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TABLE OF CONTENTS

1 INTRODUCTION 118

1.1 OBJECTIVE 118

1.2 SCOPE 118

1.3 STRUCTURE OF THE DOCUMENT 1411

1.4 DEFINITIONS, ACRONYMS & ABBREVIATIONS 1512

1.5 REFERENCES 1613

1.5.1 APPLICABLE DOCUMENTS 1613
1.5.2 REFERENCE DOCUMENTS 1613
1.5.3 MINUTES OF MEETINGS 1714

2 GENERAL DESCRIPTION 1714

2.1 ASSUMPTIONS 1714

2.2 INFORMATION FLOW GENERAL DESCRIPTION 1814

2.2.1 INFORMATION FLOW RELATED TO MOC 1814
2.2.2 INFORMATION FLOW RELATED TO THE FSC 1815
2.2.3 INFORMATION FLOWS RELATED TO ICCS 1916
2.2.4 TM DATA FLOW 2016
2.2.5 INFORMATION FLOW BETWEEN CENTERS SUMMARY 2118
2.2.6 INFORMATION FLOW IN ILT AND IST 2218

3 INTERFACE REQUIREMENTS FOR IN-ORBIT AND POST-MISSION PHASES 2319

3.1 MOC TO FSC INTERFACES 2319

3.1.1 CONSOLIDATED TM 2319
3.1.2 S/C ORBIT PREDICTOR SW & DATA 2521
3.1.3 S/C ATTITUDE CONSTRAINT SW & DATA 2521
3.1.4 S/C SLEW TIME AND PATH PREDICTOR SW & DATA 2622
3.1.5 PLANNING SKELETON DATA 2722
3.1.6 OBSERVATIONS SCHEDULE STATUS INFORMATION 2723
3.1.7 COMMANDING TIMELINE SUMMARY 2824
3.1.8 TC HISTORY 2824
3.1.9 S/C ORBIT DATA (RECONSTITUTED) 2925
3.1.10 S/C ATTITUDE HISTORY 3026
3.1.11 TIME CORRELATION 3026
3.1.12 DERIVED PARAMETERS 3127
3.1.13 OUT OF LIMITS INFORMATION 3228

3.1.14 INSTRUMENT MEMORY IMAGE 3228
3.1.15 S/C AND INSTRUMENTS DATABASES 3329
3.1.16 INSTRUMENT APERTURES POINTING MISALIGNMENT 3329
3.1.17 SSO DATABASE 3430
3.1.18 S/C GENERAL INFORMATION 3530
3.1.19 INSTRUMENTS MAL-FUNCTIONS OR OPERATION PROBLEMS INFORMATION 3531

3.2 MOC TO ICC INTERFACES 3631

3.2.1 INSTRUMENTS MAL-FUNCTIONS OR OPERATION PROBLEMS INFORMATION 3631
3.2.2 TELEMETRY IN COMMISSIONING AND FOR EMERGENCIES 3632

3.3 MOC TO ICC@MOC INTERFACES 3732

3.3.1 TELEMETRY IN COMMISSIONING AND FOR EMERGENCIES 3732

3.4 FSC TO MOC INTERFACES 3833

3.4.1 OBSERVATIONS SCHEDULE 3833
3.4.2 INSTRUMENT ON BOARD SW UPDATES 3934
3.4.3 SSO DATABASE UPDATES 3935
3.4.4 INSTRUMENTS DATABASE UPDATES 4035
3.4.5 INSTRUMENTS PROCEDURES AND COMMAND SEQUENCES UPDATES 4036
3.4.6 INSTRUMENT APERTURES POINTING MISALIGNEMENT UPDATES 4136

3.5 FSC TO ICC INTERFACES 4137

3.5.1 CONSOLIDATED TM DATA 4237
3.5.2 MOC SW & DATA 4338
3.5.3 FSC GENERATED DATA 4439
3.5.4 FSC SYSTEM SW 4440

3.6 ICC TO MOC INTERFACES 4540

3.7 ICC TO FSC INTERFACES 4540

3.7.1 INSTRUMENT ON BOARD SW UPDATES 4540
3.7.2 INSTRUMENT HEALTH REPORT 4641
3.7.3 ENGINEERING AND CALIBRATION OBSERVATIONS & SCHEDULING CONSTRAINTS 4642
3.7.4 INSTRUMENT MODE VALIDATION STATUS 4742
3.7.5 OBSERVATION ANALYSIS REPORT 4743
3.7.6 INSTRUMENT SPECIFIC SW & DATA 4843
3.7.7 INSTRUMENT OBSERVER MANUALS & GENERAL INFORMATION 4944
3.7.8 INSTRUMENTS DATABASE UPDATES 4945
3.7.9 INSTRUMENTS PROCEDURES AND COMMANDING SEQUENCES UPDATES 5045
3.7.10 INSTRUMENT APERTURES POINTING MISALIGNEMENT UPDATES 5046
3.7.11 INSTRUMENT MANUALS 5146

3.8 FCSS TO RTA INTERFACES 5147

3.8.1 TELEMETRY DURING OPERATIONS 5147

3.9 RTA TO FCSS INTERFACES 5247

3.10 FCSS TO OBSM INTERFACES 5247

3.11 OBSM TO FCSS INTERFACES 5247

4 INTERFACE REQUIREMENTS FOR ILT AND IST 5247

4.1 FCSS TO EGSE-ILT INTERFACES 5247

4.1.1 SCHEDULE 5248

4.2 EGSE-ILT TO FCSS INTERFACES 5349

4.2.1 TELEMETRY 5349

4.3 FCSS TO RTA INTERFACES 5450

4.3.1 TELEMETRY DURING ILT/IST 5450
4.3.2 INSTRUMENT DATABASE UPDATES 5550

4.4 RTA TO FCSS INTERFACES 5551

4.5 FCSS TO OBSM 5651

4.6 OBSM TO FCSS 5651

4.7 RTA TO EGSE-ILT INTERFACES 5651

4.7.1 RTA EVENT HANDLING 5651

4.8 FCSS TO CCE INTERFACES (IST) 5752

4.9 CCE TO FCSS INTERFACES (IST) 5752

4.9.1 TELEMETRY 5752

1 INTRODUCTION 7

1.1 OBJECTIVE 7

1.2 SCOPE 7

1.3 STRUCTURE OF THE DOCUMENT 9

1.4 DEFINITIONS, ACRONYMS & ABBREVIATIONS 9

1.5 REFERENCES 10

1.5.1 APPLICABLE DOCUMENTS 10
1.5.2 REFERENCE DOCUMENTS 10

1.5.3 MINUTES OF MEETINGS 11

2 GENERAL DESCRIPTION 11

2.1 ASSUMPTIONS 11

2.2 INFORMATION FLOW GENERAL DESCRIPTION 11

2.2.1 INFORMATION FLOW RELATED TO MOC 11
2.2.2 INFORMATION FLOW RELATED TO THE FSC 12
2.2.3 INFORMATION FLOWS RELATED TO ICCS 13
2.2.4 TM DATA FLOW 13
2.2.5 INFORMATION FLOW SUMMARY 14

INTERFACES REQUIREMENTS 15

3.1 MOC TO FSC INTERFACES 15

3.1.1 CONSOLIDATED TM 15
3.1.2 S/C ORBIT PREDICTOR SW & DATA 17
3.1.3 S/C ATTITUDE CONSTRAINT SW & DATA 18
3.1.4 S/C SLEW TIME AND PATH PREDICTOR SW & DATA 19
3.1.5 PLANNING SKELETON DATA 19
3.1.6 OBSERVATIONS SCHEDULE STATUS INFORMATION 20
3.1.7 COMMANDING TIMELINE SUMMARY 20
3.1.8 TC HISTORY 21
3.1.9 S/C ORBIT DATA (RECONSTITUTED) 22
3.1.10 S/C ATTITUDE HISTORY 22
3.1.11 TIME CORRELATION 23
3.1.12 DERIVED PARAMETERS 24
3.1.13 OUT OF LIMITS INFORMATION 24
3.1.14 INSTRUMENT MEMORY IMAGE 25
3.1.15 S/C AND INSTRUMENTS DATABASES 25
3.1.16 INSTRUMENT APERTURES POINTING MISALIGNMENT 26
3.1.17 SSO DATABASE 26
3.1.18 S/C GENERAL INFORMATION 27
3.1.19 INSTRUMENTS MAL FUNCTIONS OR OPERATION PROBLEMS INFORMATION 27

3.2 MOC TO ICC INTERFACES 28

3.2.1 INSTRUMENTS MAL FUNCTIONS OR OPERATION PROBLEMS INFORMATION 28
3.2.2 TELEMETRY IN COMMISSIONING AND FOR EMERGENCIES 28

3.3 MOC TO ICC@MOC INTERFACES 29

3.3.1 TELEMETRY IN COMMISSIONING AND FOR EMERGENCIES 29

3.4 FSC TO MOC INTERFACES 30

3.4.1 OBSERVATIONS SCHEDULE 30
3.4.2 INSTRUMENT ON BOARD SW UPDATES 31
3.4.3 SSO DATABASE UPDATES 31
3.4.4 INSTRUMENTS DATABASE UPDATES 32

3.4.5 INSTRUMENTS PROCEDURES AND COMMAND SEQUENCES UPDATES 32
3.4.6 INSTRUMENT APERTURES POINTING MISALIGNEMENT UPDATES 33

3.5 FSC TO ICC INTERFACES 33

3.5.1 CONSOLIDATED TM DATA 34
3.5.2 MOC SW & DATA 35
3.5.3 FSC GENERATED DATA 36
3.5.4 FSC SYSTEM SW 36

3.6 ICC TO MOC INTERFACES 37

3.7 ICC TO FSC INTERFACES 37

3.7.1 INSTRUMENT ON BOARD SW UPDATES 37
3.7.2 INSTRUMENT HEALTH REPORT 38
3.7.3 ENGINEERING AND CALIBRATION OBSERVATIONS & SCHEDULING CONSTRAINTS 38
3.7.4 INSTRUMENT MODE VALIDATION STATUS 39
3.7.5 OBSERVATION ANALYSIS REPORT 39
3.7.6 INSTRUMENT SPECIFIC SW & DATA 40
3.7.7 INSTRUMENT OBSERVER MANUALS & GENERAL INFORMATION 41
3.7.8 INSTRUMENTS DATABASE UPDATES 41
3.7.9 INSTRUMENTS PROCEDURES AND COMMANDING SEQUENCES UPDATES 42
3.7.10 INSTRUMENT APERTURES POINTING MISALIGNEMENT UPDATES 42
3.7.11 INSTRUMENT MANUALS 43

4 INTERFACES REQUIREMENTS VERSUS OPERATIONAL PHASES 43

APPENDIX A : GLOSSARY 45

1 INTRODUCTION

1.1 Objective

The objective of this document is to define the operational interface requirements between the different centres elements of the FIRST Ground Segment (GS).

By operational interface, one should understand the information and control flow between the different centres of tThe FIRST GS necessary for each centre to fulfil its mandate as is defined in the FIRST SMP [AD-1] and elaborated in the FIRST GS scenario [RD-1].

The interface requirements in this document are applicable to the design, development and operation of the different systems or centres supporting the FIRST GS centres. It is complementary to the user requirements documents on these systems, see [RD-5], [RD-6].

1.2 Scope

This document defines the functional, control flow and performance requirements applicable to the interfaces between the different elements applicable to the information and associated control flow between the different centres of the FIRST GS GS and the performance of the systems and communication lines as far as this is directly related to this flow.

The FIRST GS elements are the FGS operational centres and the FGS systems.

The different centres of the FIRST GS considered in this document are the following, see [RD-1] section 4:
- The FIRST Mission Operations Centre (MOC)
- The FIRST Science Centre (FSC)
- The FIRST 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 [RD-1] 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 FIRST GS considered in this document are the following, see [RD-10]

- The FIRST Common Science System (FCSS) which with the RTA and the OBSM systems supports the FSC and ICC operations as well as the instrument teams in ILT and IST
- The RTA system which supports the RT analysis of the instrument HK data
- The OBSM system which supports the instrument on board SW maintenance
- The EGSE-ILT which supports the test executions in ILT
- The CCE which supports the test executions in IST
- The MCS which supports the MOC operations

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

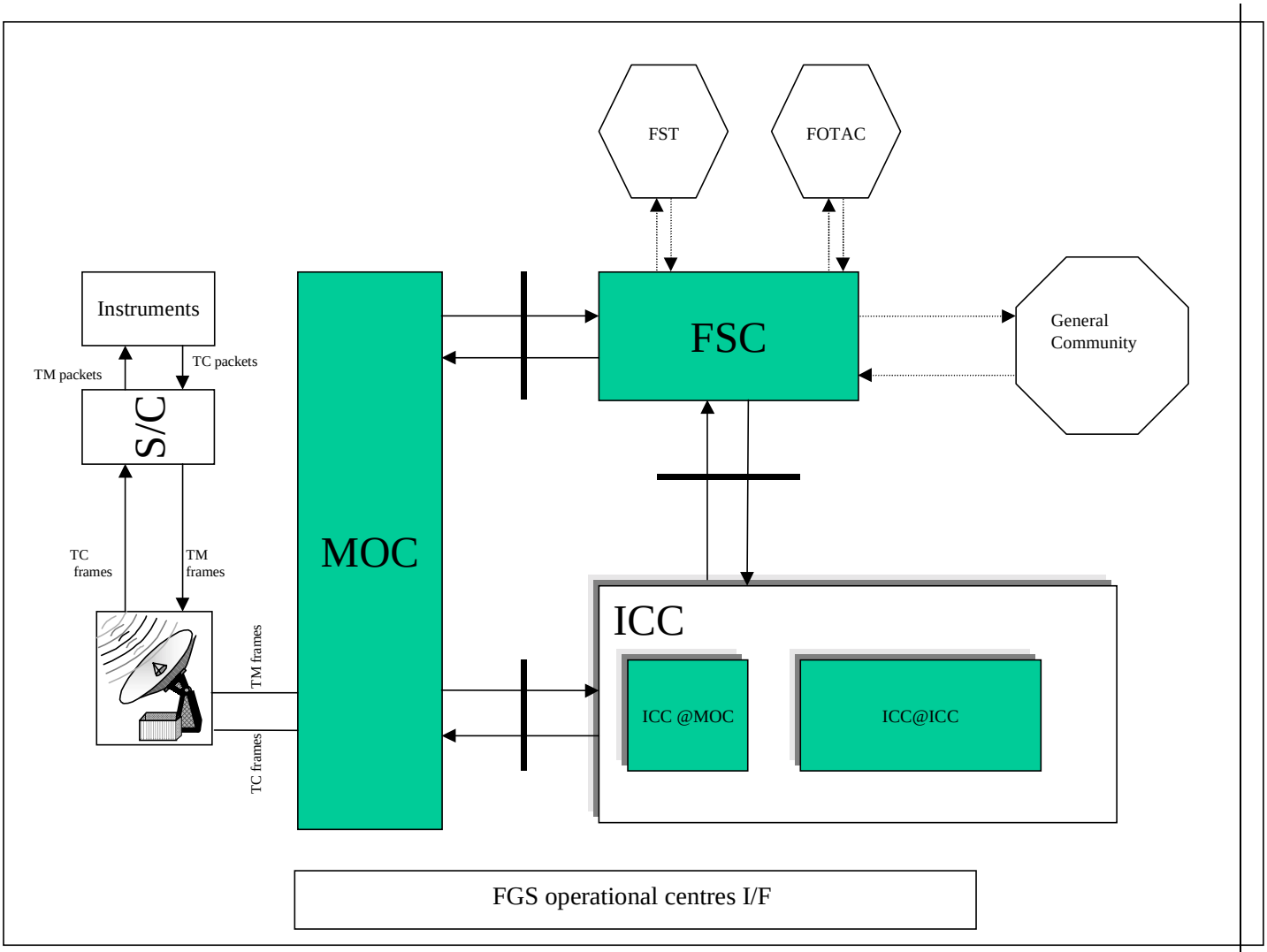
~~During LEOP, the FIRST science ground segment will be in "listening" mode only.~~

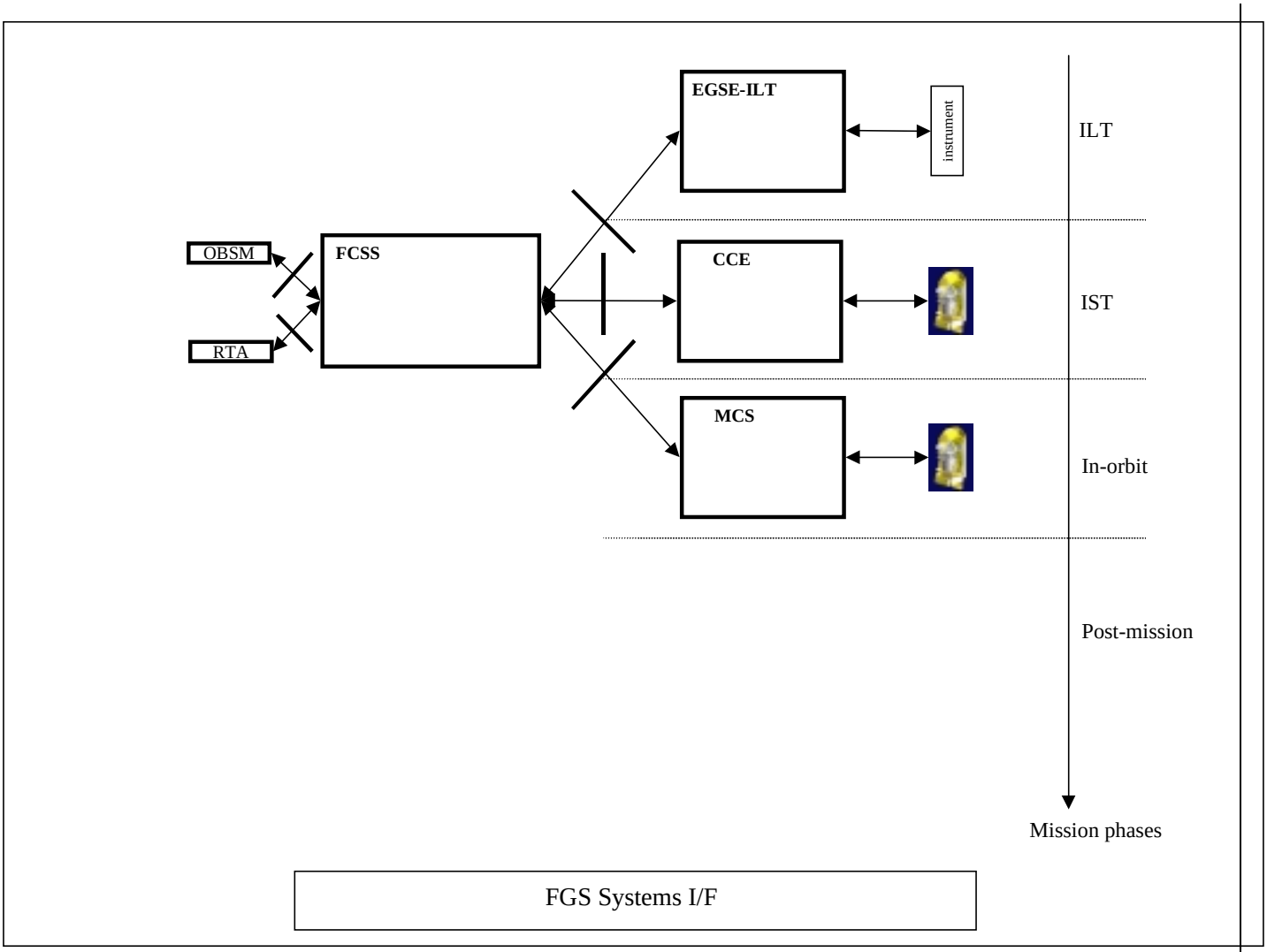
The Ground System Tests are not further addressed in this document, it is not expected to yield any new requirements with respect to the in-orbit phase.

The During LEOP, the FIRST science ground segment will be in "listening" mode only.~~This document does not cover the instruments or S/C testing phases (e.g. ILT or IST). FSC and MOC are not in the loop during these phases.~~

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 FIRST GS. These requirements can be added at a later stage if needed.

The two following figures illustrate~~s~~ the interfaces covered by this IRD. These interfaces are marked with


FST
FOTAC
Instruments
TM packets
TC packets
S/C
FSC
General
Community
MOC
TC
frames
TM
frames
TM frames
TC frames
ICC
ICC @MOC
ICC@ICC
FGS operational centres I/F



In in-orbit phase, the MCS will support the MOC operation and the FCSS will support the FSC and ICCs operation.

1.3 Structure of the document

The core of this document is are sections 3 & 4. The section 3, which defines all the interface requirements between the FIRST GS centres and systems for the in-orbit and post operation phases and the section 4 defines the interface requirements between the FIRST GS systems during ILT and IST.
In in-orbit phase, as mentioned above, the MCS will support the MOC operation and the FCSS will support the FSC and ICCs operation. The interfaces between the FCSS and the MCS are then the same as the ones between the MOC and the FSC or ICCs and are therefore not specifically addressed.

. It The section 3 & 4 is are structured at the highest level around at the highest level along the main interfaces between the MOC the FSC and the ICCscentres or systems.

Each main high levelinterface section is then divided up into as many subsections (information subsection) as there are types of information exchanged with the other centres of the FIRST GSas 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)

The Section section 2 of this document gives an overview of the information flow between the different FIRST GS centres and systems based on the FIRST operation scenario document [RD-1] and .

Section 4 of the document identifies for which test and operational phases the interface requirements are applicable.

1.4 Definitions, acronyms & abbreviations

1.4.1.1 Acronyms and abbreviations

AOT	**A**stronomical **O**bservation **T**emplate
APID	**A**pplication **P**rocess **ID**
DTCP	**D**aily **T**ele**C**ommunication **P**eriod
EGSE	Electrical Ground Support Equipment
FCSS	FIRST Common Science System
FINDAS	**F**IRST **I**ntegrated **N**etwork and **D**ata **A**rchive **S**ystem
FIRST	**F**ar **I**nfra**r**ed and **S**ubmillimetre **T**elescope
FOTAC	**F**IRST **O**bservation **T**ime **A**llocation **C**ommittee
FSC	**F**IRST **S**cience **C**entre
GS	**G**round **S**egment
HIFI	**H**eterodyne **I**nstrument for **FI**RST
HK or H/K	**H**ouse **K**eeping (data)
IA	**I**nteractive **A**nalysis
ICC	**I**nstrument **C**ontrol **C**entre
ICD	**I**nterface **C**ontrol **D**ocument
ILT	**I**nstrument **L**evel **T**est
IPAC (NASA/JPL)	**I**nfrared **P**rocessing and **A**nalysis **C**enter
IRD	**I**nterface **R**equirements **D**ocument
IST	Instrument Integrated **S**ystem **T**est
MCS	Mission Control System
MOC	**M**ission **O**perations **C**entre

N/A	**N**ot **a**pplicable
NRT	**N**ear **R**eal **T**ime
OBS or OBSW	**O**n-**b**oard **S**oftware
OBSM	On-board Software Maintenance
OD	**O**perational **D**ay
OOL	**O**ut **O**f **L**imit
PACS	**P**hotoconductor **A**rray Camera and Spectrometer
PCS	**P**ermanent **C**ommand **S**equence
PV	**P**erformance **V**erification
QLA	**Q**uick**L**ook **A**ssessment
RD	**R**eference **D**ocument
RT	**R**eal-**t**ime
RTA	**R**eal-**t**ime **A**ssessment
S/C	**S**pa**c**ecraft
S/W or SW	**S**oft**w**are
SIRD	**S**cience **I**mplementation **R**equirements **D**ocument
SPIRE	**S**pectral and **P**hotometric **I**maging **Re**ceiver
SSO	**S**olar **S**ystem **O**bject
SSR	**S**olid **S**tate **R**ecorder
TBC	**T**o **b**e **C**onfirmed
TBD	**T**o **b**e **D**etermined
TBW	To be Written
TC	**T**ele**c**ommand
TM	**T**ele**m**etry
URD	**U**ser **R**equirements **D**ocument
VC	**V**irtual **C**hannel

1.4.1.2 Definitions

The definition of terms for the FIRST GS can be found in [RD-8] and accessed at -. http://astro.estec.esa.nl/FIRST/FINDAS/fscdt.html~~For readability purpose, a copy is attached in as an appendix to this document~~

1.5 References

1.5.1 APPLICABLE DOCUMENTS

[AD-1] FIRST Science management plan (SMP)

1.5.2 REFERENCE DOCUMENTS

[RD-1] FIRST Operation Scenario Document, issue 0.95
[RD-2] FIRST Science Operations Implementation Requirements Document (SIRD) (TBW)
[RD-3] Mission Implementation Requirements Document (MIRD) (TBW)

[RD-4] FIRST Operations Interface Requirements Document (OIRD) Draft 3, 24-09-1999
[RD-5] FSC System URD, FIRST/FSC/DOC/0115, issue 0.4, 17-03-2000
[RD-6] PACS ICC SW URD, issue 0.12, July 1, 1999, (PACS-KL-RD-001)
[RD-7] FIRST-PLANCK Packet Structure ICD, PP-IS-F-07527, draft 0, 22-02-20000
[RD-8] Glossary document, FIRST/FSC/DOC/0120, draft 0.7, 20-04-2000
[RD-9] FSC System SPMP, FIRST/FSC/DOC/0116, issue 1.0, 05-05-2000
[RD-10] FGS Design Document, FIRST/FSC/DOC/0146 draft 1, to be issued
[RD-11] Instrument Interface Document-Part A, SCI-PT-IIDA/ , ITT issue
[RD-12] HIFI Instrument Interface Document-Part B, SCI-PT-IIDB/HIFI-02125, ITT issue 1.0, 01-09-2000
[RD-13] PACS Instrument Interface Document-Part B, SCI-PT-IIDB/PACS-02126, ITT issue 1.0, 01-09-2000
[RD-14] SPIRE Instrument Interface Document-Part B, SCI-PT-IIDB/SPIRE-02124, ITT issue 1.0, 01-09-2000

1.5.3 MINUTES OF MEETINGS

[FGSSE#1] FIRST Ground Segment System Engineering Group meeting #1, FIRST/FSC/MOM/0097
[FGSSE#2] FIRST Ground Segment System Engineering Group meeting #2, FIRST/FSC/MOM/0101
[FGSSE#3] FIRST Ground Segment System Engineering Group meeting #3, FIRST/FSC/MOM/0104
[FGSSE#4] FIRST Ground Segment System Engineering Group meeting #4, FIRST/FSC/MOM/0107
[FGSSE#5] FIRST Ground Segment System Engineering Group meeting #5, FIRST/FSC/MOM/0129
[FGSSE#6] FIRST Ground Segment System Engineering Group meeting #5, FIRST/FSC/MOM/0132
[FGSSE#7] FIRST Ground Segment System Engineering Group meeting #5, FIRST/FSC/MOM/0142

[FGSSW#2] FIRST Ground Segment Workshop#2, Vilspa 13-15 October 1999

2 GENERAL DESCRIPTION

2.1 Assumptions

This document takes into consideration a number of high-level design assumptions in line with [RD-1].

1. During routine phase, the FIRST GS will only provide guaranteed high data rate communication links (e.g. >= 256 kbs) between the MOC and the FSC and between the FSC and the ICC@ICC.
   [Source: [RD-1] section 4]

2. RT commanding to the S/C can only be performed from the MOC
   [Source: [RD-1] section 4]

3. The MOC-FSC I/F is a non-RT interface.
   [Source: [RD-1] 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 FIRST GS are driven by the operational mandate of these centres as defined in [RD-1], section 4.3.

2.2.1 INFORMATION FLOW RELATED TO MOC

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

- Generating the commands to be uplinked to the satellite from the commanding requests originating from the FSC and ICCs and reporting to the FSC and ICCs on the satellite commanding. *[Source: [RD-1] section 4.3.3]*.
- Making the satellite TM data available to the FSC and ICCs (including ICC@MOC) *[Source: [RD-1] section 4.3.3 &5.7.8 & 5.7.9]*. The TM data flow is further discussed in section 2.2.4 of this document.
- Making the instrument and S/C databases reference available to the FSC and ICCs *[Source: [RD-1] section 4.3.3]*
- Making available SW and data to support instrument and S/C commanding requests by FSC and ICCs, e.g.:
  - S/C predicted orbit data *[Source: [RD-1] section 5.7.9]*.
  - S/C attitude constraints *[Source: [RD-1] section 5.3.1.1 & 5.3.1.3]*.
  - S/C slew time and path *[Source: [RD-1] section 5.3.1.3]*.
  - Observations scheduling constraints (planning skeleton) *[Source: [RD-1] section 5.3.1.1]*.
- Making available SW and ancillary data to support science and calibration data processing by the FSC and ICCs, e.g.:
  - S/C reconstituted orbit data *[Source: [RD-1] section 5.7.9]*.
  - S/C attitude history *[Source: [RD-1] section 5.7.9]*.
- Making available instrument safety information to support instrument operation by ICCs., e.g.:
  - Flagging satellite mal-functions or operational problems to the FSC and ICCs for them to take appropriate actions *[Source: [RD-1] section 4.3.3 & 5.5]*.

The MOC will make available TM data and ancillary data to the rest of the GS; it will not distribute them. *[Source: [RD-1] section 5.7.8]*.

2.2.2 INFORMATION FLOW RELATED TO THE FSC

The FSC is the single-point interface to the outside world for all FIRST observatory matters *[Source:[RD-1] section 4.3.1]*. As such, it acts as a single point of contact in particular for:

- the provision of information on the observatory
- observation proposal handling
- observation scheduling (referred in [RD-1] as scientific mission planning)
- observation products and observation quality control data generation
- provision of observatory related SW to the observatory users.

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

These overall FSC responsibilities lead to the following responsibilities in terms of interface vis-a-vis the ICCs and MOC:

- Receiving engineering and calibration observations and associated scheduling constraints from ICCs for inclusion in the scientific mission planning *[source [RD-1] 5.2.1]*.
- Delivering to MOC the observations schedule commanding requests for each scheduling period resulting from the scientific mission planning process *[Source [RD-1] 5.3.3]*.
- Retrieving from MOC TM and ancillary data for permanent storage and for making this data available to the ICC@ICC *[Source [RD-1] 5.7.10]*.
- Making engineering and calibration observational data available to the ICCs together with any observational data needed by ICCs for calibration purposes.
- Receiving from the ICCs and transmitting to the MOC (after PS approval) the instrument on-board SW memory updates *[Source [RD-1] 5.11.1]*.
- Receiving instrument and S/C information and SW from respectively ICCs and MOC which is of interest to the FIRST observatory users and making such information available to these users *[Source [RD-1] 4.3.1]*.

2.2.3 INFORMATION FLOWS RELATED TO ICCS

The ICCs are responsible for the successful operation of their instruments and for making possible the processing of TM into resulting data. This leads to the following responsibilities vis-à-vis the FSC and the MOC:

- Delivering instrument manuals to FSC and MOC *[Source [RD-1] 4.3.2]*
- Delivering instrument IA SW and documentation to FSC to be made available to astronomers
- Delivering instruments procedures and commands to MOC for commanding and monitoring of their instruments *[Source [RD-1] 4.3.2]*
- Delivering the instruments on-board SW update to MOC (via FSC) for uplink *[Source [RD-1] 4.3.2 & 5.11.1]*
- Delivering the instrument modes scientific validation status information to the FSC *[Source [FGSSE#4]]*
- Delivering instruments engineering observations to the FSC *[Source [RD-1] 5.2]*
- Delivering instruments calibration observations to the FSC *[Source [RD-1] 5.2]*
- Delivering to the FSC available science observation quality data. *[Source [RD-1] 4.3.2]*. Not all the ICCs commit to perform systematic quality control of observations.
- Delivering to the MOC (via FSC) instrument data base updates
- Delivering instrument specific SW and data updates to support proposal handling and scientific mission planning at the FSC; this includes:
  - Instrument observation time estimator SW and data (including calibration data) *[Source [RD-1] 4.3.2]*
  - Commanding requests generation SW *[Source [RD-1] 4.3.2]*

- Delivering instrument specific SW and data (including calibration data) updates to support data processing and evaluation at the FSC *[Source [RD-1] 4.3.2]*
- Delivering instrument simulator SW *[Source [RD-1] 4.3.2]*

2.2.4 TM DATA FLOW

The ground coverage of the S/C will be limited to a few hours per operational day (nominally 3 hours in routine phase). At all times, the S/C will record on board on a mass memory all the S/C and instruments TM. The recorded TM of the last operational day will be downloaded during the period of ground coverage. During this period, the S/C will also transmit live the S/C and instruments TM.
[Source: [RD-1] section 3.4.3]

Consequently, the S/C will transmit during a given DTCP to MOC (via the Ground Station) four different TM data flows summarised in the following table:

Live HK TM	HK TM generated during the DTCP and downloaded live
Live Science TM	Science TM generated during the DTCP and downloaded live
Dump HK TM	HK TM generated during the previous OD and downloaded during DTCP
Dump Science TM	Science TM generated during the previous OD and downloaded during DTCP

The MOC will make available the TM received from the Ground Station in NRT (i.e. with a delay limited to the time needed by MOC to relay a TM packet) and later in a consolidated form. *[Source: [RD-1] 5.7.8]*

The consolidation of TM takes place over a period of time. Consolidated TM data will be guaranteed by MOC to be:
- Complete and transmission error free over the consolidation period (to the extent that the TM data have been successfully received on ground, i.e. data lost in the space/ground link will not be recovered),
- (On–board generation) time ordered.

For all instrument calibration that can be carried out off-line and for science activities, the ICCs will normally work from consolidated TM. The FSC is expected to work exclusively from consolidated TM *[Source: [RD-1] 5.7.10]*.

For instrument operation purposes, the ICCs will be interested in monitoring the live TM of their own instruments in NRT during certain phases of the mission (commissioning) or following emergencies *[Source: [RD-1] 5.7.11]*.
For NRT TM monitoring to make sense, it should be associated with the possibility for the ICCs to command their instruments in RT, i.e. during the period of ground coverage. RT commanding of an

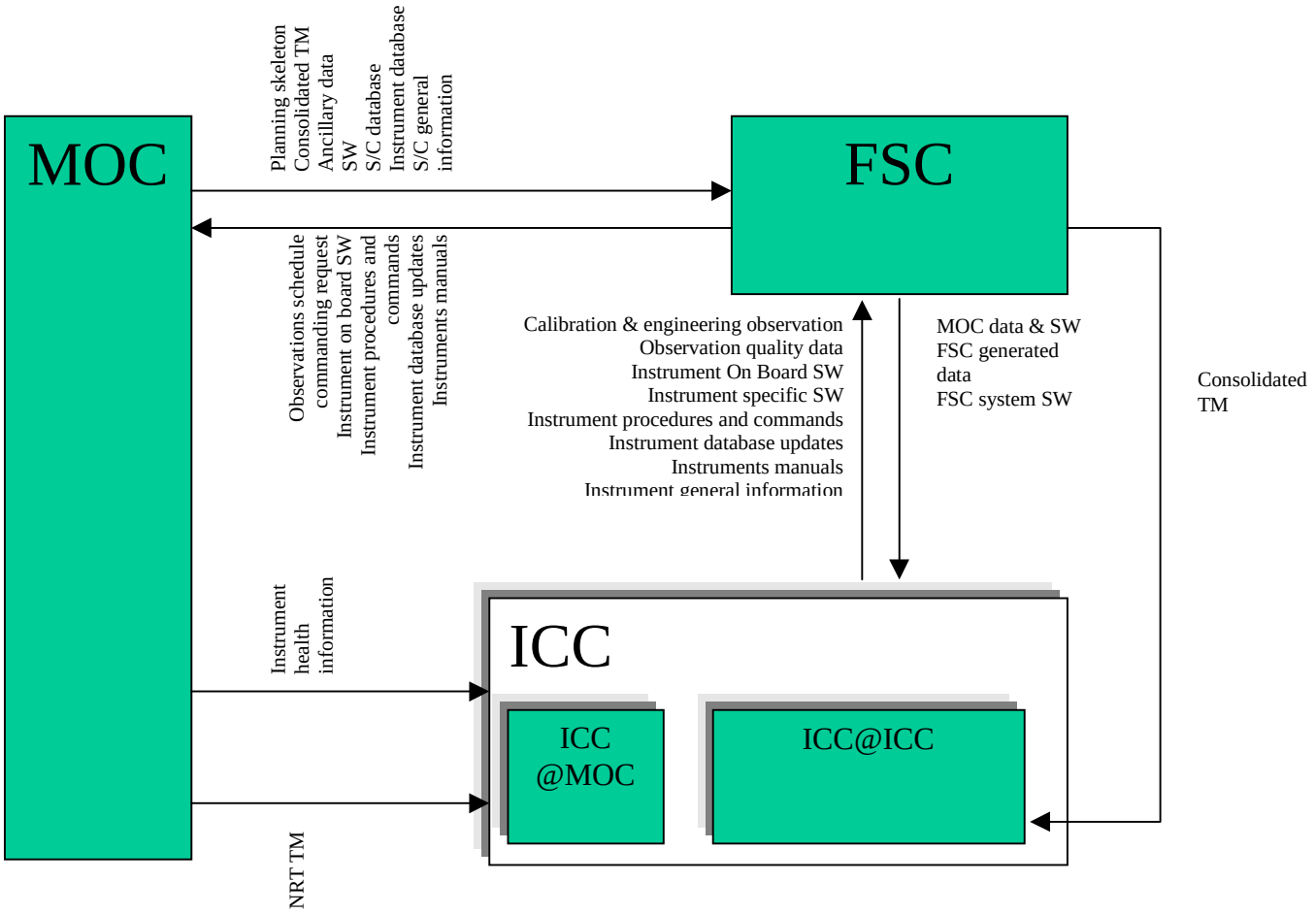
instrument will only be possible from the MOC mission control system *[Source: [RD-1] 4.3.3]* which leads to having the ICCs RT operations located at the MOC (ICC@MOC).

Consequently, the following types of TM data flow originating from MOC need to be considered:

Near Real Time (NRT) TM data flow	TM distributed as is and as soon as received by MOC. It includes both live TM (HK and science) and dump TM (HK and science).
Consolidated TM data flow	TM made available after consolidation over a period of time. S/C HK, instruments HK and science can be consolidated separately.

2.2.5 INFORMATION FLOW BETWEEN CENTERS SUMMARY

The following diagram summarises the discussion on the information flow between the different FIRST GS centres:



3

2.2.6 INFORMATION FLOW IN ILT AND IST

This section introduces the information flow between the FGS systems in ILT and IST. In ILT and IST, respectively the EGSE-ILT and the CCE 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 CCE can be seen to a large extent as a subset of the interfaces between the MOC and the FSC or ICCs during operation, see also the concept of smooth transition in [RD-10].

In essence, in ILT and IST, the FCSS will generate a test schedule which will be passed over to the EGSE-ILT or CCE for execution on board the instrument or by the test environment. The FCSS will then retrieve the resulting TM for analysis and storage. As in in-orbit phase, the test schedule will be built as a sequence of observations.

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

3.1 *MOC to FSC interfaces*

3.1.1 CONSOLIDATED TM

3.1.1.1 Information flow requirements

FGS-IR-3.1-10 The MOC shall make available all S/C and instrument TM data to the FSC.

[Source: [RD-1] section 5.7.10]
Important: In operations, TM packets lost during space-ground transmission will not be recovered.

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

[Source: [RD-1] section 5.7.10 & FGSSE#1]

FGS-IR-3.1-30 The MOC shall make available TM data (S/C and instruments) to the FSC in a format from which the source TM packets generated on board can be extracted.

[Source: [RD-1] section 5.8 & FGSSE#1]
The MOC is not processing the scientific TM packets [Source:[RD-4]]. Therefore the science TM data and by extension all instrument HK TM 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 It shall be possible for the FSC to detect missing consolidated TM data.

TM data lost during the space-ground transmission will be missing in the consolidated archive. This may lead to having several APIDs per instrument, see [FGSSE#1].
Note: This requirement is not to be implemented by the MOC but by the satellite. It is therefore expected (TBC) that Project will forward this requirement onto the satellite via the PS ICD [RD-6].

FGS-IR-3.1-50 The instrument and spacecraft TM data shall include the necessary information for the FSC to be able to associate, when relevant, each TM data to the context of an observation.

For this purpose, all instrument TM packets should be tagged on board with the current observation id. The S/C TM data could be related to an observation via on board time tags [Source: FGSSE#2].

Note: This requirement is not to be implemented by the MOC but by the satellite. It is therefore expected (TBC) that MOC will forward this requirement onto the satellite via the OIRD [RD-4]. [Source [FGSSE#4]].

FGS-IR-3.1-60 The instrument and spacecraft TM data shall include the necessary information for the FSC to be able to associate, when relevant, each TM data to the context of an observation measurement.

[Source: FGSSE#2]
Note: This requirement is not to be implemented by the MOC but by the satellite. It is therefore expected (TBC) that MOC will forward this requirement onto the satellite via the OIRD [RD-4]. [Source [FGSSE#4]].

FGS-IR-3.1-70 The instrument and spacecraft TM data shall include the necessary information for the FSC to be able to detect when TM data have been generated outside the context of an observation.

TM may be generated following manual commanding of satellite from the MOC.

3.1.1.2 *Control flow requirements*

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

- Event TM data per APID
- TC verification data per APID
- HK TM data per APID
- science TM data per APID
- S/C TM data

[Source: [RD-1] 5.7.10]
This should allow the early retrieval of consolidated event, verification and HK TM data that represents a small proportion of the overall TM data.
[Source: [RD-1] 5.7.8]

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

FGS-IR-3.1-100 The FSC shall pull consolidated TM data from the MOC.

[Source: [RD-1] 5.7.8]

3.1.1.3 Performance requirements

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

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

3.1.2 S/C ORBIT PREDICTOR SW & DATA

3.1.2.1 Information flow requirements

FGS-IR-3.1-120 The MOC shall make available the S/C orbit predictor SW & data updates to the FSC.

[Source: [RD-1] 5.7.9]
The FSC will use this SW & data in scientific mission planning to assess the relative velocity of the S/C 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.

3.1.2.2 Control flow requirements

FGS-IR-3.1-130 The MOC shall notify the FSC of the availability of S/C orbit SW & data updates for a given operational period (TBC).

FGS-IR-3.1-140 The FSC shall pull S/C orbit SW & data updates from the MOC.

3.1.2.3 Performance requirements

TBW

3.1.3 S/C ATTITUDE CONSTRAINT SW & DATA

3.1.3.1 Information flow requirements

FGS-IR-3.1-150 The MOC shall make available to the FSC the S/C attitude constraints SW and data updates.

[Source: [RD-1] 5.3.1.1 & 5.3.1.3]
The FSC will use this SW & data to check that an observation, when scheduled to be performed at a given absolute time, does not violate the S/C attitude constraints. The S/C attitude constraints can be due to astronomical constraints (e.g. solar aspect angle) or to

S/C engineering constraints (e.g. pointing of high gain antenna to earth during space-ground communication).

3.1.3.2 *Control flow requirements*

FGS-IR-3.1-160 The MOC shall notify the FSC of the availability of S/C attitude constraint SW & data updates for a given operational period (TBC).

FGS-IR-3.1-170 The FSC shall pull S/C attitude SW & data updates from the MOC.

3.1.3.3 Performance requirements

TBW

3.1.4 S/C SLEW TIME AND PATH PREDICTOR SW & DATA

3.1.4.1 Information flow requirements

FGS-IR-3.1-180 The MOC shall make available to the FSC the S/C slew time and path predictor SW and data updates.

[Source: [RD-1] 5.3.1.4]
The FSC will use this SW & data in scientific mission planning to predict slew durations and to check that the slew path is compatible with the S/C attitude constraints.

3.1.4.2 *Control flow requirements*

FGS-IR-3.1-190 The MOC shall notify the FSC of the availability of S/C slew time and path predictor SW & data updates (TBC).

FGS-IR-3.1-200 The FSC shall pull S/C slew time and path predictor SW & data updates from the MOC.

3.1.4.3 Performance requirements

TBW

3.1.5 PLANNING SKELETON DATA

3.1.5.1 Information flow requirements

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

[Source: [RD-1] section 5.3.1.1]
The FSC 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 MOC shall notify the FSC of the availability of a new planning skeleton for a given scheduling period (TBC).

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

3.1.5.3 Performance requirements

FGS-IR-3.1-240 During routine phase, the MOC shall make available to the FSC the last update of a planning skeleton for a given scheduling period not later than TBD days before the actual start of the scheduling period.

FGS-IR-3.1-250 During Commissioning & PV phase, the MOC shall make available to the FSC the last update of a planning skeleton for a given scheduling period not later than TBD days before the actual start of the scheduling period.

Faster turn-around is expected in Commissioning & PV phase (TBC).

3.1.6 OBSERVATIONS SCHEDULE STATUS INFORMATION

3.1.6.1 Information flow requirements

FGS-IR-3.1-260 The MOC shall make available to the FSC the observations schedule status information for any observations schedule received from the FSC.

[Source FGSSE#1]
The FSC will use the observations schedule status information to update the state of the observations belonging to the observations schedule (e.g. to move observations state to "executed"). See 1.4.1.2. for the definition of the state of an observation.

3.1.6.2 Control flow requirements

TBW

3.1.6.3 Performance requirements

TBW

3.1.7 COMMANDING TIMELINE SUMMARY

3.1.7.1 Information flow requirements

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

[Source FGSSE#1]
The commanding timeline summary will include the list of all TCs uplinked to the satellite for autonomous execution during this operational period.
The FSC will use this information to verify the translation by MOC of an observations schedule into the corresponding timeline and ICCs may use this information to help in diagnosing instrument mal-functions.

3.1.7.2 Control flow requirements

FGS-IR-3.1-280 The MOC shall notify the FSC of the availability of a new commanding timeline summary (TBC).

FGS-IR-3.1-290 The FSC shall pull the new commanding timeline summary from MOC.

3.1.7.3 Performance requirements

TBW

3.1.8 TC HISTORY

3.1.8.1 Information flow requirements

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

[Source FGSSE#1]

The TC history information will include the uplink and execution status of all the TCs uplinked for execution during the operational period. The TC history is made available to the ICCs in addition to the TC verification reports that are part of the instrument HK TM. The FSC is not using this information. It will make it available to the ICCs. An ICC will use the TC history for instrument command verification purpose.

FGS-IR-3.1-310 The TC history data shall include the necessary information for the FSC to be able to associate (when relevant) the TC to the instrument or S/C commanding requests in the corresponding observations schedule.

[Source FGSSE#4]

3.1.8.2 Control flow requirements

FGS-IR-3.1-320 The MOC shall notify the FSC of the availability of new TC history data for a given operational period (TBC).

FGS-IR-3.1-330 The FSC shall pull new TC history data from the MOC.

3.1.8.3 Performance requirements

FGS-IR-3.1-340 The MOC shall make available to the FSC the TC history for a given operational period at the same time as the consolidated HK TM for this period.

[Source: [FGSSE#4]]
See 3.1.1.3 for performance requirements on consolidated HK TM.

3.1.9 S/C ORBIT DATA (RECONSTITUTED)

3.1.9.1 Information flow requirements

FGS-IR-3.1-350 The MOC shall make available the S/C reconstituted orbit data to the FSC.

[Source: [RD-1] section 5.7.9]
The FSC 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 FSC of the availability of new S/C reconstituted orbit data for a given operational period (TBC).

FGS-IR-3.1-370 The FSC shall pull S/C reconstituted orbit data from the MOC.

3.1.9.3 Performance requirements

TBW

3.1.10 S/C ATTITUDE HISTORY

3.1.10.1 *Information flow requirements*

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

[Source: [RD-1] section 5.7.9]
The FSC and the ICCs will use this data for scientific data reduction and for calibration on top of the raw attitude data included in the S/C HK TM. The S/C attitude history will allow to reconstitute the pointing of the S/C at any given time of the operational period (including slew and SSO tracking periods).
The FSC and the ICCs will have to reconstruct instrument pointing from the S/C attitude data and instrument misalignment against the S/C pointing reference (e.g. STR).

3.1.10.2 Control flow requirements

FGS-IR-3.1-390 The MOC shall notify the FSC of the availability of new attitude history data for a given operational period (TBC).

FGS-IR-3.1-400 The FSC 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 (TBC) after the actual reception by the MOC of the related TM packets.

[Source: FGSSW#2]

3.1.11 TIME CORRELATION

3.1.11.1 Information flow requirements

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

[Source: FGSSE#1]

The FSC 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 S/C on board time with the UTC time.

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

3.1.11.2 Control flow requirements

TBW
It is expected that the time correlation data will come as part of the flow of consolidated TM [Source: [FGSSE#1]] as separate TM packets.

3.1.11.3 Performance requirements

FGS-IR-3.1-440 The MOC shall make available to the FSC the time correlation data for a given operational period at the same time as the S/C consolidated HK TM for this period.

[Source: [FGSSE#4]
See 3.1.1.3 for performance requirements on consolidated HK TM.

3.1.12 DERIVED PARAMETERS

3.1.12.1 Information flow requirements

FGS-IR-3.1-450 The MOC shall make available to the FSC the instruments derived parameters for a given operational period.

[Source: FGGSE#1]
The FSC may be using this data for the purpose of scientific data processing. It will also make it available to the ICCs. An ICC will use the values of the instruments derived parameters for monitoring their instruments.

3.1.12.2 Control flow requirements

TBW
It is expected that the derived parameters data will come together with the flow of consolidated TM [Source: [FGSSE#1]] as separate TM packets.

3.1.12.3 Performance requirements

FGS-IR-3.1-460 The MOC shall make available to the FSC the derived parameters data for a given operational period and instrument at the same time as the instrument consolidated HK TM for this period.

[Source: [FGSSE#1]]
See 3.1.1.3 for performance requirements on consolidated HK TM.

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.

[Source: FGGSE#1]
The FSC 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 & hard) for a given operational period.

3.1.13.2 Control flow requirements

TBW
It is expected that the OOL data will come together with the flow of consolidated TM [Source: [FGSSE#1]] as separate TM packets.

3.1.13.3 Performance requirements

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

[Source: [FGSSE#4]]
See 3.1.1.3 for performance requirements on consolidated HK TM.

3.1.14 INSTRUMENT MEMORY IMAGE

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

[Source: FGGSE#1]

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

3.1.14.1 Control flow requirements

TBW

3.1.14.2 Performance requirements

TBW

3.1.15 S/C AND INSTRUMENTS DATABASES

3.1.15.1 Information flow requirements

FGS-IR-3.1-500 The MOC shall make available to the FSC the S/C and instruments reference databases.

[Source: [RD-1] 4.3.3]
The MOC is responsible for maintaining the S/C and instruments reference databases for the FIRST GS. [Source: [FGSSE#1]].
The FSC will make the S/C and instrument reference databases available to the ICCs. Updates to the instruments reference databases originate from the ICCs and are forwarded by the FSC to the MOC.
The FSC and ICCs will use the S/C and instrument databases to decode the TM. It is not clear at this stage whether or not the FSC will use the S/C database.

3.1.15.2 Control flow requirements

TBW

3.1.15.3 Performance requirements

TBW

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 FSC the instruments (virtual) aperture misalignment reference data w.r.t. the S/C attitude reference.

[Source: FGSSE#4]

The MOC is responsible for maintaining the instruments apertures pointing misalignment reference data for the FIRST GS.
The FSC will make these reference data available to the ICCs.
Updates to these reference data originate from the ICCs and are forwarded by the FSC to the MOC.
The FSC and ICCs will use this data to reconstitute the instrument (aperture) pointing from the S/C pointing information delivered by MOC.

3.1.16.2 Control flow requirements

TBW

3.1.16.3 Performance requirements

TBW

3.1.17 SSO DATABASE

3.1.17.1 Information flow requirements

FGS-IR-3.1-520 The MOC shall make available to the FSC the SSO reference database (TBC).

[Source: [RD-1] 4.3.3]
The MOC is responsible for maintaining the SSO reference database for the FIRST GS.
The FSC will make the SSO reference database available to the ICCs.
Updates to the SSO reference database originate from the FSC.
The FSC and ICCs will use the SSO database to compute the celestial co-ordinates of SSOs.

3.1.17.2 Control flow requirements

TBW

3.1.17.3 Performance requirements

TBW

3.1.18 S/C GENERAL INFORMATION

3.1.18.1 Information flow requirements

FGS-IR-3.1-530 The MOC shall make available to the FSC the S/C information of interest to the FIRST observers.

[Source: [RD-1] 4.3.1]
E.g. S/C pointing accuracy
The FSC will post this information for FIRST observers to consult.

3.1.18.2 Control flow requirements

TBW

3.1.18.3 Performance requirements

N/A

3.1.19 INSTRUMENTS MAL-FUNCTIONS OR OPERATION PROBLEMS INFORMATION

3.1.19.1 Information flow requirements

FGS-IR-3.1-540 The MOC shall make available to the FSC the mal-functions or operation problems information related to the instruments.

[Source: [RD-1] 4.3.3 & 5.5]

3.1.19.2 Control flow requirements

TBW

3.1.19.3 Performance requirements

TBW

3.2 MOC to ICC interfaces

3.2.1 INSTRUMENTS MAL-FUNCTIONS 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 mal-functions or operation problems information related to their instruments.

[Source: [RD-1] 4.3.3 & 5.5]

3.2.1.2 Control flow requirements

TBW

3.2.1.3 Performance requirements

TBW

3.2.2 TELEMETRY IN COMMISSIONING AND FOR EMERGENCIES

3.2.2.1 Information flow requirements

FGS-IR-3.2-20 The ICC@ICC shall have available their instrument TM in NRT during the commissioning phase and for instrument emergencies.

[Source: created]
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 TM data to be available at nearly the same time as ICC@MOC.

FGS-IR-3.2-30 The MOC shall make available the TM data to the ICC@ICC in a format from which the source TM packets generated on board can be extracted.

3.2.2.2 Control flow requirements

TBW
It is expected that the NRT TM 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.
[Source: [FGSSE#5]]

3.2.2.3 Performance requirements

FGS-IR-3.2-40 During the commissioning phase and for instrument emergencies, the ICC@ICC shall have its instrument TM packets available not later than 20 minutes after the TM packet has been received by MOC.

[Source: FGSSE#2].

3.3 MOC to ICC@MOC interfaces

In addition to TM data (see below), ICC@MOC could also require access to ancillary data from MOC (TBC). This can only be confirmed after the role of ICC@MOC has been further detailed for each ICC [Source: [FGSSE#4]].

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 TM in NRT during the commissioning phase and for instrument emergencies.

[Source: [RD-1] 4.3.3]

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

3.3.1.2 Control flow requirements

FGS-IR-3.3-30 The ICC@MOC shall pull TM data from the MOC.

[Source: [RD-1] section 5.7.8]

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 TM not later than 1 minute after the TM packet has been received by MOC.

[Source: FGSSE#2].

3.4 FSC to MOC interfaces

3.4.1 OBSERVATIONS SCHEDULE

3.4.1.1 Information flow requirements

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

[Source: [RD-1] 5.3.3]
The observations schedule exported to the MOC will include the sequence of UTC time tagged S/C and instrument commanding requests for this schedule.
Instrument commanding is expected to be in the form of TC mnemonics that will have a one to one translation with instrument TC packets (TBC). [Source: [FGSSE#5]].
The MOC will use the observations schedule to generate the commanding timeline to be uplinked to the satellite for the given scheduling period.

FGS-IR-3.4-20 An observations schedule made available to the MOC by the FSC shall not include instrument or S/C commands implementing hazardous functions.

[Source: [RD-4]
Hazardous functions are those which, when executed at the incorrect time, could cause mission degradation or damage to on-board equipment.

FGS-IR-3.4-30 An observations schedule made available to the MOC by the FSC shall be compatible with the S/C operational and design constraints.

[Source: [RD-1] 5.3.13]
E.g. the observations schedule shall be compatible with:
- *the observation windows as defined in the planning skeleton*
- *the S/C attitude constraints (e.g. the ones linked to DTCP)*
- *the commanding rate between the S/C DHSS and the instruments*
- *the amount of data which can be uplinked by MOC during a DTCP*
- *the amount of instrument TM which can be stored on board between two consecutive DTCPs.*

3.4.1.2 Control flow requirements

FGS-IR-3.4-40 The FSC shall notify the MOC of the availability of a new observations schedule.

FGS-IR-3.4-50 The MOC shall pull observations schedules from the FSC.

3.4.1.3 Performance requirements

FGS-IR-3.4-60 During commissioning and PV phase, the FSC shall make available the observations schedule to MOC at least TBD hours before its uplink to the S/C.

FGS-IR-3.4-70 During routine phase, the FSC shall make available the observations schedule to MOC at least TBD days before its uplink to the S/C.

3.4.2 INSTRUMENT ON BOARD SW UPDATES

3.4.2.1 Information flow requirements

FGS-IR-3.4-80 The FSC shall make available to the MOC instrument on board SW updates.

[Source: [RD-1] 5.11.1]
The FSC will receive the on board SW memory update from the ICCs for approval before the FSC passes it over to MOC for uplink.
It is expected that the entire memory image is to be delivered to MOC for each on board SW update. It will then be up to MOC to define the part of the image to be uplinked
[Source: FGSSE#3]

3.4.2.2 Control flow requirements

FGS-IR-3.4-90 The FSC shall notify the MOC of the availability of an instrument on board SW update to be uplinked.

FGS-IR-3.4-100 The MOC shall pull on board SW memory updates from the FSC.

3.4.2.3 Performance requirements

TBW

3.4.3 SSO DATABASE UPDATES

3.4.3.1 Information flow requirements

FGS-IR-3.4-110 The FSC shall make available to the MOC SSO database updates (TBC).

[Source: [RD-1] 4.3.3]

The requests for new SSOs (leading to SSO database updates) will come from observers or ICCs via the FSC.
The MOC is responsible for maintaining the SSO reference database reference for the FIRST GS. (TBC)

3.4.3.2 Control flow requirements

TBW

3.4.3.3 Performance requirements

TBW

3.4.4 INSTRUMENTS DATABASE UPDATES

3.4.4.1 Information flow requirements

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

[Source: [RD-1] 4.3.3]
Instruments database updates originate from the ICCs and are forwarded by the FSC to the MOC.
The MOC is responsible for maintaining the instruments reference databases for the FIRST GS.

3.4.4.2 Control flow requirements

TBW

3.4.4.3 Performance requirements

TBW

3.4.5 INSTRUMENTS PROCEDURES AND COMMAND SEQUENCES UPDATES

3.4.5.1 Information flow requirements

FGS-IR-3.4-130 The FSC shall make available to the MOC the instrument procedures and command sequences updates.

[Source: [RD-1] 4.3.2]
Command sequences in this context are also referred to as PCS.

Instruments procedures and command sequences originate from the ICCs and are forwarded by the FSC to the MOC.
MOC will use the instrument procedures and command sequences in manual commanding of the instruments.

3.4.5.2 Control flow requirements

TBW

3.4.5.3 Performance requirements

TBW

3.4.6 INSTRUMENT APERTURES POINTING MISALIGNEMENT UPDATES

3.4.6.1 Information flow requirements

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

[Source: FGSSE#4]
Misalignment data originate from the ICCs and are forwarded by the FSC to the MOC. The MOC is responsible for maintaining the misalignment data reference for the overall FIRST GS.

3.4.6.2 Control flow requirements

TBW

3.4.6.3 Performance requirements

TBW

3.5 FSC to ICC interfaces

The ICCs and FSC are expected to have a common data repository, see [RD-1] 4.2.2. In this context, the FSC should make available most of its data and SW to the ICCs. Data in the FSC data repository include the data generated at the FSC (e.g. proposal, observation, schedule data) and data imported from MOC (TM and ancillary data). This section differentiates between these data as they are expected to be associated with different control flow and performance requirements.

3.5.1 CONSOLIDATED TM DATA

3.5.1.1 Information flow requirements

FGS-IR-3.5-10 The FSC shall make available to the ICC@ICC all the S/C and instrument consolidated TM received from the MOC.

[Source: [RD-1] 5.7.10]
The ICC@MOC gets the TM directly from the MOC, see 3.3.1 above.

3.5.1.2 Control flow requirements

TBW
One possible scheme would be for the FSC to push to an ICC@ICC all the consolidated TM related to its instrument. The ICCs having to pull when needed the rest of the TM.

3.5.1.3 Performance requirements

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

Delay includes consolidation by MOC, physical transfer from MOC to FSC, ingestion into the FSC system and transfer from FSC to ICC.	HK TM	Science TM
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 TM 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 S/C to MOC transfer of science TM data is expected to take 16 hours (200 kbs link). Consequently, in routine phase, science TM data can be consolidated and retrieved by FSC on an OD basis (i.e. once every 24 hours).

In PV phase, the operation cycle (including: analysis of science TM 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 TM in NRT from ICC@MOC to cover NRT activities. Consolidated TM will be made available by the FSC in the same manner as during PV phase [Source [FGSSE#5]].

3.5.2 MOC SW & DATA

This section specifies ICC requirements on SW & data retrieval from FSC for SW & data originating from MOC, see 3.1 above (with the exception of TM that have been addressed above).

3.5.2.1 Information flow requirements

FGS-IR-3.5-30 The FSC shall make available to the ICCs the S/C orbit predictor SW & data updates received from the MOC.

FGS-IR-3.5-40 The FSC shall make available to the ICC@ICC the commanding timeline summary data received from the MOC (TBC).

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

FGS-IR-3.5-60 The FSC shall make available to the ICC@ICC the reconstituted S/C orbit data received from the MOC.

FGS-IR-3.5-70 The FSC shall make available to the ICC@ICC the S/C attitude history data received from the MOC.

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

FGS-IR-3.5-90 The FSC 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 FSC shall make available to the ICC@ICC the OOL information of their respective instrument received from the MOC.

FGS-IR-3.5-110 The FSC shall make available to the ICC@ICC the S/C & instruments reference databases received from the MOC.

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

FGS-IR-3.5-130 The FSC 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

TBW

3.5.2.3 Performance requirements

TBW

3.5.3 FSC GENERATED DATA

3.5.3.1 Information flow requirements

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

[Source: [RD-1] 4.2.2]
FSC generated data include proposal data, observation data (except TM) and schedule data.
Note that ICCs may not have the access right to all FSC generated data.

3.5.3.2 Control flow requirements

TBW

3.5.3.3 Performance requirements

TBW

3.5.4 FSC SYSTEM SW

3.5.4.1 Information flow requirements

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

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

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

[Source: [RD-1] 5.2.1]

3.5.4.2 Control flow requirements

TBW

3.5.4.3 Performance requirements

TBW

3.6 *ICC to MOC interfaces*

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

3.7 ICC to FSC interfaces

3.7.1 INSTRUMENT ON BOARD SW UPDATES

3.7.1.1 Information flow requirements

FGS-IR-3.7-10 The ICCs shall make available to the FSC instrument on board SW updates and associated information.

[Source: [RD-1] 4.3.2 & 5.11.1]
The FSC will receive the on board SW memory update from an ICC for approval by the PS before passing it over to MOC for uplink.
The on board SW update 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.
[Source: [FGSSE#4]]

3.7.1.2 Control flow requirements

FGS-IR-3.7-20 The ICCs shall notify the FSC of the availability of an instrument on board SW update to be validated.

FGS-IR-3.7-30 The FSC shall pull the on board SW memory update from the ICCs.

3.7.1.3 Performance requirements

TBW

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 FSC their information on the health of their instruments.

[Source: FGSSE#1]
After processing of their instrument TM 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 FSC.
The FSC 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).

3.7.2.2 Control flow requirements

TBW

3.7.2.3 Performance requirements

TBW

3.7.3 ENGINEERING AND CALIBRATION OBSERVATIONS & SCHEDULING CONSTRAINTS

3.7.3.1 Information flow requirements

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

[Source: [RD-1] 5.2.1]
The FSC 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 FSC the scheduling constraints information associated with engineering and calibration observations.

[Source: [RD-1] 5.2.1]

3.7.3.2 Control flow requirements

TBW

3.7.3.3 Performance requirements

TBW

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 FSC their instrument modes validation status.

[Source: [FGSSE#4]]
The FSC 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

TBW

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 FSC their information on quality of executed observation.

[Source: [RD-1] 4.3.2]
This shall allow feedback from ICCs to FSC (and beyond to observers) concerning observation quality information. [Source: FGSSE#1]. Note that not all ICCs commit to performing systematic quality control of observations.

3.7.5.2 Control flow requirements

TBW

3.7.5.3 Performance requirements

N/A

3.7.6 INSTRUMENT SPECIFIC SW & DATA

3.7.6.1 Information flow requirements

FGS-IR-3.7-90 The ICCs shall make available to the FSC their instrument simulator SW & data updates (TBC).

[Source: [RD-1] 4.3.2]
The FSC will use the instrument simulator SW to check instrument commanding requests resulting from observations schedules or to validate instrument on board SW updates (TBC) [Source [RD-1] 5.11.1].

FGS-IR-3.7-100 The ICCs shall make available to the FSC their instrument time estimator SW & data updates.

[Source: [RD-1] 4.3.2]
The FSC will use the instrument time estimator SW as part of the FSC proposal submission process and scientific mission planning.

FGS-IR-3.7-110 The ICCs shall make available to the FSC their instrument commanding SW & data updates.

[Source: [RD-1] 4.3.2]
The FSC will use the instrument commanding SW and data as part of the FSC scientific mission planning.

FGS-IR-3.7-120 The ICCs shall make available to the FSC their instrument observation data processing SW & data updates.

[Source: [RD-1] 4.3.2]
The FSC will use the instrument data processing SW and data updates as part of the FSC data processing and evaluation process (including quality control processing and observation product generation).
The FSC will also make available this SW to observers.

3.7.6.2 Control flow requirements

TBW

3.7.6.3 Performance

TBW

3.7.7 INSTRUMENT OBSERVER MANUALS & GENERAL INFORMATION

3.7.7.1 Information flow requirements

FGS-IR-3.7-130 The ICCs shall make available to the FSC their instrument observer manuals updates.

[Source: [RD-1] 4.3.2]

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

The FSC will post this information for FIRST observers to consult.

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

[Source: [RD-1] 4.3.2]
The FSC will post this information for FIRST observers to consult.

3.7.7.2 Control flow requirements

TBW

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 FSC their instruments database updates.

[Source: [RD-1] 4.3.3]
The FSC will not make direct use of the instruments database updates. The FSC will forward them to the MOC.

3.7.8.2 Control flow requirements

TBW

3.7.8.3 Performance requirements

TBW

3.7.9 INSTRUMENTS PROCEDURES AND COMMANDING SEQUENCES UPDATES

3.7.9.1 Information flow requirements

FGS-IR-3.7-170 The ICCs shall make available to the FSC the instrument procedures and command sequences updates necessary for the operation and monitoring of their instruments by MOC .

[Source: [RD-1] 4.3.2]
Command sequences in this context are also referred to as PCSs.
The FSC will not make use of the instrument procedures and command sequences. The FSC will forward them to MOC.

3.7.9.2 Control flow requirements

TBW

3.7.9.3 Performance requirements

TBW

3.7.10 INSTRUMENT APERTURES POINTING MISALIGNEMENT UPDATES

3.7.10.1 Information flow requirements

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

[Source: FGSSE#4]
The FSC will not directly use this data. The FSC will forward it to the MOC.

3.7.10.2 Control flow requirements

TBW

3.7.10.3 Performance requirements

TBW

3.7.11 INSTRUMENT MANUALS

3.7.11.1 Information flow requirements

FGS-IR-3.7-190 The ICCs shall make available to the FSC their instrument manuals updates.

[Source: [RD-1] 4.3.2]
The instrument manuals will describe the internal design of the instruments. It shall be available to the FSC for information.

3.7.11.2 Control flow requirements

TBW

3.7.11.3 Performance requirements

N/A

3.8 FCSS to RTA interfaces

3.8.1 TELEMETRY DURING OPERATIONS

3.8.1.1 Information flow requirements

FGS-IR-3.8-10 The FCSS shall make instrument (HK) telemetry available to RTA.

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

3.8.1.2 Control flow requirements

TBW

3.8.1.3 Performance requirements

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

With the current on board data rate for HK this would amount to about 40 kbits/second.

3.9 RTA to FCSS interfaces

TBW

3.10 FCSS to OBSM interfaces

TBW

3.11 OBSM to FCSS interfaces

TBW

4 INTERFACE REQUIREMENTS FOR ILT AND IST

4.1 FCSS to EGSE-ILT interfaces

For the interfaces between FCSS and EGSE-ILT the requirements as described under the corresponding FSC to MOC interfaces apply. They can be taken directly as is from the corresponding sections with MOC replaced by EGSE-ILT and FSC by FCSS:

- Instrument on board software updates - 3.4.2
- Instrument database updates - 3.4.4
- Instruments procedure and command sequence updates – 3.4.5
- Instrument apertures pointing misalignment updates - 3.4.6

4.1.1 SCHEDULE

4.1.1.1 Information flow requirements

FGS-IR-4.1-10 The FCSS shall make available to the EGSE-ILT the test schedule.

The test schedule exported to the EGSE-ILT will include the sequence of absolute or relative (TBD) time tagged instrument and test equipment commanding requests for this schedule.
Instrument commanding is expected to be in the form of TC mnemonics that will have a one to one translation with instrument TC packets (TBC). [Source: [FGSSE#5]].
The Test Control component of the EGSE-ILT will use the test schedule as the commanding timeline from which commands are sent to the instrument and test equipment.

FGS-IR-4.1-20 An observations schedule made available to the EGSE-ILT by the FCSS shall be compatible with the test operational and design constraints.

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

4.1.1.2 Control flow requirements

FGS-IR-4.1-30 The EGSE-ILT shall pull schedules data from the FCSS

4.1.1.3 Performance requirements

FGS-IR-4.1-40 During ILT it shall be possible to generate a new schedule within 0.1 seconds (TBC).

It is expected that during ILT the Test Control component will (automatically) request new schedules to be generated on the fly by directly calling FCSS functions to form a sequence out of the available (pre-defined) test observations.

FGS-IR-4.1-50 During ILT it shall be possible to pull a new schedule from FCSS to EGSE-ILT within 0.1 seconds (TBC).

Pulling a schedule should be a matter of selecting and copying it over. There should be no access constraints (the test controller should be allowed to get any schedule he/she wants) or applicability constraints (e.g. checking on time is not needed since often/always that will be adjusted by Test Control) that need to be checked.

4.2 EGSE-ILT to FCSS interfaces

For the interfaces between EGSE-ILT and FCSS all requirements described under the corresponding MOC to FSC interfaces apply. They can be taken directly as is from the corresponding sections with MOC replaced by EGSE-ILT and FSC by FCSS:

- Observation schedule status information (TBD)- 3.1.6
- Commanding timeline summary (TBD) - 3.1.7
- TC history - 3.1.8
- Time correlation - 3.1.11
- Instrument memory image - 3.1.14
- Instrument databases - 3.1.15

4.2.1 TELEMETRY

These interfaces correspond closely to the MOC to ICC@MOC interfaces (see section 3.3)

4.2.1.1 Information flow requirements

FGS-IR-4.2-10 The EGSE-ILT shall make available to the FCSS in real time all instrument and test equipment telemetry generated during tests.

FGS-IR-4.2-20 The EGSE-ILT shall make available the TM data to the FCSS in a format from which the source TM packets generated on board can be extracted.

4.2.1.2 Control flow requirements

FGS-IR-4.2-30 The FCSS shall accept TM data as a stream from the EGSE-ILT

4.2.1.3 Performance requirements

FGS-IR-4.2-40 During ILT the instrument TM shall be available in the FCSS no later than 0.1 seconds (TBD) after the EGSE-ILT has received it.

4.3 FCSS to RTA interfaces

4.3.1 TELEMETRY DURING ILT/IST

4.3.1.1 Information flow requirements

FGS-IR-4.3-10 The FCSS shall make instrument (HK) telemetry available to RTA.

FGS-IR-4.3-20 The FCSS shall make the telemetry available to the RTA system as source packets as provided by MOC.

4.3.1.2 Control flow requirements

TBW

4.3.1.3 Performance requirements

FGS-IR-4.3-30 During ILT the instrument telemetry shall arrive at the RTA system in within 0.1 seconds (TBD) from arriving in the FCSS.

This requirement explicitly only applies to ILT. The requirement follows from the fact that in ILT RTA has an important role in emulating the on-board autonomous functions. In that role RTA is part of a parameter monitoring and feedback loop that has a round trip timescale of less than a second. In IST the instruments are integrated with the satellite and then this feedback loop through RTA does not exist.

4.3.2 INSTRUMENT DATABASE UPDATES

4.3.2.1 Information flow requirements

FGS-IR-4.3-40 The FCSS shall make instrument data base updates available to RTA.

FGS-IR-4.3-50 Instrument data base updates shall be made available in the form appropriate for the RTA system (currently the SCOS 2000 MIB)

4.3.2.2 Control flow requirements

TBW

4.3.2.3 Performance requirements

N/A

4.4 RTA to FCSS interfaces

For the interfaces between RTA and FCSS the requirements as described under the corresponding MOC to FSC interfaces apply. They can be taken directly as is from the corresponding sections with MOC replaced by RTA and FSC by FCSS:

- Derived parameters - 3.1.12
- Out of limits information - 3.1.13

4.5 FCSS to OBSM

4.6 OBSM to FCSS

4.7 RTA to EGSE-ILT interfaces

4.7.1 RTA EVENT HANDLING

4.7.1.1 Information flow requirements

FGS-IR-4.7-10 RTA shall send event packets (TBD) to EGSE-ILT when HK data processing results call for procedures to be carried out by EGSE-ILT.

This facility will mimic the in-flight autonomy procedures. Examples of such events are

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

4.7.1.2 Control flow requirements

FGS-IR-4.7-20 RTA shall push the RTA event packets to EGSE-ILT.

FGS-IR-4.7-30 The EGSE-ILT shall never reject RTA event packets.

4.7.1.3 Performance requirements

FGS-IR-4.7-40 RTA event packets shall arrive at the EGSE-ILT within 0.1 seconds (TBD).

~~4INTERFACES REQUIREMENTS VERSUS OPERATIONAL PHASES~~

~~This section identifies for which test or operational phases the requirements identified in section 3 of this document have to be fulfilled.~~

4.8 FCSS to CCE interfaces (IST)

All information and dataflow from instrument group to CCE shall follow TBW requirements as given in the IID-A and IID-Bs (see [RD-11], [RD-12], [RD-13] & [RD-14]). It is expected (TBC) that there will be no direct FCSS to CCE interface during the relevant Integrated System Tests, all material (procedures, databases, others?) will have been delivered to Project through TBD channels.

To facilitate ingestion of the IST telemetry into the FCSS (see below) a number of items to be delivered to the CCE (according to the specifications mentioned above) may have to be generated within the FCSS.

4.9 CCE to FCSS interfaces (IST)

For the interfaces between CCE and FCSS the requirements as described under the corresponding MOC to FSC interfaces apply. They can be taken directly as is from the corresponding sections with MOC replaced by CCE and FSC by FCSS:

- Observation schedule status information (TBD) - 3.1.6
- Commanding timeline summary (TBD) - 3.1.7
- TC history - 3.1.8
- Time correlation - 3.1.11
- Derived parameters - 3.1.12
- Out of limits information - 3.1.13
- Instrument memory image - 3.1.14
- S/C and instrument databases - 3.1.15
- S/C general information - 3.1.18
- Instruments mal-functions or operation problem information (TBC) - 3.1.19

4.9.1 TELEMETRY

These interfaces correspond closely to the MOC to ICC@MOC interfaces (see section 3.3)

4.9.1.1 Information flow requirements

FGS-IR-4.9-10 The CCE shall make available to the FCSS all satellite, instrument and test equipment telemetry generated during tests.

FGS-IR-4.9-20 The CCE shall make available the TM data to the FCSS in a format from which the source TM packets generated on board or in the relevant test equipment can be extracted.

4.9.1.2 *Control flow requirements*

FGS-IR-4.9-30 The FCSS shall pull TM data from the CCE

4.9.1.3 *Performance requirements*

FGS-IR-4.9-40 During IST the instrument and test equipment TM shall be available to the FCSS no later than 10 (TBD) seconds after the CCE has received it.

APPENDIX A: GLOSSARY

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Intoduction

This document defines terminology specific to the problem domain (the FSC and its activities), explaining terms, which may be unfamiliar to the reader of the use-case descriptions or other FSCDT documents. Note: The tables have a column for synonyms. These synonyms are not to be used by the FSCDT. They are listed as they may be encountered in other, non FSCDT, documentation.

Definition of Terms