

DART Radio Science Bundles PDS4 Review

Reviewer: Dustin Buccino
Jet Propulsion Laboratory
Planetary Radar and Radio Science Group

Date: February 16, 2023

Executive Summary

The data relating to the DART Radio Science bundle was reviewed. The contents of this include the DSN TRK-2-34 tracking data type and corresponding DSN ionosphere calibrations, a set of files pertaining to spacecraft thruster firings, and a document bundle. I focused my review efforts on ensuring the data types were readable and documented properly. The data files themselves are well-formed and complete; I suggest minor updates to the documentation to make things easier on the data user.

Data Comments

data_trk234 -

Traditional tracking data in standard DSN TRK-2-34 data. Documentation states that the files were sorted by record number for easier labeling, similar to what is usually done with this data format. I took several of the TNF files and confirmed that the files were sorted correctly. I did spot checks of the label entries which look good. I ran the PDS transform tool over some data files, which produced table outputs from the binary data as expected.

I ingested the entirety of the TRK-2-34 data into the JPL MONTE orbit determination software to confirm that the data can be loaded correctly into a third party tool and validate the data are complete for a radio science analysis of the DART mission. The data summary include:

<u>Points</u>	<u>Measurement Type</u>	<u>First Point (TAI)</u>	<u>Last Point (TAI)</u>
120002	DSN Two-way Doppler	24-NOV-2021 09:21:09	26-SEP-2022 23:14:59
1859	DSN Three-way Doppler	24-NOV-2021 09:22:48	26-SEP-2022 23:14:55
38340	DSN Two-way SRA Range	24-NOV-2021 09:46:37	26-SEP-2022 18:54:45
106	DSN One-way Sc Wideband	24-DEC-2021 23:18:17	23-SEP-2022 12:09:44
142	DSN Quasar Wideband VLBI	24-DEC-2021 23:10:57	23-SEP-2022 12:17:43
106	DSN One-way Sc Narrowband	24-DEC-2021 23:18:17	23-SEP-2022 12:09:44
7733	DSN Two-way PN Range	25-JAN-2022 20:59:12	22-JUN-2022 18:19:08
168288	Total points	24-NOV-2021 09:21:09	26-SEP-2022 23:14:59

Examining the Two-way Doppler measurement type, one of the observable quantities of interest, the data look as expected. There are a small number of points (~1%) that do not appear to line up with the rest of the DART data but the TRK-2-34 metadata appropriately marks them as duplicates, likely due to some DSN-related issues that sometimes happen.

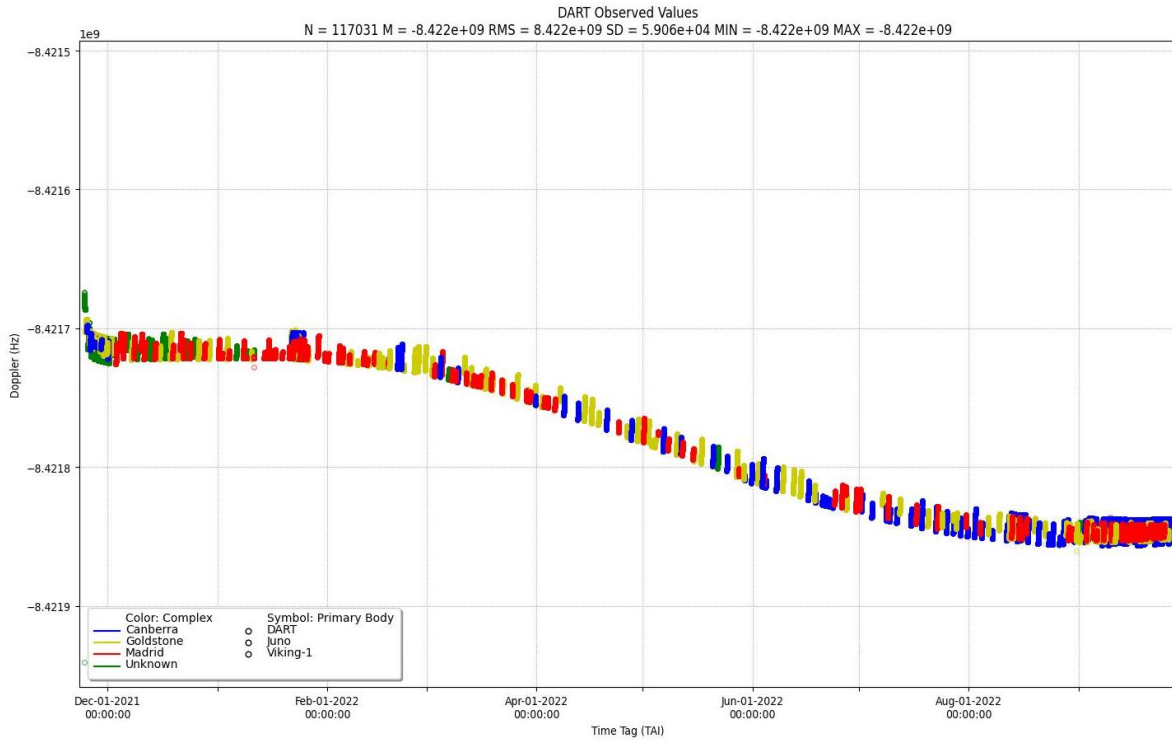


Figure 1. DART Two-Way Doppler measurement observables.

Based on this I believe that the TRK-2-34 data type is archived appropriately and formed well enough for scientific use.

data_trk223 -

This data collection contains standard formatted DSN TRK-2-23 media calibration files for the Earth’s ionosphere. Two subtypes, with identical formats, are provided – one for Doppler and one for Delta-DOR data. This data, along with the bundles in the mission-independent radio science bundle on geosciences node, is used to calibrate the TRK-2-34 data. The data provided in the data_trk223 collection is complete, and data coverage is consistent with the data provided in data_trk234 collection.

In the `overview_data_trk223.txt`, there is a typo “three character string: "dop" indicates it is doppler and ranged data,” (should be “range” instead of “rangeg”)

data_maf -

This collection contains DART-unique data files called Maneuver Acceleration Files (MAF) which describe the thruster firings executed by the DART spacecraft. This data contains the same information that is typically provided in a “Small Forces File”. Additionally, the file contains the associated loss of mass from propellant ejection, an important quantity to model other non-gravitational forces.

The files appear to be well formed. The file format is described at a high level in the documentation bundle. The coverage of these files is consistent with the primary TRK-2-34 data files.

Documentation Comments

The documentation bundle contains a SIS for the bundle. This information includes data processing, naming convention, and file format details. I suggest small updates to this document to improve usability and include some additional data, below:

jhuapl_dart_rs_sis_v01.pdf -

- 1) Page 5 Section 2: Replace DRACO references with Radio Science
- 2) Page 5 Section 3: Replace DRACO references with Radio Science
- 3) Page 5-6, Section 4.1: Information on the radio science is provided, including details about the HGA.
 - a. I recommend adding a link to the NAIF bundle where the gimbaled C-Kernels can be accessed, similar to the links provided to the DSN data product SISes later on in the file. Any radio science analysis would need to know the orientation of the spacecraft and position of the HGA to calibrate the phase center to center-of-mass offset by the gimbal.
 - b. No information is given about the telecom system. What radio does DART use? What are the nominal frequencies and turnaround ratios? This could be a good place to add that.