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DAN PDS Data processing flow

version 1.0

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Оглавление

1	SCOPE	3
2	ENGINEERING DATA	3
3	DERIVED PASSIVE	3
4	DERIVED ACTIVE	4
5	AVERAGED PASSIVE	5
6	AVERAGED ACTIVE	5

1 Scope

This describes the conversion flow of DAN data from raw instrument data to PDS formatted files.

Currently, DAN PDS has 5 formats:

- Engineering data
- Derived passive (time series)
- Derived active (time series)
- Averaged passive (averaged over a location)
- Averaged active (averaged over a location)

2 Engineering data

Structure (IDL):

```
A = {DAN_RDR_DERIVED_ENG, $
    DAN_TIME           : OUL, $           Instrument time
    UTC                : BYTARR (23), $   UTC timestamp
    TEMP               : FLTARR (6), $    Temperatures
    HV_LEVEL_CTN       : BYTE (0), $     HV levels
    HV_LEVEL_CETN      : BYTE (0), $
    DSC_LEVEL_CTN      : BYTE (0), $     DSC levels
    DSC_LEVEL_CETN     : BYTE (0), $
    LST                : BYTARR (8) }    Local Solar Time
```

Process flow:

- The dataset is selected by the timeframe required for the current PDS delivery.
- All instrument frames (HK, Passive, Active) are sorted by time.
- The required fields are then moved from instrument frame to PDS ENG frame.
- The resulting frame are put into a .pds file.

3 Derived Passive

Structure (IDL):

```
A = {DAN_RDR_DERIVED_PASSIVE, $
    DAN_TIME           : OUL, $           Instrument time
    UTC                : BYTARR (23), $   UTC timestamp
    BEGIN_LAT          : 0.0, $           Measurement coordinates
    BEGIN_LON          : 0.0, $
    END_LAT            : 0.0, $
    END_LON            : 0.0, $
    COLL_DURAT         : 0.0, $           Collection duration (sec)
    CTN_BKGD           : 0.0, $
    CTN_COUNTS         : 0.0, $
    CETN_BKGD          : 0.0, $
    CETN_COUNTS        : 0.0, $
    LST                : BYTARR (8) }
```

Process flow:

- The dataset is selected by the timeframe required for the current PDS delivery.
- The passive datasets are normalized:

- Separate power-on periods are selected (if 2 consecutive frames are more than 1200 secs apart, than the 2 datasets are considered to be in different power-ons). In case there was an active measurement right before the current passive dataset, it is accounted for normalization purposes.
- Within each power-on, the normalization is performed according to the following law:

$$C_{eff_corrected}(t) = C(t) / A_{norm}$$

where

$$A_{norm} = \left(1 - e^{-a1(t-a2)}\right)$$

CTN detector: a1=11.985331, a2=-0.17908154

CETN detector: a1=3.7732457, a2=-0.4379

C(t) – detector count rate in channels 3-14.

t – “Martian Julian day”, where 1.0 corresponds to a duration of 1 sol.

- All frames with collection duration = 0 are discarded.
- CTN_BKGD and CETN_BKGD are set to 30,72 and 13,73 respectively.

4 Derived Active

Structure (IDL):

```
A = {DAN_RDR_DERIVED_ACTIVE, $
    DAN_TIME           : OUL, $           Instrument time
    UTC                : BYTARR(23), $    UTC timestamp
    LAT                : 0.0, $           Measurement coordinates
    LON                : 0.0, $
    COLL_DURAT        : OUL, $           Collection duration (sec*10)
    NUM_PNG_PULSE     : OUL, $           Number of pulses during frame
    PNG_FREQ          : BYTE(0), $       PNG frequency (hz)
    TIME_BIN_DURAT    : OUL, $           Always 999 (NaN)
    TIME_BIN_START    : FLTARR(64), $    Start of bin (msec)
    CTN_BKGD          : FLTARR(64), $
    CTN_COUNTS        : FLTARR(64), $
    CETN_BKGD         : FLTARR(64), $
    CETN_COUNTS       : FLTARR(64), $
    LST               : BYTARR(8) }
```

Process flow:

- The dataset is selected by the timeframe required for the current PDS delivery.
- All frames with NUM_PNG_PULSE = 0 are discarded
- Each Active frame is then put into the .pds file with the following assumptions:
 - Time scale is only written into TIME_BIN_START array
 - Background bins are considered to be bins with time scale start > 10000 μsec.
 - Background is calculated as: $C / PulsNum / BgdTime$, where C – total counts in channels [3:14] of all background bins, PulsNum – number of pulses during current frame, BgdTime – the length of background bins (in sec).
 - The background is equal for all 64 items of the BKGD array
 - The COUNTS array is filled with the sum of counts in channels [3:14], for channels [0:61]. Channels 62 and 63 are discarded.
 - The above statements are true for both, CTN and CETN arrays.

5 Averaged Passive

Structure (IDL):

```
A = {DAN_RDR_AVERAGED_PASSIVE, $
      START_DAN_TIME      : OUL, $           Instrument time
      END_DAN_TIME        : OUL, $
      START_UTC           : BYTARR (23), $    UTC timestamp
      END_UTC             : BYTARR (23), $
      BEGIN_LAT           : 0.0, $           Measurement coordinates
      BEGIN_LON           : 0.0, $
      END_LAT              : 0.0, $
      END_LON             : 0.0, $
      COLL_DURAT          : OUL, $           Collection duration (sec*10)
      CTN_AVG              : 0.0, $
      CTN_BKGD            : 0.0, $
      CTN_ERROR           : 0.0, $
      CTN_NORM            : 0.0, $
      CETN_AVG            : 0.0, $
      CETN_BKGD           : 0.0, $
      CETN_ERROR          : 0.0, $
      CETN_NORM           : 0.0, $
      START_LST           : BYTARR (8), $
      END_LST             : BYTARR (8) }
```

Process flow:

- The dataset is selected by the timeframe required for the current PDS delivery.
- Frames are normalized as described in the Derived Passive section
- The distinction between different rover locations are based on DE_state x/y/z coordinates, new location is assumed if the mentioned coordinates differ by more than 10 cm along any axis between the 2 consecutive passive frames.
- Collection duration is a sum of all collection duration values of the frames in the current location. In case collection duration cum is 0, the whole frameset is discarded.
- AVG counts are a sum of all normalized counts in channels [3:14] in all passive frames of the current location divided by the collection duration and divided by 10 (collection duration in here is sec*10).
- ERROR is the counts from the point above divided by collection duration and divided by 10
- Background is 30,72 and 13,73 for CTN and CETN respectively.
- All the above is true for both CTN and CETN.

6 Averaged Active

Structure (IDL):

```
A = {DAN_RDR_AVERAGED_ACTIVE, $
      START_DAN_TIME      : OUL, $           Instrument time
      END_DAN_TIME        : OUL, $
      START_UTC           : BYTARR (23), $    UTC timestamp
      END_UTC             : BYTARR (23), $
      BEGIN_LAT           : 0.0, $           Measurement coordinates
      BEGIN_LON           : 0.0, $
      END_LAT              : 0.0, $
      END_LON             : 0.0, $
      COLL_DURAT          : OUL, $           Collection duration (sec*10)
      NUM_PNG_PULSE       : OUL, $
      PNG_FREQ            : BYTE (0), $
      TIME_BIN_DURAT      : 0.0, $ }
```

```

TIME_BIN_START      : 0.0, $
CTN_AVG             : 0.0, $
CTN_BKGD           : 0.0, $
CTN_ERROR          : 0.0, $
CTN_NORM           : 0.0, $
CETN_AVG           : 0.0, $
CETN_BKGD          : 0.0, $
CETN_ERROR         : 0.0, $
CETN_NORM          : 0.0, $
START_LST          : BYTARR (8), $
END_LST            : BYTARR (8) }

```

Process flow:

- The dataset is selected by the timeframe required for the current PDS delivery.
- The distinction between different rover locations are based on DE_state x/y/z coordinates, new location is assumed if the mentioned coordinates differ by more than 10 cm along any axis between the 2 consecutive active frames.
- The distinction is also made by different time scales, i.e. if a time scale change was detected, the data set is split into separate averages.
- Collection duration is a sum of all collection duration values of the frames in the current location.
- Number of pulses is a sum of all pulses across the frames of the current average set.
- PNG frequency is in Hz.
- Background bins are considered to be bins with time scale start > 10000 μ sec.
- Background is calculated as: $C / PulsNum / BgdTime$, where C – total counts in channels [3:14] of all background bins for all the frames in current location, PulsNum – number of pulses during all frames in current location, BgdTime – the length of background bins (in sec). The background is the same for all the 64 PDS frames.
- Since the PDS structure does not allow to save data for every bin separately, the PDS structures are copied 64 times into the .pds file with the same values across all fields except for the ones that refer to different bins and described below:
 - TIME_BIN_START and TIME_BIN_DURAT describe the selected time scale
 - CTN_AVG and CETN_AVG are a total number of counts in channels [3:14] in current bin across all active frames of the location divided by the number of pulses (sum in all frames of location) divided by the TIME_BIN_DURAT value in secs.
 - CTN_ERROR and CETN_ERROR are square roots of the total number of counts in channels [3:14] in current bin across all active frames of the location. This is then divided by the number of pulses (sum in all frames of location) divided by the TIME_BIN_DURAT value in secs.
 - CTN_NORM and CETN_NORM are equal to the number of pulses across all frames in current location.