MINUTES OF MEETING

FIRST/Planck Project

date	26 June 2000	reference	SCI-PT/-MN-07910	page	1/2
meeting date	23-6-2000	meeting place	ESTEC		
chairman	S Thürey, SCI-PXI				
participants	J. Charra, IAS, J.L. Beney, LAL, S. Sidher, RAL, C. Ponzoni, LABEN, R.C. Butler, ITESRE, R. Orfei, IFSI, A. Naber, SRON, S. Thürey, ESA	copy	F.VDB., Th.Pa. O. Bauer, MPE, PACS K. King, RAL, SPIRE		

subject **3rd F/P Data Working Group Meeting**

description	action	due date

Agenda:
1) Status of 1553 Protocol development
2) PS-ICD, review and clarifications
3) Planck data rates
4) AOB

1) Status of 1553 Protocol development

ESA presentation: see pages 2 to 7 of attachment 1.
Specific points:

- The Time Synchronisation function will consist of

a) a 1-sec-marker, which arrives periodically at all users/Remote Terminals on the data bus as a broadcast bus message.

b) a protocol with Enable and Time Information packets, which will allow users to set their local clock to the Central Time Reference.

- The routing of special asynchronous TC packets on the data bus is foreseen. These packets will be used for the Planck Spin Reference Message or for the FIRST On Target Message. These packets are restricted in size to less than 64 octets in total, corresponding to one 1553 bus message. The routing latency for such a message is now specified to be 1.0 ms (update of requ. 2.8) because an ongoing message transmission, which may take 0.74 ms, cannot be interrupted. this is still in line with Planck requirements.

a

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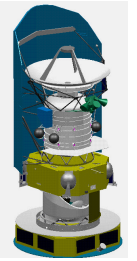
description	action	due date
2) PS-ICD, review and clarifications ESA presentation on draft 1.0 of SCI-PT-ICD-07527: see pages 8 to 13 of attachment 1. Specific points: - Telecommand Verification (Service 1): Acceptance Reports shall be generated “immediately”, i.e. within a period of about 0.5 sec after reception of a TC packet, this value is currently TBD/TBC. - Time Synchronisation and Verification (Service 9): ESA will provide clarification about how a local time information field shall be marked, if a user is not yet synchronised to the Central Time Reference (see A6.3.6 of the PS-ICD). ESA will also generate flow diagrams for the time sync. function. - CNR-IFSI gave an overview about the FIRST Commanding Concept, see attachment 2. The specific capabilities and TM/TC packet types/subtypes have to be brought in line with draft 1.0 of the PS-ICD. 3) Planck data rates The baselined data rate and memory allocations (see IID-A) will not be changed but potential modifications will be studied during phase B activities. 4) AOB ESA presentation: see page 15 of attachment 1. Tentative date for the 4th meeting of the Data WG: Tue, 19-9-2000, instrument groups are requested to confirm.		



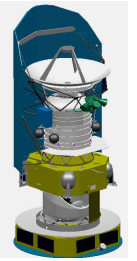
FIRST / Planck Instruments to CDMS Interfaces Working Group

Meeting 3, 23-6-2000, ESTEC

Stefan Thürey SCI-PXI

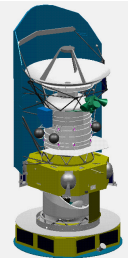
- **Agenda:**

  - 1) Mil 1553B data bus I/F: status of HW and protocol developments
  - 2) Packet Structure ICD: review and clarifications
  - 3) Packet data rates
  - 4) Open issues, action items,AOB



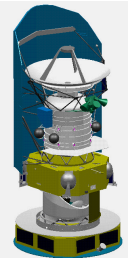
1) MIL 1553B Bus-to-Instrument I/F : Status of HW and Protocol Developments

- 1) Three meetings have been conducted with Astrium - Bremen (Orbital Infrastructure) for the purpose of defining the approach and scope for a
  - **Satellite Data Bus Protocol Specification**.
    - An overview of the technical approach will be given separately.
- 2) Agreed delivery date for the specification is 15-8-2000, it will become Appendix 9 of the PS-ICD.



1) MIL 1553B Bus-to-Instrument I/F : Status of HW and Protocol Developments, 2

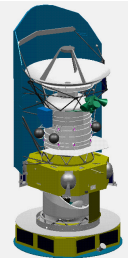
- 3) Structure of the development activity:
  - 1. Analysis of the system level requirements and convert them into detailed requirements for the three main protocol levels (Physical, Data Link, and Transfer Layer)
  - 2. Proposal of a detailed technical concept for a synchronous data transfer protocol which is in line with the system-level requirements and compliant with the MIL 1553 B standard.
  - 3. Analysis if the performance requirements can be met, identification of critical areas and implementation alternatives with their consequences for performance.
  - 4. Identification of (groups of) requirements, which are to be covered in an electrical I/F specification separately from the protocol specification.
  - 5. Proposal of a detailed design of the data bus protocol.
  - 6. Generation of the Satellite Data Bus Protocol Specification document.
  - 8. Demonstration by analysis that the protocol specification is compliant to the MIL 1553B standard and to the system-level requirements.
  - 9. Proposal of a test and validation approach for the protocol, which can be applied by each independent user.
  - 10. Update of the protocol specification in a review cycle in cooperation with ESA.



Satellite Data Bus Protocol, Updated Requirements 1

- **1. Functional requirements** for the Data Bus Interface:

  - 1.1. The on-board data bus interface circuits shall be according to MIL Std. 1553B.
  - 1.2. The spacecraft data bus shall provide redundant, AC-coupled signals to the users.
  - 1.3. The (redundant) Command and Data Management System (CDMS) shall act as Bus Controller (BC), all other users connected to the data bus shall act as Remote Terminals (RTs).
  - 1.4. The CDMS shall at least support the following services across the data bus:
    - Routing of TM and TC Packets according to the FIRST/Planck PS-ICD and control messages.
    - Distribution of time synchronisation and time information to all users.
    - Sending of short asynchronous TC-Packets for special user control functions.
    - Sending of Broadcast Messages for system ancillary data.
    - Monitoring of the bus traffic and associated reporting, as higher level CDMS function. The bus protocol shall provide related FDIR messages and other status information
  - 1.5. All packet transfers on the data bus shall be controlled by the CDMS (BC).
  - 1.6. All other users shall support the services listed above as Remote Terminals, and to the extent the services are needed by a certain user. Optional RT services are:
    - Reception of asynchronous short TC-Packets (64 octets),
    - Reception of Broadcast Messages.

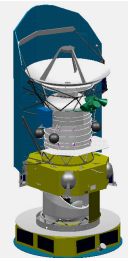


Satellite Data Bus Protocol, Updated Requirements 2

- 1.7. The data bus protocol shall have a deterministic, periodic structure, which is synchronised with the central on-board time, implemented in the CDMS.
- 1.8. Each on-board user shall be served in a quasi-periodic way at least 2 times per second.

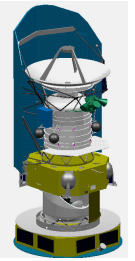
• 2. Performance requirements:

- 2.1. Coupling of users to the data bus via stubs longer than 30 cm shall be possible.
- 2.2. Maximum throughput for all users shall be at least 350 kbps on TM/TC packet level.
- 2.3. The minimum latency for a single user between the end of a packet transfer and the start of a new transfer of the same type (TM or TC) shall be 4 ms, TBC.
- 2.4. The maximum size of TM-Packets shall be 1024 octets, for TC-Packets the maximum size is 248 octets. The TM/TC-Packets may have variable length.
- 2.5. One complete packet shall be exchanged with a user without interruptions for the user (Remote Terminal).



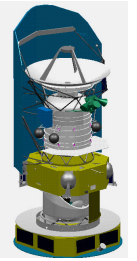
Satellite Data Bus Protocol, Updated Requirements 3

- 2.6. The Data Bus Interface Protocol shall support each second the exchange of at least
  - 2.6.1. 50 TM-Packets,
  - 2.6.2. 16 TC-Packets,
  - 2.6.3. 1 time synchronisation.
  - 2.6.4. 2 asynchronous TC-Packets, with a maximum length of 64 octets, addressed independently to dedicated buffers within RTs.
- 2.7. The accuracy for timing and synchronisation across all on-board systems up to the data interface of users shall be better than 100 microseconds, TBC.
- 2.8. The routing latency of an asynchronous TC-Packet according to 2.6.4 from the CDMS to the input buffer of a RT shall be below 1.0 milliseconds.
- 2.9. The CDMS shall control the TM data rate of a maximum of ten users by adjusting the actual data rates according to allocated bandwidths on a 2 second timescale. The bus protocol has to generate the necessary support information for the associated higher level control function of the CDMS.



Satellite Data Bus Protocol, Basic Structure

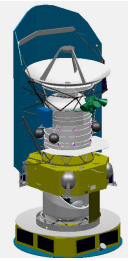
- Three communication protocol layers (in reference to ISO - OSI) will be covered:
  - 1) Physical Layer:
    - All electrical characteristics like signal levels, waveform timing, transformer parameters are directly according to MIL Std. 1553 B. They will be specified later in a FIRST/Planck Electrical I/F Spec.
  - 2) Data Link Layer: All relevant parameters will be specified in the Protocol Spec:
    - Timing on message level
    - RT addresses, subaddresses
    - Command Words, Mode Commands and their usage
    - Structures of Data and Status Words, Flag bits
    - FDIR for this layer
  - 3) Transfer Layer:
    - Synchronisation and timing for message and block / packet transfer
    - Buffer allocations
    - FDIR on Transfer Layer
- The basic timing will be designed around a periodic scheme with 64 frames each second. In most of them one maximum-length TM packet can be transferred, and other activities like TC packet delivery, polling, handling of short packets, etc. take place additionally.



2) Packet Structure ICD: Review and Clarifications

- **Comments on slected subjects:**

  - 1) Protocol layers below the Application Layer, which serve for transferring TC- and TM-Packets on a **physical medium between on-board units**, also have to be defined in a mission-specific way. Therefore, this document specifies in an **appendix** a Satellite Data Bus Protocol, which provides the necessary definitions for controlling the on-board data transfer within the **Data Link Layer and Transfer Layer.** (i.e. the MIL Std. 1553B protocol)
  - 2) In the order of increasing complexity **Task** or **Function Management** Services or **On-Board Control Procedures** (OBCPs) can be used for the control of S/C units incl. instruments. The OBCPs can constitute autonomous on-board control loops, which make use of the exchange of TM/TC Packets, can affect more than one unit, and may be active for a considerable period of time. They shall be kept simple and reduced to the **essential minimum**.



2) Packet Structure ICD: Review and Clarifications, 2

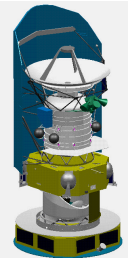
- 3) In the event of unforeseen on-board events, on-ground actions will be necessary to investigate and correct anomalies utilising the **available telemetry and command functionality**.

- Several TM / TC packet services in support of unit-specific data structures are implemented in support of contingency operations:

    - activation or modification of test or diagnostic operational modes and associated TM packet structures,
    - modification of the on-board operations schedule,
    - modification of on-board control procedures,

- **Excluded** are modifications of existing TM packet definitions or SW modifications.

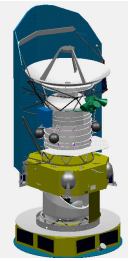
- 4) For **all** cases of **failed Telecommand execution**, i.e. for not started, unsuccessfully executed, or otherwise aborted TC executions an event-message of **Type (1,8)** can be generated, if the unit or application involved is capable of doing this.



2) Packet Structure ICD: Review and Clarifications, 3

- 5) Periodic **Housekeeping TM Packets** (HK Packets) shall be used to report the status and health of each unit or subsystem on-board. In nominal conditions only **one HK Packet per unit** / subsystem / instrument should be generated with a fixed sampling period. Supercommutation within a sampling period may be used for certain parameters; they are recorded at the end of a given packet structure as a sequence of fixed-length arrays of parameters.

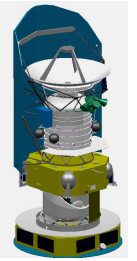
- If a number of user-parameters need to be reported with a sampling interval significantly longer or shorter than the nominal period, or if certain HK parameters are only relevant in **specific operational modes or configurations** of a unit / subsystem / instrument, additional Housekeeping TM Packets may be implemented. Equivalently one or several Diagnostic TM packets may be pre-defined.



2) Packet Structure ICD: Review and and Clarifications, 4

- **Tasks - Functions (Services 7 and 8):**

  - **Definitions:**
    - According to the ECSS-PUS is a **Task** a SW-entity , in many cases running under close control of a (Realtime-) Operating System (in parallel with other tasks), **for which the ground normally does not have a command interface**. Only for troubleshooting or contingencies direct task commanding might be necessary.
    - A **Function** instead **can** (normally) **be commanded from external,** and may seemingly serve for 'doing whatever a certain user likes to define'.
    - An Application Process may be designed to execute **Functions in support of (external,) physical interfaces. and to control the spacecraft-related functions of these interfaces**. (The actual I/O-handler may be a Task as part of the Function.) Examples of such Application Functions could include control of the operation of a payload instrument or spacecraft units and subsystems, including changes of operational modes. Additionally, processes that are (mainly) devoted to internal data processing, and which rely on nominal control capability from ground, can be covered under the Function Service.

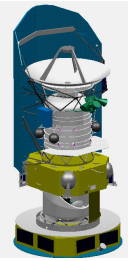


2) Packet Structure ICD: Review and and Clarifications, 5

- **Time Synchronisation and Verification:**

  - The Time Management Service provides the capabilities to transfer a master time information on-board a spacecraft, the **Central Time Reference** (CTR), to other units or applications after activation, reset, or for the purpose of re-synchronisation in order to achieve a high accuracy of **"local copies" of the CTR**. Additionally, the service supports the verification of time information, which is maintained (independently) within applications, against the on-board master time.

  - This is accomplished by executing a **time synchronisation procedure** in the CDMS, and locally within the addressed end-user or Application. This consists of sending an Enable Time Synchronisation packet TC(9,4) to this Application, and then sending a synchronisation signal or message to one or more end-users and freezing a copy of the on-board master time **at this moment**. As the addressed end-user or Application has to start its local clock from Zero at the reception of the synchronisation signal, the sum of this local time and the copy of the master time, which can be delivered and added at any time later, gives an exact copy of the on-board master time.

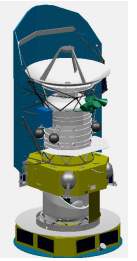


2) Packet Structure ICD: Review and and Clarifications, 6

- **Event / Action Service, No. 19:**
  - On reception of an **event report of type/subtype (5,2) and (5,1),** the **CDMS** scans the detection list and if a matching event report is detected and the associated action is enabled, the corresponding Telecommand packet is sent to the destination Application Process. (Severe events, which are classified as **errors/alarms, type (5,3),** should either be covered by an action, which was triggered by an event of type (5,2) already, or are so unpredictable in nature that **no autonomous on-board activity** can be initiated.)

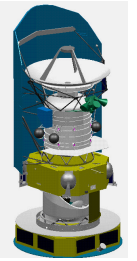
  - In **exceptional cases**, the Event/Action List may be modified by adding or deleting events or activating / deactivating related actions. **The related Telecommands may have mission-wide implications** and have therefore to be classified as hazardous.

- **Science Data, Service 21:**
  - In order to avoid an unnecessarily large number of Application IDs for a single instrument several subtypes of Science TM packets are introduced. These subtypes should be used to identify groups of scientific data of significantly different character or origin (e.g. different detectors). Each subtype can make use of several structure definitions. **The individual naming of the Science TM packets can be chosen by the instruments, the number of allowed subtypes is TBC.**



3) Planck Data Rates, Status

- The current position of the Project Office is, that allocated data rates (total 60 kbps in 24 hrs) have not been changed. However, the subject is under evaluation and potential options for introducing an increase of the allocated bandwidth are studied.



4) Open Issues, Action Items

1) The Project Office has updated para. 5.11.1 of the IID-A:

"**Instruments, which are not the prime instrument for a certain observation, shall not exceed a TM rate of 2kbps each.** "

> **AI**: Instrument groups to comment / approve

2) If an instrument knows (because of internal configuration or after reception of an Information TC packet) that the **currently produced Science Data TM packets are useless**, **it should terminate or decrease the production rate for these TM packets** (in a controlled way), in order not to waist mass memory and downlink capacity.

Mission Control will ensure in any case that the allocated average data rate per user, i.e. the agreed fraction of **100kbps over 24 hours (FIRST)is not exceeded**. This may be done by stopping the science mode of a certain instrument or by terminating the recording of Science TM packets.

FIRST Commanding Concepts.

Based on:

- FIRST/Planck OIRD (SCI-PT-RS-07360, Draft 5, 03/05/2000)
- FIRST Instrument Commanding Concepts (Joint Technical Note, Draft 1 - 22/10/1999)
- FIRST/Planck PS-ICD (SCI-PT-IF-07527, Draft 0 - 22/02/2000)
- Telemetry and Telecommand PUS (ECSS-E-70/41 Draft 04)
- Minutes of 2nd F/P Data I/F Working Group Meeting (20-04-2000)

Mandatory Packet Telemetry Services:

- Telecommand Verification (service Type 1)
- Housekeeping Data Reporting (service Type 3)
- Event Reporting (service Type 5)
- Memory Management (service Type 6)
- Time Management (service Type 9)
- Packet transmission Control Service (service Type 14)
- Test Service (service Type 17)
- Science Data Transfer Service (service Type 20)

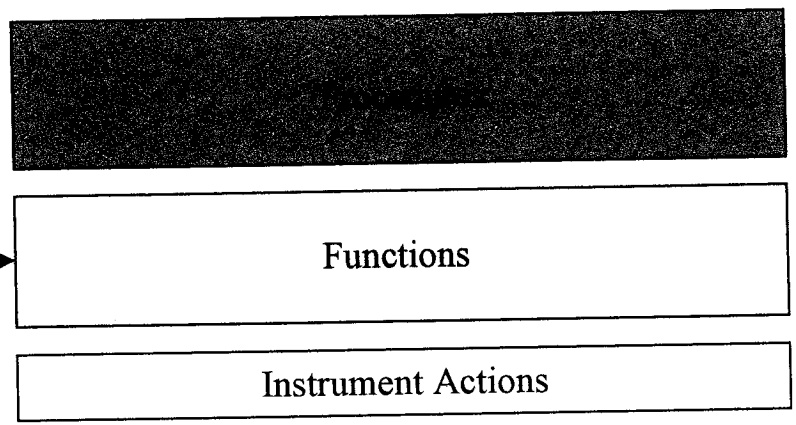
Optional Packet Telemetry Services (all related with instrument commanding):

- Function Management (service Type 8) FPD#2?
- On Board Control Procedure (service Type 18)
- Task Management (service Type 7) FPD#2?

Measurement execution

Three different levels of commanding :

Each procedure consists of a set of steps each of which may contain either an instrument function to be executed or a single instrument action. The steps can be linked by simple logic (e.g jump, loop).



The Instrument Functions (stored on board) provide the execution of a series of actions.
The details of the actions performed are controlled by parameters either transmitted in the TC packet (application data field) or read from tables stored on board.

Single commands - instructions to the instrument subsystems

- Functions are part of the OBS code, to be compiled before any upgrade/change.

- Procedures are used to 'customise' the instrument observation at an higher level than the functions. Procedures are not compiled, but shall be interpreted by the OBS. Procedures can be either stored on-board or provided by ground for a single execution on board. The parameters contained in the Start Procedure TC are used to configure the specific instance of execution of the procedure.

Measurement execution

Therefore, according to the "Instrument Commanding Concepts" document (Draft 1) the OBS shall be able to:

1. ***perform single instrument actions:*** to send commands to the subsystems according to the command syntax described in the ICDs and considering the adopted low speed interfaces protocols. This action is commanded by the request of service (8,3).
2. ***execute instrument functions:*** to execute the code procedures indicated by the function ID field contained in the TC, with the parameters indicated in the application data field of the TC. This action is commanded by the request of services (8,1) and (8,2).
3. ***interpret instrument procedures***: to go through the procedure step by step with the interpreter, which will be able to recognise also very simple logic instructions (e.g. jump, loop). This action is commanded by the request of services (18,1) (18,3) and (18,4).

The present version of the OBS functional decomposition in the circulated logical model has been provided by taking into account the above requirements.

F/P DWG #2:

Service (8,4) **Load Function parameters**, without changing the (stopped, suspended) state of a function. This command is needed to hand over new parameters to a function (and possibly verifying them before actually using them) without interfering with an ongoing activity.

Service (8,5) **Dump Last Function Parameters**: see above.

Service (8,1) **Start Function**, (without parameters) should be possible. This allows for acting on these parameters, from a well defined moment in time onwards. The status of a function may also be "running", and a Start Function (8,1) without parameters, would activate the previously loaded parameters. Start Function, with parameters, would activate the new parameters immediately.

The **type (8,2), Stop Function**, seems to be the only additional type which is needed, **type (8,3) Perfom Activity of Function**, may be used.

Assumptions:

Task *(from F/P DWG2)*: " a software entity, in many cases running under close control of an operating system (in parallel with other tasks), for which the ground normally does not have a command interface. Only for troubleshooting or contingencies direct task commanding might be necessary."
This task definition is agreed and in the OBS the number of tasks will be minimised.

Autonomy functions ≡ Instrument functions

Measurement execution