FIRST/Planck Project	**MINUTES OF MEETING**	Date : 19 May 1999 Ref : PT-MM-06797 Page : 1 of 5

SUBJECT: Minutes of 2nd meeting Commonality Working Group #4/5/5: 2nd Meeting -- 19 May 1999

PLACE: ESTEC, room Bf228

Participants	*Organisation*	*Distribution*
C. Butler	ASI/Roma	Participants +
R. Cerulli	IFSI	J. Charra (IAS/Orsay)
B. Cougrand	IAS/Orsay	K. King (RAL/Oxfordshire)
P. Estaria	ESTEC/SCI-PT	R. Gispert (IAS/Orsay)
O. Bauer	MPE/Garching	R. Orfei (IFSI)
T. Dimbylow	RAL/Oxfordshire	J. Tauber (ESTEC/SCI-SA)
P. Roelfsema	SRON/Groningen	F. Vandenbussche (SCI-PT)
J.M. Herreros	IAC/Tenerife	D. Giunta (TOS-ETD)
M. Gomez	IAC/Tenerife	FIRST/Planck Project File
J. Dodsworth	TOS/OFC	
N. Todd	RAL/Oxfordshire	
G. Pilbratt	ESTEC/SCI-SA	

AGREEMENTS STATEMENTS	**ACTION**
The 2nd meeting of CWG # 4/5 (On-Board Software and Instrument Operations) took place at ESTEC on 19.05.1999. The agenda - Appendix 1 - was accepted. **1. Review of Action Items from meeting # 1** **AI:1/1: closed** Project-related documentation already existing in electronic form will be stored -as previously agreed- into the Project Domain in SSD/SA DMS. Documentation existing only in hard-copy form (e.g. PSS-05 standards) will not be scanned. If urgent it will be sent by DHL. Request for documentation to be addressed by E-mail to P. Estaria with copy to Inge van de Wetering (FIRST/Planck Project secretary - email: ivdweter@estec.esa.nl). **AI:1/2: closed** CWG #4 and CWG #5 merged. No specific AIV CWG created. Command Verification (CV) moved from RTA CWG to this WG. **AI:1/3: closed** Responsibilities as defined in 1st meeting. SPIRE pointed out that a SPIRE SPU might not be needed. **AI:1/4: closed** Minutes of 1st meeting distributed to chairman of CWG #1/2. E-mail Estaria-Vandenbussche on 26-03-99, reminder on 12-05-99.	

AGREEMENTS STATEMENTS	ACTION
AI:1/5: on-going See agenda point 5. Estaria pointed out that responses to AIs and any other inputs should be circulated to *all* members of the CWG. The inputs should be circulated *at least* two weeks in advance. The inputs should be analysed by the WG members *prior* to the meeting. **AI:1/6: on-going** Drafts #2 of the F-OIRD and the P-OIRD will be released by ESOC on 15-06-99. These revised versions will include improvements made for the ROSETTA and Mars-express OIRDs. Many of the ROSETTA "solutions" are potentially applicable to FIRST/Planck and a considerable amount of work has already been carried out for ROSETTA. In addition the text in the old draft will be considerably expanded to include precise definition of the terminology used, examples, and explanations as to why certain requirements are imposed on the payload. Comments made by the Instrument Groups on Draft #1 will be incorporated as far as possible. If necessary a dedicated meeting will be organised with ESOC to review the Drafts #2. Issue 1 for both F-OIRD and P-OIRD is planned for mid-Nov '1999. (TBC). **AI:1/7: closed** **AI:1/8: closed** for HFI, LFI and PACS; **open** for HIFI and SPIRE **2. Telecommanding: MOC view** J. Dodsworth presented the MOC view on "commanding" (see Appendix 2). This is based on the experience gained by ESOC on several missions as well as the facilities provided, and requirements imposed by the TM/TC packet standards. It was noted that: • TC baseline uplink rate is 4 Kbs. • The list of "Packet Services" is the list made available for ROSETTA (best model for FIRST/Planck) Estaria was requested to bring to the attention of the FIRST/Planck Project management the need for a quick decision on the TM rate which will be available to the FIRST and Planck Instruments. *Note:* This has been done. The issue will be discussed at the next meeting of CWG #1/2 (planned for 15.06.99) **3. On-Board S/W Maintenance: MOC view** J. Dodsworth presented the MOC view on OBSW maintenance (see Appendix 3). This is based on the experience gained by ESOC on several missions. It was noted that: • The scheme proposed for FIRST/Planck follows the ROSETTA approach.	

AGREEMENTS STATEMENTS	ACTION
• Provided that the instrument on-board micro-processors and choice of Operating System (e.g. VIRTUOSO) are the same, the S/W Maintenance Environment(s) (SMEs) and the S/W Validation Facilities (SVFs) could be common. This would represent a substantial saving for both ESA and the PI teams.	

4. VIRTUOSO

The VIRTUOSO (Eonics) Operating System is considered by all instrument groups as a potential candidate for the OS upon which to build the Instrument OBSW. ESTEC (TOS-ETD) have started in January 1998 evaluation of potential candidates. Their findings, as well as corresponding support documentation, are available in the following public directory: ftp://ftp.estec.esa.nl/pub/ws/TSC21020.
The following was noted:

- Mr. D. Giunta (TOS-ETD) e-mail:dgiunta@estec.esa.nl; Tel: +31-71-565-3863) is the contact point for all ESTEC-based VIRTUOSO related activities.
- VIRTUOSO seems to be the only viable alternative if an operating system is required (this is currently assumed)
- Final presentation on the results of the evaluation activities foreseen in Oct. '1999. D. Giunta will inform P. Estaria in advance in order to invite the relevant FIRST/planck specialists.
- Additional study contracts have been initiated with Austrian Aerospace, CAPTEC, CIR, ETEL and Space Systems Finland. A final combined presentation is foreseen mid-April '2000.
  D. Giunta will inform P. Estaria.
- D. Giunta is prepared to provide ad-hoc support to the members of CWG #4/5.

FIRST (R. Cerulli) and Planck would like to obtain a free evaluation licence from Eonics. D. Giunta will approach Eonics and inform R. Cerulli (copy to P. Estaria)

5.1 FIRST requirements on Instrument Commanding

R. Cerulli (IFSI) presented FIRST "co-ordinated" requirements. See Appendix 4.
P. Roelfsema had sent 3 viewgraphs (to Estaria only) outlining HIFI "commanding". See Appendix 5. These were not discussed.
O. Bauer had sent an E-mail (to Estaria only) outlining PACS "commanding". See Appendix 6. These were not discussed.
SPIRE provided no input.

5.2 Planck requirements on Instrument Commanding

C. Butler (ASI/Roma) presented Planck "co-ordinated" requirements.

AGREEMENTS STATEMENTS	ACTION
See Appendix 7. He had sent an E-mail (to the WG members) providing more details on LFI “commanding”. See Appendix 8. These were not discussed. J. Charra (HFI) had sent an E-mail (to the WG members) stating that LFI approach “fits almost perfectly HFI ideas on the subject”. The small differences implied by the “almost” were not discussed.	
6. General conclusions on Instrument Commanding	
Planck “requirements” on instrument commanding and instrument “command verification” (CV) are simpler than for FIRST. The need for ASAP commands -see Appendix 4- was questioned by the WG. No general conclusions were drawn.	
It is clear that one “unified” “common” view needs to be derived from the various FIRST inputs. This should be attempted at the FIRST Science GS Workshop from 4-7 July (possibly during a splinter meeting). The FIRST participants to the workshop should review **all** available inputs (including MOC) prior to the workshop.	**CWG4-AI:2/1**
7. Review of CWG working plan	
This was not discussed in detail. The activities are clear. See responses to AI:1/7 and chapter 4 of these minutes.	
8. Date and place of next meeting	
The next meeting is planned for 14-09-99 at ESTEC provided there is a sufficient number of “commonality” items to discuss.	
9. AOB	
There was no AOB	

Ordinal Action Number	Title and Description	Due Date	Originator		Actionee		Completion	
			Firm	Person	Firm	Person	Date	By Document No.
AI:2/1	Review and evaluate all FIRST inputs on commanding. Derive a “common” FIRST concept	05-07-99		Estaria	FIRST CWG members			

Pierre Estaria on 26-05-99 15:45:05

To: Ingeborg van de Wetering/estec/ESA@ESA
cc:
Subject: CWG OBSW and Operations

Appendix 1.

-------------------- Forwarded by Pierre Estaria/estec/ESA on 26-05-99 15:55 --------------------------

Pierre Estaria on 12-05-99 14:21:37

To: Pierre Estaria/estec/ESA@ESA, charra@iaslab.ias.fr, couchot@lal.in2p3.fr, gispert@ias.fr, pajot@ias.fr, butler@tesre.bo.cnr.it, P.R.Roelfsema@sron.rug.nl, fgb@mpe.mpg.de, c.d.pike@rl.ac.uk, jhl@iac.es, cerulli@ifsi.rm.cnr.it, John Dodsworth/esoc/ESA@ESA, stefano.pezzuto@ifsi.rm.cnr.it, fgr@iac.es
cc: ohb@mpe.mpg.de, t.g.dimbylow@rl.ac.uk, k.j.king@rl.ac.uk, GPILBRAT@estec.esa.nl@ESA, Ana Heras/estec/ESA@ESA
Subject: CWG OBSW and Operations

Dear Colleagues,

The 2nd meeting of the CWG will take place at ESTEC, on the 19th May 1999 from 9: 00 to 12: 30 in Room Bf 228.
Please note that the RTA CWG meeting will take place in the same room from 14:00 to 17: 30.

The following agenda is proposed:

1. Review of Action Items from meeting # 1

2. Telecommanding (MOC's view - presentation by J. Dodsworth - appr. 30 mins)

3. On-board S/W maintenance (MOC's view - presentation by J. Dodsworth - appr. 30 mins)

4. VIRTUOSO OS (evaluation study by ESTEC/TOS-ETD - D. Giunta- appr. 30 mins)

5. 1 FIRST "Requirements" on Instrument Commanding (presentation R. Cerulli)
(It is assumed that IFSI presentation covers the "common" approach by the 3 FIRST Instruments)

5.2 Planck "Requirements" on Instrument Commanding (presentation C. Butler)
(It is stated that LFI presentation covers the "common" approach by LFI and HFI)

6. General conclusions on Instrument Commanding

7. Review of CWG working plan (up to end '99)

8. Date and place of next meeting

9. AOB

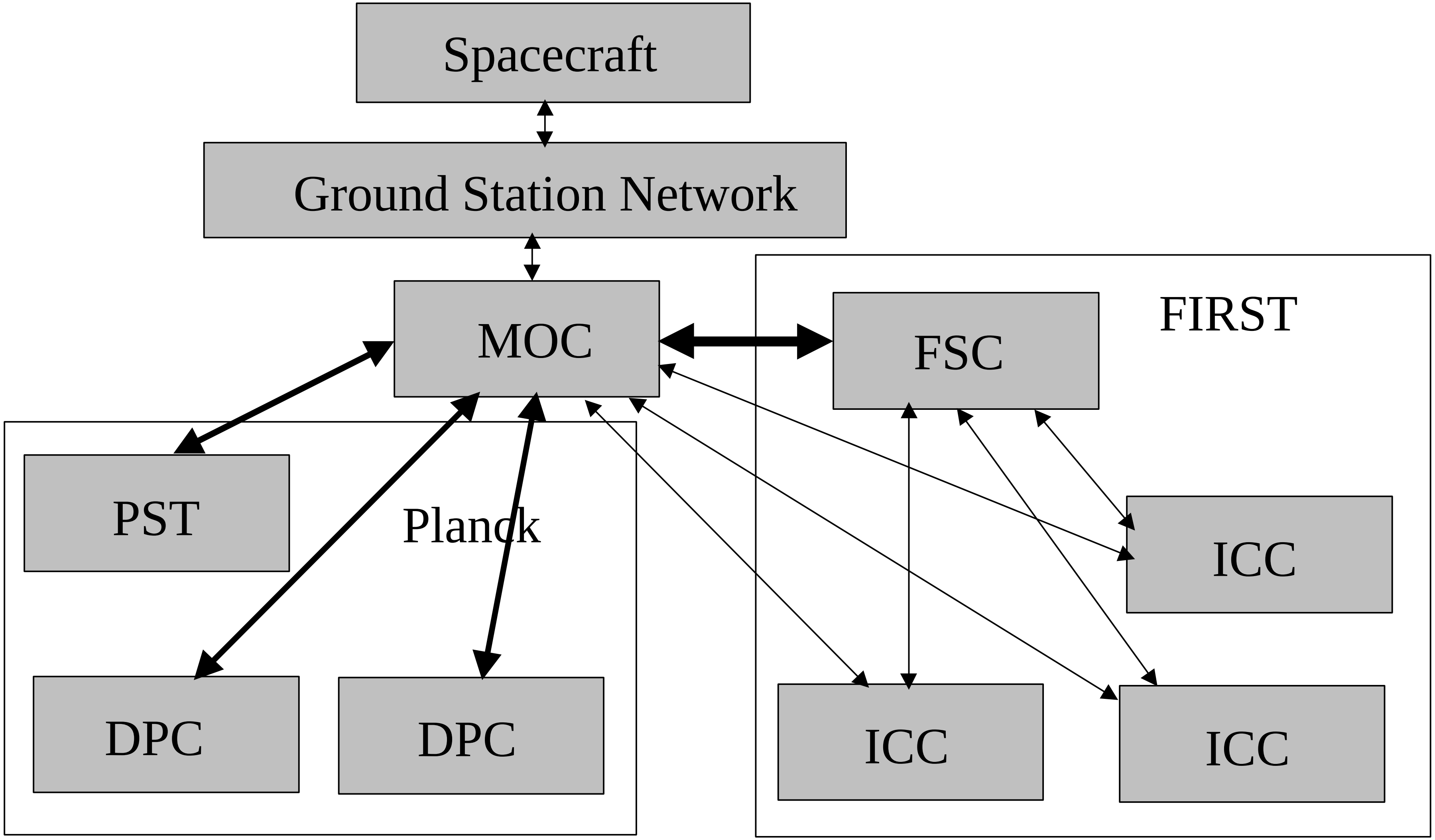
Please let me know if you plan to participate to the meeting. Badges will be available at the ESTEC main gate.

Regards

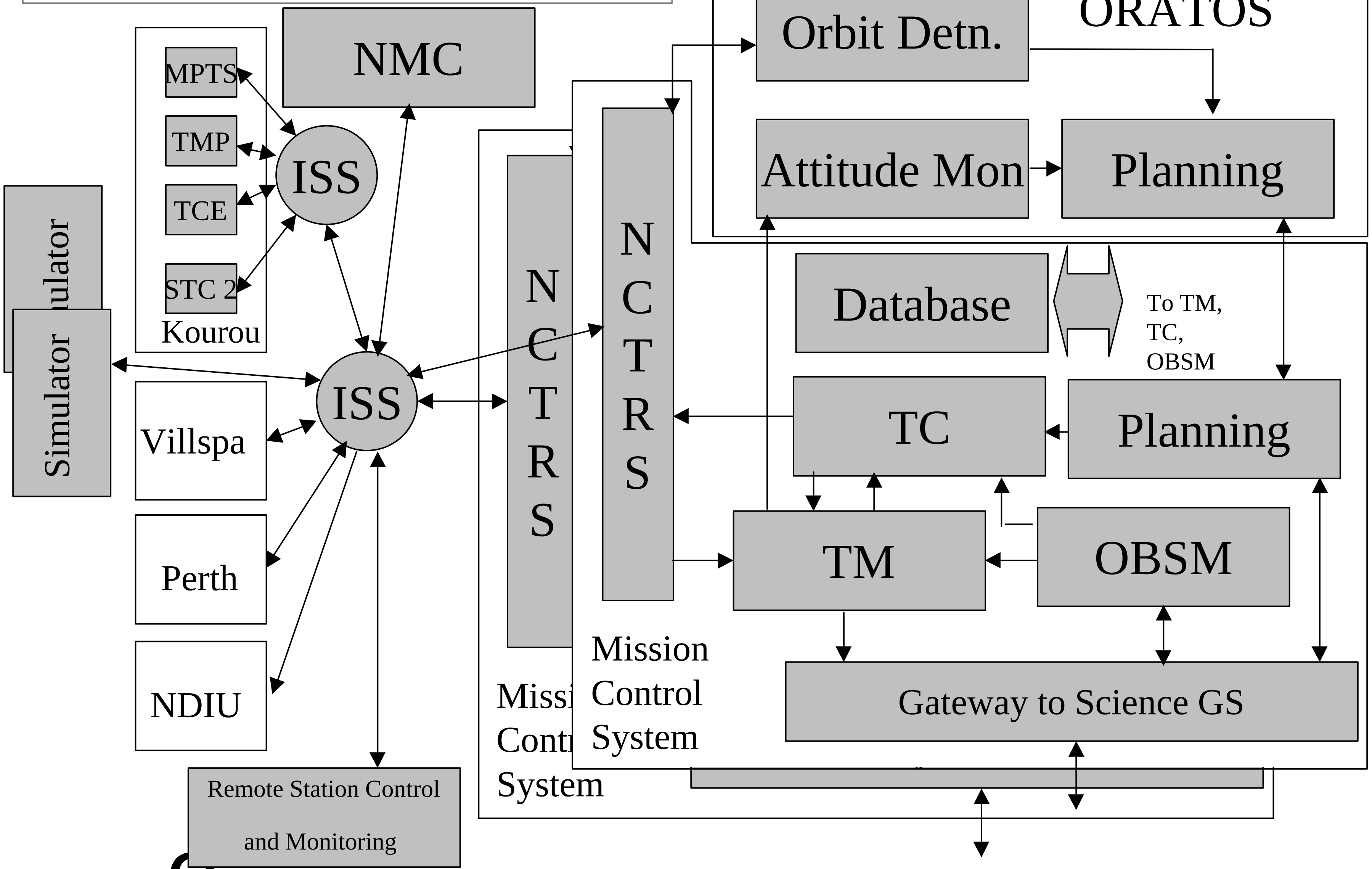
Commanding

A MOC View

Ground Segment

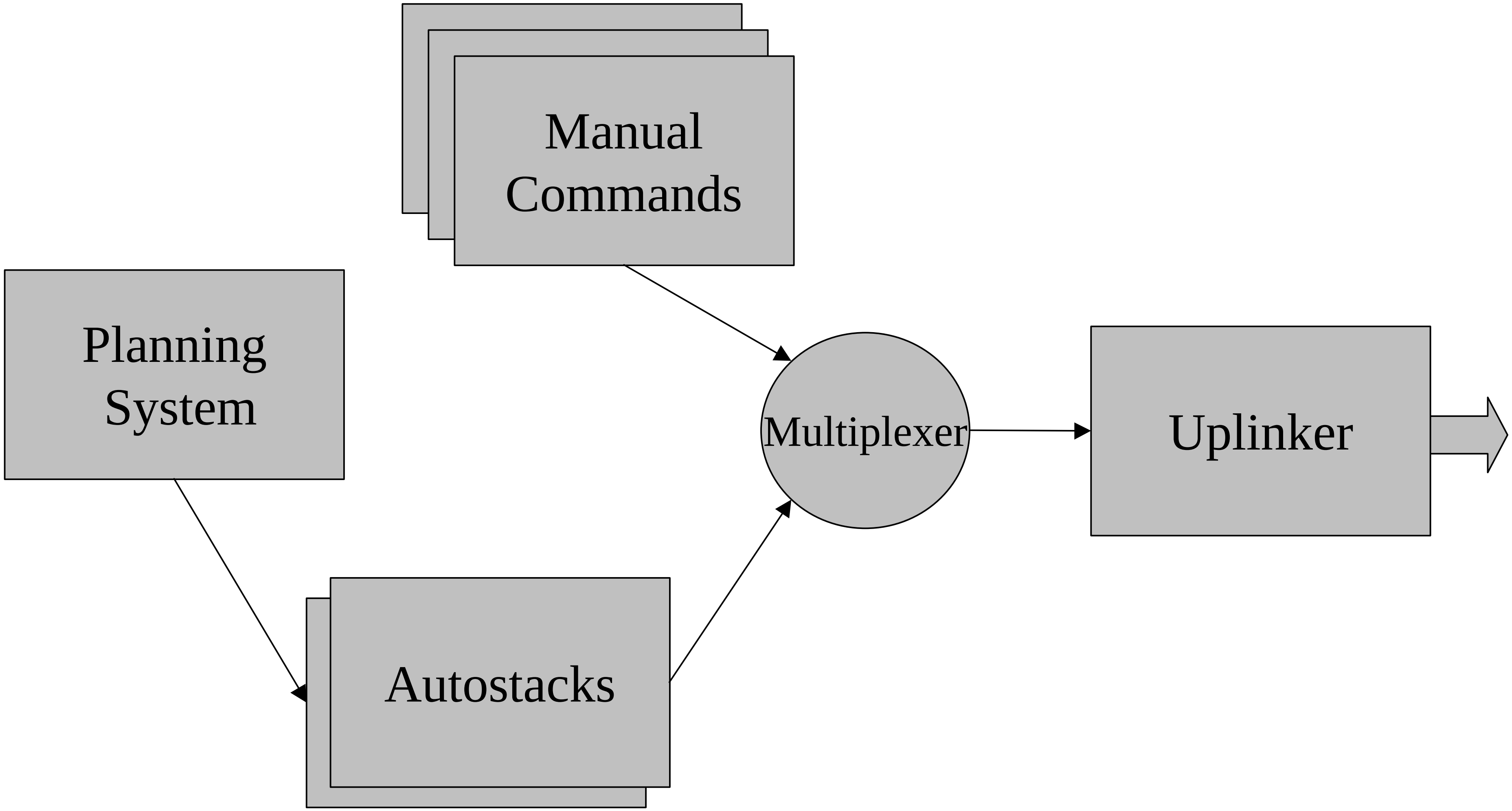


Carrier

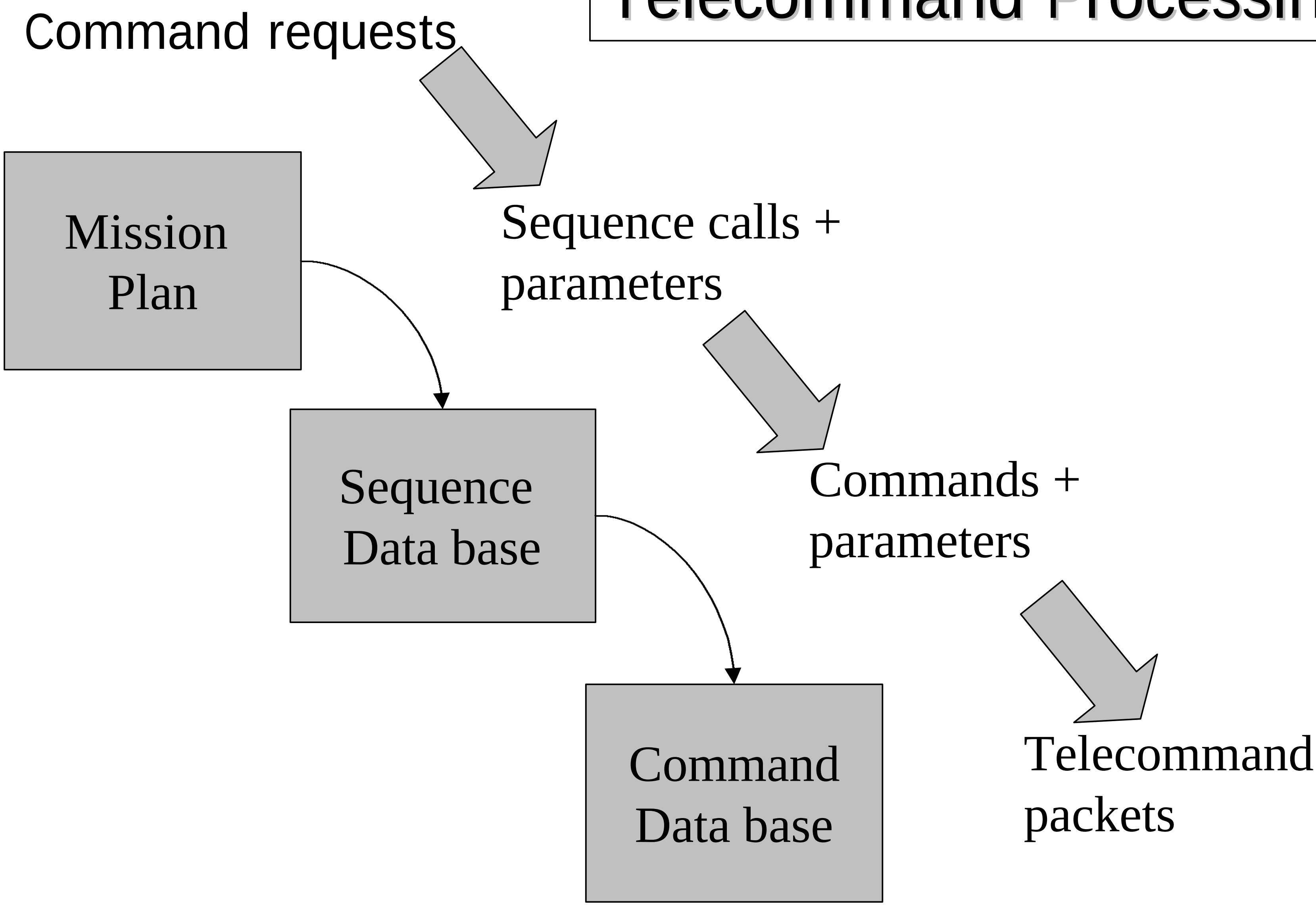


ORATOS
Orbit Detn.
Attitude Mon
Planning
NMC
MPTS
TMP
TCE
STC 2
Kourou
ISS
ISS
Simulator
Simulator
Villspa
Perth
NDIU
Remote Station Control
and Monitoring
N C T R S
N C T R S
Database
To TM,
TC,
OBSM
TC
Planning
TM
OBSM
Gateway to Science GS
Mission
Control
System
Missi
Contr
System

Typical Commanding subsystem



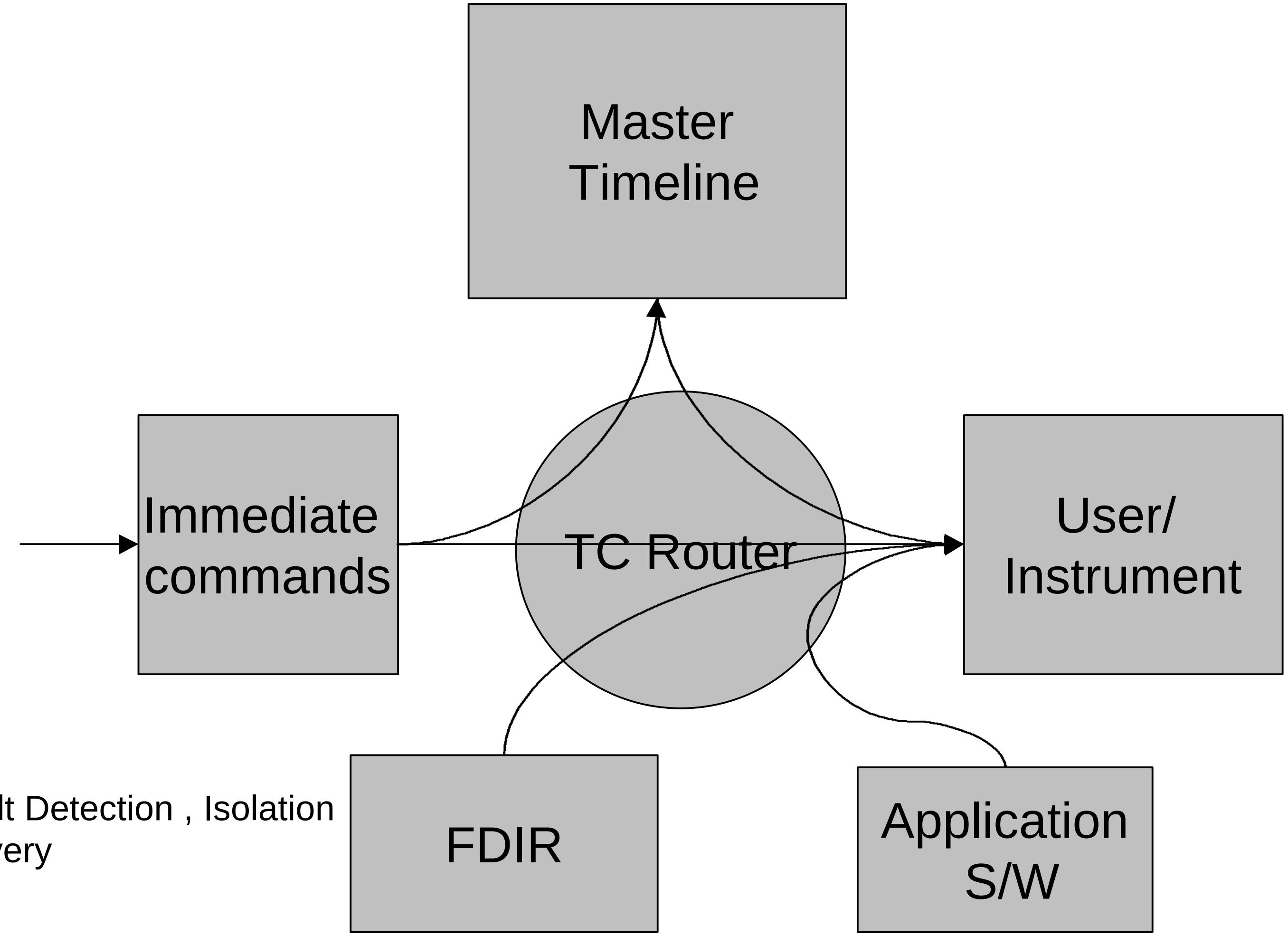
Telecommand Processing



Proposed Command Request Interface

- All TC's are described in the DB (derived from AIV/AIT) at ESOC (variable parameters are allowed)
- TC sequences (with parameters) defined in DB (structure, resources, constraints) at ESOC
- Command Requests submitted in form (typically):
  - Preferred execution time of operation
  - Execution time window
  - TC sequence mnemonic
  - Param 1...... Param n
- Tracking of requests: reports of (via Gateway)
  - Status of command request
  - Status of command schedules
  - Command History (verification information)
  - Raw TM

On-Board system



FDIR: Fault Detection , Isolation and Recovery

Telecommand Control

- OBDH Level:
  - – Master Timeline
    - command sub-schedule inhibit/enable
  - – Command router
    - commands to a particular destination
- User/Instrument level:
  - – refuse all commands except ….

Why the different Levels?

- Sub-schedule in MTL:
  - controlled by the OBDH, when an instrument problem is detected, or on request from the ground
  - allows immediate interaction with a “live” instrument, without being interfered with by commands from the MTL (e.g. rejoin the timeline after recovery actions)
- Commands to a given destination
  - controlled by router, on request from FDIR, ground
  - prevents commands from any source reaching the instrument, until re-enabled.
- Commands at the instrument
  - controlled by the instrument
  - prevents all but a subset of commands (e.g. dump memory, switch to standby, send data) being executed as a protective measure.

Telecommand Services

Source Documentation:

- Standards
  - Packet telecommand standard PSS-04-107
  - Packet telemetry standard PSS-04-106
  - Packet utilisation standard PSS-07-101
- Reference mission (Rosetta)
  - Rosetta SGICD RO-ESC-IF-5002

Packet Services(1)

nments/R arks	ST	Telecommand	FIRM	DMS	AOC	STR	CA M	SSMM	P/L	ST	Telemetry	FIRM	DMS	AOC	STR	CA M	SSMM	P/L	pkt cat
		Service 1: TC Verification																	
										1	Telecommand Acceptance Report - Success	Y	Y	Y	Y	Y	Y	M	ACK
										2	Telecommand Acceptance Report - Failure	Y	Y	Y	Y	Y	Y	M	ACK
										7	Telecommand Execution Completion Report - Success	Y	Y	Y	Y	Y	Y	O	ACK
										8	Telecommand Execution Completion Report - Failure	Y	Y	Y	Y	Y	Y	O	ACK
		Service 2: Device Command Distribution																	
	1	Distribute On/Off Commands	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	2	Distribute Register Load Commands	N/A	Y	N/A	N/A	N/A	N/A	N/A										
rect oder TCs	3	Distribute CPDU Commands	N/A	Y*	N/A	N/A	N/A	N/A	N/A										
		Service 3: Housekeeping Reporting																	
	1	Clear and replace a Housekeeping Report Packet descriptor	N/A	Y	Y	N/A	N/A	N/A	N/A										
	3	Add to an already defined Housekeeping Report Packet descriptor	N/A	Y	Y	N/A	N/A	N/A	N/A										
	5	Enable Housekeeping Report Packet Generation	N/A	Y	Y	N/A	N/A	N/A	M										
	6	Disable Housekeeping Report Packet Generation	N/A	Y	Y	N/A	N/A	N/A	M										
* Only on Private TC request										25	Housekeeping Report Packet	N/A	Y	Y	Y	Y	Y*	M	HK
	27	Modify Housekeeping Report Packet Generation Frequency.	N/A	Y	Y	N/A	N/A	N/A	N/A										
		Service 5: Events Reporting																	
										1	Normal/Progress Report	N/A	Y	Y	Y	Y	Y	M	EVENT

Packet Services(2)

										2	Error/Anomaly Report - Warning	N/A	Y	Y	Y	Y	Y	M	EVENT
										3	Error/Anomaly Report - Ground Action	N/A	Y	Y	Y	Y	Y	O	EVENT
										4	Error/Anomaly Report - On-board Action	N/A	Y	Y	Y	Y	Y	O	EVENT
	5	Read Critical Events Log	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	7	Clean Critical Events Log	N/A	Y	N/A	N/A	N/A	N/A	N/A										
		Service 6: Memory Management																	
	2	Load Memory using Absolute Addresses	Y	Y	Y	Y	Y	Y	O										
	5	Dump Memory using Absolute Addresses	Y	Y	Y	Y	Y	Y	O	6	Memory Dump using Absolute Addresses Report	Y	Y	Y	Y	Y	Y	O	DUMP
	9	Check Memory using Absolute Addresses	Y	Y	Y	Y	Y	Y	O	10	Memory Check using Absolute Addresses Report	Y	Y	Y	Y	Y	Y	O	EVENT
		Service 7: OBCP Management																	
	1	Start OBCP	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	2	Stop OBCP	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	3	Suspend OBCP	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	4	Resume OBCP	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	6	Communicate Parameters to an OBCP.	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	10	Report list of OBCPs	N/A	Y	N/A	N/A	N/A	N/A	N/A	11	OBCPs List Report	N/A	Y	N/A	N/A	N/A	N/A	N/A	TABLE
		Service 8: Application Programs Management																	
	1	Start Application Program	N/A	Y	Y	N/A	N/A	N/A	N/A										
	2	Stop Application Program	N/A	Y	Y	N/A	N/A	N/A	N/A										
	6	Communicate with an Application Program	N/A	Y	Y	N/A	N/A	N/A	N/A										

Packet Services(3)

		Service 9: Time Synchronisation																	
	1	Accept Time Update	N/A	Y	N/A	Y	Y	Y	M										
	2	Send Time to user	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	3	Stop Time update to user	N/A	Y	N/A	N/A	N/A	N/A	N/A										
		Service 10: Time Reference Management																	
	1	Change Time Report Packet generation rate	N/A	Y	N/A	N/A	N/A	N/A	N/A	2	Time Report	N/A	Y	N/A	N/A	N/A	N/A	N/A	TIME
	3	Change On-Board Time	N/A	Y	N/A	N/A	N/A	N/A	N/A										
		Service 11: Mission Timeline Management																	
	1	Enable Release of Selected Telecommands	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	2	Disable Release of Selected Telecommands	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	3	Reset Command Schedule	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	4	Insert Telecommands in Command Schedule	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	5	Delete Telecommands by Application Process ID and Sequence Count	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	6	Delete Telecommands over Time Period	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	8	Time-Shift Telecommands over Time Period	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	9	Report Command Schedule in Detailed Form over Time Period	N/A	Y	N/A	N/A	N/A	N/A	N/A	10	Detailed Schedule Report	N/A	Y	N/A	N/A	N/A	N/A	N/A	TABLE
		Service 12: On-board Monitoring																	
		Parameter Monitoring																	
	1	Enable Monitoring of Parameters	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	2	Disable Monitoring of Parameters	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	4	Clear Parameter Monitoring List	N/A	Y	N/A	N/A	N/A	N/A	N/A										

Packet Services(4)

	5	Add/Modify Parameters to Monitoring List	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	6	Delete Parameters from Monitoring List	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	8	Report Current Parameter Monitoring List	N/A	Y	N/A	N/A	N/A	N/A	N/A	**9**	Current Parameter Monitoring List Report	N/A	Y	N/A	N/A	N/A	N/A	N/A	TABLE
		Event Monitoring																	
	10	Enable Recovery Action	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	11	Disable Recovery Action	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	14	Clear Event Monitoring List	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	15	Add Events to Monitoring List	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	16	Delete Events from Monitoring List	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	18	Report Current Event Monitoring List	N/A	Y	N/A	N/A	N/A	N/A	N/A	**19**	Current Event Monitoring List Report	N/A	Y	N/A	N/A	N/A	N/A	N/A	TABLE
		Service 13: Large Data Transfer																	
										1	First Downlink Part Report	N/A	Y	N/A	N/A	N/A	TBD	O	FT
										2	Intermediate Downlink Part Report	N/A	Y	N/A	N/A	N/A	TBD	O	FT
										3	Last Downlink Part Report	N/A	Y	N/A	N/A	N/A	TBD	O	FT
										4	Downlink Abort Report	N/A	Y	N/A	N/A	N/A	TBD	O	FT
	5	Downlink Reception Acknowledgement	N/A	Y	N/A	N/A	N/A	TBD	O										
	6	Unsuccessfully Received Parts List	N/A	Y	N/A	N/A	N/A	TBD	O										
	8	Abort Downlink	N/A	Y	N/A	N/A	N/A	TBD	O										
	9	Accept First Uplink Part	N/A	Y	N/A	N/A	N/A	TBD	O										
	10	Accept Intermediate Uplink Part	N/A	Y	N/A	N/A	N/A	TBD	O										
	11	Accept Last Uplink Part	N/A	Y	N/A	N/A	N/A	TBD	O										
	13	Abort Reception of Uplinked Data	N/A	Y	N/A	N/A	N/A	TBD	O										
										14	Uplink Reception Acknowledgement Report	N/A	Y	N/A	N/A	N/A	TBD	O	FT
										15	Unsuccessfully Received Parts Report	N/A	Y	N/A	N/A	N/A	TBD	O	FT

Packet Services(5)

										16	Reception Abort Report	N/A	Y	N/A	N/A	N/A	TBD	O	FT
		Service 14: Packet Real-Time Downlink Control																	
	1	Enable Downlink of Selected Packets by APID	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	2	Disable Downlink of Selected Packets by APID	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	3	Report Real-Time Downlink Routing Table	N/A	Y	N/A	N/A	N/A	N/A	N/A	**4**	Real-Time Downlink Routing Table Report	N/A	Y	N/A	N/A	N/A	N/A	N/A	TABLE
		Service 15: On-board Telemetry Storage and Retrieval																	
	1	Start Storage of Packets in a store	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	2	Stop Storage of Packets in a store	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	3	Add APID to Packet Store Definition	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	4	Remove APID from Packet Store Definition	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	5	Report Packet Store Definition	N/A	Y	N/A	N/A	N/A	N/A	N/A	**6**	Packet Store Definition Report	N/A	Y	N/A	N/A	N/A	N/A	N/A	TABLE
	7	Downlink Packet Store Contents for Packet Range	N/A	N/A	N/A	N/A	N/A	Y	N/A										
	8	Stop Retrieval from a Packet Store	N/A	N/A	N/A	N/A	N/A	Y	N/A										
	9	Downlink Packet Store Contents for Time Period	N/A	N/A	N/A	N/A	N/A	Y	N/A										
	10	Delete Packet Stores Contents up to Specified Packet	N/A	N/A	N/A	N/A	N/A	Y	N/A										
	11	Delete Packet Stores Contents up to Specified Time	N/A	N/A	N/A	N/A	N/A	Y	N/A										
	12	Report Storage Catalogue	N/A	N/A	N/A	N/A	N/A	Y	N/A	**13**	Storage Catalogue Report	N/A	N/A	N/A	N/A	N/A	Y	N/A	TABLE
	14	Copy Packet Store Contents for Packet Range	N/A	N/A	N/A	N/A	N/A	Y	N/A										
	15	Stop Copy Packet Store Contents	N/A	N/A	N/A	N/A	N/A	Y	N/A										
	16	Copy Packet Store Contents for Time Period	N/A	N/A	N/A	N/A	N/A	Y	N/A										
		Service 16: On-board Traffic Management																	
	1	Add APID to a Routing Table	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	2	Delete APID from a Routing Table	N/A	Y	N/A	N/A	N/A	N/A	N/A										
	3	Report a Routing Table Contents	N/A	Y	N/A	N/A	N/A	N/A	N/A	**4**	Routing Table Contents Report	N/A	Y	N/A	N/A	N/A	N/A	N/A	TABLE

Packet Services(6)

		Service 17: Connection Test																	
	1	Request Connection Test Response	Y	Y	Y	Y	Y	Y	M	**2**	Connection Test Response Report	Y	Y	Y	Y	Y	Y	M	EVENT
	3	Request Connection Test	N/A	Y	N/A	N/A	N/A	N/A	N/A										
		Service 18: Context Transfer (DMS <-> User)																	
	1	Report Context	N/A	Y	O	N/A	N/A	TBD	O	**2**	Context Report	N/A	Y	O	N/A	N/A	TBD	O	CONTEXT
	3	Accept Context	N/A	Y	O	N/A	N/A	TBD	O										
		Service 19: Information Distribution (DMS -> User)																	
	1	Initiate Information Distribution	N/A	Y	N/A	N/A	N/A	N/A	O										
	10 to 255	Information Distribution sub types 10 to 255	N/A	Y	N/A	N/A	N/A	N/A	O										
		Service 20: Science Data Transfer																	
	1	Enable Science Report Packet Generation on RTU Link	N/A	N/A	N/A	N/A	N/A	N/A	M	**3**	Science Report on RTU Link	N/A	N/A	N/A	N/A	N/A	N/A	M	PRIVATE
	2	Disable Science Report Packet Generation on RTU Link	N/A	N/A	N/A	N/A	N/A	N/A	M										
	10	Enable Science Report Packet Generation on High Speed Link	N/A	N/A	N/A	N/A	Y	N/A	M	**13**	Science Report on High Speed Link	N/A	N/A	N/A	N/A	Y	N/A	M	PRIVATE
	11	Disable Science Report Packet Generation on High Speed Link	N/A	N/A	N/A	N/A	Y	N/A	M	**12**	Report Science Data Generation Stopped at Packet Boundary	N/A	N/A	N/A	N/A	Y	N/A	M	EVENT
		Service 191 to 255: Private Services Payload																	
	n	Payload Private Telecommand n	N/A	N/A	N/A	N/A	N/A	N/A	M	**n**	Payload Private Telemetry n	N/A	N/A	N/A	N/A	N/A	N/A	M	FUNC

Payload Packet Services(1)

Comments/Remarks	ST	Telecommand	P/L	ST	Telemetry	P/L	pkt cat
		Service 1: TC Verification					
				1	Telecommand Acceptance Report - Success	M	ACK
				2	Telecommand Acceptance Report - Failure	M	ACK
				7	Telecommand Execution Completion Report - Success	O	ACK
				8	Telecommand Execution Completion Report - Failure	O	ACK
		Service 2: Device Command Distribution					
	5	Enable Housekeeping Report Packet Generation	M				
	6	Disable Housekeeping Report Packet Generation	M				
* Only on Private TC request				**25**	Housekeeping Report Packet	M	HK
		Service 5: Events Reporting					
				1	Normal/Progress Report	M	EVENT
				2	Error/Anomaly Report - Warning	M	EVENT
				3	Error/Anomaly Report - Ground Action	O	EVENT
				4	Error/Anomaly Report - On-board Action	O	EVENT
		Service 6: Memory Management					
	2	Load Memory using Absolute Addresses	O				
	5	Dump Memory using Absolute Addresses	O	**6**	Memory Dump using Absolute Addresses Report	O	DUMP
	9	Check Memory using Absolute Addresses	O	**10**	Memory Check using Absolute Addresses Report	O	EVENT
		Service 9: Time Synchronisation					
	1	Accept Time Update	M				
		Service 10: Time Reference Management					

Payload Packet Services(2)

Comments/Remarks	ST	Telecommand	P/L	ST	Telemetry	P/L	pkt cat
		Service 10: Time Reference Management					
		Service 13: Large Data Transfer					
				1	First Downlink Part Report	O	FT
				2	Intermediate Downlink Part Report	O	FT
				3	Last Downlink Part Report	O	FT
				4	Downlink Abort Report	O	FT
	5	Downlink Reception Acknowledgement	O				
	6	Unsuccessfully Received Parts List	O				
	8	Abort Downlink	O				
	9	Accept First Uplink Part	O				
	10	Accept Intermediate Uplink Part	O				
	11	Accept Last Uplink Part	O				
	13	Abort Reception of Uplinked Data	O				
				14	Uplink Reception Acknowledgement Report	O	FT
				15	Unsuccessfully Received Parts Report	O	FT
				16	Reception Abort Report	O	FT
		Service 17: Connection Test					
	1	Request Connection Test Response	M	**2**	Connection Test Response Report	M	EVENT
		Service 18: Context Transfer (DMS <-> User)					
	1	Report Context	O	**2**	Context Report	O	CONTEXT
	3	Accept Context	O				
		Service 19: Information Distribution (DMS -> User)					

Payload Packet Services(3)

Comments/Remarks	ST	Telecommand	P/L	ST	Telemetry	P/L	pkt cat
		Service 19: Information Distribution (DMS -> User)					
	1	Initiate Information Distribution	O				
	10 to 255	Information Distribution sub types 10 to 255	O				
		Service 20: Science Data Transfer					
	1	Enable Science Report Packet Generation on RTU Link	M	**3**	Science Report on RTU Link	M	PRIVATE
	2	Disable Science Report Packet Generation on RTU Link	M				
	10	Enable Science Report Packet Generation on High Speed Link	M	**13**	Science Report on High Speed Link	M	PRIVATE
	11	Disable Science Report Packet Generation on High Speed Link	M	**12**	Report Science Data Generation Stopped at Packet Boundary	M	EVENT
		Service 191 to 255: Private Services Payload					
	n	Payload Private Telecommand n	M	**n**	Payload Private Telemetry n	M	FUNC

On-Board Software Maintenance

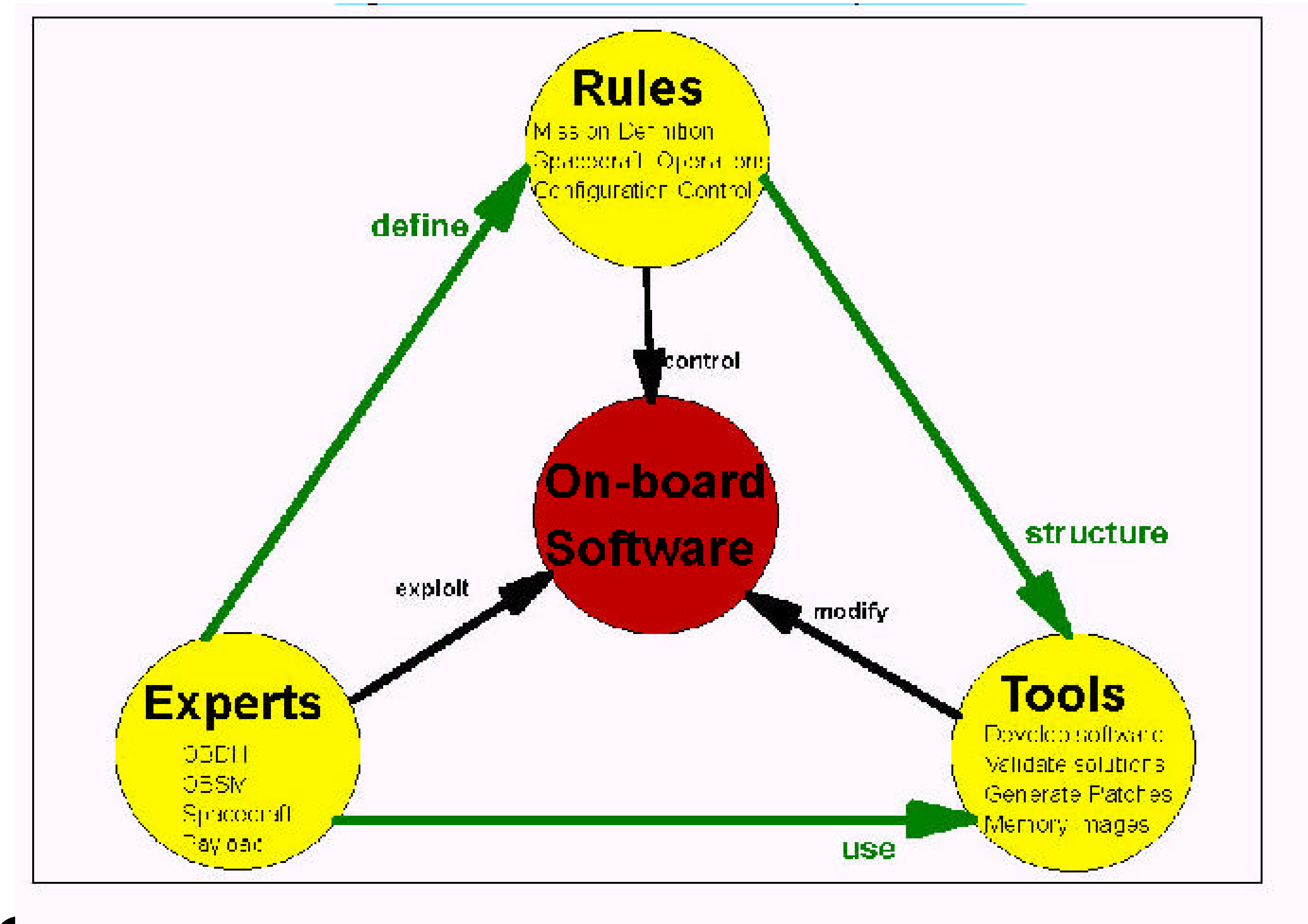
A MOC View

John Dodsworth

OBSM Goals

- WHAT: Image (All) + Source (Partial)
- WHY: Problem, improvement
- Identify:
  - experts
  - rules
  - tools

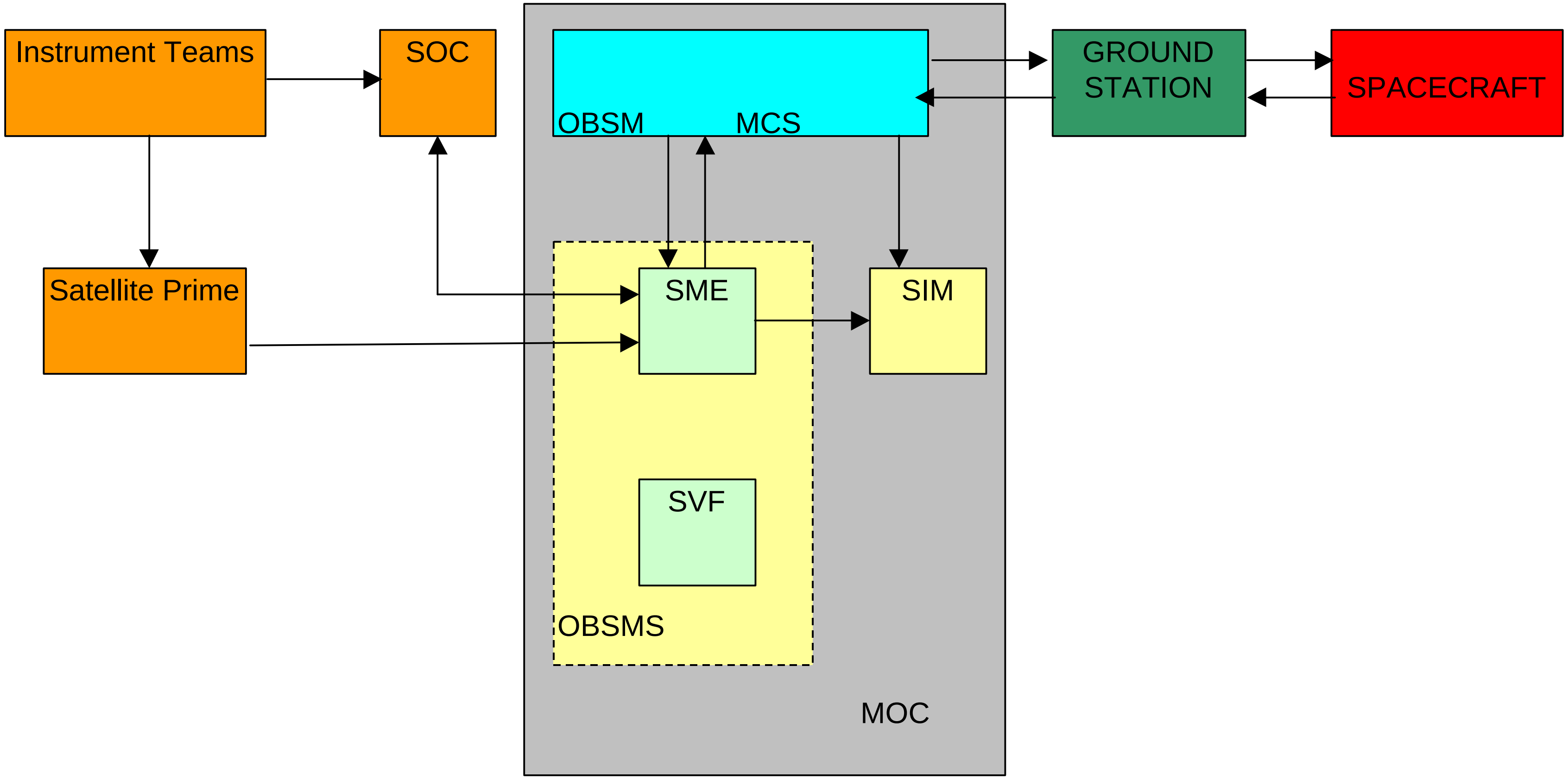
On-board Software and operations



Typical OBSM Concept

- Only full image transfer from external parties to OBSMS (no patches)
- SW modifications related to SVM validated in the OBSMS SVF
- Configuration Control for full SVM code + images, and PLM images only
- Use of SIM to test the TC generation/ procedures

Typical OBSM Overview



OBSM System Tasks

- Import and export Images
- Image storage
- Generate TC’s from images or comparisons
- Compare images
- Checksum calculation
- Dump telemetry processing (image construction)
- Displays and printouts

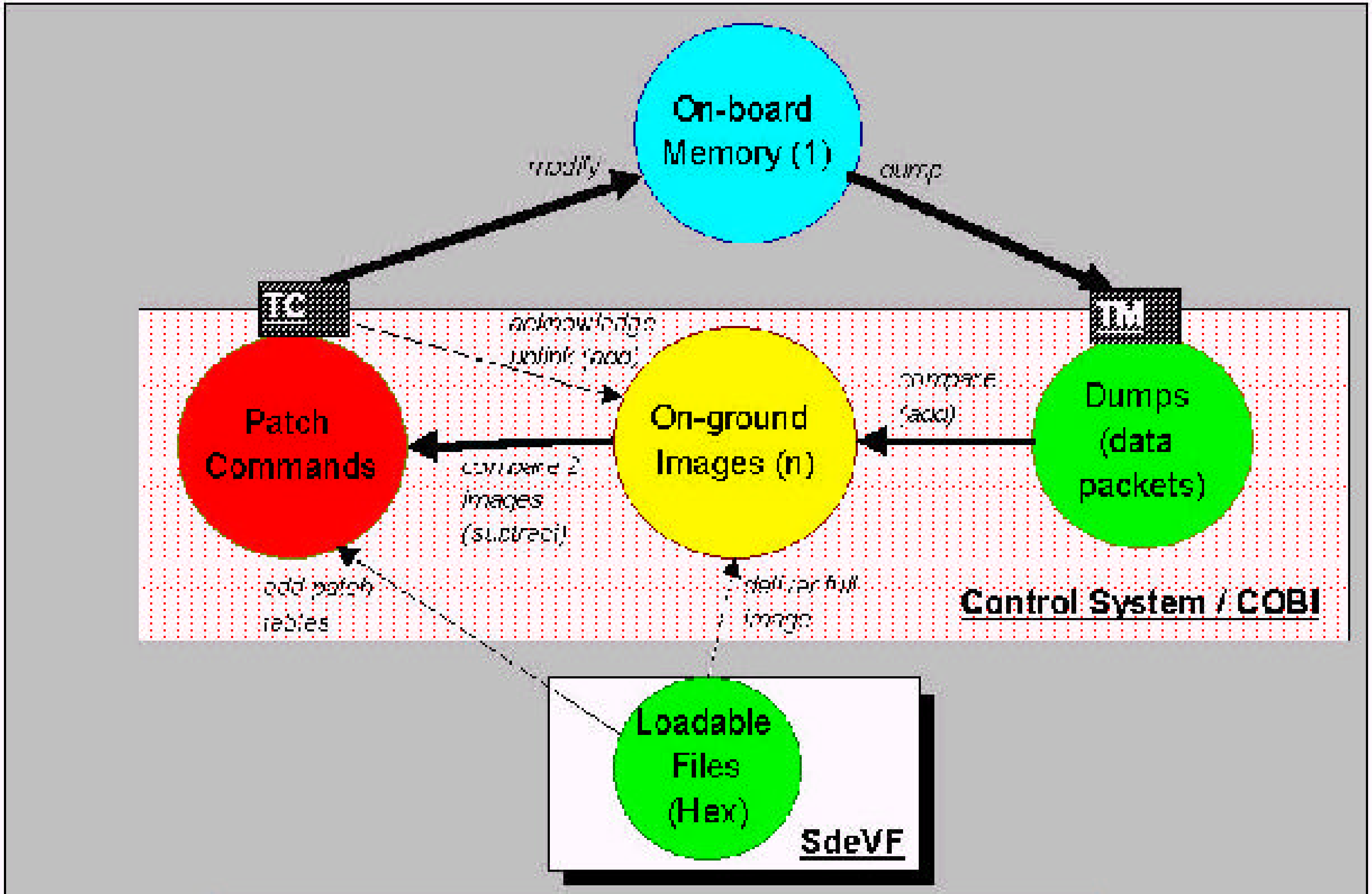


Fig. 6 : the image modification loop

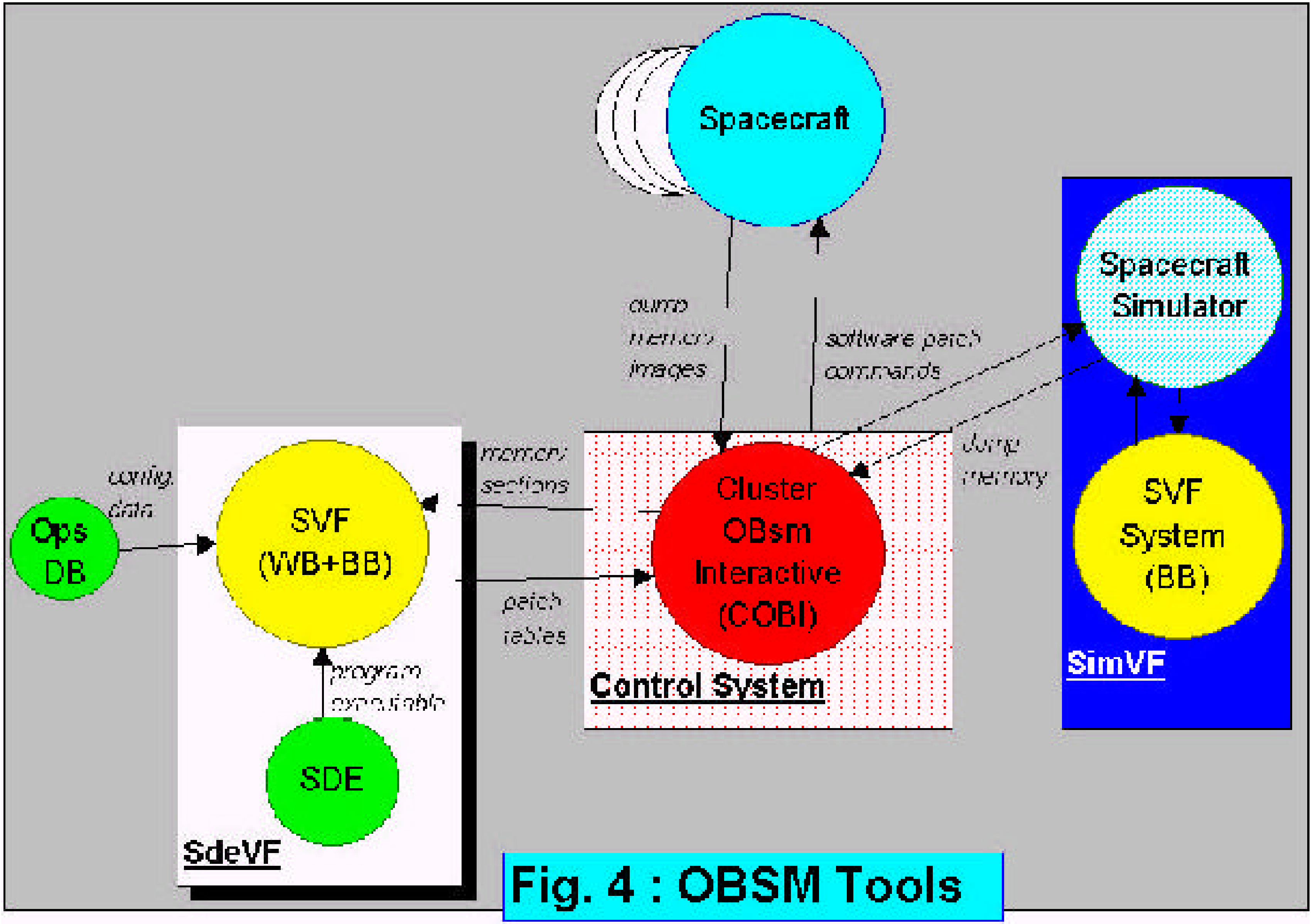


Fig. 4 : OBSM Tools

Challenges

- Match SW understanding to system view
- Expertise maintenance and transfer
- What is NOT possible
- Tools Maintenance
- Configuration Control
- Interaction with SDB / MIB

Recommendations

- Design for maintenance
- Ensure tools for software development and validation are available
- Ensure responsibilities are clear
- Commit to commonality:
  - processors
  - development environments
  - common services
  - common methods e.g. for:
    - software storage
    - loading subordinate processors

Reference

For a good account of a typical on-board software maintenance system for the SVM for the Cluster mission see:

ESA bulletin, number 91, august 1997:

“The Cluster On-board Software Maintenance Concept”

Note on AI 1/5 of CWG #4: Generate and co-ordinate “requirements “ on instruments commanding.

Prepared by A. M. Di Giorgio, R. Cerulli-Irelli

- ## Packet services

In the following it is assumed that the ESA packet telemetry and telecommand standard with implementation similar to the Rosetta project will be used by FIRST.

At this stage of the project we can only provide a preliminary list of packet services TBC. We believe that in the near future some of this services will be dropped.

Service Type	Service Name	Service Scope
1	Telecommand verification	It provides the capability for the verification of telecommand packets.
3	Housekeeping Reporting	It provides for the reporting to the ground of HK info
5	Event reporting	It provides for the reporting to the ground of various events as: failures, anomalies, autonomous actions etc
6	Memory management	It provides the capability for loading, dumping, and checking the contents of on board memory.
9	Time management	It provides the capability for the distribution of S/C time reference
11	On board scheduling	It provides the capability to command on board application processes using telecommands pre-loaded on board the S/C
12	On board monitoring	It provides capability to monitor on board parameters with respect to checks defined by the ground
13	Large data transfer	It provides capability to transfer large data units in a controlled manner.
20	Science data transfer	It provides the control of the science data transfer to OBDH
21	Private telecommands	It is used to send private telecommands (i.e. those TC, not covered under other packet services)

- ## Instrument commanding

Each instrument command is transmitted as a variable length packet of 16 bit words having the following general structure:

1. a Header describing the Command **function**;
2. the **number** of words to follow;
3. the new values of the **parameters**, if any.

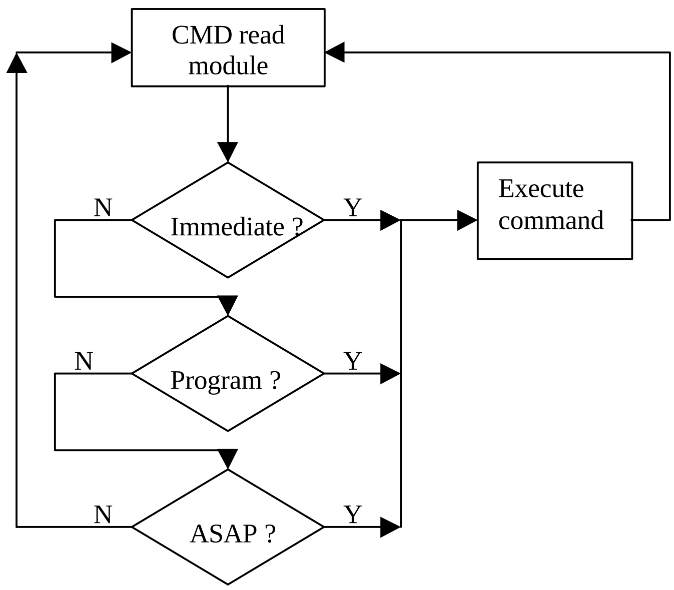
There are two main categories of commands:

- Standard Commands
- Time tagged Commands

The time tagged commands are standard commands to be executed at a specified time. Due to the communications constrain of the FIRST S/C we expect that nearly all commands will be time tagged and the delivery time to the instrument will be managed by the OBDH.

There are 3 types of standard commands, defining the execution priority from high to low, stored by the OBS in different circular buffers.

- Immediate commands **I**
- Program commands **P**
- ASAP commands **A**



Generally each command can belong to each of the 3 types.

Immediate commands are executed at the end of the current command execution phase.

Program commands are commands executed as a sequence. The sequence (i.e. the program) is formed by standard commands plus a few "pseudo instructions" special commands, defining elementary programming language statements (i.e. for loop, if statements, setting of program variables etc). A few of possible "pseudo instructions" are:

RUNP n	Execute program # n
ENDP	End of program
SETRX n, x	Set S/W register n to x
INCRX n	Increment/decrement S/W register n
JUMP …	Various jump based on S/W register count (Jump, Loop, if…..goto)
WAIT	Wait for internal action or fixed time

A program is initiated by a **I** or **A** *RUNP* command and is terminated by the *ENDP* instruction. Depending on the (ring) buffer dimension for programs commands, more than one program may be stored on board and executed at any time with a time tagged RUNP n command.

ASAP commands are executed when no other command type is present.

HIFI commanding philosophy

- initial discussions have started within the consortium
- needs well defined ‘Instrument Command Language’
- uses IFSI concepts
- no clear view on command verification yet
- HIFI is single-CPU,.... i.e. relatively simple
- complication comes from control loops involving optimisation of the set-up of several subsystems
- required tables for optimisation loops to be stored in spacecraft memory (TBD)

HIFI commanding

- based on time tagged commands with timing controlled by the onboard schedule
- based on a command language;
  - single commands with no parameters
  - single commands with parameters
  - sub functions (i.e. macros with arguments)
  - loop structures (*mus*t be predictable)
- command language to be used for tests
  - structure should allow commanding of test equipment

Current work

- compiling a list of possible (atomic) instrument commands
- defining control loops
- defining complete observations
- decompose these into (atomic) instrument commands
- use this as a basis for requirements on ICL
- defining tests
- uses these to extend ICL for test-equipment

Pierre Estaria on 26-05-99 15:51:08

To: Ingeborg van de Wetering/estec/ESA@ESA
cc:
Subject: FIRST/Planck CWG#4: AI 1/5: PACS commanding scheme : first darft

appendix 6.

--------------------- Forwarded by Pierre Estaria/estec/ESA on 26-05-99 16:02 ---------------------------

OHB@MPEPL.PLASMA.MPE-GARCHING.MPG.DE on 16-05-99 22:48:48

To: Pierre Estaria/estec/ESA
cc:
Subject: FIRST/Planck CWG#4: AI 1/5: PACS commanding scheme : first darft

---

From : O.H. Bauer, PACS PM, MPE Garching

To : P. Estaria, FIRST Project

Cc : CWG#4, A. Poglitsch

Date : 14-May-1999

Ref : FIRST/PACS/99-024/Em

Subject: CWG4-AI:1/5 : FIRST Requirements on Instrument Commanding
----

PACS input:
----

(1) Commanding

This input is based on the Commanding Scheme developed by IFSI for the three FIRST instruments.

It is also based on the assumption that all time-tagged commands are stored in the spacecraft memory and are sent to the instrument at the given time.

In addition we would like to introduce the requirement that the spacecraft memory holds the memory contents (progams and tables) of the three PACS microprocessor units (Prime and Redundant):
- Digital Processing Unit (DPU)
- Signal Processing Unit (SPU)
- Mechanism Control/Detector Control (MEC/DEC)
For each of these units we will have separate POWER-ON/OFF commands

(TBC).

PACS microprocessor units (schematic):

```
                    +---------+                           +----------+
       TC/TM        |         |   TC/Housekeeping         |          |
  S/C --------------+         +---------------------------+          |
                    |   DPU   |                           | MEC/DEC  |
                    |         |        +-------+          |          +-
FPU
                    |         |  TC    |       |          |          |
                    |         +--------+  SPU  +--------+ |          |
       Power-DPU    |         | Science|       | Science| |          |
  S/C ==============+         |        |       |        | |          |
       Power-SPU    |         |        |       |        | |          |
  S/C ==============+         +========+       |        | |          |
                    |         |        |       |        | |          |
       Pow-MEC/DEC  |         |        +-------+        | |          |
  S/C ==============+         +===========================+          |
                    |         |                           |          |
                    +---------+                           +----------+
```

The Turn-On sequence for PACS could then be:

- POWER-ON DPU
- Memory load: S/C -> DPU
- Memory verification DPU
- POWER-ON SPU
- Memory load: S/C -> DPU -> SPU
- Memory verification SPU
- POWER-ON MEC/DEC
- Memory load: S/C -> DPU -> MEC/DEC
- Memory verification MEC/DEC

PACS will make use of the following command types:

- Single commands : Mnemonic + parameter
- Dummy commands : Text information to structure the command queue, will be reflected in the Housekeeping Packet.
- Instrument Command Sequences (ICS) : Sequence of commands with partly undefined parameters
- Permanent Command Sequences (PCS) : Sequence of commands,
completely
  defined

ICSs and PCSs will be stored in the DPU memory.
Command Functions (see IFSI) will be used to fill in the missing ICS parameters. PCSs will also be called by Command Functions.

The DPU check the parameter range of the commands and then send the commands to MEC/DEC or SPU.
MEC/DEC will syncronise the command execution with the reset cycle of the detectors.
The SPU will always get a copy of all MEC/DEC commands in order to
be
prewarned about the setting of the mechanisms in the FPU and the
timing
of the incoming detector data. According to this information the

SPU will preselect the data reduction and compression algorithms.

(2) Command verification

Three instrument configuration buffers will be used for command verification:

- COMMANDED: This buffer holds all parameters of the instrument setting as defined by the incoming commands.
- EXPECTED : This buffer holds all settings which can be precalculated for the commanded values, e.g. scanner setting calculated from start values, step size, step time.
- ACTUAL : This buffer holds all actual settings received from the read-out electronics.

DPU or MEC/DEC autonomous functions will compare the contents of the three buffers and issue success or error messages. The actual buffer and theses messages will be part of the Housekeeping Packet, but will also be sent to the spacecraft for Event Reporting.

It is still under discussion to which extend we should use Command Verification Packets. It might not be useful to send such a packet for each command, but perhaps for each ICS or PCS including the success or error message, e.g. for a whole scan.

Other autonomy functions will check SPU or MEC/DEC temperatures, voltages and currents. The actual values will be part of the House-keeping Packet. Out of limits will be sent as Event Packets to the spacecraft which then can take corrective actions.

Glitch rates and saturation will be calculated by the SPU and handled the same way. For certain error messages the DPU might be able to change certain settings by internal commands.

FIRST/PLANCK CWG#4/5, ESTEC 19/5/99

Command Verification for Planck Instruments

by Chris Butler LFI PM

LFI/HFI Commanding scenario

- Both LFI and HFI expect to send very few commands to their instruments during ordinary operations and would be routine commands (typically less than 10 per day each).
- Most of these would be time tagged commands (TBC)
- The commands would be

  -simple hardware set up commands

  -science telemetry output mode changes
- Neither instrument is expecting to initiate long or involved processes by single commands.

LFI/HFI command types

- Real time commands via CDMU to instrument

  - These would take priority over time tagged commands in the time tagged buffer
- Time tagged commands via CDMU with a resolution of 1 sec.
- Both RT and TT CMDS appear as RT Cmds to instruments
- Both RT and TT CMDS could contain sets of single commands eg. For setting up amplifier voltages
- If any S/W patching is needed it would be expected to be done in real time - with scientific activity suspended

Command Verification 1/4

- For the instruments this should foresee

  - Cmd transmission and onboard time tagged command buffer management, control and verification at MOC

  - CDMU management of real time and time tagged commands, with return in CDMU telemetry eg. via history files

  -Watchdog activity by CDMU using S/C Bus transmission protocol and instrument status registers for command acceptance and consequent status

Command Verification 2/4

-Simple instrument verification of command contents prior to application with return to

-CDMU through status registers (CDMU watchdog)

- direct to MOC in telemetry via specific packets for history file creation on ground (if possible)

-Instrument created current configuration buffer available to MOC in real time (might also be useful to put this in telemetry at a very low rate)

Command Verification 3/4

- MOC verification of instrument status - MOC is responsible for operations control in and out of visibility
  - In real time using housekeeping with,
    out of limit checking, and commanded status checking
  - On out of visibility data (mass memory) using instrument
    housekeeping data, out of limit checking, and command
    history files
- If possible the out of limit checking should be cross correlated with the commanded status

Command Verification 4/4

- DPC verification of instrument status - DPC is responsible for verification of operation results and scientific performance generally working with previous days data using:-

  -housekeeping data with OOL checking and cmd history files cross referencing

- scientific data to evaluate scientific performance results of commands

- instrument trend analysis

Problem Areas

- These tend to come from the System restrictions on telemetry production functions of both instrument and CDMU

  - Will the system allow event driven variable length packets to be produced by the instruments - at least for command verification?

  -How will the instrument housekeeping be presented in telemetry to the MOC?

  - through packets produced by the instruments

  - through packets of overall satellite housekeeping produced by the CDMU

Pierre Estaria on 26-05-99 15:56:20

To: Ingeborg van de Wetering/estec/ESA@ESA
cc:
Subject: I: LFI input on command verification

Appendix 8.

-------------------- Forwarded by Pierre Estaria/estec/ESA on 26-05-99 16:07 ---------------------------

"montini" <montini@asi.it> on 06-05-99 15:14:58

To: Pierre Estaria/estec/ESA, charra@iaslab.ias.fr, couchot@lal.in2p3.fr, gispert@ias.fr, pajot@ias.fr, P.R.Roelfsema@sron.rug.nl, fgb@mpe.mpg.de, c.d.pike@rl.ac.uk, jhl@iac.es, cerulli@ifsi.rm.cnr.it, sdodswor@esoc.esa.de, stefano.pezzuto@ifsi.rm.cnr.it
cc: ohb@mpe.mpg.de, e.taddei@batman.laben.it, alippi.e@batman.laben.it, mambretti.an@batman.laben.it, reno@tesre.bo.cnr.it, marco@ifctr.mi.cnr.it, pasian@ts.astr.it, butler@tesre.bo.cnr.it
Subject: I: LFI input on command verification

-----Messaggio originale-----
Da: Chris Butler <butler@tesre.bo.cnr.it>
Data: 05 May 1999 16:48
Oggetto: LFI input on command verification

Ref:LFI/ASI/RCB/99-0020, 6/5/99
From: Chris Butler actually at butler@tesre.bo.cnr.it

I refer to the CWG#4 action 1/5 on command verification - specifically for LFI but I suspect the same kind of command situation applies atleast to HFI and thus to Planck. In FIRST the situation might be different (more complicated) as it has a far more dynamic observation program and inter-instrument coordination activity, but I am not convinced of this.

I forsee the following types of command for LFI:-
- Realtime commands from the ground station/MOC which always have priority over timetagged commands in the CDMU timetag cmd buffer.
- Timetagged commands
- Timetagged or real time commands can contain either single commands (eg. set a certain DAC to a certain value or contain multiple single commands (eg. to set a series of different DAC's to different voltage values). This option is particularly useful as it reduces the number of timetagged commands and allows the MOC a more easily structured commanding approach for
instrument setup.

The above types should be sufficient:-
- All commands take a certain time to be executed after receipt by the instrument, and these times are known, so adequate command spacing can be assured by MOC planning either of realtime commands or timetagged commands -
a simple default time separation is usually all that is necessary.

"Stacking" of commands should be absolutely avoided - so "as soon as possible commands" (ASAP) are not necessary.

It is not expected that LFI will require a large number of commands during
operation, and the overall system should be designed/dimensioned around this
fact, and not around the verification phase where inevitably we will want to
send more commands while fine tuning amplifier voltages etc - there is always away around this. Command verification information in the telemetry should be kept to "a just minimum" as we need the maximum telemetry space available for science data.

Command verification can be split into the following:-

- Construction of commands and command sequences on the ground (at MOC)
- Transmission to the satellite from the ground
- Command handling by the CDMU and transmission from the CDMU to the instrument
- Verification of command contents by the instrument itself
- Return information in the telemetry and towards the CDMU
- Verification of the result on the ground at MOC
- Subsequent verification of the result at DPC

1). Construction of commands and command sequences on the ground (at MOC)
Physical command structures and command sequences will be created at the MOC, within a configuration controlled and highly tested system setup. This system should be considered to be highly reliable and will have its own verification processes, including those necessary to manage the CDMU timetagged command buffer.

2).Transmission to the satellite from the ground
The ESA command transmission protocol (ground-satellite and verfication satellite -ground) is very good and there is no reason honestly to be worried that a command sent to the satellite (either immediate or time tagged) will be received wrongly or somehow lost in this process. The protocol related processes cover these possabilities specifically.

3).Command handling by the CDMU and transmission from the CDMU to the instrument
All commands both immediate and timetagged for LFI will be handled by the CDMU. Any verification activity on CDMU ASW task required by ESA for the non
payload subsystems should be expected to be perfectly adequate also for payload commands.

Timetagged commands will be stored in the CDMU timetagged command buffer and the CDMU ASW will distribute them at the correct onboard time. Generally this service is limited in number of commands operated per second eg. total maximum for all spacecraft could be 4 per second, and time resolution of application would be limited to one second - application order
within one second would come from order stored in the buffer. It is the MOC which should be responable for the contents of the CDMU time tagged buffer, and also the MOC should be responsable when sending realtime commands with timetagged commands already onboard that an inconsistent situation is not created. Remember we may have timetagged commands onboard for another day of

operation already when being serviced by the ground station.

The command transmission protocol CDMU - LFI should be considered to be highly reliable. The only time this might go wrong is if the satellite has a
contingency itself eg. CDMU switchover during command transmission - under these circumstances it is usually the CDMU (here the redundant) that would have as one of its autonomous tasks the "safing" of the instrument eg.instrument power-off or standby.

In the case that the CDMU-LFI protocol (from the CDMU's point of view without a contingency) has not been completed correctly we will have to decide, for the CDMU ASW, requirements whether the instrument should be powered off or put in a standby mode with further timetagged commands transmission to the instrument being inhibited by the CDMU. In the case of choosing standby mode, which I would suggest, this CDMU activity becomes part of an overall watch-dog activity of the CDMU which would include other factors eg. does the instrument reply correctly to requests for housekeeping? Is the LFI currently responsable for commanding the Sorption Cooler?

4).Verification of command contents by the instrument itself
The possability exists, though we may never have it happen, that the contents of a command having passed successfully all the transmission protocols and arrived in the instrument, is still actually illegal either in
its internal sintax or associated parameter value (eg. commands a non existing unit or a DAC to an out off range value). Thus for all commands, an
instrument should control command sintax and legallity prior to execution. In the case that a fault is found, the instrument should obviuosly not try to execute the command, but should instruct the CDMU that it has rejected the command prior to execution - at this point the CDMU should intervene as at point (3) because obviously something is wrong somewhere. Note, the only intelligence around is that on the ground!
The only exception to this are software patch commands where only the sintax
can be checked by the instrument, but this is not a problem as we will only perform patches in invisibility under a special procedure.

4).Return information in the telemetry and towards the CDMU, Verification at
MOC and verification at DPC

4.1)So that the CDMU can perform its funcions at (3) and (4) above, the instrument should make available to the CDMU a short status buffer which does not have to be part of the instrument telemetry and therefore packetised data. This will allow basic control of the instrument to be done by the CDMU ASW both in conclusion of commanding and periodicaly eg. once a second for watchdog activity. This status buffer could be part of the system
required by the ground so that it can command and interrogate the instrument
even when the instrument is is not producing telemetry packets eg. low level basic diagnostics/memory dumping - with the telemetry packets being produced at this point by the CDMU.

4.2). The CDMU should produce a history file/telemetry so that the MOC can follow which timetagged commands have been transmitted to the spacecraft subsystems and instruments.

4.3).The instrument should contain a configuration buffer, that contains its current commanded status including parameters eg. commanded DAC values. This buffer would be updated by the instrument's command handling process during command execution, and if the instrument changes any of the commanded values as part of its internal control processes it should update the buffer. This buffer should be available to the MOC on request in realtime. Note, I do not believe that we really need to go to the level of history files in the instrument- this point is effectively covered by (4.4).

4.4).The instrument as part of its command handling process, should produce command receipt acknowledgement packets, containing the command contents and the instrument generated onboard time (resolution typically one second). These packets would allow the reconstruction on the ground of an instrument history file and allow the MOC/DPC to rapidly and easily reconstruct/control instrument history.
The instrument should not produce aswell, packets impling that that it has completed the execution of a command, or packets acknowledging that it has completed a certain percentage of a task. In the final analysis of command execution verification the data in packets of this type do not verify anything useful (see 4.5).

4.5). Final command execution verification requires the analysis of the instrument's housekeeping and science data, as has always been the case traditionally - there is no substitution for this. This can be as complicated as we wish to make it, but in the end it tends to be reduced and divided between MOC and DPC.
4.5.1). The MOC handles only clear functional information by an analysis of instrument and satellite housekeeping, and data available from points 4.1 to 4.4 for instance, to ensure overall status and perform out of limit checking. To this end, as all instrument housekeeping data should be limited to that of a functional character (hardware/software settings), all instrument housekeeping has to be available to the MOC eventhough its main interest is in out of limit and status checking only. As CDMU control of the instrument is covered by activities like (4.1) these data could be packetised by the instrument, or if ESA prefer by the CDMU and thus enter directly into the spacecraft housekeeping data.
This instrument housekeeping should be very traditional in nature. It should be fixed format, and fixed rate, and not event driven like that at (4.4).
4.5.2). The DPC may do more verification on the housekeeping data than the MOC eg. to check values and not just status and out of limits. The DPC can also verify the instrument performances using the scientific data, and thus verify the performance results part of command verification.

I hope the above demonstrates how command verification can be done in a simple way for LFI. I believe that the above is consistent with the

contents
of the OIRD FP-ESC-RS-0001, Draft 1, 26/8/97. It should however, be noted that the instruments may be required by the system to produce only fixed length packets - just the right size to go into single telemetry frames. This makes event driven packet production eg. the small packets envisaged at
(4.4) very inefficient in telemetry use.

I intend to use the above points for the short presentatrion requested for the next CWG#4 meeting.

Kind regards, Chris Butler