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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.

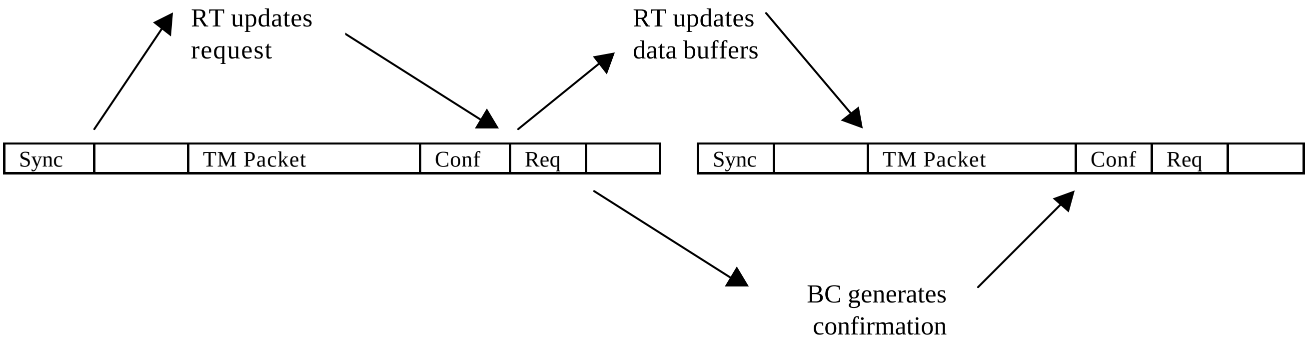

Figure 4-1: Bus message transmission in Burst Mode (PS-ICD)

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.

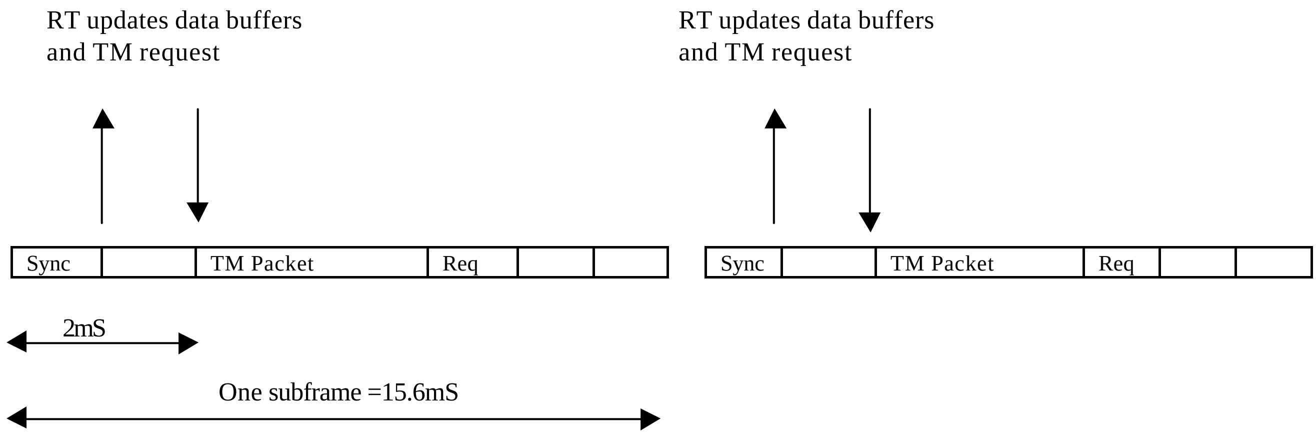

Figure 4-2: Modified Packet transfer protocol

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.