meeting date *date de la réunion*	15-16 November 99	ref./*réf.*	FIRST/FSC/MOM/0097	page/*page*	1 / 14

meeting place *lieu de la réunion*	ESTEC	chairman *président*	SV
minute's date *dates de minute*	23 November 1999	participants *participants*	see attached
subject/objet	**Minutes of FGSSE meeting #1**	copy/*copie*	see attached

description/description	action/action	due date/date limite

Agenda

See SV's VG attached page 1.

Scope & Objective

See presented SV's VGs attached (pp 2-4)

The commissioning phase shall be added to the different phases to be considered by the group (PE).
Phases to be covered by the group are:
- ILT
- IST
- SVT/EE
- Commissioning
- PV
- Routine
- Post mission

During LEOP, it is understood that the FIRST science GS will be listening mode only (PE).

Commissioning and possibly part of PV phase is understood to take place during transfer to L2. It is assumed that the transfer will not generate specific requirements on the FIRST Science Ground Segment and that the additional constraints, i.e. attitude constraints, can be handled as part of the nominal ground segment.

[JRR's post-meeting comments: In my view this assumption could severely constrain the kind of interface we have with Flight Dynamics to determine target visibility during the mission. Especially during the early

part of the transfer phase the Earth/Moon system will post a significant viewing constraint which will not exist during routine phase; I believe we DO need to handle this additional constraints in a special way.]

It is understood that the group will first focus on logical interfaces between the different centres (IRD level) initially on the basis of the group experience with similar missions and then on the basis of the operations scenario/concept. It will then move its focus to the definition of the system architecture of the FIRST GS (identification of the different physical elements of the FIRST GS) and the definition of the physical interfaces between these elements (ICD level).

The above approach is in line with the FIRST GS documentation tree: IRD -> System architecture -> ICDs (PR)

The definition of the procedural interface is not formally part of the scope of the group. However when discussing logical interfaces, the group should still try to identify all interfaces independently of whether they will be later on implemented as data interface or procedure interfaces (JD).

Work Plan:

See presented SV's VGs attached (pp 5)

The issue of the FIRST GS IRD by Jan 00 and System design + ICDs by June 00 was found acceptable.

The proposed short-term work-plan is geared toward having something ready in terms of system architecture and ICDs for the start of the ILT. It is in line with internal development milestones of both ICCs and FSC.
It is recognised by all parties that MOC will not be in position to start any development next year.

ILT shall be understood as a continuous test running over several years (from March 2001 until delivery of the proto-flight model- mid 2004), evolving from the most simple tests (corresponding to single TC) towards complete and complex instrument testing.

It is important that the purpose/content of the ILT and the different phases of this test and facilities required in each phase be defined ASAP, in particular with respect to the involvement or not (see discussion below) of FINDAS in ILT.

=> AI#151199-1: each ICC to define the purpose/content of the ILT, the phasing of this test (e.g. concept of ILT 0, 1, 2, ...) and the facilities needed in each pase. Due for next meeting.

Data flow analysis (general)

See presented SV's VG attached (pp 6-12)

Data flow originating from MOC:

The following has been discussed:

TM

The meeting confirmed the Vilspa agreement that TM will be made available by MOC to the FSC and ICCs through the consolidated archive with the following understanding:

- The consolidated archive will probably only include TM downloaded from the on board SSR (TBC) (i.e. no real time TM acquired during the DTCP) because this data is assumed to be complete.
- The consolidated archive is file based (no TM stream between MOC and FSC or ICCs). In fact, for SSR data, the ground station-MOC transfer will be file based (NP).
- MOC will guarantee that no SSR data are lost between the ground station and MOC (IDA protocol) however data lost between the S/C and the ground station will not be recovered.
- Files can be produced in the consolidated archive on an APID and packets types basis. The event packets being downloaded first followed by the HK data and the science data. This will allow each of these three types of data can be consolidated separately. This means that as soon as the event data and the HK data are arrived at the MOC, it can be consolidated which will usually take about 10-20 minutes. ICCs do not foresee to command their instrument in real time on the basis of these event and HK TM data.

A direct consequence of this set-up is that RT TM data (transported via VCs 0 & 1) are only accessible in the MOC in real time (the data from the SSR will include this data anyway).

[RH's post meeting question: This is definitely true during PV phase when ICC personnel is physically located at the MOC. But do we need RT data during nominal operations? If we do, we have to find a solution since we can't have someone located continiously at the MOC. If we don't, then why are we testing the RT capabilities of FINDAS?]
[SV's post meeting answer: my understand was that RT TM data were not needed by ICC during nominal operation. This point is important to ge ahead with the design of the system and shall be clarified asap, hopefully as part of the scenario discussion which are to take place the week before the next FGSSE meeting].

Upon ICCs proposal (PR & RH), it was agreed by all parties that instrument TM packets (HK + science) made available by the MOC to the FSC and ICCs will be instrument source TM packets (i.e. TM packets as produced by the instrument and delivered to the OBDH), in particular:

- The science TM packets data segment will be in a compressed format. The decompression algorithm will have to be made available to FSC.
- The TM packets data field header will include the packet generation on board time (OBT). The FSC and ICCs will have to convert OBT to UTC using the time correlation information from MOC (see below).

- The parameters will be delivered in raw format which will have to be converted (using the instrument database) into engineering units before processing can proceed.

Science TM packets will be designed by ICC to include everything that is needed for science processing. ICC confirms this is the intention. However, it cannot be ruled out that instrument or even S/C HK TM are found to be needed at a later stage. In addition, the FSC will certainly need instrument HK TM for cross calibration purpose.

Starting with the PV phase, the ICC would like to be able to retrieve all TM, S/C + Instruments (in particular a given ICC want the possibility to retrieve TM from other instruments). S/C TM and TM from other instruments may be needed by an ICC for calibration purpose and shall be accessible. It was agreed that there should be no built-in barriers in the system to prevent such access. However, it was pointed out that the concurrent retrieval by all ICCs of all TM could lead to cost and performance issues (PE). No performance requirements have been clearly spelt out at this stage.

In addition to S/C TM the MOC will make available in pseudo TM format (TBD) information derived from processing of S/C TM (SCOS-2000 standard functions) (NP):
- synthetic parameters (or derived parameters) whose values are computed from downlinked parameters.
- detected OOL of downlinked parameters

Because there is no end-to-end guarantee that no TM packets will be missing in the consolidated archive, the FSC and ICCs may have to be able to detect missing packets. ESA standard packets allow for this through the packet sequence count, however sequence count is APID based. It was therefore discussed the possibility to have several APID per instrument (e.g. one for science packet, one for HK packet). This proposal was supported by MOC (NP).

TC history

It was clarified that the ICC will not perform TC verification in a systematic way. The systematic TC verification will be done primarily on board and on ground by MOC from the instrument TC verification report TM.
The TC verification report will be made available by MOC in the consolidated archive (as part of the instrument HK TM) for processing by ICC on request.
In addition, the MOC will make available to both ICC and FSC the TC history file which will sum up the TC verification for all instruments + S/C TC in a given period. This TC history file will be made available as an ASCII file. To allow TC verification in ICC (i.e. to relate TC verification report to TC), MOC will also make available the Timeline summary information file that contains all the TC uplinked to the S/C and instruments together with the time-keys at which these commands are to be distributed for execution by the on-board schedule.
These files will be made available on a regular basis (e.g. for each Operational Day) for ingestion into FINDAS.

Attitude data

ICCs believe they need instrument pointing data as delivered by MOC on top of what will be made available through FRD.

[JRR's post-meeting comment: On XMM the MOC do not make available "instrument pointing data" because the S/C reference is the star tracker (I don't remember: was that different on ISO ??). However, I agree that we need reconstructed attitudes from which (at the FSC ?) instrument boresight data can be derived via instrument misalignment matrizes against the STR.]

Schedule execution status

Related to the schedule status feedback from MOC to ICC, the issue related to guide star not found was raised (JD). It was concluded that, in the likely assumption that the instrument commanding can go as planned in case of guide star not found (i.e. the pointing imprecision does not affect the safety of the instrument), no specific design/interfaces are needed to tackle this contingency.

Time Correlation

This is needed by the FSC and ICCs to correct/translate on board time into UTC. This will made available by MOC in the consolidated archive on a regular basis so as to guarantee that the on board time to UTC translation is correct enough for FSC and ICC data processing.
The OBDH time will be distributed (via time packets) to all users on a regular basis (PE) so that the ground shall not care about delta between instrument and OBDH on board time.

Memory dump:

Memory dump will be made available by MOC in the consolidated archive both as TM source packets and as reconstructed memory image

In addition the following data flows originating from MOC were agreed but not further discussed:
- Orbit file
- Observable bins (to be renamed attitude constraint data, as observable bins refer to a particular implementation (ISO one) which may not be approriate for FIRST)
- Planning skeleton

Data flow originating from ICC:

The following has been discussed:

Instrument commanding outside observation schedule

Any instrument commanding outside observation schedule (e.g. for diagnostic purpose or instrument adjustment setting as change of a gain) will only be possible from MOC (not from ICC). Two cases can be considered:

- pre-defined commanding: commanding will be done from MOC based on written procedures by ICC agreed with MOC (IFOP on ISO) (This case includes instrument activation de-activation).
- ad-hoc RT commanding: it will be done directly from MOC (i.e. ICC experts will physically go to MOC).

It was also stressed that any instrument commanding outside commanding via pre-agreed procedures (IFOP) will require the pre- approval of the PS.
The same applies to On board SW update.

On board SW update:

The MOC receives the memory image (and addresses) to be uploaded and take care of translating this image into instrument TC (JD).

Is there any issue related to the usage of VIRTUOSO, i.e. addressing through the operating system ? (RH).

Because of the required approval by PS of any memory load, ICCs suggest that memory load transfer to MOC should be handled by FSC. PS should be able to retain visibility/control without FSC actively handling the instrument memory load (SV).

This led ICCs, MOC and project to welcome a system where MOC would only interface with FSC.

Instrument health report:

The ICC agrees to provide to FSC the instrument health status on a regular (OD?) basis. The intention is to make it available for information/action to FSC users. It is not expected that the FSC makes an automatic usage of it in scheduling (e.g. the FSC on reception of an instrument health report would automatically exclude from schedules observations making use of a reported malfunctioning instrument sub-mode).

Observation quality report:

The system shall allow the feedback from ICC to FSC of observation quality reports. It has however been made clear that the ICC do not commit in any way to provide such reports. The interface will be there only to get the quality information into the FCS if this is made available by the ICC in the context of instrument health check.

Instrument database and database update

For each instrument, the database will include TM, TC packets and instrument parameters definition (including limits). The definition of command sequences may have to be defined in a separate database (TBC).

Although the information originates from ICCs, the reference for the instrument databases will be held by the MOC for the operations phase. JD suggested that the Prime could be the reference during the satellite integration and test phase.
The instrument databases need to be accessed by both the FSC and ICCs. Replication was suggested as a mean to implement accesses by FSC and ICC (TBC).

In addition the following data flows originating from ICC were agreed but not further discussed:
- engineering and calibration observation definition
- engineering and calibration observation scheduling constraints
- calibration data

Data flow originating from FSC:

The following has been discussed:

Observation schedule instrument commanding:

It was clarified that the instrument commanding request from the FSC will not be performed at TC packet level (as proposed in IRD draft 0). TC packet are produced in MOC/SCOS-2000 only before the commands is actually released for uplink and the handling of the commanding is done at command and command sequence levels ((These command sequences could be generated by WINFOPS (tool used in CLUSTER II) and imported into the control system).

A command or a command sequence can be viewed as a unique mnemonic (unique across instruments) and a set of associated parameters. A command sequence is a macro, which can be expanded into a set of individual commands. There is a 1:1 relationship between a command and a TC packet. The translation of a command into a TC packet will be performed by MOC using the instrument database (part of SCOS-2000 MIB). Translation includes packetisation, translation of engineering values into bit paatern, translation to on board time and wrapping into on board scheduling services PUS packets. (JD).

Example of Command sequence: PACS_SET_OPT_GAIN <label>
Example of command: PACS_SET_GAIN <label> <value>

An observation schedule instrument commanding delivered by FSC to MOC is therefore expected to be a sequence of UTC time tagged commands or command sequences and only that.

The above defined commanding hierarchy (command sequence/command/TC packets) is to be checked with respect to the commanding scheme proposed by PACS in the PACS ICC SW URD (PACS-KL-RD-001 dated July 1,1999.

=> AI #151199-2: RH to check relevance of proposed commanding scheme wrt the one in PACS ICC SW URD. Due date: next meeting.

FRD:

ICC expect the FRD to contain instrument data in a format as close as possible (ideally the same) as the TM source packets generated by the instrument, i.e. instrument TM packet structure & compressed raw data. Obviously, the FRD shall also contain S/C pointing data (both expected and actual). ICCs have made clear that it is not expected to have FITS file format for FRD. If FITS files are required, e.g. for distribution purposes outside the ground segment, an export mechanism will extract the FRD from FINDAS and produce a 'file' in the requested format (RH).

Conceptually, the MOC will make available the instrument TM packets to the FSC. The FSC will ingest these TM packets and will allow its users to retrieve these TM packets on observation basis or along other views and/or queries.

Data flow analysis versus ILT & Discussion on the ILT FIRST GS Design

See supporting PR's VG attached.

Overall discussion:

Overall, the discussion was centred on the usage of FINDAS in the ILT.

All parties agreed that introducing FINDAS as early as possible in the test phases is positive with respect to minimising overall development effort and testing the operational system.

The main concern is the risk this puts on ILT. The execution of ILT which are to start end next year is partly made dependent on a subsystem (FINDAS) whose development has not started and whose definition has proven more than laborious over the last two years (PE + SV). In addition, delays in ILT induced by FINDAS could significantly alter ESA management support to FINDAS (PE).

The clarification by ICC (PR) that FINDAS would not be needed at the start of ILT but at a later TBD stage and not all FINDAS (see detailed discussion below) potentially leaves room for a scenario where FINDAS can support ILT while reducing risk at an acceptable level.

In this context, the result of the action on ICC (see AI#151199-1 above) to identify ILT phases and associated support functionality is recognised by all parties as very important.

Also, its was agreed that the definition of the FINDAS data model should start ASAP in order to define the overall data model, identify and detail the parts relevant to ILT. This activity is planned to start early next year as far as FSCDT is concerned (SV).

It was also agreed that ILT test data, which needs to be archived in FINDAS for further usage, could be temporarily archived by other means (waiting for FINDAS to be operational).
It was also pointed out that the ILT will in fact involve three instances of FINDAS (one for each ICC), that will have to be regrouped in the operational FINDAS at the end of ILT. It is not yet clear if this can cause some difficulties (e.g. overlapping schedules (PR)).

The following tables report on the discussion for each identified data flow:

See also supporting SV's VGs attached (pp 10-12)

Data originating from MOC	Needed for ILT?	Discussion
TM to FSC	No	
TM to ICC	Yes	- During ILT, ICC will primarily receive their instrument TM in RT through instrument station (RTA SCOS-2000 based) connected to the MOC M/U - At some stage in the ILT, i.e. when detectors data are produced and tests procedures are implemented through observation, the consolidated archive interface to FSC & ICC will be useful. That will allow to ingest TM data into FINDAS (in the same manner as in operation) in order to be able to retrieve TM data (by queries, e.g. on observation related attributes) for QLA/IA purpose (QLA/IA are not SCOS-2000 based). ICCs insist that although QLA/IA will take as inputs TM raw data, interfacing QLA/IA to MOC M/U during the ILT or part of the ILT is not acceptable (feasible but means significant effort for a throw-away development). This claim is not really understood by ESA considering the required QLA functionality for ILT. - ICCs propose to implement the ingestion of TM data into FINDAS for ILT. This however means that the overall data model and detailed data model for data relevant to ILT are elaborated beforehand. - ICC also stressed the importance of being able to re-play ILT

		TM data at a later stage (e.g. during commissioning) for calibration purpose.
Orbit file	No	
Observable bins	No	
Planning skeleton	No	
Planned observation status report	No	
Consolidated attitude data	No	- However, a simulated "on target flag" may be needed (PR)
Instrument commanding history	Yes	- TBC not needed in FINDAS
Time correlation	Yes	- Simulated one

Data originating from ICC	Needed for ILT?	Discussion
Inst. Commanding Sequences	Yes	- Resident in MOC M/U
Inst. PCS, Activation/De-activation	Yes	- Resident in MOC M/U
Inst. On Board SW update	Yes	- not further discussed
Instr. Calibration Data	Yes	- Foreseen to be produced/used at a late stage in ILT (PR)
Eng. & Cal. Observations	Yes	- Foreseen to be needed at some stage in ILT to implement test procedures
Eng. & Cal. Observations schedule constraints	Yes?	- FSC mission planning available to ICC?
Instr. analysis report	Yes	- For archive only
Obs. Analysis report	Yes	- For archive only
Instr. Databases	Yes	- resident in MOC M/U & FSC/ICC

Data originating from FSC	Needed for ILT?	Discussion
Observation schedule	Yes	- TBC. Scheduling facilities are seen by ICC as useful to have for ILT, as it will allow individual test implemented as engineering/calibration observation to be send in a batch

		sequence. - Scheduling facilities would not be useful at the beginning of ILT but only when tests are conducted within the context of observations. - Only basic manual scheduling would be useful. - If no scheduling facilities are available from FSC, ICC should still be able to simulate FSC scheduling facilities.
Observation schedule S/C pointing request	No	- TBC. Will not be processed by MOC M/U.
Observation Schedule instrument commanding	Yes	- same comments as for observation schedule - observation schedule execution will nominally rely on the on board scheduling for its execution. For ILT, ESA does not provide an OBDH simulator. The ICCs consider implementing the OBDH scheduling facility. One alternative would be to use the scheduling facilities provided by SCOS-2000 (JD). - in any cases it was agreed, that the observation schedule instrument commanding interface between FSC and MOC should not differ in ILT from operational phases.
Formatted Raw Data	Yes	- to be understood as the implementation of a particular query on TM packets from FINDAS (TBC), no pre-processing/reformatting of TM packets by FSC should be required (SV).
SSO data base	No	

AOB & Next Meeting

The FGSSE group meeting #2 will be held in ESOC on the 21/12. On 20/12 afternoon, a demonstration of SCOS 2000 as used in INTEGRAL will take place.

The FIRST GS IRD draft 0 will be updated in time for review at next meeting.

Attendees:

John Dodsworth (ESA – ESOC)
Pierre Estaria (ESA - FIRST/PLANCK project)
Rik Huygens (KUL)
Nestor Peccia (ESA-ESOC)
Peter Roelfsema (SRON)
Sunil Sidher (RAL)
Stephane Veillat (ESA – FSC)

Cc:

O. Bauer (MPE)
J. Brumfit (Aurora – FSC)
P. Claes (ESA – FSC)
T.G. Dimbylow (RAL)
K. Galloway (Aurora – FSC)
S. Lord (IPAC)
J.J. Mathieu (ESA)
J. Riedinger (ESA - FSC)
G. Pilbratt (ESA – FSC)

PR's VG:

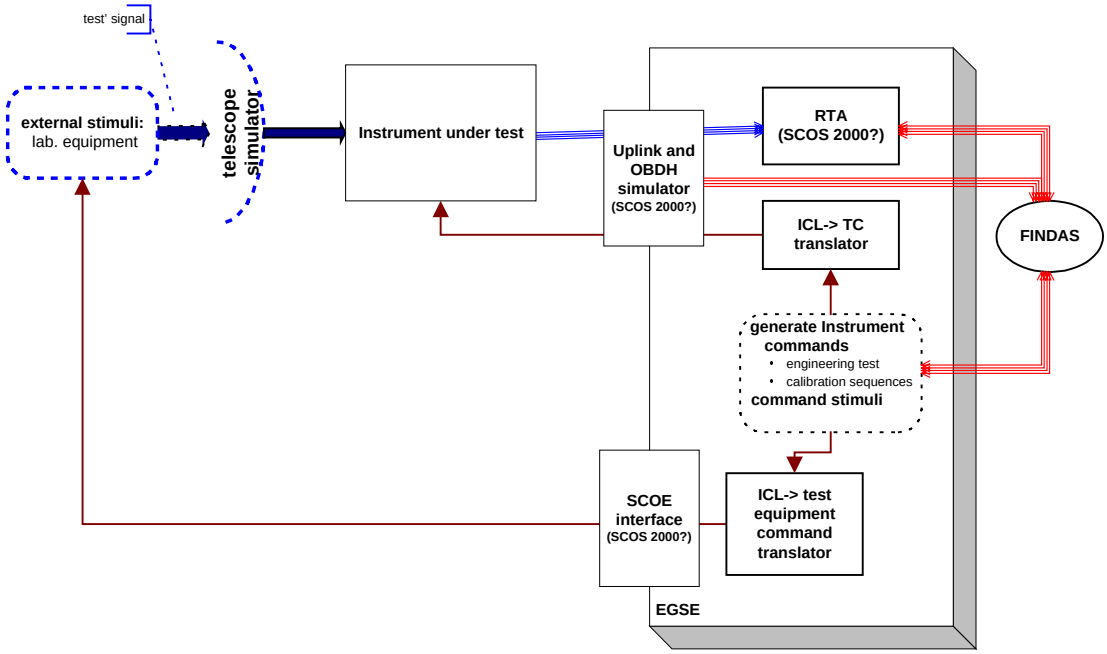


Figure 1: logical set up for Instrument Level Tests

House keeping and event data are analysed in real time using RTA and science data are analysed off line from FINDAS using IA and CA. Also when needed RTA can be used when replaying house keeping data from FINDAS. Data in FINDAS will be analysed both by ICC personnel at the test site as well as by instrument experts at other consortium locations. The latter group will do this analysis at their local FINDAS node. The acceptable time delays between data transmission from the instrument and receival at any of the ICC work places is given in Table 1.

Location	Data	Delay	Driver
ILT			
ICC@ICC	HK	~1 min.	At the ICC only off-line analysis is carried out on data taken during ILTs. Feedback for tests is given after analysis of complete data sets.
	Science	~1 min.	
ICC@EGSE	HK	<2 sec.	Personnel at the EGSE station need to interact directly with the instrument. Feedback is real time.

Table 1: acceptable data transmission delays during ILT and IST.

Ideally at the DM ILTs, but definitely at the QM ILTs operational as well as data analysis procedures are tested out on real instrument hardware. In this period such procedures can be further developed and optimised for satellite operations. ICC and FSC personnel will participate extensively in the ILTs as they present an ideal learning ground as well as a solid test bed for procedures and analysis software.

6.2 System level tests

Input received from PR:

The integrated system tests are carried out with the instrument integrated with the satellite at ESA premises. Only pre-programmed test procedures are carried out under ESA responsibility. Instrument specialists monitor the instrument behaviour at the Central Checkout Equipment and (possibly) at a

SV's VGs:

FGSSE Group meeting #1 Agenda

first day (Monday afternoon)

- Introduction
- Meeting agenda consolidation
- FGSSE group scope and objectives consolidation
- FGSSE group milestones to prepare for ILT
- FIRST GS data flow concept presentation and discussion
- Identification of data flows (across systems and phases)

  Review of data flows identified in IRD draft 0: are they all relevant? are some missing?

second day (Tuesday)

- Prioritisation of data flows definition

  What are the data flows needed for ILT?
- ILT interfaces requirement analysis discussion
- Introductory discussion on the ILT FIRST GS system design (PACS inputs) (TBC)
- AOB & next meeting place/date

FIRST GSSE Scope

- FIRST (science) ground segment system architecture & interfaces: MOC+ ICCs + FSC
- Test & operational phases: ILT, IST, EE, PV, Routine, Post operation

- SW deliverables (e.g slew time predictor) are not covered?
- Procedural interfaces are not covered
- MOC-S/C and S/C-Instr. interfaces are not covered

FIRST GSSE Objectives (overall)

- Analysis of the FIRST science GS data interfaces (IRD level)
  - *what* is the data flow
  - *constraints* to be met: performance
  - *when* is the data flow required vs. FIRST GS test & operational phases
- Definition of the FIRST science GS System architecture (not of the individual centers) and of the FIRST GS test & operational data interfaces (ICD level)
  - *how* to implement interfaces to meet requirements
  - identification of requirements towards FINDAS
- Implement the concept of seamless transition across test and operational phases
  - centers M/U used in tests should be as much as possible the kernel of the operational centers
  - system and user interfaces for test should be as much as possible retained for operational phases

FGSSE Group Objectives (Meeting #1)

- Agree on short term work plan (see proposal)
- Identification of FIRST GS data flows
- Consolidation of requirements on main/top priority FIRST GS data flows
  - identification of main data flows and data flows needed for ILT
  - identification/consolidation of functional and performance requirements on above identified data flows.

FGSSE Group (short term) Workplan

- Monthly meeting until June 00.
- IRD issue 1 by January 00 as input to FSC/ICC elaboration phase
- System design & ICD(s) issue 1 by June 00 as input to construction phase for ILT (TBC).

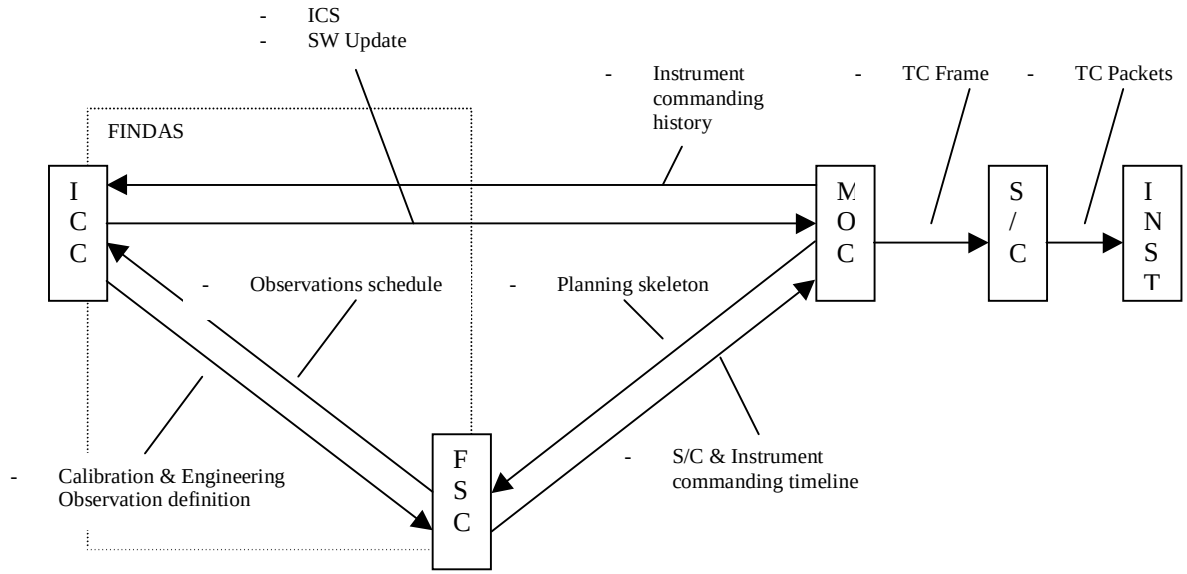
FIRST GS data flow analysis (starting point)

- The MOC is responsible for all the aspects of the S/C operation as well as the safety of the instruments.

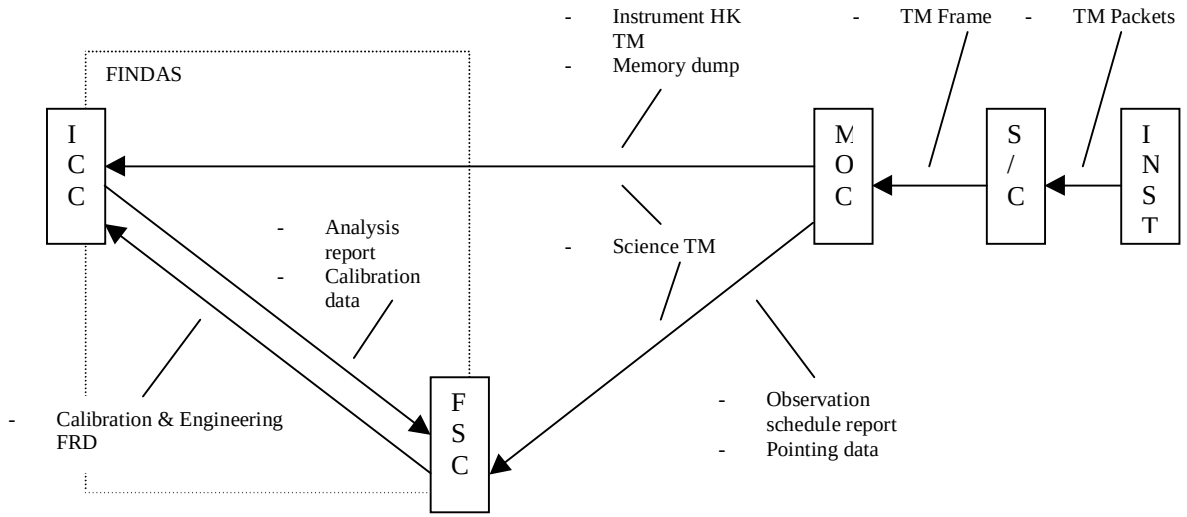
- An ICC is responsible for the testing, calibration and operation of its instrument before and during the mission as well as providing the software enabling its instrument science data processing.

- The FSC is responsible for defining the science operation of the spacecraft and its instruments, for making available to the science community the science data resulting from this operation and for providing support for the user community and the FOTAC.

FIRST GS (main) data flow analysis (Uplink)



FIRST GS (main) data flow analysis (Downlink)



FIRST GS data flow analysis (complete ?)

- From MOC:
  - orbit file
  - observable bins
  - planning skeleton
  - telemetry
    - instrument memory dump
  - consolidated attitude data
  - time correlation
- From FSC:
  - observations schedule
  - observations schedule S/C & instrument commanding
  - formatted raw data
  - SSO data base
- From ICC:
  - engineering and calibration observations
  - engineering and calibration observations scheduling constraints
  - instrument command sequences
  - instrument activation/deactivation
  - instrument calibration data
  - instrument on board SW load
  - instrument analysis report
  - observation analysis report
  - instrument database update related interfaces

FIRST GS data flow analysis (from MOC)

Data originating from MOC	Relevant PUS services	ILT?	Comments/Questions

TM to FSC	- Science data (not formally a PUS service)	No	- Instrument TM source packets?
			- Consolidated?
			  - Raw/Calibrated?
			  - Error control?
			- Performance requirements – File vs. Stream – File granularity?
			- TM association with observation/exposure?

TM to ICC	- TC verification? - HK+Diag - Event - Memory dump - OOL - Connection test ? - Science data	Yes	- No S/C TM? - Instrument TM source packets? - TC verification supported by MOC? (SCOS 2000) - Consolidated? - Performance requirements – File vs. Stream – File granularity? Need for RT HK TM during DTCP? - Retrieval mode?
Orbit file	N/A	No	
Observable bins	N/A	No	
Planning skeleton	N/A	No?	
Planned observation status report	N/A	No	
Consolidated attitude data	N/A	No?	
Instrument commanding history	N/A	Yes	- Instrument TC packets and associated absolute time?
Time correlation - Ground/board - OBDH/instruments?	- Time reporting - ??	No	- PUS data not readable by FSC/ICC - Period of validity?

FIRST GS data flow analysis (from ICC)

Data originating from ICC	Relevant PUS services	ILT?	Comments/Questions

Inst. Commanding Sequences	- Define/Clear HK+ Diag
	- Enable/Disable HK + Diag
	- Dump memory
	- Check memory
	- Parameters monitoring mgt
	- TM transmission mgt?
	- Perform connection test
	- On board procedure mgt
		Yes	- Originate from MOC (manual stack)?
			- Or from ICC?
			  - Live request from ICC? (SCOS-2000 concept)
			  - Or Predefined instrument commanding sequence?
			  - PUS TC packets?
			- Uplink time controlled by MOC?
			- Immediate on-board commanding?
			- Raw/calibrated?

Inst. PCS, Activation/De-activation	?	Yes	- Resident in MOC?
Inst. On Board SW update	- Load memory - Dump memory? - Check memory?	Yes	- Predefined instrument commanding sequence by ICC? - PUS TC packets? - Uplink time controlled by MOC? - Immediate on-board commanding? - Check done by MOC? - Load/dump size requirement (as limited ground coverage)?
Instr. Calibration Data	N/A	No?	
Eng. & Cal. Observations	- Function mgt? - Perform activity?	Yes	- Level of abstraction of the interface: e.g functional units (ISO CAL verbs)? - Level of abstractions supported on ground/on board?
Eng. & Cal. Observations schedule constraints	N/A	Yes?	- FSC mission planning available to ICC?
Instr. analysis report	N/A	No	- Results from RTA?
Obs. Analysis report	N/A	No	- Results from QLA?
Instr. Databases	N/A	Yes	- resident in MOC & FSC? - update? - TM, TC packets definition + instrument parameters definition

FIRST GS data flow analysis (from FSC)

Data originating from FSC	Relevant PUS services	ILT?	Comments/Questions
Observation schedule		No?	- (Re-)schedule range? Observation window? - Back-up schedule? (compatibility with absolute time tag?) - Needed by MOC?
Observation schedule S/C pointing request	N/A	No?	- <time> S/C pointing requests (pointing, tracking, raster)
Observation Schedule instrument commanding	- Function management - Perform function activity	Yes	- <time> PUS TC packets? (in line with SCOS2000?) - Dummy TC to carry observation/exposure context to instrument? - On board scheduling time resolution constraints - Raw/calibrated? - PTV done by MOC?
Formatted Raw Data	N/A	No	- Granularity of FRD: observation/exposure?
SSO data base	N/A	No	