esa

MINUTES OF MEETING

Herschel/Planck Project

reference	SCI-PT/ 10006
page	1/4
meeting date	9-10-2001
meeting place	ESTEC
chairman	S. Thürey
copy	participants + DATAMWG + J.M.C., A.E., J.B.
subject	8th Data Management WG Meeting

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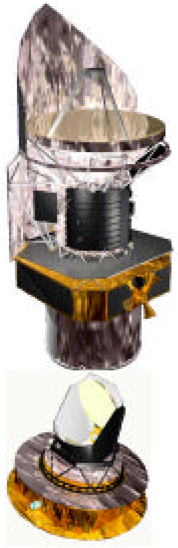
description	action	due date
1) Introduction (Presentation, Attachment 1)		
AI 1 from last WG: closed, see Attachment 2		
2) PS-ICD, Open points, Clarification: see attachment 1, part 2		
2.1: Modification of Instrument-SW: PACS expressed a concern about the long average time needed (~ 6 months). They have considered to use several SW-updates during the Commissioning Phase.		
Instruments are asked to provide an estimate of their total number of HK-parameters, in order to allow Industry to size several CDMU requirements.	AI 1, Instr.	19-10-2001
2.4 Variable-length Parameter Fields: ESA recommends not to introduce any variable-length parameter fields in Telecommands.		
2.5 RAL-TN (Attachment 3):		
Alcatel will analyse the Message Slot allocation per Subframe and make a proposal for their use (instruments, other on-board units).	AI 2, Alcatel	19-10-2001

description	action	due date
– Packet Handshake (Attachments 3, 4): Currently the CDMS-Simulator is limited to a transfer each 3rd Subframe, because of buffer-swapping (A↔B). (see allso a #. 7, p. 11)		
– Alcatel will study, if Event-Busmessages can be defined to be of fixed length, 64 octets. If necessary, all modifications of requirements will be identified, and a DCR generated by Alcatel.		AI 3 Alcatel 19-10-2001
– Alcatel will also study the detailed timing of the SDB Protocol, and derive more detailed requirements, if necessary.		AI 4 Alcatel 9-11-2001
3) On-board Time Sync.:		
Instruments will investigate, if only the SDB Prot. features are sufficient for local time-setting (i.e. SA 8R and Frame-Sync), and TC(9,4), TC(9,5) can be deleted.		AI 5, Instr. 19-10-2001

description	action	due date
4) SDB-Protocol: Open points w.r.to Industry: Handling, timing of TM-Packets with smaller length than max. during Burst mode.		
4.3 Use of SAST, GT for fast messages: Instruments are asked to check if there are any instrument TM-packets, which would need a reaction time < 500ms. If yes, details should be provided.		A16 Instr. 19-10-2001
5. Subframe-Allocation, Bus Data Rates: Alcatel-Presentation: Attachment 5 All instruments are asked to provide a request for the number of subframes/sec, for all operational modes.		A17, Instr. 2-11-2001
LFI and HFI are asked to define a common (agreed) approach for sharing the 100kbps of Planck-Sci-data.		A18, LFI, HFI, 2-11-2001



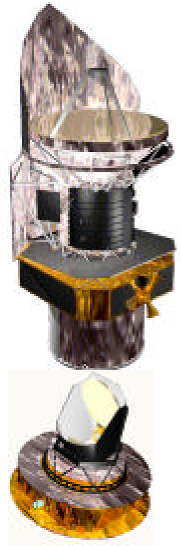
Herschel / Planck

Instruments to CDMS Interfaces Working Group

(Data Management WG)

Meeting 8, 9-10-2001, ESTEC

Stefan Thürey, SCI-PT



Data Management WG, Meeting 8

- **Agenda:**

- **1) Introduction, Action Item Status**
- **2) PS-ICD: Clarifications on Packet Structures**
- **3) On-board Time Synchronisation**
- **4) Utilisation of the SDB Protocol**
  - **4.1 General remarks to data bus I/F testing**
  - **4.2 CDMS Sim. acceptance test: open points, future activities**
  - **4.3 Asynchronous message handling**
  - **4.4 Other implementation issues**
- **5) Data traffic scenarios and throughput on the data bus**
- **6) Status of Instruments, A.O.B.**

1) Introduction, Action Items

- **The last meeting of the Data Management WG took place on 30-1-2001 in Garching.**

  Thereafter various issues were dealt with in the framework of the Instrument-EGSE WG, like the CDMU Simulator, or in conjunction with the Prime kick-off clarification meetings, System Requirements Review, etc.

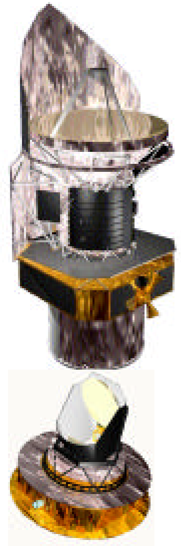
  - **The meeting of today should serve for presenting the status of the data management I/F as established after the SRR, and should give an overview of the development status of the instruments.**

  - **Open issues related to this I/F should be addressed, and action items in order to resolve them, should be defined.**

- **After this meeting the Data Management WG will be organised and chaired by the Alcatel.**

- **AIs from last meeting:**

  IFSI was asked to provide a proposal how the 16 plus 16 bits of the Memory ID and Address Field of the Memory Management Service should be used with a TCS 21020 DSP (still pending).



2) Packet Structure ICD: Review and Clarifications

- **Comments on selected subjects:**
  - **1) Introduction of capability to modify, or define, HK/ Diagnostic-Packets:**
    - **Instruments have indicated that they do not see a necessity for that service, and would rely instead of a code patch, if HK-packets need to be modified.**
  - **It should be pointed out that any SW modification in-orbit has a cycle time from definition to activation of new code on-board in the order of 3 to 6 months, among others depending on the quality of the delivered SW maintenance facility.**
  - **2) Modification of HK / Diagnostic packets:**
    - **Currently only TM-packets up to the length of about 242 octets can be (re-)defined. Considering this capability as 'additional' service, this might be acceptable. However, the subservice TC(3,1), (3,2), and (3,9), (3,11) are under review.**

2) Packet Structure ICD: Review and Clarifications, 2

- **3) Start Function, TC(8,1):**

  The parameter N will be replaced by a Spare-field, set to zero. A Start Function TC should always be carried out with parameters, defined by a SID. (The SID=0 can define an empty parameter field). The same applies for TC(8,4).

- **4) Variable-length Parameter-fields in Telecommands (8,1) or (8,4):**

  If only a few out of a larger group of parameters need to be changed, either a specific SID is used for only those parameters, or a larger parameter field is sent, with only a few changes.

2) Packet Structure ICD:
Review and Clarifications, 3

- **5) A Technical Note '1553 Bus Protocols', SPIRE-RAL-PRJ-issue 1, has been circulated last week.**

- **The purpose of this note is <u>only,</u> to summarise several thoughts and suggestions of a single party (RAL), after first experiences with the SDB Protocol. This was done on request by ESA.**

- **The suggestions for modifications will be analysed and commented.**

But only if evidence of a definite and severe flaw of the protocol can be provided, a <u>proposal</u> for a modification will be worked out by Prime / ESA, and then circulated to all parties affected, in order to assess the impact of a change. Only after agreement by all parties the SDB Protocol will be modified.

- **Currently, no update is foreseen. The only need for updating the protocol may be in the area of more detailed definitions of error-handling.**

3) On-board Time Synchronisation

- **On-board time synchronisation is used to allow central and remote units to utilise a common time, which is identical for all users, with high accuracy. Currently, the detailed timing requirements related to the TM-Packet Service 9 are missing or TBD.**

- **These requirements need to be defined in order to enable all on-board users (ACC, instruments, etc.) to carry out the on-board time synchronisation properly.**

- **The following timing is under consideration (currently TBD / TBC by industry):**

```
--------------|------------------------|-----------------------|------------------------|-----------------------|----------------->
             0.5 s                   1.0 s                   1.5 s                    2.0 s                   2.5 s
              |                      Frame-Sync.                                      Frame-Sync.
  - - - ---------->                    |                                                |
CDMU sends TC(9,4), Enable             |    <---------------->|                         |
                                      CDMU sends  TC(9,5), Time Code                    |
                                                                                      Time Code is valid,
- - -> Local user clock increments from arbitrary start value ------->                 local clock is set to value of Time Code.
```

- **Time Verification may be carried out independently from Time Sync. (before / after).**

4) Utilisation of the SDB Protocol (1)

- 4.1 General remarks to data bus I/F testing

The success of a on-board data bus infrastructure based on the Mil 1553 B standard depends on several factors:

- Selection of a subset of Mil 1553 B options, agreed by all parties
  - specified as part of SDB Protocol
- A consistent data exchange protocol for all communication layers
  - specified in overall PS-ICD
- A detailed and comprehensive test and verification approach / plan
  - For the Physical Layer and basic characteristics of the Data Link layer the plan shall be based on Section 100 of the MIL-HDBK-1553A (AD 2 of Appendix 9, PS-ICD).
    For requirements up to the Transfer Layer the test plan/procedure should be based directly on App. 9, PS-ICD
- Proper testing according to these plans on various levels of integration (I/F-unit-level, instrument-level, ... to overall S/C-level)

4) Utilisation of the SDB Protocol (1, cont'd)

- **For the 3 Herschel Instruments the following test specifications for the data bus I/F have been generated:**
  - **CDMS-interface test-requirements spec., SRON-U/HIFI-SP-2000-5 (mainly applicable for RT, i.e. instrument)**
  - **CDMS Simulator Acceptance Test Plan, SPIRE-RAL-PRJ-000733 (adapted for BC, like CDMS Sim.)**
  - **Filled-in CDMS-Sim. Acceptance Test Plan = Test Report (final issue pending)**
- **They represent an adequate test approach for this interface.**
- **However, the draft of the DPU / ICU Spacecraft I/F Acceptance Test Plan, CNR.IFSI.2001TR04, seems to be too superficial, as it skips many detailed test steps.**
- **If this test plan is not improved significantly, and followed during ICU/DPU-tests, the Acceptance Data Package at instrument-delivery will be considered incomplete, and ESA will have reservations against connecting instruments with undocumented I/F characteristics to the S/C.**

4) Utilisation of the SDB Protocol (2)

- **4.2 CDMS Simulator acceptance test: open points, future activities**

  - **The first extensive acceptance test of the data bus I/F simulator for three Herschel instrument EGSEs (called CDMS Simulator) has been <u>successfully</u> carried out at RAL on 26, 27-9-2001.**

  - **However, certain deficiencies have been registered:**

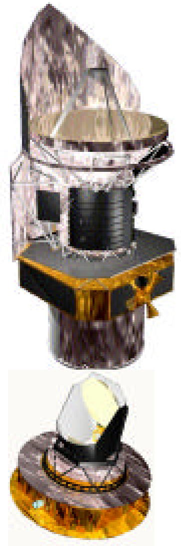
    - **Missing capability to link the protocol to a master/external clock, I.e. to make it synchronous to the on-board timing based at a 1.0-sec-cycle.**
    - **Setting of instrument time**
    - **Dynamic/ instantaneous switching between different bus profile lists (without data gaps)**
    - **Burst mode, or any capability to transfer data in more than about 21 Subframes per second.**
    - **Fast asynchronous message handling**
    - **Any error handling (error reporting to higher layers, and reaction to anomalies)**
    - **More extensive performance testing**

4) Utilisation of the SDB Protocol (2, cont'd)

- CDMS Simulator acceptance test: Future activities on open points
  - **Synchronisation of the protocol to a master/external clock: RAL has taken an action to investigate several options and implement one out of them.**
  - **Setting of instrument time with the CDMS-Sim.: under investigation by RAL**
  - **Dynamic/ instantaneous switching between different bus profile lists (without data gaps): under development by RAL.**
  - **Burst mode, or any capability to transfer data in more than about 21 Subframes per second: currently acceptable as starting point, under development. Firm goal: full compatibility with spec.**
  - **Fast asynchronous message handling: desired by instruments, under consideration by RAL.**
  - **Any error handling: to be implemented. It should be noted that details on this subject are TBD. S/C-level system engineering should generate the detailed requirements for the CDMS, which then can be simulated in instrument EGSEs.**
  - **More extensive performance testing will be done by RAL to cover the operational envelopes of the instruments.**

4) Utilisation of the SDB Protocol (3)

- **4.3 Asynchronous Message Handling (Utilisation of Subaddresses 5T, 6T for short TM-messages, and SA 3R, 4R for short TC-messages):**
  - **It should be recalled, as introduction to the subject, that**
    - **the PS-ICD is a specification of data structures and generic protocol rules. It does normally not specify the operational use and their limitations.**
      However, some operational requirements are put into the introductions of several paragraphs, others may still be missing.
    - **The PS-ICD covers the total envelope of all definitions needed on-board the two spacecraft. Some of these data structures and capabilities are for overall S/C-control (only), or for high priority functions (in contrast to instrument communication). Several features are not (fully) available to instruments.**
    - **Several details related to the use of certain packet structures were TBD (on purpose) in order to give the freedom to the Prime to design an optimised S/C.**



4) Utilisation of the SDB Protocol (4)

- **The open issue:**
  - **It is requested by several instrument parties to use SA 5T and 6T for short TM-packets, like all TC-Verification and Event-Packets on a regular basis, in order to have a capability to route two TM-packets per Subframe, instead of just one long or short one.**

- **However the concept for the use of Subaddresses 5T, 6T is, that the S/C has the capability to retrieve short high priority messages much faster than normal. The CDMU would need to poll one or a small group of RTs each Subframe to check, if new messages are waiting, also in 'Instrument-Subframes'.**

- **This service will <u>not be available to instruments</u> but used in support of e.g. FDIR functions of the S/C or ACMS. Only in exceptional cases, where a fast system reaction is needed (< 500 ms), this service can be used. Approval of ESA / Prime is needed for each individual case / packet.**

5) Data Traffic Scenarios, Data Bus Use

- A TN has been distributed by Alcatel, in which certain boundary conditions, which have impact on the data rates on the data bus, are discussed.

  The TN does not define data rates which are actually available to instruments - the binding values are laid down in the IID-A.

- This TN was a first attempt to analyse the effects of the various parameters. As several points could not be taken into consideration at the time the TN was generated, the figures provided in that issue of the TN are all under review and will be updated.

- Now, as the System Requirements Review comes to a conclusion, resulting in consolidated and updated specifications on all levels, the TN will be updated in line with the actual status of ESA and industrial specifications, and re-issued.

- Certain aspects will be addressed in a separate presentation:

6) Any other Business, Action Items

- **Short overview on development status and future activities of Instruments:**

- **Summary of Action Items: see MoM**

- **Next Meeting: as agreed during the meeting of 9-10-2001**

Tentative date: Thur., 29-11-2001

Location: Cannes

Attachment 2

Objet: **PS-ICD Service 6 - memory management**
Date: Wed, 14 Feb 2001 17:27:56 +0100 (MET)
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A: K.J.King@rl.ac.uk, L.Dubbeldam@sron.nl, ohb@mpe.mpg.de, fgb@mpe.mpg.de, beney@lal.in2p3.fr, fgr@ll.iac.es
Copies à: orfei@eqs.ifsi.rm.cnr.it

Dear All,

IFSI has an open action within the Data Management Working Group for providing a proposal to modify the length of the address field in the memory management TCs.

The past week I had some discussions about this topic here at IFSI with Riccardo Cerulli and Renato Orfei (and with Carlo Gavazzi Space, which is ivolved in the topic because it is goig to provide us with the PROM power-on procedure).

The first thing to note is that the data address generators in the ADSP21020 foresee a 24 bits address bus for the Program Memory and a 32 bits address bus for the Data Memory.

With 32 bits we can in principle address "absolutely" up to ~2.15 x10^9 memory locations. In our case we don't have such a big memory segment on board: our Program RAM is dimensioned to 512Kwords (3 MB with 48bits words), the Data RAM is 512Kwords (2MB , 32bits words) and the EEPROM is 256Kwords (1MB, 32bits words).
Therefore even a smaller Start Address Field in the memory management TCs can be used for an "absolute" addressing on board.

Our suggestion is to maintain the 32 bits totally allocated in the TCs for the memory addressing, but to ask ESA to divide the two fields into:
Memory ID field: 8bits
Start Address Field: 24bits.

The Memory ID field is intended to indicate the memory bank/block to which the start address is referred to. With 8 bits, up to 256 memory blocks can be assigned on board and even in the case of PACS, where more than one DSP is foreseen, these should be sufficient to identify all the different non-consecutive memory segments present in the instrument.

The Start Address Field length will allow to address the PM correctly, and to address up to a maximum of 8 Mw in the DM.

What do you think about this suggestion?

I've already had a positive feedback from Helmut and, before sending an "official" request to ESA for a modification of the PS-ICD, I would like to know if you all agree with this proposal.

Thank You in advance,

Best Regards,

Anna

Dr. Anna Maria Di Giorgio e-mail: annadg@ifsi.rm.cnr.it

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CONTENTS

1. INTRODUCTION

This tech. note discusses some of the problems in implementation of the 1553 bus protocols as specified in the Packet Structure – Interface Control Document SCI-PT-ICD-7527.

Suggestions are made as to possible simplifications.

2. FRAME STRUCTURE

The PS-ICD describes the one second major frame cycle, divided into 64 subframes of 24 message slots each. It suggests a simple scenario for the transfer of telecommand and telemetry packets in various subframes. Further definition is needed to allocate the telemetry transfers on a subframe-by-subframe basis to each subsystem. It seems inevitable that several such allocations will be needed for various instrument configurations, eg. SPIRE prime, PACS prime, etc.

The PS-ICD also gives a utilisation of the message slots within a 15.6mS subframe. Further definition is also needed in this area for software design and testing of the instruments and the CDMS-Simulator. A suggestion by the HFI team was made in a Data working group meeting see TN-PH-200001-LAL, 3 April 2001, reproduced below. This allocation, which is important to define the time available for the handshaking protocol, was used in the CDMS-Sim design.

Message Slot	Message Description	SubAddress
1	Sync broadcast	31
2	Status polling or Low-level Command	1T 1R
3	Broadcast time (subframe 33) or Event TM	8R 4T
4	Event TM	5T
5 - 20	Packet TM or Packet TC	11T-26T 11R-14R
21	TM Confirmation or TC Descriptor	27T 27R
22	TM Request	10T
23	TC Confirmation	10R
24	Use only for Asynchronous TC	3R or 4R

3. DATALINK LAYER

3.1 Error handling and Recovery

The PS-ICD hints at various possibilities but does not specify what should be the CDMS philosophy for error handling at a low level. Possible strategies on detecting a bus error could be :

- Delete the RT causing the errors from bus activities until recovered by some special procedure.
- Ignore the error and continue.
- Initiate a recovery sequence.

The 1553 bus is a general-purpose bus applicable to synchronous and asynchronous systems. Spacecraft data systems normally work on a synchronous basis – if there is a failure in one area we don't want to stop telemetry from the others. This implies no autonomous recovery; re-configuration or recovery sequences would be initiated from the ground.

3.2 Retrying Bus Messages

Retry is an option in the low-level 1553 controller. There is a parameter in the channel control word to enable retry for each message. If a parity error occurs for example, the bus controller will automatically collect the same message again. The duration of 32 word message is approximately 500uS. The slot time is 750uS for the Hershel/Planck packet data messages. This means that there is not enough time to collect a message twice. If any errors occur there is likely to be more than one, which would completely disrupt the frame structure, hence retry is not likely to be used.

4. TRANSFER LAYER

Alcatel technote H-P-ASPI-TN-186 has some different scenarios for the allocation of subframes to TM packet transfer. These are based on the nominal bitrates allocated to each instrument assuming full length (1kbyte) transfers. However this is not a valid assumption. The packet ICD includes many packet service types which naturally generate very short packets, for example the telecommand acceptance reports. Since there is only one packet transferred per subframe, this leads to a very inefficient packing density.

As a result we estimate that with SPIRE prime, up to 30 subframes per second will be needed.
Another example of the problem is with PACS in burst mode. Confirmation of TCs will still be needed even though the whole TM packet transfer allocation is filled.

An agreement on the mechanism for transfer of TC acceptance reports is urgently needed for those writing software.

4.1 Packet TM Handshake

According to the PS-ICD two different handshaking protocols are required:

4.1.1 'Normal Handshake'

A. RT puts new data into output buffers
B. RT sets flow control = 01 in TMReq
C. TMReq transferred over bus
D. BC reads TMReq and creates transfer messages.
E. Transfer occurs
F. BC writes TM confirmation with flow control = 11
G. RT reads TM confirmation

In this transfer case the TMReq message can be two subframes before the packet data is transferred. This works out very conveniently for a BC created with the DDC ACE chip. The BC memory management scheme uses double buffering so that the host processor is always working with one buffer, and the ACE with the other. Buffers swap over at the end of a subframe. According to the PS-ICD packet data is not transferred from RT to BC unless required, so the transfer messages are not created unless there is a valid TMReq. In conjunction with the double buffering this means that the TMReq MUST be two subframes before the packet transfer.

So referring to the numbered list above:
A & B occur in subframe 1
C can also be in subframe 1
D occurs in subframe 2
E is in subframe 3 (one subframe delay required because of double buffers).
F should also be in subframe 3 if unnecessary delay is to be avoided.
Restarting, A & B are in next subframe, number 4 .

4.1.2 Burst Mode Handshake

A. RT puts new data into output buffers
B. RT sets burst mode flag in TMReq (first time)
C. TMReq transferred over bus
D. BC copies ready-made messages for a maximum length TM packet transfer into execution buffer.
E. In next subframe the packet transfer occurs, TM confirmation, AND and new TMReq is polled
F. RT senses new subframe, puts new data into output buffers, and updates TMReq.

In burst mode the handshake is compressed in time A,B,C & D occur first to establish burst mode. E & F repeat during each subsequent subframe while burst mode is maintained. Referring to the figure below we see that both BC and RT have to write to the ACE chip's active buffers (those used during the currently running subframe). This presents a more difficult problem than the 'normal' case of section 4.1.1, since more exact timing is required and a memory clash must be avoided. It is preferred to use double-buffering as discussed above.

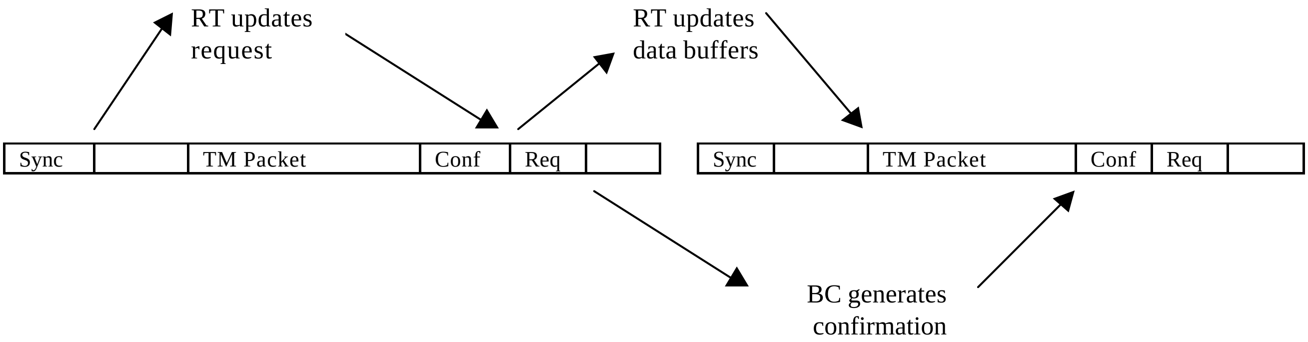


Figure 4-1: Bus message transmission in Burst Mode (PS-ICD)

Figure 4-1 illustrates PS-ICD requirement 4700-TFL-T, specifying burst mode transfers. An RT recognises a subframe containing its packet transfer from the subframe sync message. It updates its TMReq at this point. It may update the TM Packet buffers at the same time; a maximum of 2mS is allowed from start of subframe. Alternatively, if this suits the RT software, it may prepare a new packet after the confirmation in the previous subframe as illustrated in the figure.

The BC, on reading the TMReq message, generates a TM confirmation message which will be run in the next subframe. At run-time there will not be enough time to evaluate the packet transfer for errors before the confirmation message is actually transferred. Hence the TM Confirmation merely indicates the expected transfer.

Since the bus transactions are regular and deterministic, the RT already knows that if a packet is ready it will be transferred in that subframe where the sync message contains its RT number. Thus the TM confirmation is redundant in a practical system.

4.1.3 Simplified Handshake

It does not make sense to have two different handshaking protocols. If burst mode is being used at all, we may as well always use the burst mode handshake. However the timing requirements are more stringent.

As mentioned in the previous section it is likely that in a practically constructed system, the TM Confirmation message will not be as useful as implied in the PS-ICD, at least in burst mode. The message is redundant if the RT uses the information in the subframe sync, and is fast enough to update its buffers in 2mS. Hence we could propose to delete it altogether.

The modified 'handshake' uses the TM Request as defined in the PS-ICD. It is polled in the same subframe as its associated Packet TM and the BC uses the information to build a packet from the data in subaddresses 11-26. The BC will always transfer all of these subaddresses from the RT. This system has the advantage that all of the messages related to one packet are in one subframe, making it much easier to construct a complete bus polling sequence for the whole spacecraft. There is also consistency between normal and burst mode requirements.

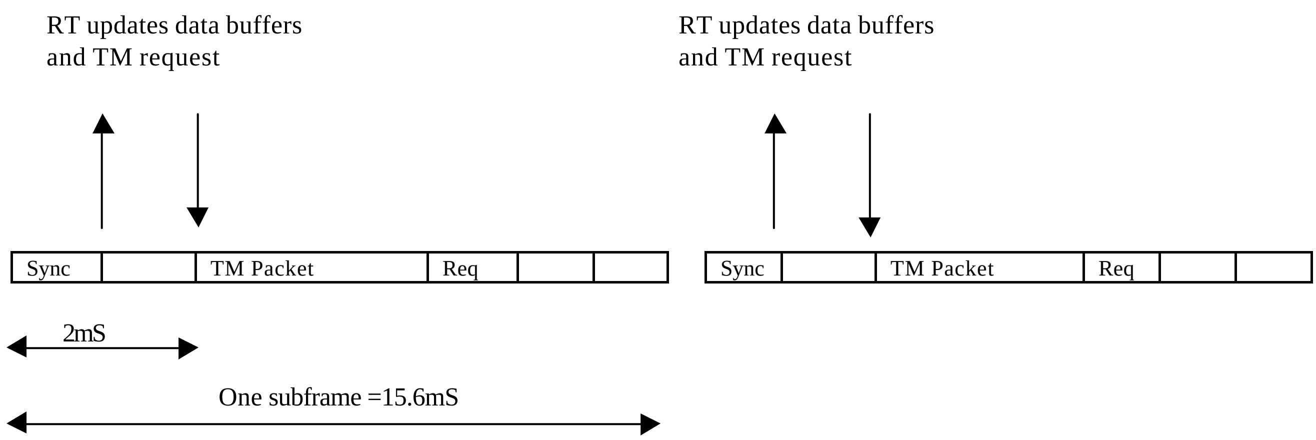


Figure 4-2: Modified Packet transfer protocol

4.2 Event Telemetry

It is not specified in the PS-ICD how the length of an EventTM message is determined. It would be possible to use the 'Number of data words in last message' field in the TMRequest message. However this prevents the same TMRequest being used to request a packet transfer. This could be unacceptable for example in burst mode if Event telemetry is required at the same time.

So the proposal is for all Event TM messages to be of fixed length i.e. 32 words.

5. SUMMARY OF PROPOSALS

- Allocate fixed message slots for each message type and user (eg LAL suggestion).
- No retry of 1553 bus messages by the Bus Controller.
- Transfer TC Acceptance report packets over the bus using Event Telemetry messages.
- Delete the TM Packet Confirmation message.
- All Event TM messages to be of length = 32 words.

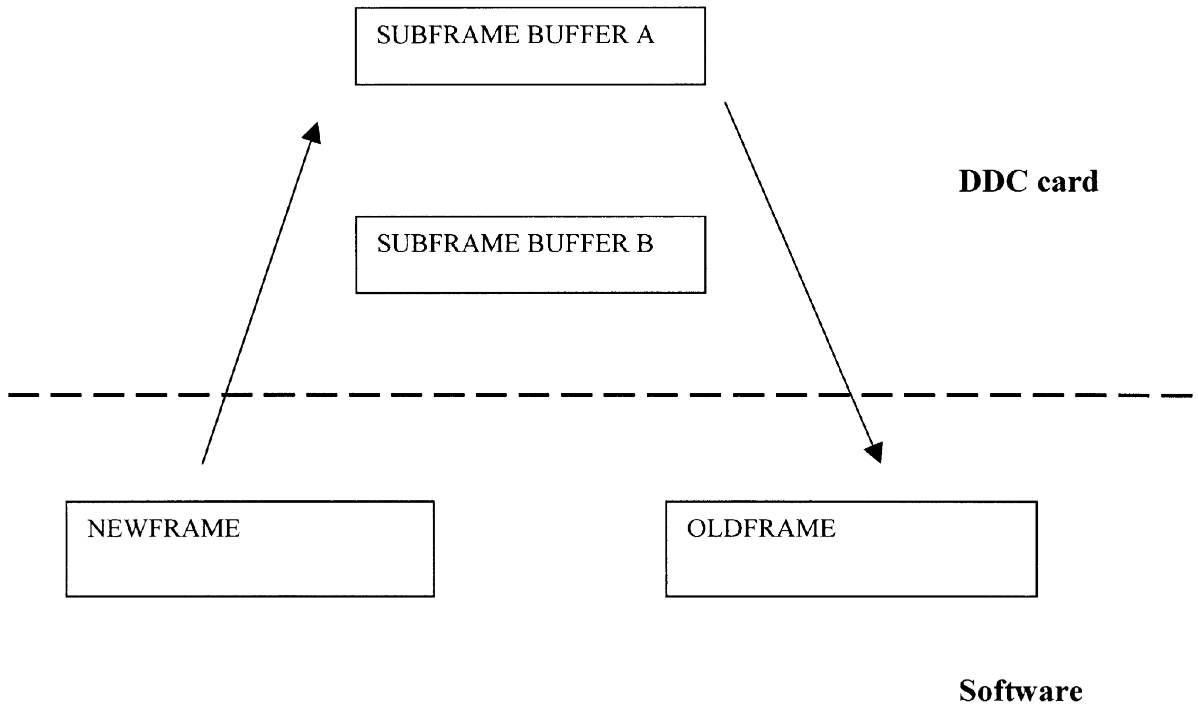
Attachment 4.1

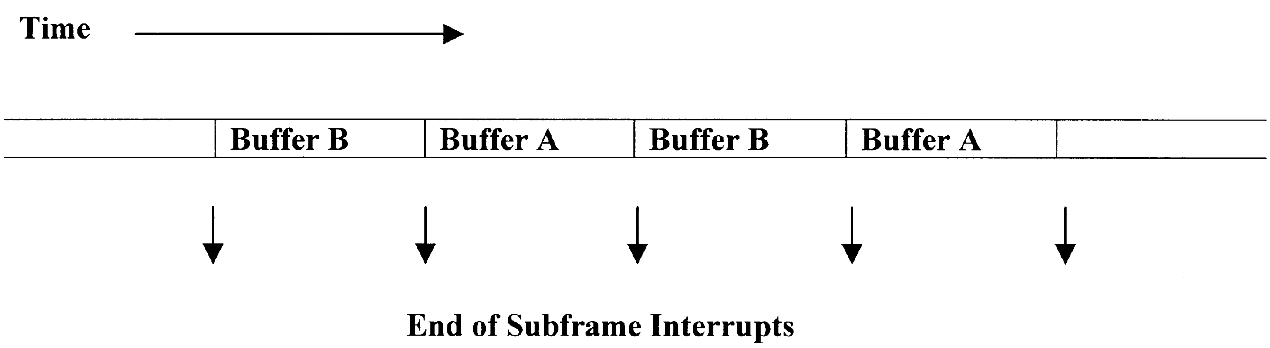
Packet TM transfers for single RT (as specified in PS-ICD)

BC	Bus	Subframes	RT
Build TMReq		x	Update TM buffers
			↓ 2mS max
	TMReq	x+1	
Extract TMReq Check it, if valid… Build TMPacket, TMConf		x+2	
Build TMReq	TMPacket TMConf	x+3	
Extract TMPacket	TMReq	x+4	Read TMConf Update TM buffers
Extract TMReq Check it, if valid… Build TMPacket, TMConf		x+5	
Build TMReq	TMPacket TMConf	⋮	
Extract TMPacket	TMReq	⋮	Read TMConf Update TM buffers
Extract TMReq Check it, if valid… Build TMPacket, TMConf			

⋮

DDC Card Data Exchange





- General : Science data return is limited by 3 factors
  - Mil 1553 Bus + ESA specified protocol
    - currently specified in kbps
    - PS ICD propose a basically synchronous scheme with a subframe concept and slots allocation
  - Mass Memory size
    - it is required to store the max average data rate (instruments+spacecraft) over 48h
  - Downlink capacity and time
    - it is required to permit the simultaneous transmission of :
      - the data acquired at the max average data rate over the past 24h
      - the data acquired in real time

Slot No.	Content/ Purpose	Duration in micro seconds
1	Subframe synchronization	150
2	Command/ Acquisition Slot	750
3	Command/ Acquisition Slot	750
4	Command/ Acquisition Slot	750
5	Packet transfer	750
6	Packet transfer	750
7	Packet transfer	750
8	Packet transfer	750
9	Packet transfer	750
10	Packet transfer	750
11	Packet transfer	750
12	Packet transfer	750
13	Packet transfer	750
14	Packet transfer	750
15	Packet transfer	750
16	Packet transfer	750
17	Packet transfer	750
18	Packet transfer	750
19	Packet transfer	750
20	Packet transfer	750
21	Packet control (e.g. polling)	150
22	Packet control	150
23	Packet control	150
24	Regulation Slot	≤ 775

Slot 2 → 1x full length 1553 message

Slots 5–20 → 1x full length TM packet

Slot 22 → 1x 1553 mode code

Slot 24 → 1x full length 1553 message (asynchronous)

Slots allocations within each subframe

Sub frames allocations : assumptions

General

- proposed baseline is a very basic handshake mechanism :
  - no message resent

Instruments

- 4 subframes/s are reserved for instruments TC's. Accordingly, 4 TC's acknowledge subframes+ 4 TC's Content report subframes are allocated
- 1 subframe/s per instrument is allocated to HK TM

Spacecraft

- 1 subframe/s reserved for ACMS TC's. Accordingly, 1 TC's acknowledge subframes+ 1 TC's Content report subframes are allocated
- 2 subframe/s allocated for ACMS TM packets
- 1 subframe/s allocated for PCDU TM
- Slots n°3 & 4 reserved for PCDU & CCU commands/acquisition

- Sub frames allocations : sizing cases
  - Herschel :
    - only PACS in operation (100kbps); HIFI and SPIRE only deliver HK packets
  - Planck :
    - HFI delivers 48kbps +2kbps HK
    - LFI delivers 30kbps +2kbps HK

Planck

PACKET Budget for IIDB issue 1 scenario		
	Subframe/s	kb/s
TC reserved	4	
TC Acknowledge	4	
TC Content Report	4	
HFI Science	6	49.152
LFI Science	4	32.768
HFI HK	1	8.192
LFI HK	1	8.192
Sorption Cooler HK	1	8.192
Total Payload Science+HK	**13**	**106.5**
AOCS TM	2	
PCDU TM	1	
CDMS - AOCS TC	1	
CDMS - AOCS TC ACK	1	
CDMS–AOCS Content Report	1	
Margin	33	
Total	64	

Planck

PACKET Budget for LFI request of 12 Subframes		
	Subframe/s	kb/s
TC reserved	4	
TC Acknowledge	4	
TC Content Report	4	
HFI Science	6	49.152
LFI Science	12	98.304
HFI HK	1	8.192
LFI HK	1	8.192
Sorption Cooler HK	1	8.192
Total Payload Science+HK	**21**	**172.03**
AOCS TM	2	
PCDU TM	1	
CDMS - AOCS TC	1	
CDMS - AOCS TC ACK	1	
CDMS–AOCS Content Report	1	
Margin	25	
Total	64	

Planck

PACKET Budget for IIDB 2.0 Allocation		
	Subframe/s	kb/s
TC reserved	4	
TC Acknowledge	4	
TC Content Report	4	
HFI Science	6	49.152
LFI Science	8	49.1526
HFI HK	1	8.192
LFI HK	1	8.192
Sorption Cooler HK	1	8.192
Total Payload Science+HK	**17**	**139.264**
AOCS TM	2	
PCDU TM	1	
CDMS - AOCS TC	1	
CDMS - AOCS TC ACK	1	
CDMS–AOCS Content Report	1	
Margin	29	
Total	64	

Herschel

PACKET Budget for IIDB issue 1 scenario		
	Subframe/s	kb/s
TC reserved	4	
TC Acknowledge	4	
TC Content Report	4	
HIFI Science	0	0
PACS Science	13	106.5
SPIRE Science	0	0
HIFI HK	1	8.192
PACS HK	1	8.192
SPIRE HK	1	8.192
Total Payload Science+HK	**16**	**131.072**
AOCS TM	2	
PCDU TM	1	
CDMS - AOCS TC	1	
CDMS - AOCS TC ACK	1	
CDMS–AOCS Content Report	1	
Margin	30	
Total	64	

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Herschel

PACKET Budget for PACS Burst mode		
	Subframe/s	kb/s
TC reserved	0	
TC Acknowledge	0	
TC Content Report	0	
HIFI Science	0	0
PACS Science	37	303.104
SPIRE Science parallel	0	0
HIFI HK	1	8.192
PACS HK	1	8.192
SPIRE HK	1	8.192
Total Payload Science+HK	**40**	**327.68**
AOCS TM	2	
PCDU TM	1	
CDMS - AOCS TC	1	
CDMS - AOCS TC ACK	1	
CDMS–AOCS Content Report	1	
Margin	18	
Total	64	

- Mass memory sizing
  - Sizing assumption is 140kbps total (Science data + HK +margin) from instruments

S/C HK	432	Mbits
MTL	19	Mbits
Events	0.5	Mbits
Copy of Flight SW	16	Mbits
SubTotal	467.5	Mbits
Margin	467.5	
Total for Satellite System	935	Mbit
Instrument Data 140kb/s for 48hours including margin	24.192	Gbit
Total Mass Memory	25.127	Gbit

Instrument Max Data rate / Download Time

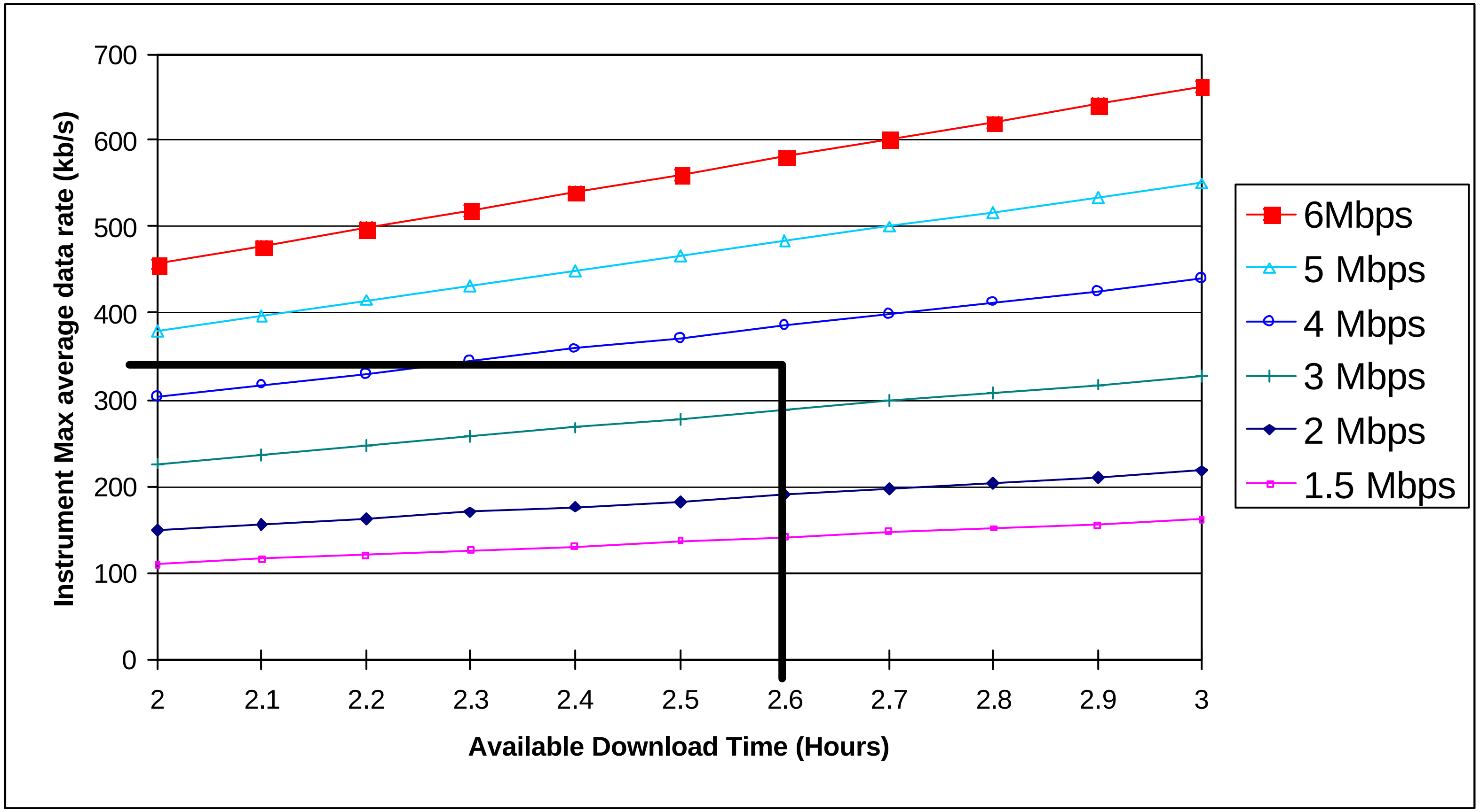
1.5Mbits/S with a contact time of 2.6 Hours means that a total of 14040Mbit can be downlinked. In 2.6hours, 1372Mbit realtime data can be generated on the bus so the mass memory has to be sized for

14040-1372 Mbit = 12.7Gbit.

To fill this memory over 24hours permits a maximum bus datarate of 147kb/s (which includes all spacecraft data + science + instrument TM).

Removing allocation for satellite HK + margins yields a **max average datarate of 140kb/s for the instruments.**

Therefore the IIDA allocation of 100kb/s is in line with the maximum datarate allowing for uncertainties.



Graph shows Instrument max average datarate as a function of dowload time and downlink datarate
Absolute maximum on the databus is 350kb/s (with no TC and associated overheads)
and typical 2.6hours contact time defines the possible working area