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SAX Payload Management
Elements for discussion.

G.Boella & L.Chiappetti, IFCTR Milano
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1. Lessons learned from Exosat

Why a comparison with Exosat ? On one hand a comparison of SAX with flown non-scientific satellites is not particularly significant, on the other hand the term of comparison should be of similar complexity (e.g. multiplicity of instruments for coordinated observations, observatory structure) which was not the case of previous missions.

1.1 OBDH overall structure

The information in this section is drawn from the Exosat User's Manual (PT-UM-S00.000; 15-5-81).

With reference to the OBDH overall block diagram (fig. 1) we note that :

- all interfacing with the users (scientific payload instruments, AOCS and other s/s) occurred through the RTU's (the Low Speed one mainly handling HK data, and the High Speed one handling scientific data).

- CTU was in charge of all the traditional OBDH functions for telemetry and commanding (with the exception of time tagged commands) and provided all i/o to the OBC.

- The OBC (On-Board Computer) was configured as an intelligent peripheral of the CTU, and was in charge of the scientific data processing (packet generation included), of some AOCS-related functions, of time tagged command queue handling and also (in a second time) of some specific HK monitoring.

1.2 OBC : h/w and s/w

The OBC was based on an 8-bit CPU with 128 kHz clock and 2 8-kbytes memory modules for a total of 16k (normal operation implied the use of the full 16k, while a degraded 8k mode was foreseen as backup). DMA transfer with the OBDH (CTU) was used. It should be noted that the telemetry (down-link) rate was limited to 8 kbps !

A typical BIF (Basic In-Flight System) used the memory resources as follows : besides the Operating System, one had fixed and interchangeable Application Programs (APs). A ~ 6k output buffer space was provided and shared among the various APs.

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Fixed APs were always memory-resident (even when not running). They included the time tagged command function, some scientific basic modes (their use was however reduced after the early stages of the mission) and some AOCS and s/c support functions (on the contrary their use increased during the mission).

Six slots (for a total of ~ 2.3k) were available for interchangeable programs (loaded from ground). This was essentially used for the main scientific APs (also for AOCS support at the beginning of the mission, however these APs were later moved to fixed locations).

Fig. 2 gives a simplified view of the In-Flight s/w system.

1.3 Experiment data acquisition by OBC

The scientific data were acquired by OBC from CTU using DMA, with 512 8-bit data samples acquired in a 31.25 ms software cycle. The sequence of interrogation of the various data channels in the 512-byte buffer was under control of the SDS (Scientific Data Sequencer). The SDS was a small (32 location) buffer memory which was programmable **independently** of the OBC.

Each experiment supplied the High Speed RTU with a number of parallel 8-bit data channels (for each event e.g. energy, position, burst length, time, detector id etc.), which were suitably multiplexed. Of course each AP did not need to sample all of them.

Using the SDS the experiment output channels were sampled at different, programmable, sampling rates (from 16 kHz to 32 Hz), which **are to be intended as mean rates !!**

Moreover the consistency between the channels to be sampled and the sampling rates set up by SDS and those expected by OBC according to the current AP choice had to be guaranteed by the ground operator.

A 3-element ring input buffer was shared by all APs. Direct APs inserted the acquired data (eventually after suitable thresholding) in the telemetry packets, which were built in the output buffer area. Indirect APs instead constructed, over a fixed time interval, histogram-like structures (e.g. spectra, time profiles), which of course required larger dedicated space in the output buffer area.

1.4 Operational constraints

It should first of all be noted that Exosat was in continuous view of the ground station in the active part of the highly eccentric orbit. Therefore commanding was not a problem (even with an uplink bit-rate as low as 160 bps).

In preparation of each observing period the payload and the OBC had to be separately (and independently !) configured. The payload (hardware) configuration was established uplinking a few memory load commands. The collect data from and construct the telemetry data stream for the other instruments.

The packet collection and the retransmission towards the mass memory shall be decoupled from payload operations.

The payload controller shall check and maintain the integrity of the programs stored in its memory. This shall be done at suitable intervals to reduce the occurrence of errors induced by radiation and disturbances.

It shall be completely redundant for maximum reliability

2.2.3 Spacecraft and mission controller

This controller coincides with the CTU in the OBDH. Its role and functions are the usual ones for a CTU.

3. Conclusive remarks

The comparison between the Exosat and SAX cases may be summarized as follows :

Exosat:	CTU + OBC
SAX:	CTU + DMU + Instrument Controllers

The functions of the Exosat OBC have therefore been redistributed (for what the payload is concerned) among the CTU, the DMU and the Instrument controllers.