DART Radio Science Data Set Review

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Date: February 28, 2023

Executive Summary

The DART radio science bundle (urn:nasa:pds:dart) was reviewed. The contents include DSN tracking files (TRK-2-34), media calibration files (TRK-2-23), and maneuver acceleration files (MAF), along with supporting documentation. The Maneuver Acceleration File (MAF), also known as a small forces file, describes the thruster activities undertaken by DART, which would be needed to understand the Doppler shifts associated with the RS data.

The files are readable and well documented. The main items that should be addressed are as follows:
1. Reference to troposphere and weather files
2. More information about the radio comm system should be included
3. Minor editorial corrections to the SIS
4. Better documentation and/or examples for processing of the DSN tracking files

Documentation

The text in 4.1 claims to contain ionosphere, troposphere, and weather (trk-2-24) files. The Data Product Overview (4.2) claims ionosphere and troposphere, but not weather. Aside from those being inconsistent with each other, only ionosphere files are present in the data sets. The exclusion of troposphere or weather from the tables in section 4.3.1 suggests that the archive only intends to include ionosphere. However, **it is recommended to reference weather and troposphere,** which can be done easily. The user can be pointed to the radio science multi-mission archive maintained by the Radio Science Sub-Node and hosted by Geosciences Node (https://pds-geosciences.wustl.edu/radiosciencedocs/urn-nasa-pds-jpl_dsn_mmm/).

More exposition about the spacecraft comm system is needed. Please include the nominal uplink/downlink frequencies, the turnaround ratio (880/740), transponder delay, and antenna phase center locations.

Although referenced, there are no documents specifically for TRK-2-34 and TRK-2-23 in the archive.

Minor editorial corrections to jhuapl_dart_rs_sis_v01.pdf:
1. typo in title "ProductSoftware".
2. The files are all formatted in standard ways~~,~~ and documented in a series of Software Interface Specifications (SIS) noted in Table 1.
3. For the final PDS archive, DSN data files are retrieved from the SOC data repository and prepared for delivery ~~by~~ to the Planetary Data System who convert them into PDS 4 format.
4. The DART HGA is gimballed. It is the primary antenna of DART that provides most of the RS data collected during ~~in~~ last 30 days of the mission
5. 5.2 trl234 data are stored in binary format as one or more binary tables.

Data

Data are sorted according to data type, then separated by years 2021 and 2022. Coverage is complete and consistent with documentation. Tracking data, MAF, and ionosphere files are consistent in coverage. The TRK-2-23 *vlb files occur intermittently and do not span the entire time.

	TRK-2-34	Ionosphere (dop)	Ionosphere (vlb)	MAF
Start	2021-11-24	2021-11-24	2021-12-24	2021-11-24
End	2022-09-26	2022-09-30	2022-09-02	2022-09-26

Data_trk234:
Using the PRRSG's software tools, summary information and data (uplink ramps and sky frequency) could be extracted from a sample file as follows:

```
[kahan@chiron 2021]$ trk234_info2 -p -m dart_hga_tnf_20211124T032120_v01.dat
    0%              100%
    ***************************
    Report for File: dart_hga_tnf_20211124T032120_v01.dat
    Generation Date: 2023-054T11:43:51
        Start Time: 2021-328T03:21:20
          End Time: 2021-328T18:50:07
      Spacecraft ID: 135
    Downlink DSS ID: 56
     Downlink Bands: X
  Doppler Count Time: 60.0
      Uplink DSS ID: 56
       Uplink Bands: S, X
      Tracking Mode: None, 2W, 1W, 3W/25
   Number of Records: 121720
 Data Description IDs: C123, C124, C125
 Available Data Types: 0, 1, 2, 3, 7, 9, 11, 16, 17
            00: Uplink Carrier Phase - 55709
            01: Downlink Carrier Phase - 40452
            02: Uplink Sequential Ranging Phase - 23225
            03: Downlink Sequential Ranging Phase - 301
            07: Sequential Ranging - 301
            09: Ramps - 103
            11: DRVID - 301
            16: Carrier Observable - 664
            17: Total Phase Observable - 664

 DSS-56 X-band Downlink:
            1W @ 2021-328T07:52:06  - 2021-328T09:19:35 (Final Loop BW = 15.0 Hz)
            2W @ 2021-328T09:20:02  - 2021-328T15:39:23 (Final Loop BW = 15.0 Hz)
            1W @ 2021-328T15:39:34  - 2021-328T15:49:51 (Final Loop BW = 15.0 Hz)
          3W/25 @ 2021-328T15:50:29  - 2021-328T18:40:28 (Final Loop BW = 15.0 Hz)
```
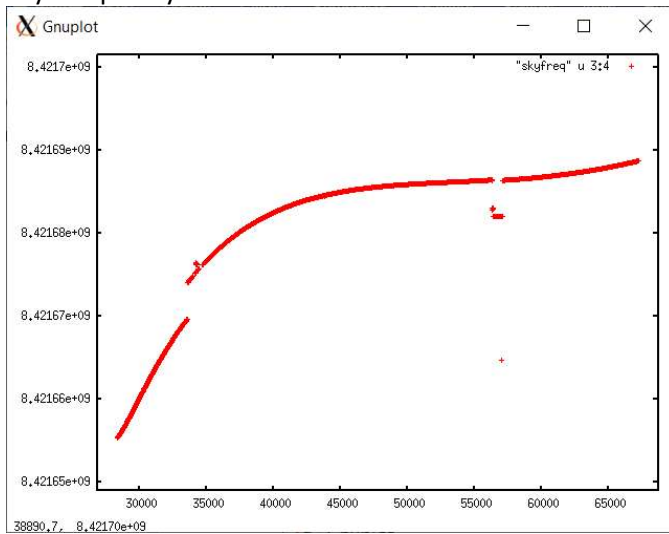
Ramps:
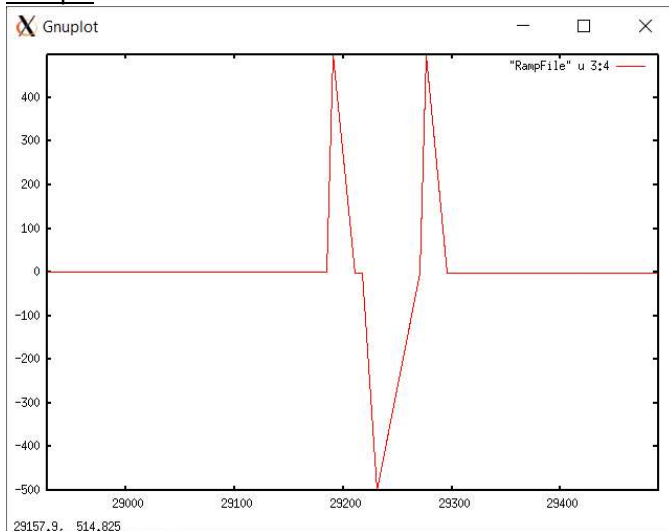
Sky Frequency:

Labels: Labels look good. I ran the pds4.tranform tool and was able to verify correspondence between the major fields and the output of transform.

The TRK-2-34 data would be difficult to parse for a new user. Although going to the TRK-2-34 documentation would provide specifications from which the user could write new code, in the PDS4-compliant format, these files can be read with the PDS4 transform tool. Some examples of the use of that tool would be immensely beneficial for the user.

Data_maf
Data in the Maneuver Acceleration Files could be easily plotted, for example, total spacecraft mass:
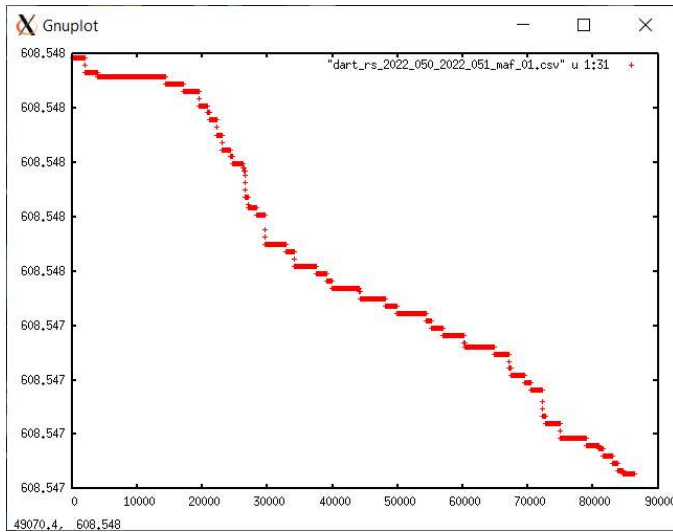
Labels look good. I confirmed correspondence between the data header and fields listed in the xml file.

Label Validation:

There is a label for every product.

Results from 'validate' tool:

data_maf:

overview_data_maf.xml – passed
collection_data_maf.xml - passed except context products
dart_rs_2021_328_2021_328_maf_01.xml – passed except context products

data_trk234:

overview_data_trk234.xml – passed
collection_data_trk234.xml – passed except context products
dart_hga_tnf_20211124T032120_v01.xml – passed except context products

data_trk223:

overview_data_trk223.xml – passed
collection_data_trk223.xml – passed except context products
dart_rs_2021_328_dop_01.xml – failed, null pointer exception

document_rs:

collection_document_rs.xml – passed except context products
jhuapl_dart_rs_sis_v01.xml – passed