EIS Onboard Software

Informal Discussion Meeting 27/Apr/99 @ RAL
Re-Soho CDS experiences

Those present : A.McCalden,M.Carter,R.Gowen,R.Harrison,J.Lang,J.Payne,D.Pike,E.Sawyer.

I would like to thank everybody for the large number of interesting ideas generated at the meeting, which I have attempted to recreate here together with some initial post meeting thoughts.

The ideas and responses will provide useful input to both formation of the EIS onboard software requirements and in the EIS system design.

Please feel free to comment on these minutes, raise other topics, or advance the existing ones.

Many thanks again,
Rob & Alec

p.s. I was surprised by how significant some of the proposed capabilities of the EIS are, as a successor to the CDS.
E.g. :-

time cadence	:	~x10 to 100	improvement	(for EIS 0.5s down to10's ms)
count precision	:	x4	improvement	(for EIS 14 bits a-to-d)
telemetry rate	:	x2 to 60	improvement	(for EIS 64kbps to 2Mbps)
sensitivity	:	up to ~x10	improvement	(guesstimate for some lines)

GENERAL COMMENTS

People were keen to know current EIS instrument & spacecraft basic design characteristics. This made us acutely aware of current lack of firm information on many basic aspects.

- Good idea to present current information at Birmingham consortium meeting regarding spacecraft knowledge, EIS instrument status and preliminary software strawman designs.

- Recommend meet with other EIS consortium members for similar ideas storming sessions, relating to requirements, and exchange of information.

INDIVIDUAL ITEMS

	Comments	Initial Responses
1	Blue book good	- Read EIS science case studies on web
2	Biggest limitation on CDS was time response. (e.g.100ms exposure but 4 to 5 sec cadence) (due to slow ccd flushing/readout proc) (E.g. to study flares with rise times down to ~1sec.)	- Will attempt to get few 10's ms cadence for EIS. (1 to 2 orders magnitude improvement) - EIS CCD flushing will be fast ~4ms (& could be terminated early if required) - EIS 'full image' 120x2048 (TBC) pixel readout will take ~0.5 secs, & faster for limited windows. - Consider use CCD as a store (e.g. narrow slit 3 pixel rows for rapid cadence 3 row readouts).
3	Faster AEC response may be useful. (e.g. for flare response, down to sec) (CDS has slow cadence/response)	- Possibilities include :- • Aim for next exposure (~10's of ms response) • Use short pre-exposure (metering exposure) • Consider fast but regular cadences (can integrate data for weak features)
4	Flare flag useful Ability to downlink high res data for period (e.g. 5mins) prior to detection of flare onset.	- Flare flag planned from XRT. - Could store rolling 5 mins of high res data which is continually updated, and only telemeter to MDP when flare onset is detected, or stop overwriting the data if stored in spacecraft telemetry store. Need to consider affects on cadence rates if collecting more data, storage requirements and transmission rates to MDP. (Alec favours mass memory store in EIS, otherwise difficult s/c i/f. Rob notes s/c has much larger potential storage capacity).
5	Takes too long to re-point instruments to study flare	- How fast to re-point EIS fov with mirror if detected flare is in EIS mirror movement range ? - Could get instant fov change by moving windows if flare images on higher or lower part of CCD.
6	Cosmic rays kill long exposures (spikes)	- Could perform series of short exposures, and integrate images onboard after cosmic ray events have been eliminated, either by excluding affected exposures or identifying and removing affected areas of images (despiking). (Need to despike before data compression to prevent artefacts.)
7	Feature tracking not good on CDS (require step size to be ~0.1 pixel size)	- This makes requirement on e.g. EIS mirror scan control.
8	Post launch flexibility good	- Software uplink ability is a requirement.

		(Likely to be limited on EIS by limited command uplink capability (TBD).
9	Inter-instrument flags not used much on CDS.	- Seems to be a core requirement on Solar-B for coordinated instrument response to e.g. XRT flare detection. - Need to flesh out how effective it is likely to be for Solar-B.
10	Compression schemes not used much on CDS. (perhaps because of conservatism , ingrained habit after commissioning without compression, fear of loss of whole observation if lose one frame ?)	- Needs champion of compression in science camp. - Already have requirement in EIS to limit 'loss of science study' arising from transmission errors. (e.g. limit loss to 1 exposure & see next item also) - Should be 'normal' to employ lossless comp -> no loss of science data - just get more of it ! - Lossy compression can be useful for particular studies not possible any other way. (e.g. very high time resolution studies, such as movies of flare development) - EIS considering 'wavelet' compression, which is well represented on the web.
11	Can lose whole study (e.g. 3 hours) if lose just one telemetry packet. (e.g. header packet)	- Make requirement that lose no more than e.g. 5 mins (TBC) data if lose any single EIS telemetry packet. (e.g. by periodic re-transmission of 'key' packet for exposures/obs > 5 mins).
12	Watchdog kicked often on CDHS because of SEU's, & takes ~1 hour to reboot & re-upload software patches.	- Intend to implement rad-hard memory for EIS. (will effectively eliminate SEU watchdog kicks) - Intend to ask for keep-alive line for EIS RAM - Intend to store main code in EEPROM. (can be changed, but remains when inst is off).
13	Flexible response to variable telemetry allocation rates on CDHS was good. (E.g. No instrument commands required to cope with different spacecraft telemetry allocation modes; be able to automatically cope with much larger tel allocation if another Solar-B exp fails.)	- Already implicitly recognised for EIS with 'nominal' 64 kbps tel allocation and 1 to 2 mbps max transfer rate to MDP defined (TBC). - Currently no spacecraft telemetry modes defined. - Could make these operational requirements explicit
14	Variable hk telemetry rates useful. (a) for ground engineering checks (b) for fault finding/diagnosis (e.g in orbit) but even with fastest rate 2 sec not good enough.	- Variable hk rates planned for EIS. - Could require EIS to make very high rate hk reports, only limited by speed of collection of hk and tel rate, by using all tel capacity.
15	Retain flexibility (people will change their minds)	- Could make it an EIS design requirement or guideline, and review at onboard software

requirements and design reviews.

16 Aim for onboard simplicity
(Software complexity on CDHS may have resulted in some controls not being used.)

- Could make it an EIS design requirement or guideline, and review at onboard software requirements and design reviews, & is connected with simplicity of operation as seen by science user via the ground operational/planning interface.

17 CDS operational modeling/planning difficult to better than 100 secs resolution due to software module interplay resulting in large latencies and timing uncertainties.

- Aim for deterministic timing, e.g. :-
- Long Time Scale Modelling:
  - Use of time tabled observing modes (deferred commanding) can make start and end times of modes very precise.
    (when no real-time change of mode by XRT coordinated flare obs is required.)
- Short Time Scale Modelling: If required :-
  - Could make s/w requirement to target a limit for latencies in 10's μsec to msec range with use of priority interrupts with real-time multi-tasking operating system.
- Applicability may depend on whether particular requirements are for 'fixed' or 'fast as possible' cadences. (e.g. take full ccd image, process and transfer to MDP as fast as possible, then take new image, where variable compression ratio scheme is applied.)

18 Instrument management on CDS was time intensive:
(2 people full time for health/safety checking and uploading daily studies)

- EIS will be out of ground contact most of the time so current plan is to perform health & safety onboard.
  - Not possible to do real-time ground health checks
  - HK checking frequency can be much higher than telemetering frequency)

(Large uplink volume for tables to be loaded & dumped to check, dropped commands, and re-uplinks)

- EIS expected to have very limited cmd uplink rate but no numbers given yet (maybe cf Yohkoh).
  - Plan to store tables onboard and only uplink changes.
  - Could save operational effort by being able to store multiple days operations onboard.
    (See also item 25)

(Complicated temperature management: different thermal conditions for each s/w mode)

- Current plan is for spacecraft to manage EIS temps
  - Recognise may cause problems with temperature control precision requirements (need to talk to s/c people.
  - Could possibly ease some situations by having thermal compensation heaters to counter mode changes where e.g. subsystems are turned off. But is not simple, needs to be looked into.

19	Would like more temperature monitoring points to <0.25˚C because CDS calibration depends on temperature. Used heaters to control optical bench.	- Need to look at EIS temperature control reqs, especially whether should be handled by inst rather than spacecraft ? (Optical path may need tight <2˚C thermal control)
20	Onboard contamination monitor ?	- There is one for EIS. - Determine EIS onboard s/w reqs for this.
21	Onboard calibration source Useful to know where stationary lines should fall on ccd.	- Lamp too big ? impossible ? - Temperature manage EIS elements.
22	CDS users choose wavelengths to observe not windows, because line positions may change depending on calibration (temp etc.)	- We should remember this as useful requirement for for operational ground planning system.
23	Fail Safe Mode (If instrument switched on and no uplink capability, after TBD time (hours/days), instrument will go into default science mode returning useful data)	- Will consider this - seems possible. (E.g. need to avoid inst switching on subsystems which may have developed faults during mission lifetime.)
24	Mechanism cycle count Report in HK number of cycles that a mechanism has operated. Could be useful if need to service (e.g. lubricate or calibrate) after certain number of cycles. Also useful for determining how near mechanism is to total life cycle max count.	- Will consider applicability to any EIS mechanisms - Could keep total count in KAL (Keep ALive) RAM in EEPROM, or in EGSE. - Need to consider what happens if KAL goes down or uplink new code or data areas.
25	How long ahead to allow timer obs. (e.g. Sundays off for ops planners, holidays, xmas etc)	- Will consider EIS onboard storage capabilities for multi-days ops without uplink. (Could make requirement for size of store to allow e.g. 4 days operations.)
26	EGSE (e.g. requirements for calibration, spectra out, fitting)	- Is MSSL responsibility. Needs to be sorted out.
27	Operational quick look views of engineering and sci data in operations.	- Need to think about. Note that EIS will only see data at infrequent times of downlink times of about 1/2 a day (at present planned) - Possibly use international electronic links.
28	Consider frequent downlink situation. E.g. once per orbit. (note that some other missions had	- Need to think about. Could affect :- our telemetry storage allocation per dump, ie ability to support a much higher rate to MDP could be

more downlink stations than originally planned.) useful. I.e. could fill onboard s/c tel store in one orbit instead of 5 or more.

28 CCD readout bias (blocked out pixels on CCD for regular readout for CCD diagnostic purposes) - Need to think about. (not sure if covered for EIS by correlated double sampling).

29 Note: Carbon structure may cause problems with :-
(a) electrical charging
(b) water absorption resulting in outgassing problems and dimensional changes.
