements

FGS-IR-4.3-40 The HCSS shall make instrument database updates available to RTA.

[Source: [AD-3] section 3.2.10].

FGS-IR-4.3-50 Instrument database updates shall be made available in the form appropriate for the RTA system (SCOS-2000 based).

4.3.2.2 Control flow requirements

FGS-IR-4.3-60 The RTA shall pull the instrument database update from the HCSS.

4.3.2.3 Performance requirements

N/A

4.4 RTA to HCSS interfaces

4.4.1 TELECOMMAND HISTORY (ILT ONLY)

4.4.1.1 Information flow requirements

FGS-IR-4.4-10 The RTA shall make available to the HCSS the telecommand history data for any given testing period.

[Source: [AD-3] section 3.2.7.4].

FGS-IR-4.4-20 The telecommand history data shall include the necessary information for the HCSS to be able to associate (when relevant) the telecommand to the instrument or TE command mnemonics exported by the HCSS.

Similar to FGS-IR-3.1-310. The telecommand history is expected to have the same format in ILT/ IST as in operation.

4.4.1.2 Control flow requirements

FGS-IR-4.4-30 The HCSS shall pull the telecommand history data from the RTA.

4.4.1.3 Performance requirements

N/A

4.4.2 RTA LOGS (ILT ONLY)

4.4.2.1 Information flow requirements

FGS-IR-4.4-40 The RTA shall make available to the HCSS its logs for any given testing period.

[Source: [AD-3] section 3.2.8].
E.g. OOL data.

4.4.2.2 Control flow requirements

FGS-IR-4.4-50 The HCSS shall pull the RTA logs data from the RTA.

4.4.2.3 Performance requirements

N/A

4.5 OBS Maintenance to HCSS (ILT and IST)

4.5.1 ON-BOARD MEMORY IMAGE

Agreed in HSGSSE#6 that this interface is not required.

4.5.1.1 Information flow requirements

FGS-IR-4.5-10 Deleted..

4.5.1.2 Control flow requirements

FGS-IR-4.5-20 Deleted.

4.5.1.3 Performance requirements

N/A

4.6 HCSS to OBS Maintenance (ILT and IST)

See previous section.

4.7 RTA to EGSE-ILT interfaces (ILT only)

4.7.1 RTA EVENT AND PARAMETERS

4.7.1.1 Information flow requirements

FGS-IR-4.7-10 RTA shall send telemetry parameter values and events (TBC) to the EGSE-ILT (test control) when housekeeping data processing results call for procedures to be carried out by the EGSE-ILT.

[Source: [AD-3] section 3.2.4].
RTA events and telemetry parameters values sent over to the EGSE-ILT will allow the triggering of autonomy procedures.
Examples of such events are:

- *housekeeping parameter out of limit -> send packet to initiate shut down of instrument*
- *housekeeping parameter out of limits -> send packet to initiate 'abort measurement'*
- *housekeeping parameter(s) at certain level ->send packet to indicate that test is finished. This could subsequently result in Test Control generating and activating a new 'schedule'.*

4.7.1.2 Control flow requirements

FGS-IR-4.7-20 The EGSE-ILT shall trigger the reception of the RTA events and telemetry parameters values.

FGS-IR-4.7-30 *Deleted.*

4.7.1.3 Performance requirements

FGS-IR-4.7-40 RTA events shall arrive at the EGSE-ILT within 0.5 second after their generation.

The figure of 0.5 second is to be put in relation with the end-to-end latency for the triggering/ execution of an autonomy procedure that is expected to be of the order of 3 to 4 seconds.

4.8 HCSS to CCS interfaces (IST only)

All information and data flow from instrument group to CCS shall follow requirements as given in the IID-A and IID-Bs (see [RD-11], [RD-12], [RD-13] and [RD-14]). In line with the concept of smooth transition, see [AD-3], it is expected that requirements between the HCSS and the EGSE-ILT as identified in section 4.1 above, i.e. requirements regarding test procedures inputs, instrument database and instrument memory image, apply as well to the interface between the HCSS and the CCS.
As explained in section 1.2, this document however does not formally identify requirements between the HCSS and the CCS.

4.9 CCS to HCSS interfaces (IST only)

In line with the concept of smooth transition, see [AD-3], it is expected that requirements between the EGSE-ILT and the HCSS as identified in section 4.2.1 and between the RTA and the HCSS as identified in section 4.4.1 above, i.e. requirements regarding telemetry and telecommand history, apply as well to the interface between the CCS and the HCSS.
As explained in section 1.2, this document however does not formally identify requirements between the CCS and the HCSS.

4.9.1 TELEMETRY

4.9.1.1 Information flow requirements

FGS-IR-4.9-10 *Deleted.*

FGS-IR-4.9-20 *Deleted.*

FGS-IR-4.9-21 *Deleted.*

4.9.1.2 Control flow requirements

FGS-IR-4.9-30 *Deleted.*

4.9.1.3 Performance requirements

FGS-IR-4.9-40 *Deleted.*

4.10 MIB editor to HCSS (ILT and IST)

4.10.1 INSTRUMENT DATABASE

4.10.1.1 Information flow requirements

FGS-IR-4.10-10 It shall be possible to store (retrieve) an instrument database from (into) the MIB editor (from) into the HCSS.

[Source: [AD-3] section 3.2.10].

FGS-IR-4.10-15 The instrument database shall be in a format compatible with the format expected by SCOS-2000.

[Source: [AD-3] section 3.2.6].

4.10.1.2 Control flow requirements

FGS-IR-4.10-20 The storage (retrieval) of an instrument database to (from) the HCSS shall be triggered from the MIB editor.

4.10.1.3 Performance requirements

N/A

4.11 HCSS to MIB editor (IST and ILT)

See previous section.

4.12 EGSE-ILT to RTA interface (ILT only)

This interface corresponds to either internal SCOS-2000 interface (SCOS-2000 commanding and SCOS-2000 monitoring) or to interface between the EGSE-ILT Interface Unit and SCOS-2000, see HSCDD [AD-3] section 3.2. Both interfaces have already been implemented and are expected to be used as is. No specific requirements have been identified for their use in the context of the Herschel ILT.

4.13 HCSS to EGSE-IST interfaces (IST only)

4.13.1 TESTS PROCEDURE INPUTS

4.13.1.1 Information flow requirements

FGS-IR-4.13-10 The HCSS shall make available to the EGSE-IST available (test) observing modes and associated parameters definitions.

[Source: [AD-3] section 3.3.4.1].
Observing modes are used by the EGSE-IST (Test Control) in the definition of test procedures

FGS-IR-4.13-20 It shall be possible to import command mnemonic sequences from the HCSS to the EGSE-IST by specifying observing modes and associated parameters values.

[Source: [AD-3] section 3.3.4.1].
The observation command mnemonic sequence exported to the EGSE-IST will include the sequence of relative time tagged instrument and test equipment commanding requests for this observation.
Commanding is expected to be in the form of telecommand mnemonics, see [AD-3] section 3.2.2].

FGS-IR-4.13-30 An observation command mnemonic sequence made available to the EGSE-IST by the HCSS shall be compatible with the test operational and design constraints.

E.g. the observations schedule shall be compatible with:
- *the commanding rate between the CDMS interface and the instruments*

4.13.1.2 Control flow requirements

FGS-IR-4.13-40 The EGSE-IST shall pull observing modes from the HCSS.

FGS-IR-4.13-50 The EGSE-IST shall trigger the reception of the observation command mnemonic sequences from the HCSS.

4.13.1.3 Performance requirements

FGS-IR-4.13-60 The elapsed time between the request by the EGSE-IST to the HCSS of the generation of an observation command mnemonic sequence and the reception of this sequence by the EGSE-IST shall not exceed 5 seconds.

During IST the Test Control component will (automatically) request observation command mnemonic sequences to be generated on the fly by directly calling HCSS functions out of an available (pre-defined) test observation mode and parameters. The elapsed time will largely depend on the complexity of the observation.

4.14 EGSE-IST to HCSS interfaces (IST only)

4.14.1 TELEMETRY

4.14.1.1 Information flow requirements

FGS-IR-4.14-10 The EGSE-IST shall make available to the HCSS all instrument and spacecraft telemetry data generated during tests.

[Source: [AD-3] section 3.3.8.2].

FGS-IR-4.14-20 The EGSE-IST shall make available the telemetry data to the HCSS in a format from which the instrument and spacecraft source telemetry packets can be extracted.

Similar to FSG-IR-3.1-30. telemetry format is expected to be the same in ILT/ IST as in operation.

4.14.1.2 Control flow requirements

FGS-IR-4.14-30 The HCSS shall trigger the telemetry data reception from the EGSE-IST.

FGS-IR-4.14-40 The telemetry data shall be received from the EGSE-IST as one single telemetry data stream.

It would be desirable to have the same protocol for the telemetry data stream in IST as in operation between MOC and ICC@MOC.

4.14.1.3 Performance requirements

FGS-IR-4.14-50 The instrument telemetry shall be available in the HCSS not later than 5 seconds after the EGSE-IST has received/ generated it.

This performance requirement is derived from the need for QLA to analyse instrument telemetry on line.

FGS-IR-4.14-60 The EGSE-IST HCSS telemetry interface shall support a data rate equivalent to the addition of the maximum instrument on-board data rate (300 kbps) and the maximum spacecraft data rate (TBD kbps).

4.14.2 TESTS PROCEDURES

4.14.2.1 Information flow requirements

FGS-IR-4.14-70 It shall be possible to store (retrieve) test procedures definitions from (into) the EGSE-IST into (from) the HCSS.

[Source: [AD-3] section 3.3.8.1].

4.14.2.2 Control flow requirements

FGS-IR-4.14-80 The storage (retrieval) of test procedures definition into (from) the HCSS shall be triggered from the EGSE-IST.

4.14.2.3 Performance requirements

N/A