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MEMORANDUM

October 6, 1999

From: M. Juda
To: Distribution
Subject: Out-of-sequence HRC Time Tags
File: /data/juda1/juda/asc/hrc/tex/bad_time_tag.tex

1 The Problem

When processing HRC data from flight, a problem appeared in the event time tags where the times of events as determined by a simple application of the time-tagging algorithm (see the time-tagging memo[1]) come out-of-sequence in the telemetry stream. There is nothing in the HRC hardware that can change the order of when events are telemetered. Time tags are based on the number of "clicks" of an internal HRC clock and the value of a sub-frame counter (the 3 LSBs of the "science" frame) when the event occurred and are measured relative to the start of the "science" frame.

A specific example occurred in the file:

/dsops/current/ap/sdp/cache/1999_08_31/hrc/hrcf052490522N001_evt0.fits.

Below is a snippet around the relevant point within the file; the out-of-sequence event is indicated.

```
   TIME                     MJF          MNF         SUB_MJF CLKTICKS
     5.249176299255712E+07       33017           71       0       129245
     5.249176300672899E+07       33017           71       0       130152
     5.249176301444774E+07       33017           71       0       130646
-->  5.249176507308844E+07       33017           72       1       131199
     5.249176303101022E+07       33017           72       1          506
```

The best clue to the origin of the problem is the value of the number of clock ticks. The largest value that the hardware will generate when functioning normally is given by $T_{sf}/T_{tick} - 1$, where T_{sf} is the duration of a science frame (2.05 s) and T_{tick} is the length of one clock tick (15.625 μs). After this, the science header pulse is received by the HRC and this resets the number of clock ticks to zero and increments the sub-frame counter. This largest value is 131199 and is the number telemetered for the event indicated above. The out-of-sequence time is caused by the details of the timing within the HRC. If the sub-frame counter is incremented before the number of clock ticks is reset and an event just happens to occur sometime during the brief interval between these events, the hardware will generate an incorrect combination of timing information. This sequence is shown schematically in figure 1. The timing information supplied is not "invalid" (the combination could occur for some event) but it is incorrect for this event. It is only because the time tag on the subsequent event is earlier than this event that we can recognize that something is wrong.

2 Recommendation

It is tempting to choose to ignore these events by labeling them as "bad" and discarding them from level 2 processing. However, given that the reason for the invalid time stamp is understood, we should

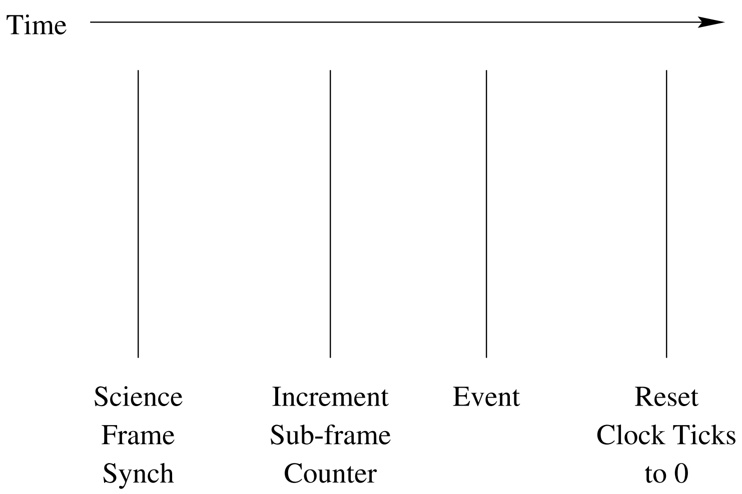

Figure 1: Schematic view of the sequence of hardware events that lead to to out-of-sequence events.

modify the time-tagging software specification to correct the time tags on the events that are shown to be invalid since they occur out-of-sequence. Note that we cannot correct the time tag if the rates are so low that the time between the events is longer than 2.05 seconds; however, this is expected to be an extremely rare case in on-orbit operations where the mean valid event rate is $\sim$50 counts/s.

The following algorithm can be used to correct the time tag of the `CLKTICKS = 131199` events. If an event has a `CLKTICKS` value of 131199, compare the values of `MJF`, `MNF`, and `SUB_MJF` of the event to that of the next event. If the values are the same, set `CLKTICKS` of the first event to 0 and then calculate the time tag.

References

[1] M. Juda memo, "HRC Time Tagging", February 28, 1996