



date	reference	SCI-PT/	page	1/ 4
meeting date	meeting place	ESTEC		
meeting date	15-3-2000			
chairman	S. Thürey, ESA/SCI-PXI			
participants	see page 2	copy all participants, F.v.d.B., Th.P., A.He., H.Sch.		
subject	1st FIP Data I/F WG Meeting			

description	action	due date
<ul style="list-style-type: none"> <li>• Agenda: see p. 1 of attachment 1</li> <li>• Action Items: see p. 3, 4, A1 1 to A1 5</li> <li>• Attachments: 2, 20 pages</li> </ul>		

description		action	due date
<u>Participants</u>		<u>Tel</u>	<u>e-mail</u>
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description	action	due date
1) Introduction (ESA) 2) I/F concepts (presentations of teams) 3) <u>MIL 1553 B Details:</u>		
<ul style="list-style-type: none"> <li>- Because the harness topology of the SIC will only be known late the "Long Stub" bus configuration with 2 transformers is recommended by ESA.</li> </ul>		
<ul style="list-style-type: none"> <li>- Remote Terminal Addresses: RTAs of the instruments shall be kept configurable (in HW and SW). ESA will take care of allocating RTAs before August 2007.</li> </ul>		
<ul style="list-style-type: none"> <li>- RT-<del>to</del> RT-Transfers: are not foreseen for FIRST/Planck</li> </ul>		
<ul style="list-style-type: none"> <li>- Broadcast Messages: will be used at least for 7-sec-time-sync, possibly for more functions, TBD.</li> </ul>		
4) Catalogue of Questions		
<ul style="list-style-type: none"> <li>- LFI/HFI to define their science data traffic (average, short/long peak rates...) (presentation next meeting)</li> </ul>	A1-1 20-4-00, LFI, HFI	
<ul style="list-style-type: none"> <li>- All instruments to clarify which frequency they need as sync/clock, at which accuracy.</li> </ul>	A1-2 20-4-00 all Instr.-teams	

description	action	due date
- ESA to present cyclic bus access scheme during next WH-meeting.	A1-3 20-4-00, ESA	
- All instrument groups to present concepts and/or requirements on the low level protocol needed to transfer a TM/TC packet within a 20ms time slot.	A1-4 20-4-00, all teams	
- The FIRST/Pancks Instrument teams think they do not have the capability and responsibility to develop the packet transfer protocol algorithm needed on the 1553-bus. ESA states this is considered as part of the specification/design work for the instrument data I/F.		
- Answers to questions: attachment 2 Date of next meeting: 20-4-2000, ESOC, TBC. (18, 19-4-00: SCOS-2000-meeting)		
5) A draft of SCI-PT-IF-07527 (PS-ICD) was handed out to all teams. Comments are expected to be returned before 20-4-00.	A1-5, 20-4-00, all teams	



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**FIRST / Planck Instruments to CDMS Working Group**

**Meeting 1, 15-3-2000, ESTEC**

**Stefan Thürey SCI-PXI**

- Agenda:
  - 1) Introduction
  - 2) HW architecture of instrument data interfaces
  - 3) Mil 1553B data bus I/F, overview (ESA)
  - 4) Catalogue of questions, issued so far: clarification, discussion (all)
  - 5) Packet Structure ICD: introduction (ESA)
  - 6) Open issues, action items (all)



# 1) FIRST / Planck Instrument to CDMS Interface (FPD)

## Introduction, Subject

- The instrument teams need a definition of the data and electrical interfaces between instruments and satellite bus for instrument development.
  - ESA will ensure, via satellite level specifications, that the industrial Prime complies with functional and performance requirements on the data interface.
  - A detailed I/F design can only be specified and worked out by instrument groups (and S/C Prime for the S/C).
  - The FPD WG will take care of providing a necessary and sufficient set of requirements to all parties involved.



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## **FIRST / Planck Instrument to CDMS Interface (FPD)**

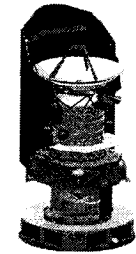
### **Objectives of Activities**

- Identify and select options from the MIL 1553B Standard for implementation on FIRST / Planck.
- Identify missing implementation issues needed to establish a complete on-board data service.
- Review S/C level requirements for consistency with the intended implementation and derive missing requirements, such that they can be incorporated into the IID-A.
  
- As ESA is not going to make a proposal for a detailed I/F-electronics design the instrument groups are requested to provide a I/F pre-design and a specific assessment of the requirement status for possible updates. These inputs shall be subject to harmonisation and endorsement by the working group.



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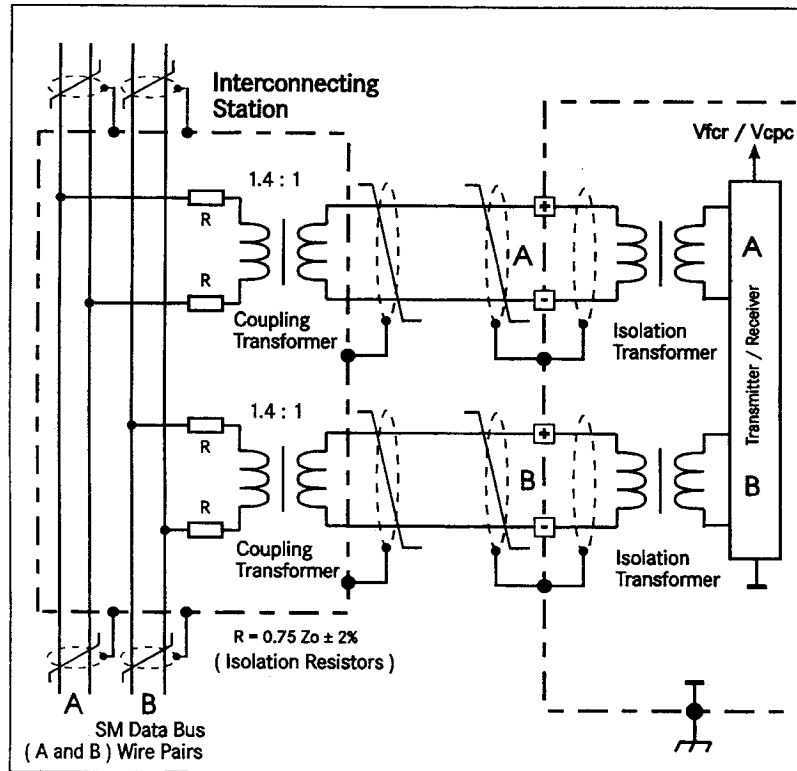
## FIRST / Planck Instrument to CDMS Interface (FPD)

- Detailed Objectives:
  - Clarification of open questions on the MIL 1553B Std., raised by the instrument teams.
  - Discussion of implementation alternatives of the data I/F design, proposed by the instrument teams.
  - Identification of missing requirements on IID-A and S/C level.
  - Modification of inconsistent existing requirements.
  - Identification of I/F electronics components for procurement.
  - Identification and clarification of open issues on TM/TC Packet structures described in the F/P PS-ICD, provided by ESA.





### 3) MIL 1553B Bus-to-Instrument I/F



MIL-Bus Principle Interface Circuit.

- The S/C will provide a AC-coupled redundant I/F
- Stub lengths can be expected to be shorter than 50 cm
- Whether transformers are needed at the input of instruments needs to be studied.

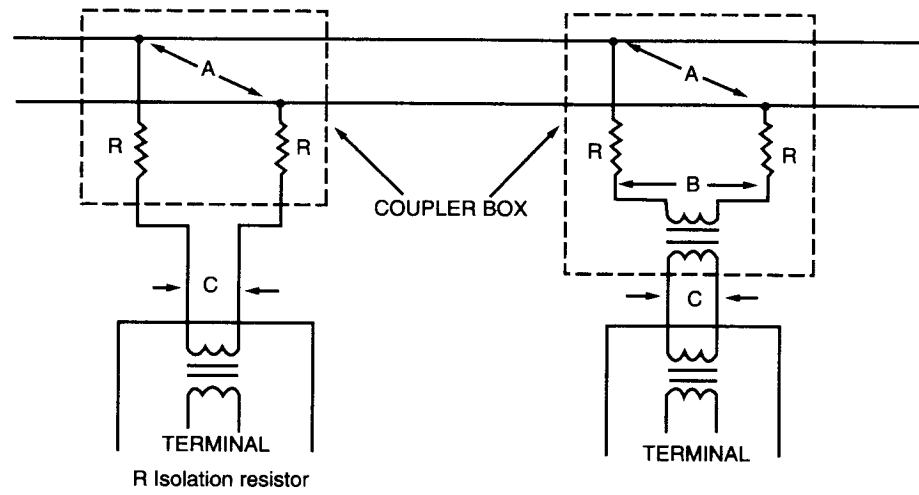


Figure II-14. MIL-STD-1553A Data Bus Interface

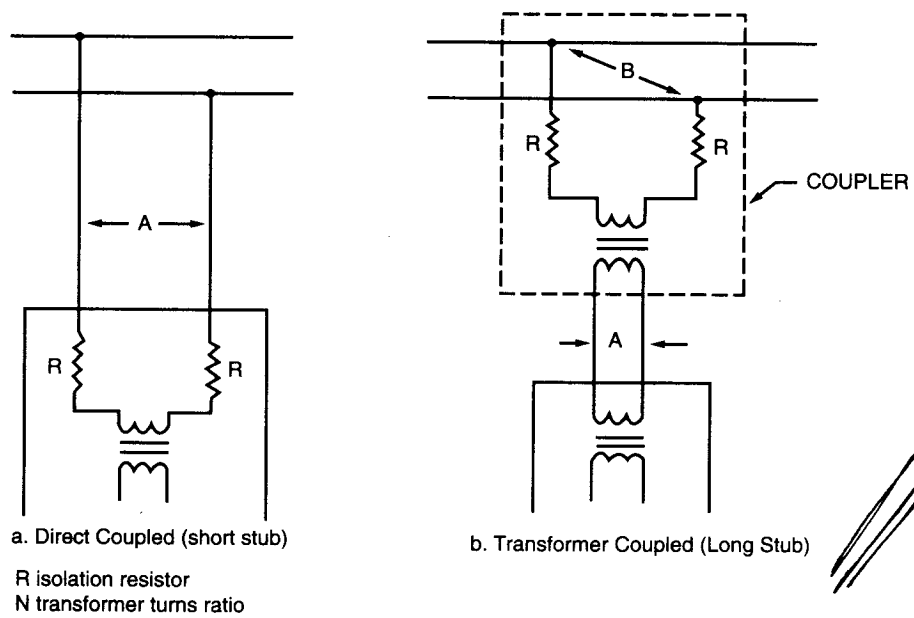
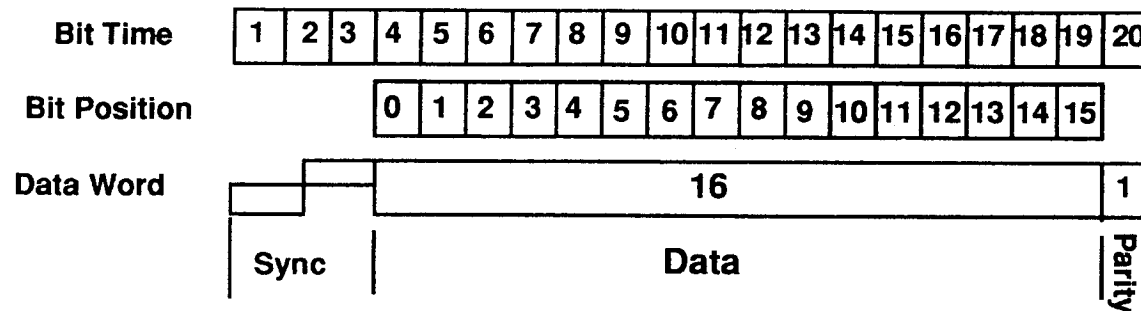


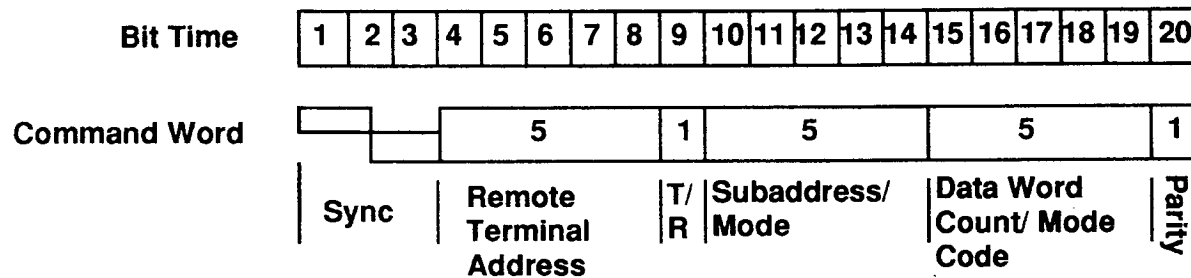
Figure II-15. MIL-STD-1553B Data Bus Interface



Mil 1553B data bus , messages



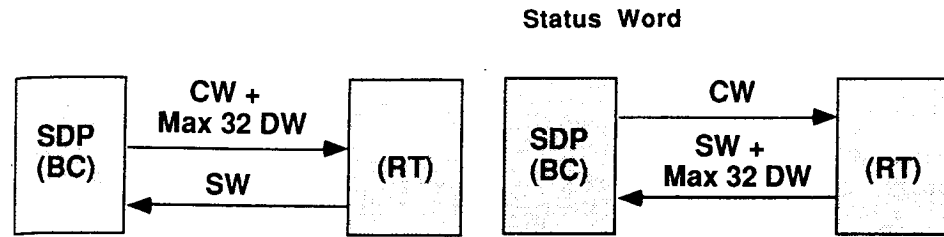
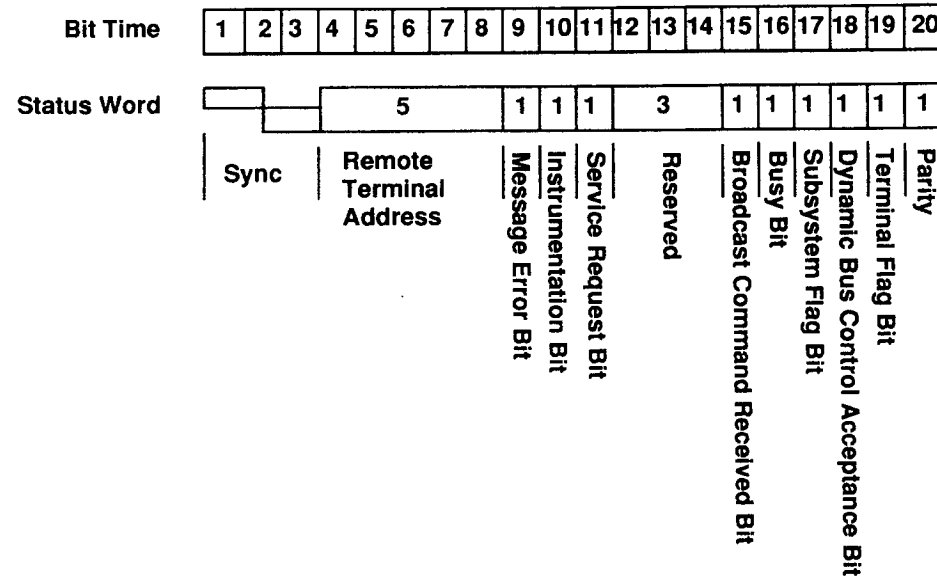
Data Word Format



Command Word



**Mil 1553B data bus I/F, messages 2**



Standard Protocol Diagrams

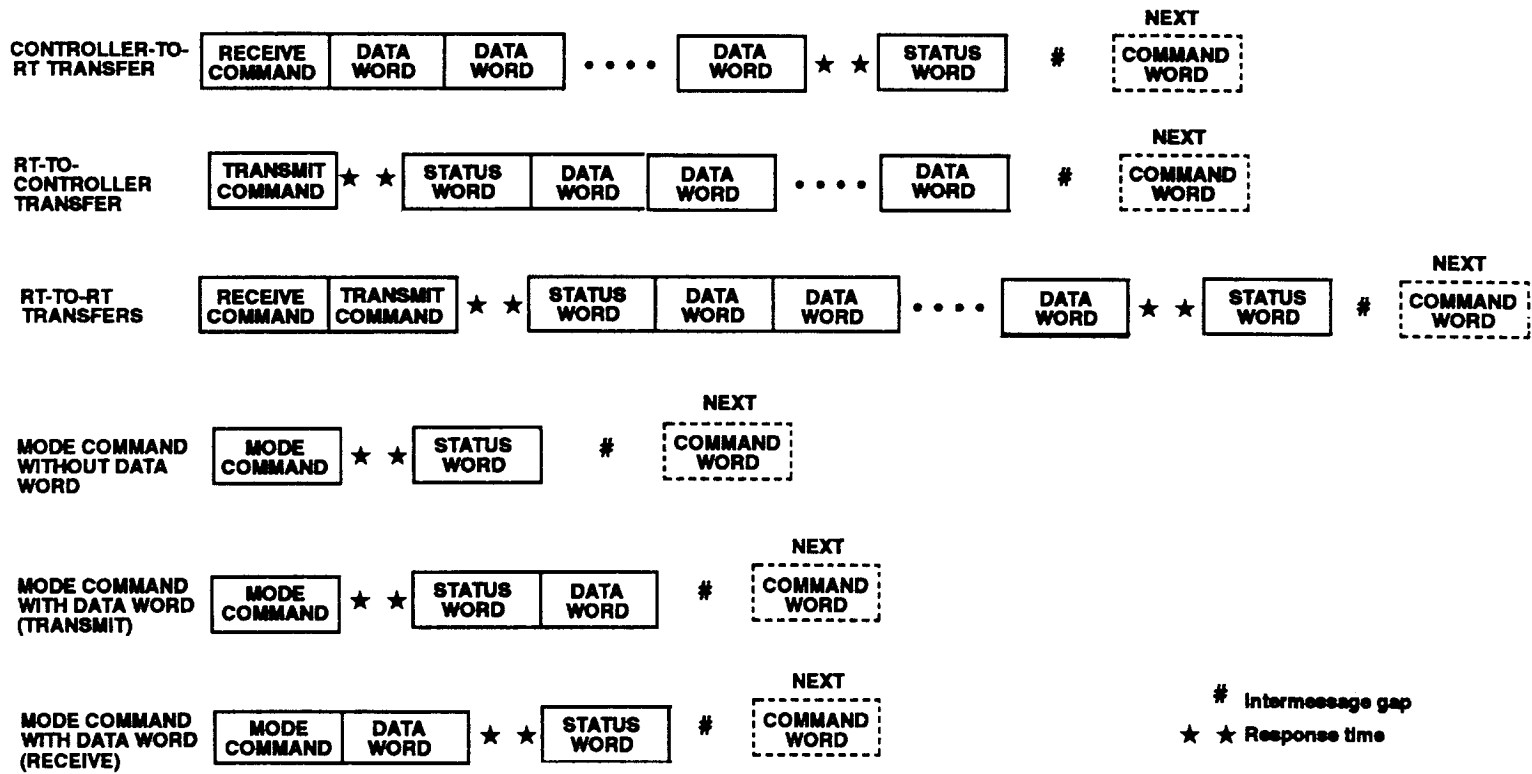


Figure 6 of 1553B. Information Transfer Formats

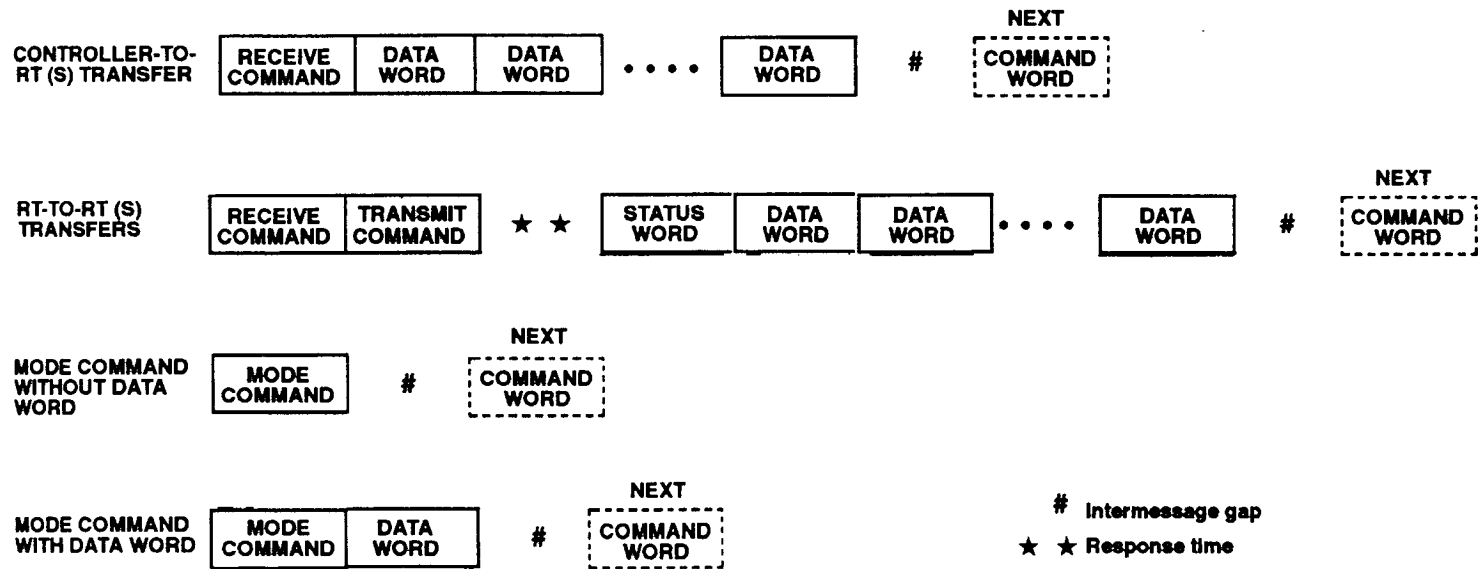


Figure 7 of 1553B. Broadcast Information Transfer Formats



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## Requirements on 1553 I/F

- One important goal of the working group activities is to agree on a set of requirements for the on-board data bus architecture which specifies all mandatory and sufficient characteristics of this bus in the IID-A.
- Such **set of requirements** can be( para 5.11.6 of IID-A: Data Bus Interface):
  - The on-board data bus interface circuits shall be according to MIL Std. 1553B.
  - The spacecraft data bus shall provide redundant, AC-coupled signals to the users.
  - The CDMS shall at least support the following services across the data bus:
    - Routing of TM and TC Packets and control messages.
    - Distribution of time synchronisation and time information to all users.
    - Monitoring of the bus traffic and associated reporting.
  - All packet transfers on the data bus shall be controlled by the CDMS.
  - Each on-board user shall be served in a quasi-periodic way for time scales larger than 1 sec.



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**Requirements on 1553 I/F cont'd:**

- Performance requirements:
  - Maximum throughput for instruments shall be 300 kbps on TM/TC packet level
  - The minimum latency for a single user between the end of a packet transfer and the start of a new transfer shall be 10 ms.
  - The maximum size of TM packets shall be 1024 octets, they may have variable length.
  - One complete packet shall be exchanged with a user without interruptions.
  - The accuracy for timing and synchronisation across all on-board systems up to the data interface of instruments shall be better than 100 microseconds.





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## 5) Packet Structure ICD: introduction

- As various **standardised services** for data formatting, storing, and routing are implemented on-board and within the Ground infrastructure **throughout the FIRST / Planck project** Instrument designers are **required to make use of TM and TC Packets** and the associated functionality.
- A **minimum** set of formats and services is mandatory, others are optional and allow for a certain flexibility. **ESA's recommendation** is to constrain the functional design of each instrument such that the number of Packet definitions, cases, exceptions stays **as simple and small as possible**.
- The current draft of the PS-ICD, Doc. No. SCI-PT-IF-07527 is handed over to Instrument Teams **for review and comment**. During the next WG meeting the responses from instrument teams will be discussed.
- Certain data services, which are not yet specified in detail, are handled by the spacecraft **CDMS only** (no I/F with instrument functionalities).



## 2 PACKET SERVICES

The Packet Services listed in

Table 2-1 below are available on FIRST/Planck for users and are specified in detail within the following chapters.

Service Type	Service Name	implemented for:
1	Telecommand Verification Service	CDMS, S/S, Instrum.
2	Device Command Distribution Service	CDMS
3	Housekeeping & Diagnostic Data Reporting Service	CDMS, S/S, Instrum.
4	not used	
5	Event Reporting Service	CDMS, S/S, Instrum.
6	Memory Management Service	CDMS, S/S, Instrum.
7	Task Management Service	CDMS, S/S, Instrum.
8	not used	
9	Time Management Service	CDMS, S/S, Instrum.
10	not used	
11	On-board Operations Scheduling Service	CDMS
12	On-board Monitoring Service	CDMS
13	not used	
14	Packet Transmission Control Service	CDMS, S/S, Instrum.
15	On-board Storage and Retrieval Service	CDMS
16	not used	
17	Test Service	CDMS, S/S, Instrum.
18	On-board Control Procedure Service	CDMS
19	Event/Action Service	CDMS
20	Science Data Transfer Service	Instruments

**Table 2-1: Packet Services specified within this document**

Spare	TM Source Packet PUS Version Number	Spare	Packet Type	Packet Subtype	Spare	Time
Bitstring (1 bit)	Enumerated (3 bits)	Bitstring (4 bits, TBC)	Enumerated (8 bits)	Enumerated (8 bits)	Bitstring (8 bits)	(48 bits)

**Spare:**

To maintain symmetry with the telecommand packet Data Field Header, this bit is reserved and shall be set to zero

**TM Source Packet PUS Version Number:**

ONLY ONE PUS VERSION NUMBER IS PERMITTED: VERSION 0 (VALUE = 0).

**Spare:**

Spare bits are introduced in order to make up an integral octet. These spare bits shall be set to zero.

**Packet Type:**

This indicates the Service to which this telemetry source packet relates.

**Packet Subtype:**

Together with the Packet Type, the Subtype uniquely identifies the nature of the Service constituted by this telemetry source packet.

The definition of Packet Type and Subtype is unique across all Application Processes

**Spare:**

Spare bits are introduced in order to make up an integral octet. These spare bits shall be set to zero.

**Time:**

This field represents the on-board reference time of the packet, referenced to TAI, expressed in CUC. Details of the time field are given in appendix 6.

The relationship of the time information to packet data generation or packet completion shall be fixed and defined per packet type/subtype of each application.

**4.1.2.2 Source Data (Variable)**

The telemetry source data constitutes the data element of the TM Packet

**4.1.2.3 Packet Error Control (PEC) (16 bits)**

The Packet Error Control field shall transport an error detection code that can be used by the ground to verify the integrity of the complete telemetry source packet. The presence of the PEC and its type is fixed for the complete mission for each Application and defined in Appendix 4.



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#### 4) Catalogue of questions, issued so far: clarification, discussion

- HFI-18 Power budgets allocated to instruments non-op substitution heaters are not included in instruments allocation. They have to be included into Planck Thermal Control System one. *confirmed*
- HFI-19 Telemetry budgets allocated to instruments spacecraft powered thermistors are not included in instruments allocation. They have to be included into Planck spacecraft HSK one. *confirmed*
- HFI-32 Is J. Dodsworth proposal to have different specialised HSK packets (physical measurements packets, events packets, TC reporting packets, instrument configuration packets,...) accepted? *yes, details in PS-ICD*
- HFI-33 If the answer is YES what is the length of each of them? Do not forget that one of the purpose of this proposal is to optimise the TM load. *max length: 1 packet*
- HFI-34 If there is only one type of HSK packet what is the length, 512 bytes? Does this length include encapsulation or is entirely free for data as indicated in the PUS? *see PS-ICD*
- HFI-35 Bus 1553 B is self redundant, is it acceptable to use this feature to connect a single unit to both S/C Main and Red bus? *yes*

At Headman 2



## Catalogue of questions, 2

- HFI-36 Bus 1553 B is selected. We need to know/impose on the Prime a commonly agreed interface circuit.

*"Long Stub" configuration*

- HFI-37 When a Planck instrument is tested/operated alone, is it possible for it to use full instruments TM allocation (about 60kbits/s TBC) ?

*yes, provided the average is kept  $\leq 60$  kbps.*

- HFI-38 What is the maximum rate of transmission from Instrument to CDMU on the data Science channel in a "burst mode" compliant in volume with the instrument daily mean TM allocation ?

*< 300 kbps*

- HFI-39 Delivered to Instruments Planck High Frequency clock frequency has to be frozen as soon as possible.

*TBD: 125 kHz or 137.xx kHz "Converter Sync"*

- HFI-40 Planck On-Board Time (OBT) driving frequency has to be frozen as soon as possible. Is HFI 65.53KHz required time frequency acceptable (Instruments and AOCS distributed OBT coded on three 16 bits words, one of them being fraction of second devoted) ?

*see HFI-39*



### Catalogue of questions, 3

- HFI-41 Planck OBT in-flight maintenance scheme is not defined : we need to know now if it shall be an absolute maintained clock (we suggest TAI) or a relative "local" synchronisation signal to be translated on-ground into absolute time.

*SCET, TAI, CCSDS Unsegmented Time Code,*
- HFI-49 IID-A suggests (§6.3) that :"(Central Check-out Equipment) detailed interfaces, hardware and software, will be defined in these areas when the CCE contractor will have been selected". We believe that such a late definition is not compatible with an instruments EGSE development schedule compatible with overall Planck planning. Dialog protocol rules have to be defined within less than 3 months.

*dealt with by AIV, not in this WG*
- HIFI-04 Implementation of the OBDH bus through wires connections or by transformers.

*"Long Stub"*
- HIFI-09 Packet structure definition.

*see PS-ICD*
- LFI-03 Verification of the LFI proposed REBA electrical hardware interfaces to the CDMU communications bus (subsequent to the CWG 1 meeting of July 1999)

*see HIFI-04*
- LFI-04 Low level protocols to use on the communications bus

*TBD, see MoM, A1-4*



### Catalogue of questions, 4

- PACS-01                      200 or 100 kbits into SSR                      *meeting PT-MM-06986:  
200kbps considered by EST, results  
at end of PB (S/C-Prime activities)*
- PACS-02                      400 kbits burst mode into SSR  
*↳ option to be studied by S/C-Prime.*
- PACS-03                      TM/TC packet size and structure ( in principle we need a special FIRST PUS ) → *PS-ICD*
- PACS-04                      TC rate from SSR to instrument : *4kbps (equal, guaranteed service to  
all users for TM+TC)*
- PACS-06                      flexible data compression factor of SPU s/w to fill the average 200/100 kbits                      *later*
- PACS-08                      1553 B interface, general specs, simulator (PC board), protocol                      *see above*
  
- SPIRE-01                      We are still confused about the telemetry/telecommand interface to the S/C - the recent email from Thuerey once again highlighted the problem as the figures quoted did not seem to be consistent with each other. Among the questions we have are: *a.* how the protocol for transferring packets between the instrument and the S/C will operate - so that we can estimate the buffering required within the instrument and how to extract the most from the average data rate. *b.* where the figure for the maximum packet size comes from. *c.* why the TC data rate is so low (we understand why the uplink rate is low, but not why the S/C cannot transfer to the instrument at a much higher rate)  
  
*a, b, c answered in various places above.*



## Catalogue of questions, 5

- HFI-1) to select an interface circuit, transformer, connector to be used *IID-4: Cannon D-Sub*
  - to know the suppliers selected by ESA: *no selection*
  - to identify the quality level of these parts: *like the other components*
- HFI-2) to define the main features of the packets exchanged (packet structure ICD) → *PS-ICD*
- HFI-3) to see if a transfer layer software already exists and is available. Where? How? *TBD*
- HFI-4) to determine a strategy for the S/C simulator development/supplying:
  - We need to develop a first level of S/C simulator to begin to work with the CQM/AVM DPU/SCE. Will the prime contractor provide a second level of S/C simulator for the PFM? In case not, we need to define S/C simulator requirements. → *"std."- PC-1/F-board + SW*
- HFI-5) OBT management through 1553 bus (requirements?).  
*to be explained during next mtg.*