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FIRST GROUND SEGMENT

INTERFACE REQUIREMENTS DOCUMENT

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C H A N G E L O G

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1 INTRODUCTION

1.1 Objective

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

By operational interface, one should understand the information and control flow between the different centres of the FIRST GS necessary for each centre to fulfil its mandate as 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 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 requirements applicable to the information and associated control flow between the different centres of the FIRST GS and the performance of the systems and communication lines as far as this is directly related to this flow.

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 test and operational phases covered in this document are the following:

- Ground system tests (SVT/EE)
- Launch and early operations phase (LEOP)
- Commissioning phase (CP)
- Performance Verification phase (PV)
- Routine phase (Routine)

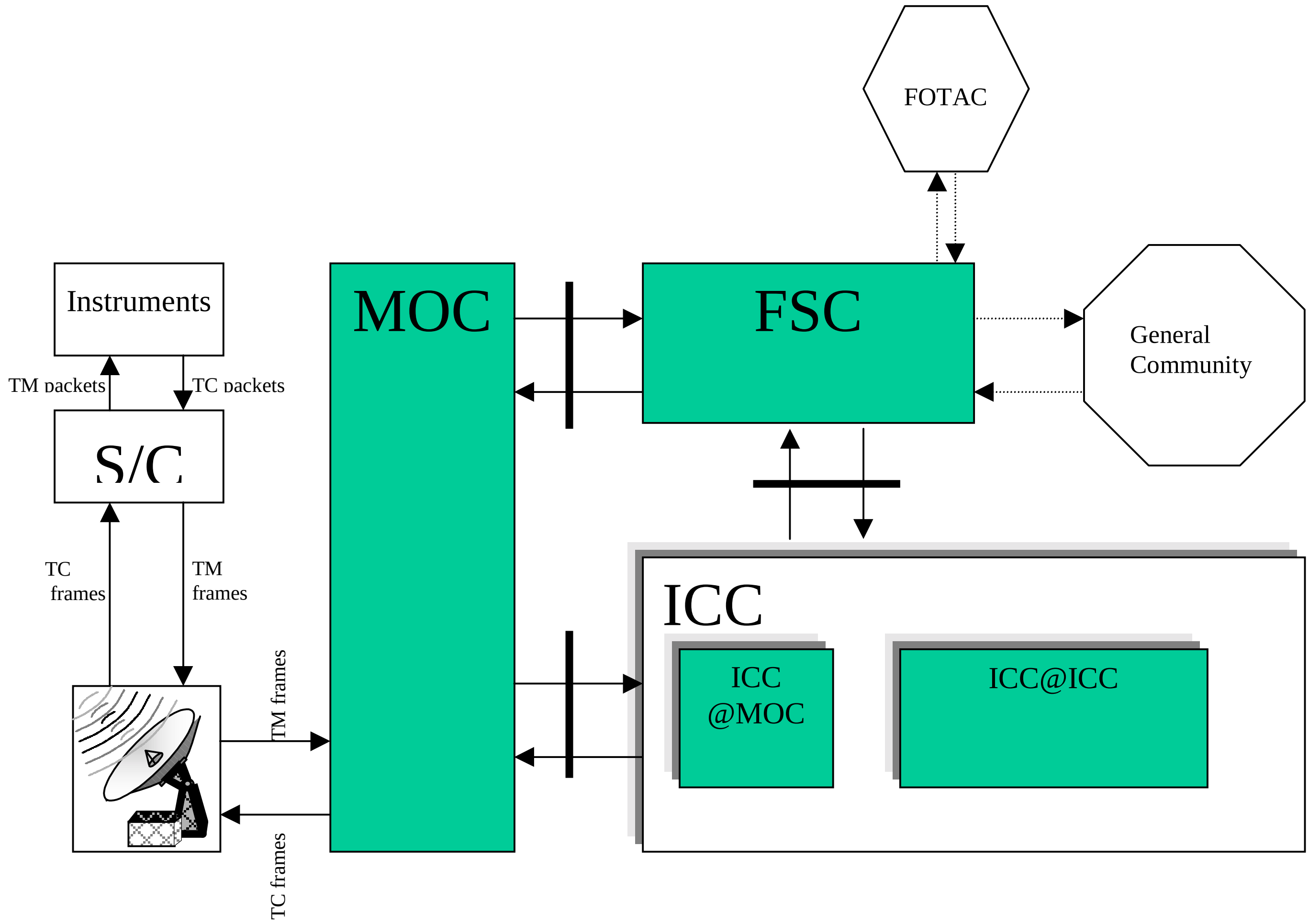
- Post-operational phase (Post-Ops) including:
  - Run-down phase
  - Mission consolidation phase
  - Active archive phase
  - Archive consolidation phase

During LEOP, the FIRST science ground segment will be in “listening” mode only.

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 following figure illustrates the interfaces covered by this IRD. These interfaces are marked with ▌



1.3 Structure of the document

The core of this document is section 3, which defines all the interface requirements between the FIRST GS centres. It is structured at the highest level around the main interfaces between the MOC the FSC and the ICCs.

Each high level section is divided up into as many subsections (information subsection) as there are types of information exchanged with the other centres of the FIRST GS.

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
- the performance associated with the exchange (when applicable)

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

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
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	**I**nstrument **S**ystem **T**est
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
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]. 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

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

[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]*.

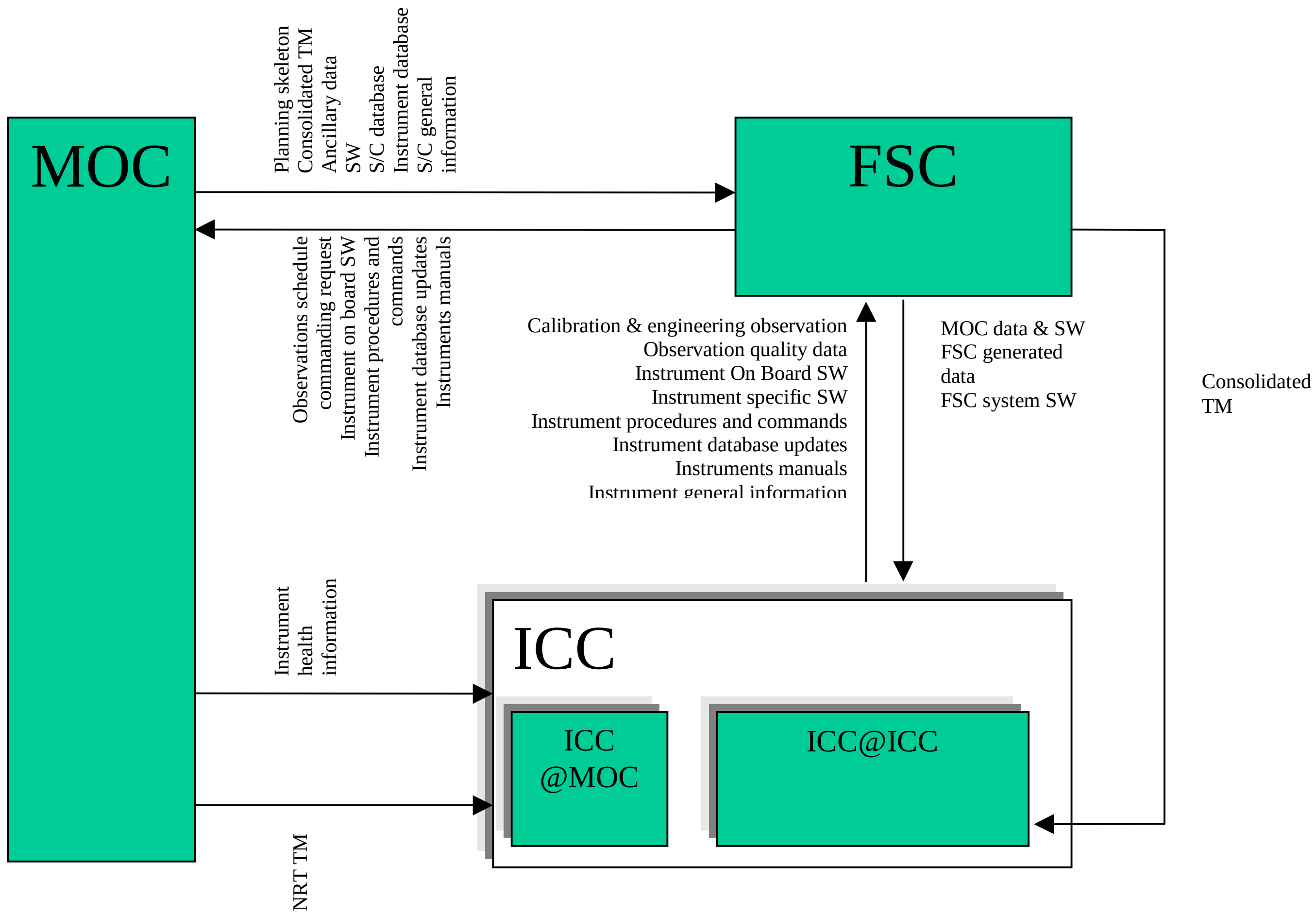
For instrument operation purposes, the ICCs will be interested in monitoring the live TM of their own instruments in NRT during certain phases of the mission (commissioning) or following emergencies *[Source: [RD-1] 5.7.11]*.
For NRT TM monitoring to make sense, it should be associated with the possibility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

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



3 INTERFACES REQUIREMENTS

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 MISALIGNMENT 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

4 INTERFACES 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.

Requirements or set of requirements from section 3	Ground System tests	LEOP	Commissioning phase	Performance Verification phase	Routine Phase	Post-operation
FGS-IR-3.1-nn (MOC to FSC)	yes	Yes (TBC)	yes	yes	yes	no
FGS-IR-3.2-nn (MOC to ICC)	no	Yes (TBC)	yes	yes (contingencies only	yes (contingencies only	no
FGS-IR-3.3-nn (MOC to ICC@MOC)	yes	yes	yes	Yes (contingencies only)	Yes (contingencies only)	no
FGS-IR-3.4-nn (FSC to MOC)	yes	no	yes	yes	yes	no
FGS-IR-3.5-nn (FSC to ICCs)	yes	no	yes	yes	yes	Yes/No (to be detailed)
FGS-IR-3.6-nn (ICCs to MOC)	no	no	no	no	no	no

FGS-IR-3.7.x.x.x (ICCs to FSC)	yes	no	yes	yes	yes	Yes/No (to be detailed)

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

Term	Description
Ancillary data	A generic term for all data originating from the MOC which has been derived from telemetry and/ or telecommands. This will/ may include: • Telecommand history • Spacecraft attitude ... • ...
Announcement of opportunity	Invitation to the astronomical community to submit proposals for open-time observations with FIRST. An AO has an opening date and a final deadline for the submission of the proposals to the FSCS.
Approved schedule	A draft schedule which has been approved as the actual schedule for a given scheduling period. Approved schedules must not overlap in the scheduling period they cover.
Archive user	An astronomer. A person who will use the FSCS to get information on the FIRST mission. Archive users can use this information to decide if they wish to become a FIRST proposer and to get public domain data resulting from FIRST observations as well as the tools to analyse this data.
Astronomer	Members of the astronomical community will use the FIRST ground segment in a variety of ways throughout all phases of the project. The astronomers are the 'raison d'etre' for FIRST. Astronomers will play the following roles: • Archive user. • Proposer.

	• Observer.
Astronomical community	The complete set of astronomers who might use the FSCS to get information on the FIRST mission.
Astronomical Observation Template	An AOT is a representation of an instrument observing mode to an observation requestor. An AOT is a template for an observation. There are many AOTs. They describe a generic observation. An AOT provides the mechanism through which an observation requestor can specify, by supplying values for the AOT parameters, the details of an observation they wish to have performed. An AOT based observation consists of a sequence (1 or more) of observation measurements (which can be seperated by slews). From a system perspective an AOT (more specifically the AOT identifier) and the parameters associated with it are used to generate a set (sequence) of functional units.
Auxiliary data	A generic term for all data, excluding observation telemetry data, which is needed to generate observation science data. This may include components of ancillary data.
Calibration data	Data which characterises the understanding of an instrument. This data is used to both configure the instruments for optimal performance and to obtain optimal science data products from the processing of the data they produce.
Calibration observation	A FIRST observation dedicated to the fulfillment of the calibration objectives expressed in the calibration plan. A calibration observation can be an observation of either a celestial target or an internal calibration source. It involves one or more of the instruments and may have the spacecraft configured to one of its observing modes for celestial targets but can be independent of the spacecraft observing mode for internal calibration sources. This observation type can be both AOT or non-AOT based.
Calibration plan	The calibration plan contains a description of all planned calibration activities and associated calibration sources (internal and astronomical) required to fully characterise each instrument. For every scheduling period the ICCs select and prioritise a set of observations based on their long term calibration plan.
Calibration status report	Relevant conclusions with respect to overall instrument calibration and health are added to the calibration status report which is periodically produced by each ICC.
Calibration/ performance verification phase	During the Cal/PV phase in-flight characterisation of all the instruments is obtained. A schedule of astronomical observations and (internal) calibrations is executed using normal observatory procedures. This schedule is based upon an agreed in-orbit calibration plan.
Call for guaranteed time proposals	Invitation to the people who qualify for guaranteed time to submit their proposals for observing time with FIRST. A call for guaranteed time proposals has an opening date and a final deadline for the submission of the proposals to the FSCS.
Call for key programme proposals	Invitation to the astronomical community to submit proposals for key programme observing time with FIRST. A call for key programme proposals has an opening date and a final deadline for the submission of the proposals to the FSCS.

Commanding request	A request, originating from the ICCs or the FSC, to the MOC to uplink telecommands to the spacecraft. A commanding request can be sent to the MOC in the context of manual commanding or automatic commanding (as part of a schedule).
Committable schedule	A daily schedule to which parallel and serendipity mode observations have been added, if applicable, so that it is suitable for export to the MOC.
Community support tools	Community support tools are used by the astronomical community. They are there to aid the astronomer. They are primarily proposal support tools but also include tools which allow the determination of statistics on data in the archive etc. TBC ????
Concatenated chain of observations	A sequence of observations is said to be concatenated if they cannot be scheduled independently. Observations in a concatenated chain have to be scheduled together in exactly the sequence specified by the proposer. The targets of a concatenated chain of observations must be located within an area of TBD degrees in diameter. The same AOT with different instrument settings or different targets may be concatenated as well as completely different AOTs.
Concatenated observation	An observation belonging to a concatenated chain of observations.
Consolidated telemetry	Telemetry made available after the consolidation process. Consolidated telemetry is made available on a time range basis. The alternative to consolidated telemetry is near real-time telemetry.
Consolidation period	The time interval from launch up to the time for which telemetry has been consolidated.
Consolidation process	The consolidation process ensures that, up to a given time, all telemetry (dump telemetry and live telemetry) downloaded to the Ground Station is complete (as received at the Ground Station) and made available in a time ordered manner.
Daily schedule	A timed sequence of schedulable units for a single operational day.
Daily telecommunications period	A time interval during the period of ground station visibility, during which telemetry is received from the spacecraft and telecommands are sent to the spacecraft.
Discretionary time	Discretionary time can be awarded to proposals made at any time (not in connection with an AO). It is limited to a maximum of 4% of open time and can only be awarded to proposers submitting proposals which could not have been foreseen at the time of an AO (see target of opportunity) .
Discretionary time proposal	A proposal submitted as a request for FIRST discretionary time. A proposal category.
Draft schedule	A candidate schedule for a given scheduling period. Several draft schedules may exist, covering overlapping scheduling periods and possibly containing the same schedulable units.
Dump telemetry	Telemetry downloaded from FIRST’s on-board mass memory during a DTCP. The alternative to dump telemetry is live telemetry.
Duration	The length of a time interval.
End-to-end tests	A pre-launch series of tests. They involve the MOC, the spacecraft, the ICCs and the FSC. The emphasis of end-to-end tests is on the scientific operability of the instruments

	and on validating the interfaces between the FSC, the MOC and the ICCs.
Engineering observation	A FIRST observation which will be dedicated to fulfilling certain instrument engineering objectives. An engineering observation has the specific intent of trouble-shooting a malfunction or interacting with a single instrument at a very low level. This observation type is not AOT based but consists of a one off sequence of instrument commands.
FIRST	Far InfraRed and Submillimetre Telescope. The fourth cornerstone in the ESA Horizon 2000 program, built by European industry under ESA leadership with contributions from NASA and national agencies.
FIRST ground segment	The FIRST ground segment consists of 5 main elements: The FIRST Science Centre, the Mission Operations Centre (MOC) and the 3 dedicated Instrument Control Centres (ICCs). In the future the (Caltech/ JPL) Infrared Processing and Analysis Center (IPAC) could become a sixth element. Note: There are many additional elements, such as the Ground Station, NCTRS, communication lines, etc.
Fixed-time observation	A fixed-time observation, in addition to satisfying the non-temporal constraints applicable to all observations, must be scheduled to start within a specified time interval (see observation time category).
FOTAC	The committee, appointed by the ESA Director of Science, that judges which submitted proposals are eligible for FIRST observing time. The FOTAC will review all categories of science proposal (open time, guaranteed time, key project time and discretionary time).
FSC	The First Science Centre (FSC) is the single-point interface to the outside world including not only the astronomical community but also the press and the general public. The FSC will be responsible for all observatory aspects of the FIRST mission. The FSC shall ensure that the scientific productivity and impact of the FIRST mission is maximised within the given constraints. For this task the FSC will be supported by the FIRST science team (FST) and the FIRST observing time allocation committee (FOTAC).
FSCDT	The FSC Development Team. Responsible for the development of the FSCS. It includes people, assets (hardware) and infrastructure as provided by ESTEC
FSCS	The FSC System. The system to be developed by the FSCDT, with specific contributions from the ICCs and MOC, to support for FIRST scientific operations.
Functional unit	All observations (AOT based and non-AOT based) consist of a sequence of functional units. A functional unit is defined as either: • a sequence of instrument procedures and instrument functions or, • a sequence of instrument commands. Observation measurements are predefined functional units which can be used to construct an observation.
Ground segment tests	Following the ISTs, a series of tests and simulations are undertaken. These are the ground segment tests and they include: • System validation tests • End-to-end tests • Testing different configurations of the FIRST ground segment elements during which a simulator replaces the satellite.

Guaranteed time	Scientists directly involved in the FIRST mission are awarded a certain fraction of the total observing time. The integrated total amount of guaranteed time over the whole mission is 32%.
Guaranteed time proposal	A proposal submitted in response to the call for guaranteed time proposals. Guaranteed time proposals may not duplicate key project time proposals. Observations proposed under guaranteed time are announced to the astronomical community during an AO as guaranteed time observations which may not be duplicated by open time observations. A proposal category.
ICC	Instrument Control Centre. There are 3 ICCs, one for each instrument. Each ICC will be responsible for enabling the operation of its instrument. This includes: • The provision of calibration and data reduction tools for all data generated. • The provision of instrument simulators • Contributing to the definition of the operational database • etc.
ILT mission phase	The instrument level tests (ILT) mission phase is the mission phase in which tests of the functional, environmental and scientific performance of the individual instrument models are performed. The instruments are characterised and the procedures and calibration parameters are established. ILTs are undertaken on PI premises.
ILT observation	An ILT observation is an observation associated with the ILT mission phase. It is a FIRST observation involving a single instrument only and with the observation corresponding to a sequence of 1 or more instrument functions. An ILT observation is **not** AOT based. It will identify a sequence of instrument commands. An observation type.
Instrument	FIRST has a complement of three science instruments; the Heterodyne Instrument for FIRST (HIFI), the Photoconductor Array Camera and Spectrometer (PACS) and the Spectral and Photometric Imaging Receiver (SPIRE). The term instrument can refer to any one of them.
Instrument aperture	An opening by which light falls on an instrument detector. An instrument can have more than one aperture and during an observation FIRST (or the instrument during on-ground testing) will be positioned such that light falls on the specified instrument aperture.
Instrument aperture pointing misalignment data	Data giving the pointing offset between an instrument aperture viewing direction and the spacecraft reference pointing direction. These data will be used by the MOC to generate the spacecraft AOCS pointing commands from an instrument aperture pointing request and by the FSC and ICCs to reconstitute an instrument aperture viewing direction from the spacecraft refererence pointing direction.
Instrument aperture viewing direction	
Instrument command	Individual instructions to an instrument. This is the lowest level of instrument commanding. Each instrument command will have a corresponding telecommand.
Instrument command sequence	A sequence of instrument commands.

Instrument database	The database including all the static and default information regarding the instrument command sequences, telecommands and telemetry. It is used in particular to derive instrument telecommands from instrument command sequences and to decode the instrument housekeeping telemetry and the headers of the instrument science telemetry.
Instrument function	An instrument function is a predefined sequence of steps that an instrument can perform. An instrument function is initiated by a single telecommand. There is no logic/ control flow associated with instrument functions. A functional unit can be defined as a sequence of instrument procedures and instrument functions.
Instrument health report	Feedback from an ICC to the FSC on the health of an instrument and its different observing modes. This information may influence the FSC scientific mission planning. For example, all observations using a faulty instrument observing mode will not be schedulable until recovery action has been taken.
Instrument housekeeping telemetry	Non-science instrument telemetry. This includes instrument events and anomaly reports, telecommand verification, memory dumps and instrument status information.
Instrument memory image	A copy of the contents of an instrument on-board memory.
Instrument mode	A predefined setup/ configuration of an instrument. A mode in which the instrument can be operated. This includes such modes as standby, sleep and off as well as the instrument observing modes that will be used when obtaining scientific data from the instrument.
Instrument observing mode	An instrument observing mode is an instrument mode dedicated to a specific type of observation. An observation requestor specifies an instrument observing mode via an AOT. As an example, for SPIRE there are the following instrument observing modes currently identified: photometer chop, photometer scan, SPIRE-PACS partner (TBC), photometer serendipity, photometer parallel, spectrometer full spectrum, low resolution spectrophotometry, photometer peak-up, jiggle-photometry and jiggle-spectral-imaging.
Instrument observing mode state	An instrument observing mode can have the following states: • Validated: The instrument observing mode has been tested and validated and the observations which will use this mode can be scheduled. • Non-validated: The instrument observing mode has not been validated and therefore observations which will use this instrument observing mode are not available for scheduling.
Instrument procedure	An instrument procedure is a predefined sequence of steps that an instrument can perform. An instrument procedure is initiated by a single telecommand. There is logic/ control flow associated with instrument procedures. A functional unit can be defined as a sequence of instrument procedures and instrument functions.
Instrument science telemetry	Telemetry which contains the science data collected by an instrument when in an instrument observing mode.
Instrument virtual aperture	**JRR Comment**: An instrument may have different “physical” apertures (ISO: SWS had 3 physical slits looking at 3 different pieces of the sky, 1 arcmin apart). Optical elements inside an instrument (filters, mirrors, aperture stops) may produce a similar displacement effect => virtual aperture, which depends on the instantaneous/ current

	"optical configuration".
IST mission phase	Integrated system tests (IST) mission phase. The objectives of the ISTs are to: • Verify the functionality of the instruments (with FPUs at LHe temperature) • Validate correct implementation of all interfaces between the instruments and spacecraft. Following integration of the instruments onto the spacecraft, ISTs provide as flight representative an environment as possible to validate: • Instruments general health. • Instruments performance. • Compatibility between instruments. As far as the test set-up and 1 g conditions allow, ISTs will cover all aspects of instrument operations, including instrument command execution and validation of engineering observations and AOTs.
IST observation	An integrated system tests (IST) observation is associated with the IST mission phase. An IST observation can be either AOT based or consist of a one off sequences of instrument commands. An observation type.
Key project	Given the novel scientific capabilities of FIRST, it is anticipated that key projects in the form of large spatial and spectral surveys will constitute very important elements of the observing programme, requiring a substantial fraction of the available time of the overall mission. Key projects are expected to systematically address areas of astronomical research either by topic (cosmology, galaxy formation, ...) or by phenomenological type (QSOs, AGMs, protoplanetary disks, ...).
Key project time	The fraction of the total FIRST observing time dedicated to key projects. It is expected that key project time be large in terms of the total FIRST observing time.
Key project time proposal	A proposal submitted in response to a call for key project time proposals. Guaranteed time proposals and open-time proposals may not duplicate key project time proposals. Observations proposed under key project time (and guaranteed time) are announced to the astronomical community during an AO as key project time (and guaranteed time) observations which may not be duplicated by open time observations.
LEOP	Launch and early operations phase. LEOP operations are centred on check-out of the spacecraft subsystems and navigation into the correct trajectory/ to the operational orbit. During this phase the scientific payload (the instruments) is switched off.
Live telemetry	Telemetry generated by FIRST during a DTCP and downloaded without being stored within the on-board mass storage device. The alternative to live telemetry is dump telemetry.
Micro slew	A slew performed inside a raster map. The moving of the spacecraft from one raster point to the next.
Mission phase	From the initial concept to the final archiving of the scientific data the FIRST mission is split into a number of phases: • Instrument level tests • Integrated system tests • Ground segment tests • Launch and early operations phase (LEOP)

	• Calibration/ performance verification phase • Science demonstration phase • Routine phase • Post operations phase
Mission timeline	A mission timeline is a time-keyed sequence of telecommands. The MOC translates a schedule into a mission timeline for uplink to FIRST and subsequent on-board execution.
MOC	The Mission Operations Centre (MOC) is responsible for the execution of all in-orbit operations including: • Generating all commands to be uplinked to the satellite based on input from the FSC, the ICCs and its own subsystems. • Receiving, recording for safekeeping and consolidation of the telemetry. • Making the telemetry available to the rest of the FIRST ground segment. • Ensuring the health and safety of the satellite and all of its subsystems, including the science instrument complement. • Generating ancillary data and making it available to the rest of the FIRST ground segment.
Near real-time telemetry	Telemetry made available as soon as it is received by MOC. Near real-time telemetry can be either live telemetry or dump telemetry. The alternative to near real-time telemetry is consolidated telemetry.
Non-fixed time observation	A non-fixed time observation can be scheduled at any time when it does not violate non-temporal spacecraft/ instrument constraints (see observation time category).
Observation	Formal Definition: A sequence of observation measurements performed during a time interval in which 1 or more of the FIRST spacecraft and the 3 FIRST instruments are dedicated to performing the activities requested via the associated observation request. This definition is worded such that it applies to all phases of the FIRST mission both pre-launch, when the instruments may not be connected to the spacecraft, and post-launch. Within the context of the FSCS an observation is associated with: • A request (observation request) from an observation requestor. • A sequence of functional units which are translated and transmitted (uplinked during post-launch phase) to FIRST and/ or the instruments and result in a series of actions being performed by the spacecraft and/ or the instruments. • Telemetry data which is generated as a result of an observation. • Science data products which are generated from the observation telemetry data and the relevant auxiliary data.
Observation analysis report	The result of manual quality checking on a given observation by an instrument calibration expert (in general an ICC member).

Observation category	Applicable to science observations only (TBC). A science observation will have the same category as the proposal to which it belongs. See proposal category.
Observation measurement	An observation measurement is the smallest constituent step of an observation that is useful to be distinguished within the raw data produced by an observation. Depending on the combination of requested instrument observing mode and requested spacecraft attitude, an observation measurement is characterised by a time interval during which at least one of (i) instrument optical-mechanical- electrical state and (ii) instrument boresight is stable. Examples: If a raster map is executed by the spacecraft while the instrument is kept in the same optical-mechanical-electrical state throughout this mapping, the observation measurement boundaries are the acquisition of a raster point in stable pointing and the start of a (micro) slew to the next raster point. If a fixed pointing is executed by the spacecraft while the instrument steps through a requested sequence of filter settings, the observation measurement boundaries are "completed acquisition of filter position x" and "starting to leave filter position x".
Observation phase	The mission phase in which an observation is to be performed.
Observation processing software	The software that generates observation science data from observation telemetry data and the relevant auxiliary data. Interactive analysis (IA), on-demand processing and quality control processing (QCP).
Observation request	A request to perform an observation submitted by an FSCS user. There will be a dedicated observation request associated with each observation. There are observation requests which have failed to be accepted for FIRST and observation requests that relate to observations that are yet to be performed, that are being performed and that have been performed.
Observation requestor	The actors/ roles associated with the submission of observation requests. There are the following observation requestors: proposer, ...
Observation science data	Science data products associated with an observation. Although normally only one set of observation science data will be associated with an observation it is possible to have more than one.
Observation state	An observation/ observation request can have the following states: • Submitted: The observation request was successfully entered and stored in the FSCS. • Accepted: The observation request was accepted by the FOTAC. • Rejected: The observation request was rejected by the FOTAC. • Released (for scheduling): The observation (as defined by the observation request) is available for inclusion in a schedule. • Blocked (for scheduling): The observation is blocked from inclusion in a schedule. • Scheduled: The observation is part of an approved schedule. • Executed: The observation has been performed by FIRST. • Successful: The observation has been executed according to the observation specification , the observation telemetry data is available and are processible into products. • Failed: An executed observation which is not successful.

	Note that not all of these states are applicable to every observation type. For example scheduling is not applicable to all mission phases and therefore observations performed during these phases will never take the scheduled state.
Observation telemetry data	Telemetry data associated with an observation. Although normally only one set of observation telemetry data will be associated with an observation it is possible to have more than one.
Observation time category.	There are the following time categories to which an observation can belong: • Fixed-time: The observation must start within a specified time interval. • Non-fixed time: The observation can be performed at any time. • Solar-system object: SSOs have time-variable target coordinates and so must be considered as a separate category.
Observation type	There are the following observation types: science observation, calibration observation, engineering observation, ILT observation, and IST observation.
Observation window	A time interval, defined in the planning skeleton, during which schedulable units may be scheduled. Each schedulable unit must be entirely contained within a single observation window.
Observer	An astronomer. An observer is a proposer who has had at least one proposal accepted by FOTAC. An observer will use the FSCS to update their observations as new information becomes available, to see the observation status and to retrieve their proprietary data.
Observing time (mission)	The total time during the post launch mission phases when FIRST is available to perform science observations. This total time is divided into 2 basic blocks: guaranteed time and open time. Guaranteed time holders are eligible to apply for open time. Discretionary time is a subset of open time. There is additionally key project time. If a guaranteed time holder applies for key project time they will have to contribute more than 50% of their guaranteed time. This means that key project time will consist of both open time and guaranteed time.
Observing time (observation)	The time interval during which the satellite is dedicated to performing an observation. There are two classes of observing time: On-target time and Target dedicated time.
On-target time	The total time spent at a target including target dedicated time and any overhead time (time required to prepare for an observation). The on-target time is the time interval that is used when scheduling an observation.
Open time	Open time will be allocated to the astronomical community, including the guaranteed time holders, on the basis of proposals for FIRST observing time submitted in response to an AO. A small fraction of open time will be allocated to discretionary time and to ToOs.
Open time observation	An observation request belonging to an open time proposal. These are always science observations. See observation category.
Open time proposal	A proposal submitted in response to an announcement of opportunity. Open time proposals are subject to peer review by FOTAC. See proposal category.
Operational day	A time interval of 24 hours for which a daily schedule is produced. Note: The satellite maintains a continuous timeline, to which a new mission timeline generated from a daily schedule is concatenated as it is uploaded (normally once every DTCP). In prin-

	ciple, the DTCP could occur at any point in the operational day (OD) and there could exceptionally be more than one DTCP in an OD.
Out of limit information	The result of limit checking on the instrument housekeeping telemetry parameters and the spacecraft telemetry parameters.
Parallel mode	A uniquely defined mode for each instrument. This mode can only be added to a submitted AOT based observation request by authorised FSC personnel. Any instrument other than the prime instrument can be added in parallel mode as long as it will not impact, in any way, on the requested instrument observing mode.
Partner mode	An instrument observing mode involving both the PACS and SPIRE instruments. In partner mode the AOT based observation request will identify instrument observing modes for both instruments (TBC - could be just 1 AOT).
Period	The duration of one cycle of a periodic event.
Planning skeleton	A set of constraints, provided by MOC, for a particular OD, which provides a sequence of observation windows, spacecraft windows and DTCP. The planning skeleton also specifies constraints on the initial and final spacecraft attitudes required during a DTCP. It is TBD whether there will be window types other than observation windows and spacecraft windows.
Pointing	A time interval and associated attitude (or is it pointing direction?), for which the spacecraft attitude is stabilised.
Pointing constraint	An area of the sky where the pointing of the satellite is forbidden. A pointing constraint may not be violated (for example, the Sun constraint).
Pointing direction	The direction (for example right ascension and declination) of the boresight of the operational star-tracker. Note that by definition, the spacecrafts X (or -X TBC) axis is aligned with the boresight of the operational star-tracker (this was true for XMM; is it true for FIRST?)
Pointing restriction	An area of the sky where the pointing of the satellite is not allowed. If necessary a restriction may be overridden.
Post operations phase	The FIRST post operations phase consists of the rundown monitoring phase, mission consolidation phase, active archive phase, and the archive consolidation phase and is the final formal phase of the mission.
Prime instrument	The instrument (or instruments in the case of partner mode) which is associated with the instrument observing mode in an AOT based observation request.
Principal investigator (instrument)	The head of the consortia responsible for the development of an instrument.
Principal investigator (proposal)	The key person associated with a proposal. A proposer.
Project scientist	
Proposal	A request for FIRST observing time containing a scientific rationale for the request. A proposal consists of one or more observation requests along with the details of the

	proposer(s) and an explanation (abstract, scientific justification) of the objectives of the observations described by the observation requests. Science observations are always associated with proposals (science proposal). It is currently unclear whether calibration observations or engineering observations are associated with proposals.
Proposal category	A science proposal will belong to one of the following categories: open time, guaranteed time, key project time or discretionary time.
Proposal science category	A proposal will belong to one of a group of science categories. These allow proposals to be grouped for review by specialised FOTAC subgroups.
Proposal state	A proposal has the following states: • Submitted: Successfully entered and stored in the FSCS. • Accepted: At least one of the requested observations in the proposal has been accepted by the FOTAC. • Rejected: No requested observations in the proposal have been accepted by the FOTAC.
Proposal support tools	A subset of the community support tools used by a proposer when generating a proposal. The following tools are currently identified: • General observing information, including relevant spacecraft and instrument documentation. • Sky visualisation tools with online access to available astronomical databases and the resources of other missions. • A sky visability tool providing information about (i) which areas of sky are visible to FIRST at given times and (ii) when areas of sky will be visible to FIRST. • An observation details tool providing PI names, proposal titles, target lists and observing modes for all accepted observations from earlier AOs. • Time estimators for all instrument modes.
Proposer	An astronomer. The sumitter of a proposal. Within a proposal the proposer is identified as the principal investigator (PI). An observation requestor.
Proprietary data	The term proprietary data is most often assocated with data generated as a result of an observation. This data belongs to the requestor of the observation for a defined period of time. This period is generally 12 months after the data has been made available to the owner. Note: authorized FIRST personnel can use proprietary data to aid them in their FIRST activities (instrument calibration for example).
Public domain data	Data on which there are no proprietary constraints.
Raster map	A series of regularly spaced pointed observation measurements, where at each pointing the observation measurement is repeated. It is defined by its centre position, the step sizes in right ascension and declination and by its orientation on the sky.
Raster point	A pointing during a raster map.

Registered user	An astronomer who has registered with the FSCS.
Routine phase	The routine phase is the mission phase in which astronomical data is produced and consequently the phase in which the astronomers are involved.
Satellite	A spacecraft with the instruments.
Schedulable unit	The smallest entity which can be scheduled independently - either an observation or a slew. Each schedulable unit must be entirely contained with a single observation window. JRR Comment: Contrary to ISO, where slews just connected observations, FIRST offers slews as part of an observation. That is, slews can be requested by observers.
Schedule	A timed sequence of schedulable units. A sequence of daily schedules covering a scheduling period.
Schedule status information	Feedback from the MOC to the FSC on the status of the processing of a schedule by MOC and/ or the status of execution of a schedule exported by the FSC to the MOC. At the time of processing a schedule can be rejected (if it does not meet the scheduling constraints) or approved by the MOC. The MOC will generate the corresponding mission timeline from an approved schedule. With respect to execution, the schedule can be aborted (following an unexpected event) or fully executed.
Scheduling period	A time interval of one or more ODs for which a schedule is produced.
Science data product	The products generated from the telemetry data and the relevant auxiliary data. Science data products will be associated with another entity, typically an observation (see observation science data).
Science demonstration phase	The science demonstration phase aims at producing, soon after launch, science data products that are suitable for use in public relations and science communications. Guided by data taken in the Cal/ PV phase and the status of the observation processing software, observations will be scheduled that are likely to produce results that will make an impact.
Science observation	A FIRST observation which is dedicated to the fullfillment of the science objectives expressed in the science proposal. Each science observation always belongs to a single science proposal. This observation type is AOT based. An additional sub-categorisation of science observation is made: Solar system object (SSO) observation and non- SSO observation due to the unique/ procedurally demanding nature of specifying and scheduling SSO observations.
Science proposal	A proposal with a stated scientific objective and which is submitted in response to a call for key programme proposals, call for guaranteed time proposals, an AO (open- time) or as a discretionary time proposal. A science proposal will be submitted in 2 stages: • Stage 1: The high level details only are provided. This will include the abstract, the scientific justification and the requested targets, the required observing time and instrument observing modes. • Stage 2: Full details of the accepted observations are entered. This 2 stage process allows the FOTAC to perform their review and only accepted proposals will progress to the second stage. Discretionary time proposals **could** be an exception and could be submitted in a single stage with all details being provided. This

	would typically apply to a serendipitous ToO.
Serendipity mode	A uniquely defined mode for each instrument. An instrument can only be in serendipity mode during a time interval for which no observation has been scheduled. Typically this will be during slews.
Slew	A spacecraft manoeuvre to change from one spacecraft attitude to another. Note that a slew within a raster map is referred to as a micro slew.
Solar system object observation	A request to perform an observation of a solar system object (SSO). SSOs have characteristics that make them unique amongst science observations. SSO observations have unique timing requirements (see observation time category).
Spacecraft	
Spacecraft attitude	The inertial attitude of the spacecraft (or should we define it as the spacecraft orientation with respect to the mean geocentric equatorial reference frame).
Spacecraft database	A database including all the necessary information to code the spacecraft telecommands or decode the spacecraft telemetry.
Spacecraft observation mode	The predefined spacecraft attitude during an observation. There will be zero or one spacecraft observing modes identified in an observation request (there are observation types which do not require a spacecraft observing mode).
Spacecraft observation mode type	There are the following types of spacecraft observation mode: pointing, nodding, slew, ...
Spacecraft telemetry	Any non-instrument telemetry.
Spacecraft window	A time interval, defined in the planning skeleton, which is reserved for spacecraft operations, such as unloading momentum wheels. Schedulable units may not be scheduled in a spacecraft window.
Synthetic parameter	A synthetic parameter is a spacecraft or instrument parameter computed (derived) from spacecraft or instrument housekeeping telemetry parameters.
System validation tests	The purpose of the SVTs is to validate the MOC operational database (ODB) contents and flight operations procedures (FOPs) against the spacecraft. These tests are undertaken without MOC to FSC/ICC data flow and they do not address the scientific operability of the instruments.
Target dedicated time	The time spent at the target, in an instrument observing mode, dedicated to the objectives of the observation. The target dedicated time is the observing time that is of interest to an observation requestor although they may have to specify the on-target time when detailing their observation.
Target of opportunity	There are two forms of target of opportunity (ToO): • Generic. The generic ToOs are objects (for example supernovae and comets) which are known but cannot be predicted in advance as to when and where they will be available for observation. Proposals for generic ToOs will be submitted as open-time proposals. • Serendipitous. The serendipitous ToOs are not expected at the time of an AO and will be submitted in discretionary time proposals.
Telecommand history	A list of all the telecommands which were to be uplinked/ executed during a given op-

	erations period with their uplink and execution status.
Telemetry	Data generated by FIRST and its instruments which is downlinked from the satellite to the Ground Station. This downlinked telemetry can originate from either the on-board mass storage (dump telemetry) or directly from the instruments during a DTCP (live telemetry). Upon reception at the MOC if the telemetry is immediately distributed to interested parties then it is referred to as near real-time telemetry otherwise it is consolidated and then distributed as consolidated telemetry.
Telemetry category	There are 2 categories of telemetry: near real-time and consolidated.
Telemetry data	Telemetry as stored within the FSCS. A set of telemetry data will be associated with some other entity, typically an observation (see observation telemetry data).
Telemetry type	There are three types of telemetry: instrument housekeeping telemetry, instrument science telemetry and spacecraft telemetry.
Telescope boresight	Ideally the same as the pointing direction, but offset by a small amount if there is a misalignment between the telescope and star tracker.
Time	An absolute point in time.
Time correlation data	Time data which allows the conversion between coordinated universal time (UTC) and spacecraft on-board time to be performed.
Time interval	The interval between two (absolute) times.
Timeline summary	A summary of the mission timeline derived by MOC from a schedule for FSC and ICC usage.