The Consultative Committee for Space Data Systems

Draft Recommendation for Space Data System Practices

DELTA-DOR RAW DATA EXCHANGE FORMAT

DRAFT RECOMMENDED STANDARD

CCSDS 506.1-R-1

RED BOOK

May 2010

AUTHORITY

Issue:	White Book, **Issue1**
Date:	May 2010
Location:	Not Applicable

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Space Communications and Navigation Office, 7L70
Space Operations Mission Directorate
NASA Headquarters
Washington, DC 20546-0001, USA

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FOREWORD

This document is a Recommended Standard for Delta-DOR Raw Data Exchange Format and has been prepared by the Consultative Committee for Space Data Systems (CCSDS). The Delta-DOR Raw Data Exchange Format described in this Recommended Standard is the baseline concept for Delta-DOR data interchange applications that are cross-supported between Agencies of the CCSDS.

This Recommended Standard establishes a common framework and provides a common basis for the format of Delta-DOR data exchange between space agencies. It allows implementing organizations within each Agency to proceed coherently with the development of compatible derived standards for ground systems that are within their cognizance.

Through the process of normal evolution, it is expected that expansion, deletion, or modification of this document may occur. This Recommended Standard is therefore subject to CCSDS document management and change control procedures, which are defined in the *Procedures Manual for the Consultative Committee for Space Data Systems*. Current versions of CCSDS documents are maintained at the CCSDS Web site:

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PREFACE

This document is a draft CCSDS Recommended Standard. Its ‘Red Book’ status indicates that the CCSDS believes the document to be technically mature and has released it for formal review by appropriate technical organizations. As such, its technical contents are not stable, and several iterations of it may occur in response to comments received during the review process.

Implementers are cautioned **not** to fabricate any final equipment in accordance with this document’s technical content.

DOCUMENT CONTROL

Document	Title	Date	Status
CCSDS 506.1-R-1	Delta-DOR Raw Data Exchange Format, Draft Recommended Standard, **Issue1**	May 2010	Current draft

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1 INTRODUCTION

1.1 PURPOSE

1.1.1 Delta-DOR (Delta Differential One-Way Ranging) is a Very Long Baseline Interferometry (VLBI) technique that can be used in conjunction with Doppler and ranging data to improve spacecraft navigation by more efficiently determining spacecraft angular position in the plane of sky. It involves the use of multiple ground stations, possibly belonging to different agencies, for simultaneous acquisition of the spacecraft and quasar signals [C2].

1.1.2 This Delta-DOR Raw Data Exchange Format (RDEF) Recommended Standard specifies a standard format for use in exchanging Delta-DOR raw data among space agencies. Delta-DOR raw data exchange is required every time the data correlation involves at least one participating station not belonging to the agency responsible for the correlation. This Recommended Standard has been developed via consensus of the Delta-DOR Working Group of the CCSDS Systems Engineering (SEA) area.

1.1.3 This document includes specifications on the parameter fields that the data format has been designed to meet. For exchanges where these specifications do not capture the needs of the participating agencies another mechanism may be selected.

1.2 SCOPE AND APPLICABILITY

1.2.1 This Recommended Standard contains the specification for a Delta-DOR RDEF designed for applications involving Delta-DOR raw data interchange among space agencies.

1.2.2 This data format is suited to inter-agency exchanges that involve automated interaction. The attributes of the RDEF make it primarily suitable for use in computer-to-computer communication.

1.2.3 The characteristics of the data recording (sampling rate and quantisation) are defined within the RDEF. There is no definition of accuracy for raw Delta-DOR data, hence no assessment of accuracy is provided in the exchange format. An assessment of accuracy for reduced Delta-DOR measurements is outside the scope of this Recommended Standard.

1.2.4 This Recommended Standard defines only the data format and content, but not the means for its transmission. The method of transmitting the data among partners is beyond the scope of this document. Data transmission could be based on a CCSDS data transfer protocol, file based transfer protocol such as SFTP, stream-oriented media, or other secure transmission mechanism. In general, the transmission mechanism shall not place constraints on the technical data content of a RDEF.

1.3 CONVENTIONS AND DEFINITIONS

1.3.1 Conventions and definitions of Delta-DOR concepts are provided in reference [C2], *Delta-DOR — Technical Characteristics and Performance*. This reference provides a detailed description of the Delta-DOR technique, including guidelines for DOR tone spectra, guidelines for selecting reference sources, applicable foundation equations, and a discussion of error sources and measurement accuracy that are not germane to the data exchange recommendation presented in this document.

1.3.2 The following conventions apply throughout this Recommended Standard:

– the words ‘shall’ and ‘must’ imply a binding and verifiable specification;

– the word ‘should’ implies an optional, but desirable, specification;

– the word ‘may’ implies an optional specification;

– the words ‘is’, ‘are’, and ‘will’ imply statements of fact.

1.3.3 The following conventions for unit notations apply throughout this Recommended Standard. Insofar as possible, an effort has been made to use units that are part of the International System of Units (SI Units); units are either SI base units, SI derived units, or units outside the SI that are accepted for use with the SI (see reference [8]).

Hz:	Hertz
s:	second

1.4 COMMON DELTA-DOR TERMINOLOGY

1.4.1 Part of the standardization process involves the agreement on common interagency terminology and definitions that apply to interagency Delta-DOR. The following conventions apply throughout this Recommended Standard:

Term	Meaning
Baseline	The vector joining two tracking stations
Channel	A slice of the frequency spectrum that contains a spacecraft or quasar signal
Raw data	Time ordered samples of received radio signal voltage
Sample	Instantaneous measurement of a radio frequency signal voltage
Scan	An observation of a radio source, typical duration of a few minutes
Session	The time period of the Delta-DOR measurement including several scans
Meteo Data	Meteorological Data (as a minimum: pressure, temperature, relative humidity must be considered; slant total electron content might also be provided)

1.5 STRUCTURE OF THE DOCUMENT

1.5.1 Section 2 provides a general overview of the Delta-DOR technique and introduces the need of the raw data exchange.

1.5.2 Section 3 describes the basic structure and contents of the CCSDS-recommended RDEF for Delta-DOR.

1.5.3 Section 4 provides a description of the RDEF observation file.

1.5.4. Section 5 provides details on the RDEF product file.

1.5.5. Section 6 describes the RDEF file naming conventions.

1.5.6. Section 7 discusses security aspects for the RDEF.

1.5.7. Annex A is a list of abbreviations and acronyms applicable to the document.

1.5.8. Annex B provides a list of informative references.

1.5.9. Annex C provides an example of a RDEF Observation File.

1.5.10. Annex D lists the parameters for which conventions need to be specified.

1.6 REFERENCES

The following documents are applicable references for this Recommended Standard. At the time of publication, the editions indicated were valid. All documents are subject to revision, and users of this Recommended Standard are encouraged to investigate the possibility of applying the most recent editions of the documents indicated below. The CCSDS Secretariat maintains a register of currently valid CCSDS documents.

[1] *Radio Frequency and Modulation Systems—Part 1: Earth Stations and Spacecraft*. Recommendation for Space Data System Standards, CCSDS 401.0-B-20. Blue Book. Issue 20. Washington, D.C.: CCSDS, April 2009.

[2] *Orbit Data Messages*. Recommendation for Space Data System Standards, CCSDS 502.0-B-1. Blue Book. Issue 1. Washington, D.C.: CCSDS, September 2004.

[3] *Tracking Data Message*. Recommendation for Space Data System Standards, CCSDS 503.0-B-1. Blue Book. Issue 1. Washington, D.C.: CCSDS, November 2007.

[4] *Delta-DOR—Operations*. Recommended Practice for Space Data System Standards, CCSDS 506.0-R-2. Red Book. Issue 2. Washington, D.C.: CCSDS, October 2010.

[5] “Radio Source Catalog.” May 26, 2006. Module 107 in *DSN Telecommunications Link Design Handbook*. DSN No. 810-005, Rev. E. Pasadena California: JPL. http://eis.jpl.nasa.gov/deepspace/dsndocs/810-005/

[7] *Information Technology—8-Bit Single-Byte Coded Graphic Character Sets—Part 1: Latin Alphabet No. 1*. International Standard, ISO/IEC 8859-1:1998. Geneva: ISO, 1998.

[8] *The international system of measures*, 8th edition BIPM (Bureau International des Poids et Mesures) < http://www.bipm.org >

[9] *IEEE Standard for Floating-Point Arithmetic*. IEEE Std.754-2008. New York: IEEE, 29/August/2008.

[10] *Time Code Formats*. Recommendation for Space Data System Standards, CCSDS 301.0-B-3. Blue Book. Issue 3. Washington, D.C.: CCSDS, January 2002.

NOTE – Informative references are provided in Annex B.

2 OVERVIEW

2.1 GENERAL

This section provides a high-level overview of the Delta-DOR technique. For more details on the technique see [5] and [C2].

2.2 THE DELTA-DOR TECHNIQUE

2.2.1 Very Long Baseline Interferometry (VLBI) is a technique that allows determination of angular position for distant radio sources by measuring the geometric time delay between received radio signals at two geographically separated stations. The observed time delay is a function of the known baseline vector joining the two radio antennas and the direction to the radio source.

2.2.2 An application of VLBI is spacecraft navigation in space missions where delay measurements of a spacecraft radio signal are compared against similar delay measurements of angularly nearby quasar radio signals. In the case where the spacecraft measurements are obtained from the phases of tones emitted from the spacecraft, first detected separately at each station, and then differenced, this application of VLBI is known as Delta Differential One-Way Ranging ('Delta-DOR' or 'ΔDOR'). See figure 2-1. Even though data acquisition and processing are not identical for the spacecraft and quasar, both types of measurements can be interpreted as delay measurements and they have similar information content and similar sensitivity to sources of error [C2]. The data produced in such a measurement session are complementary to Doppler and ranging data.

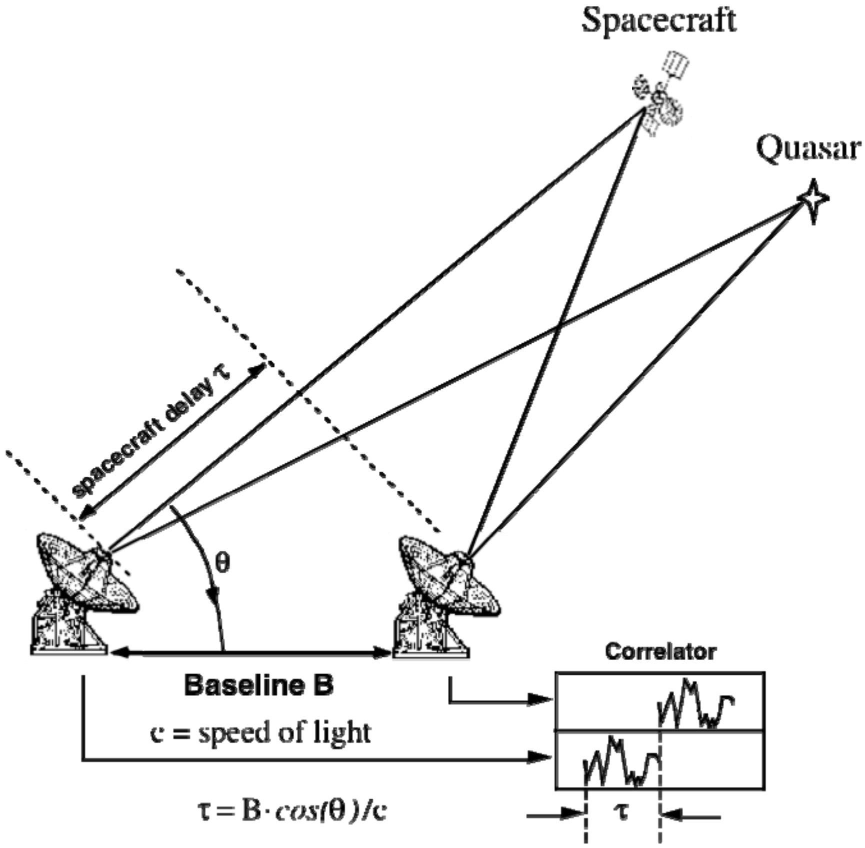

Figure 2-1 Delta-DOR observation geometry

2.2.3 To enable a Delta-DOR measurement, a spacecraft must emit several tones or other signal components spanning at least a few MHz. The characteristics of the tones are selected based on the requirements for phase ambiguity resolution, measurement accuracy, efficient use of spacecraft signal power, efficient use of ground tracking resources, and the frequency allocation for space research.

2.2.4 The Delta-DOR technique requires that the same quasar and spacecraft be tracked essentially simultaneously during the same tracking pass, at two distinct radio antennas. Normally, a Delta-DOR pass consists of three or more scans of data recording, each of a few minutes duration. A scan consists of pointing the antennas to one radio source and recording the signal. The antennas must slew to another radio source for the next scan, and so on. The observing sequence is spacecraft-quasar-spacecraft, quasar-spacecraft-quasar, or a longer sequence of alternating observations, depending on the characteristics of the radio sources and the objectives of the measurement session. A minimum of three scans is required to eliminate clock-epoch and clock-rate offsets and then measure spacecraft angular position. Normally a three-scan sequence is repeated several times. Once collected, the received signals are brought to a common site and correlated. A Delta-DOR observable is generated from a differential one-way range measurement made between the spacecraft and the two ground antennas, and by a measurement of the difference in time of arrival, at the same two stations, of the quasar signal. The observed quantity in a Delta-DOR observation is time delay for each radio source.

2.2.5 For a spacecraft, the one-way range is determined for a single station by extracting the phases of two or more signals emitted by the spacecraft. The DOR tones are generated by modulating a sine wave or square wave onto the downlink carrier at S-band, X-band, or Ka-band. Either a pure waveform may be used, producing a spectrum of pure tones, or a modulated waveform may be used, producing a spectrum that more closely resembles the spectrum of a natural radio source. DOR observables are formed by subtracting the one-way range measurements generated at the two stations. The station differencing eliminates the effect of the spacecraft clock offset, but DOR measurements are biased by ground station clock offsets and instrumental delays.

2.2.6 For measuring the quasar, each station is configured to acquire data from it in frequency channels centered on the spacecraft tone frequencies. This receiver configuration choice ensures that the spacecraft-quasar differencing eliminates the effects of ground station clock offsets and instrumental delays. By selecting a quasar that is close in an angular sense to the spacecraft, and by observing the quasar at nearly the same time as the spacecraft, the effects of errors in the modeled station locations, Earth orientation, and transmission media delays are diminished.

2.2.7 In navigation processing, the delay or DOR observable is modeled for each scan of each radio source. The measured observable depends on both geometric factors and on delays introduced by transmission media. Meteo data are provided from each tracking site so that, possibly in conjunction with other data such as GPS measurements, corrections can be computed to account for tropospheric and ionospheric path delays. The modeled or 'computed' observable is based on geometric parameters and available calibrations for tropospheric and ionospheric delays. Residuals are formed by subtracting the computed observables from the measured time delay values. The ‘Delta’ between spacecraft and quasar observations is generated internal to the navigation processing by subtracting residual values of quasar observations from residual values of spacecraft observations.

2.2.8 Because each Delta-DOR measurement requires the use of two antennas, and navigation accuracy is improved by baseline diversity, this technique is highly conducive to interagency cooperation. Measurements from two baselines are required to determine both components of angular position, with orthogonal baselines providing the best two-dimensional coverage. While no agency has enough station complexes to provide orthogonal baselines by itself, the existing assets of more than one agency today could provide two or more pairs of angularly separated baselines and good geometric coverage for missions throughout the ecliptic plane. Stations from different agencies can be used as Delta-DOR data collectors for navigation purposes, assuming that the infrastructure has been laid to facilitate such cooperation. The use of Delta-DOR has been very beneficial for numerous NASA, ESA, and JAXA missions, beginning with Voyager in 1979. Current missions using Delta-DOR for navigation, as of this writing, include Messenger, New Horizons, Dawn, EPOXI, Rosetta and Hayabusa. The technique is planned for future missions such as Mars Science Laboratory (NASA), BepiColombo (ESA), and Ikaros (JAXA), and its use has become a standard part of many mission navigation plans. CCSDS standardization will help expand the use of the technique by allowing interagency cross support.

2.3 THE NEED FOR RAW DATA INTERCHANGE

2.3.1 When performing a Delta-DOR measurement involving two (or more) agencies, raw Delta-DOR data must be exchanged at least between one of the agencies that has acquired the data and the agency that runs the correlation process and provides the results. The need of the raw data exchange intrinsically comes with the characteristics of the measurement that, being an interferometric technique, calls for the correlation of at least two data streams simultaneously acquired.

2.3.2 Raw Delta-DOR data are not the only data being exchanged during an interagency Delta-DOR session. Other data (such as tracking data messages – including meteo data – and orbit ephemeris messages) must be exchanged among agencies. Such data are objects of other CCSDS standards (see [1], [2], [3]) and are not discussed in the present Recommended Standard. The transfer of information other than Delta-DOR raw data is discussed in the Delta-DOR Operations Magenta Book (reference [5]) and will not be included here.

2.4 CONVENTIONS FOR IDENTIFIERS

2.4.1 This Recommended Standard does not specify the conventions to be used for identifiers of tracking stations, spacecraft, and radio sources. While these objects must be identified to give meaning to the data, it is outside the scope of this Recommended Standard to specify the names to be used. These parameters are described as they are introduced throughout the Recommended Standard and are collected in Annex D. Conventions to be used for such parameters should be negotiated among the participating agencies and formalized as specified in Annex A of [5].

2.4.2 If accessible and agreed catalogues for identifiers of tracking stations, spacecraft, and radio sources are available, they should be preferentially used.

3 RAW DATA EXCHANGE FORMAT BASIC STRUCTURE AND CONTENT

3.1 GENERAL

3.1.1 Delta-DOR RDEF is realized with two types of files: an *Observation File* made of a sequence of ASCII text lines (reference [7]) and of a *Product File* made of a sequence of binary lines. Both files are needed to properly perform the correlation.

3.1.2 The Observation File contains information about the Delta-DOR measurement session.

3.1.3 There shall be one Observation File for each tracking station and for each measurement session.

3.1.4 The content of the Product File is made of consecutive records each containing two basic types of data structure:

- A *Header* part
- A *Data* part

3.1.5 A Product File shall contain raw data for a single tracking station.

3.1.6 A Product File shall contain raw data for a single Delta-DOR scan (therefore either spacecraft or quasar data)

3.1.7 A Product File shall contain raw data for a single frequency channel.

4 OBSERVATION FILE STRUCTURE AND CONTENT

4.1 GENERAL

4.1.1 The Observation File contains parameters that are needed to describe the data recording session and to support data correlation.

4.1.2 The Observation File shall contain:

1) a single *Observation Header Section*, followed by

2) one or more *Scan Sections* followed by

3) an *Ending Section*.

The organization of the Observation File is shown in Figure 4.1-1.

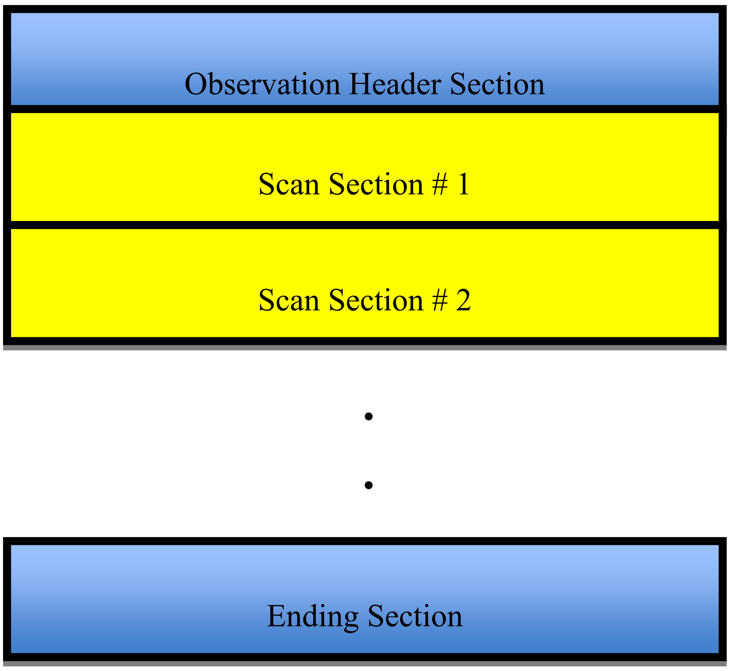

Figure 4.1-1 General structure of the RDEF Observation File

4.1.3 Each Section of the Observation File shall consist of data represented in ASCII text lines.

4.1.4 Each line shall be as follows:

1) It may have variable length up to 180 characters (excluding the termination character).

2) Only printable ASCII characters and blanks shall be used. Control characters such as TAB etc. shall not be used.

3) No blank lines can be used.

4) Each of the specified sections may contain comment lines. Each comment line shall start with the character “#”.

5) The first character in each line of an Observation File identifies the type of information contained in that line. Details regarding each line type are provided in the next sections, as appropriate.

6) One or more “blank” characters are used to separate each of the various items within each line.

7) Each line shall be terminated by a single Line Feed or a single Carriage Return or a Carriage Return/Line Feed pair or a Line Feed/Carriage Return pair.

4.1.5 Each section (except for the Ending Section) shall end with a line starting with character “Z”.

4.2 CONTENT OF THE OBSERVATION HEADER SECTION

4.2.1 The Observation Header Section is made of a free number of lines.

4.2.2 This section shall contain a single receive station line. This line starts with the character “R”.

4.2.3 The structure of the line shall be as follows:

R STATION = <station>

where <station> is the station identifier, 4 ASCII characters long.

4.2.4. This section may optionally contain a single transmitting station line. This line starts with the character “T”.

4.2.5 The structure of the line shall be as follows:

T STATION = <station>

where <station> is the station identifier, up to 4 ASCII characters long. If the data are 1-way either the transmitting station shall be set to zero or the transmitting station line shall be omitted.

4.3 CONTENT OF SCAN SECTION

4.3.1 The scan section describes the observation and provides the list of Product File(s) associated with the scan.

4.3.2 A scan section shall contain a single scan line followed by one or more Product File lines. To improve readability, the scan section should also contain comment lines providing labels for the scan line and the Product File lines.

4.3.3 The scan line shall start with character “S”.

4.3.4 The structure of the scan line shall be as follows:

```
S <scan-num> <src-id> <start-time> <stop-time> <ra> <dec> <tfreq>
```

where the parameters are defined in Table 4.3-1.

Table 4.3-1 Description of the scan line

Item Name	**Item Description**	**Format**	**Units/ Precision/Range**
SCAN-NUM	Identifies the scan number, in a progressive order	3 digit integer	No units, range 001-999
SRC-ID	Specifies the source, SC ID or Quasar ID	Up to 16 ASCII characters. Syntax is referenced in Annex D.	No units, up to 16 characters for quasar, 4 characters for spacecraft
START-TIME	Specifies the nominal start time for the scan	YYYY-DDDThh:mm:ss	UTC year day hour/minute/second, precision=1 s, range is unlimited Time format as per [10], ASCII time code B
STOP-TIME	Specifies the nominal stop time for the scan	YYYY-DDDThh:mm:ss	UTC year day hour/minute/second, precision=1 s, range is unlimited Time format as per [10], ASCII time code B

Item Name	Item Description	Format	Units/ Precision/Range
RA	Specifies the Right Ascension of the source	Decimal notation	Degrees, range 0 to 360, decimal notation with no more than 16 significant digits. Source position is corrected for precession, nutation and aberration. This field may be filled with number 999, meaning that no Right Ascension is provided.
DEC	Specifies the Declination of the source	Decimal notation	Degrees, range -90 to +90, decimal notation with no more than 16 significant digits. Source position is corrected for precession, nutation and aberration. This field may be filled with number 999, meaning that no Declination is provided.
TFREQ	Specifies the Transmitted Frequency if the source is a Spacecraft, if not, TFREQ= 0	Decimal notation	Hz, decimal notation with no more than 16 significant digits.

4.3.5 The Product File line shall start with character “D”.

4.3.6 There shall be a Product File line for each frequency channel.

4.3.7 The structure of each Product File line is as follows:

```
D <datafile> <coherence-flag> <dor-mult> <fsub> <harmonic>
```

where the parameters are defined in Table 4.3-2.

Table 4.3-2 Description of the Product File line

Item Name	Item Description	Format	Units/ Precision/Range
DATAFILE	Specifies the name of a Product File recording	39 ASCII characters, as specified in sect. 6.2	No units
COHERENCE-FLAG	Identifies whether or not the signal is coherent with the carrier. If True the fields DOR-MULT and HARMONIC are used to compute the tone frequency. If False the fields FSUB and HARMONIC are used to compute the tone frequency.	1 ASCII character	No units, 'T' for True, 'F' for False
DOR-MULT	Specifies two integers used as the numerator and denominator of a number, which represents the fundamental tone as a fraction of the TFREQ, in case COHERENCE-FLAG='T'. Example: 11/18440	A fraction of two integer numbers	No units
FSUB	Specifies the fundamental subcarrier frequency, in all cases where such subcarrier is not coherent with the carrier.	Decimal notation	Hz, decimal notation with no more than 16 significant digits
HARMONIC	Specifies the subcarrier or coherent tone harmonic number.	Integer	No units

4.4 CONTENT OF THE ENDING SECTION

4.4.1 The Ending Section shall contain an end line, optionally preceded by one or more log lines.

4.4.2 Each log line shall begin with the character "F" and may contain information on how to retrieve receiver messages, data and log

4.4.3 The end line shall begin with the "E" character and have the following format:

```
E *=END=*
```

4.5 EXAMPLE OF AN OBSERVATION FILE

4.5.1 A sample Observation File is shown in Annex C.

5 PRODUCT FILE STRUCTURE AND CONTENT

5.1 GENERAL

5.1.1 The Product File shall consist of several *Records*, each one containing exactly one second of data and related information to correlate such second of data.

5.1.2 Each Record shall consist of data represented in binary format. It shall be made of two sections:

1) The *Header* section (see Section 5.2)

2) The *Data* section (see Section 5.3)

See Figure 5.1-1.

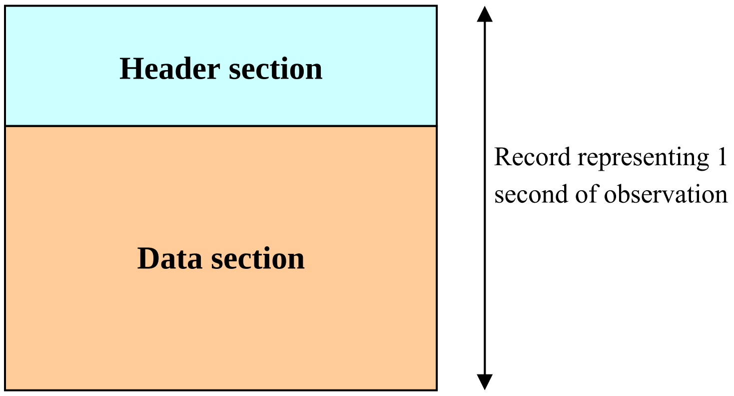

Figure 5.1-1 General structure of one Product File Record

5.1.3. Each Product File shall contain data for one scan, one channel and one station (i.e. for a typical 2-station Delta-DOR sequence with 3 scans and 4 channels there will be 24 files).

5.1.4 The length of the Header section is fixed; the length of the Data section is variable and is determined by the sample rate and sample size of the recorded data. The total length of the Data section shall be fully determined by the information written in the Header section.

5.1.5 The byte order of all integer and floating point values occupying more than 1 byte contained in the Product File shall be written as Little Endian.

5.1.6 The structure of a Record is shown in Figure 5.1-2 (where N is the total number of bytes per record).

```
      BYTE 1                  BYTE 2                  BYTE 3                  BYTE 4
      BIT
      +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
      |1 |2 |3 |4 |5 |6 |7 |8 |1 |2 |3 |4 |5 |6 |7 |8 |1 |2 |3 |4 |5 |6 |7 |8 |1 |2 |3 |4 |5 |6 |7 |8 |
      +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
BYTE 1|                                                                                               |
      |                                                                                               |
      ...                                        HEADER SECTION                                       ...
      ...                                        [176 Bytes]                                          ...
      |                                                                                               |
165   |                                                                                               |
      +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
169   |                                                                                               |
      |                                                                                               |
      ...                                         DATA SECTION                                        ...
      ...                                        [N-176 Bytes]                                        ...
      |                                                                                               |
N-3   |                                                                                               |
      +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
```

Figure 5.1-2 Detailed structure of the Product File Record

5.2 PRODUCT FILE RECORD HEADER DESCRIPTION

5.2.1 The Header section of the Record shall contain information related to the station configuration and the basic parameters used in the Record itself (i.e. start time, stop time, see 5.2.3).

5.2.2 A schematic description of the Header section of the Record is given in Figure 5.2-1. The Header contains 23 parameters and two empty fields for future expansion. The structure of the Header shall be fixed (as per Figure 5.2-1).

```
        BYTE  1                  BYTE 2                 BYTE 3                  BYTE 4

BIT     +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
        |1 |2 |3 |4 |5 |6 |7 |8 |1 |2 |3 |4 |5 |6 |7 |8 |1 |2 |3 |4 |5 |6 |7 |8 |1 |2 |3 |4 |5 |6 |7 |8 |
        +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
BYTE 1| RECORD LABEL                                                                                    |
        +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
        | RECORD LENGTH                                                                                 |
        +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
        | RECORD VERSION ID                              |STATION ID                                    |
        +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
        | SPACECRAFT ID                                  |SAMPLE SIZE                                   |
        +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
        | SAMPLE RATE                                                                                   |
        +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
        | VALIDITY FLAG                                  | AGENCY FLAG                                  |
        +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
        | RF_TO_IF DOWNCONV                 (8 bytes)                                                   |
        +                                                                                               +
        +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
        | IF_TO_CHANNEL DOWNCONV            (8 bytes)                                                   |
        +                                                                                               +
        +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
        | TIME TAG, YEAR                                 | TIME TAG, DAY OF YEAR                        |
        +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
        | TIME TAG, SECONDS OF DAY                                                                      |
        +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
        | TIME TAG, PICOSECONDS OF THE SECOND     (8 bytes)                                             |
        +                                                                                               +
        +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
        | CHANNEL ACCUMULATED PHASE         (8 bytes)                                                   |
        +                                                                                               +
```

```
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
| CHANNEL PHASE PL COEFF 0          (8 bytes)                                                    |
+                                                                                                +
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
| CHANNEL PHASE PL COEFF 1          (8 bytes)                                                    |
+                                                                                                +
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
| CHANNEL PHASE PL COEFF 2          (8 bytes)                                                    |
+                                                                                                +
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
| CHANNEL PHASE PL COEFF 3          (8 bytes)                                                    |
+                                                                                                +
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
| EMPTY FIELDS INTERNAL AGENCY USE  (40 bytes)                                                   |
|                                               ….                                               |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
| EMPTY FIELDS FUTURE USE     (36 bytes)                                                         |
|                                               ….                                               |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
| IEND LABEL                                                                                     |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|1 |2 |3 |4 |5 |6 |7 |8 |1 |2 |3 |4 |5 |6 |7 |8 |1 |2 |3 |4 |5 |6 |7 |8 |1 |2 |3 |4 |5 |6 |7 |8 |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
```

Figure 5.2-1 General structure of the Header

5.2.3 A detailed description of the Header is provided in Table 5.2-1, which specifies for each item:

– The name of the item;

– The length (in Bytes) of the item;

– The data type of the item;

– A short description of the item;

– Examples of allowed values;

– Whether a value for the item is mandatory or not.

5.2.4 Floating point values shall conform to the IEEE double precision type ‘binary64‘ (reference [9]).

The special values ‘NaN’, ‘-Inf’, ‘+Inf’, and ‘-0’are not supported in the Delta-DOR RDEF.

5.2.5 The signal downconversion is done in several stages. The data record headers contain all the information necessary to reconstruct the total downconversion frequency and phase for each channel as a function of time. Downconversion is represented as the sum of a fixed frequency plus a variable frequency signal.

The downconversion frequency and phase, respectively, for the fixed part is given by:

$$f_{DC,\,fixed} = f_{RF-IF} + f_{IF-CHAN}$$

$$\phi_{DC,\,fixed}(t) = \left(f_{RF-IF} + f_{IF-CHAN}\right)\left(t - t_b\right)$$

where

f_{RF-IF} = RF to IF downconverter frequency, Hz, item RF_TO_IF DOWNCONV in Tab. 5.2-1

$f_{IF-CHAN}$ = IF to channel downconverter frequency, Hz, item IF_TO_CHANNEL DOWNCONV in Tab. 5.2-1

t = sample time, s

t_b = experiment epoch, s (generally unknown)

It is assumed that the fixed frequency IF to channel downconverter has integer phase on the integer second boundary, that is $f_{IF-CHAN}\left(t - t_b\right)$ is an exact integer number of cycles for *t* an integer second. This is equivalent to assuming that the downconverter phase for every channel may be written as above for the full data time span using the same value of t_b.

The downconversion phase (cycle) for the variable part, over the time span within any data record, is given by:

$$\phi_{DC,variable}(t) = \Phi + c_0 + c_1(t - t_0) + c_2(t - t_0)^2 + c_3(t - t_0)^3$$

where

Φ = integer part of accumulated downconverter phase at time t_0, cycles, item CHANNEL ACCUMULATED PHASE in Tab. 5.2-1

c_i = channel phase polynomial coefficient i, i=0,1,2,3, items CHANNEL PHASE POLYNOMIAL COEFFICIENT 0 to 3 in Tab. 5.2-1

t = time within the data record, s

t_0 = start time of data record, s, item TIME TAG SECOND OF DAY in Tab. 5.2-1.

The downconversion frequency for the variable part is given by the time derivative of the downconversion phase:

$$f_{DC,variable}(t) = c_1 + 2c_2(t - t_0) + 3c_3(t - t_0)^2$$

When c_2=c_3=0, the entire downconversion chain is fixed.

Table 5.2-1 Product File Header

Item Name	Bytes	Type	Item description	Allowed values	Mandatory
RECORD LABEL	4	CHARACTER	ASCII sequence needed to identify data type	'RDEF'	Y
RECORD LENGTH	4	UNSIGNED INTEGER	Indicates the length, in bytes, of the entire Record	The value shall be equal to SAMPLE RATE*SAMPLE SIZE + HEADER SIZE in bytes, where HEADER SIZE = 176 bytes	Y
RECORD VERSION ID	2	UNSIGNED INTEGER	Version number of the data record structure	Integer	Y
STATION ID	2	UNSIGNED INTEGER	Internal network identifier for the station	Integer	N
SPACECRAFT ID	2	UNSIGNED INTEGER	Internal network identifier for the spacecraft	Integer	N
SAMPLE SIZE	2	UNSIGNED INTEGER	Specifies the resolution of the data samples contained in this data record	1, 2, 4, 8, 16	Y

SAMPLE RATE	4	UNSIGNED INTEGER	Specifies the sample rate of the data contained in this record, in complex samples per second	SAMPLE RATE * 2 * SAMPLE SIZE shall be a multiple of 32	Y
VALIDITY FLAG	2	UNSIGNED INTEGER	Contains a value to indicate whether an error was detected during recording	The value 0 shall mean no error (or no check was performed) A positive value is an implementation-dependent error code	Y
AGENCY FLAG	2	UNSIGNED INTEGER	Specifies the Agency creating the file	The value 0 shall mean that this field is not in use. 1= ESA 2 =JAXA 3 = NASA	Y

RF_TO_IF DOWNCONV	8	REAL	First downconversion stage: from RF to IF Resolution: 1 Hz	Hz Note: the downconversion value given here can either represent a physical ground station frequency difference or a logical downconversion	Y
IF_TO_CHANNEL DOWNCONV	8	REAL	Second downconversion stage: from IF to channel centre frequency Resolution: 1micro-Hz	Note: the downconversion from IF to the channel centre frequency is represented as the sum of two parameters: a fixed value in IF_TO_CHANNEL_DOWNCONV and a variable value in CHANNEL POLYNOMIAL COEFFICIENTn	Y

TIME TAG YEAR	2	UNSIGNED INTEGER	Specifies the UTC year of the data contained in the record		Y
TIME TAG DOY	2	UNSIGNED INTEGER	Specifies the UTC DOY of the data contained in the record		Y
TIME TAG SECOND OF DAY	4	UNSIGNED INTEGER	Specifies the UTC SOD of the data contained in the record	0 to 86400	Y
TIMETAG PICOSECONDS OF THE SECOND	8	REAL	Specifies the UTC picoseconds of the second of the first sample contained in the record	Note: set to 0 if unknown	Y
CHANNEL ACCUMULATED PHASE	8	REAL	The value of the accumulated whole turns of the channel variable downconverter represented by the phase polynomial coefficients (Expressed in “turns”, i.e. rad/2Π)	This parameter should give the total accumulated phase at the beginning of the frame except the additional channel phase polynomial contribution	Y

CHANNEL PHASE POLYNOMIAL COEFFICIENT0	8	REAL	The channel phase polynomial coefficient of degree 0 (expressed in rad/2Π). This item has to be referred to the second boundary, as provided by item TIME TAG SECOND OF DAY	Note: to facilitate data processing the downconverter phase represented by the phase polynomial should be continuous in phase and phase rate from one second to the next	Y
CHANNEL PHASE POLYNOMIAL COEFFICIENT1	8	REAL	The channel phase polynomial coefficient of degree 1 (expressed in rad/2Π/s). This item has to be referred to the second boundary, as provided by item TIME TAG SECOND OF DAY	See before	Y

CHANNEL PHASE POLYNOMIAL COEFFICIENT2	8	REAL	The channel phase polynomial coefficient of degree 2 (expressed in rad/2Π/s^2). This item has to be referred to the second boundary, as provided by item TIME TAG SECOND OF DAY	See before	Y
CHANNEL PHASE POLYNOMIAL COEFFICIENT3	8	REAL	The channel phase polynomial coefficient of degree 3 (expressed in rad/2Π/s^3). This item has to be referred to the second boundary, as provided by item TIME TAG SECOND OF DAY	See before	Y

EMPTY FIELDS (INTERNAL AGENCY USE)	40		Total number of bytes free to be used by each Agency for its internal purpose		Y
EMPTY FIELDS (FUTURE EXTENSION)	36		Total number of bytes free to be used for future format extension		Y
IEND LABEL	4	INTEGER	End label for data synchronisation check Shall be equal to -99999		Y

5.3 PRODUCT FILE RECORD DATA DESCRIPTION

5.3.1 The Data section of each Record of the Product File shall contain only the in-phase (I) and quadrature-phase (Q) samples recorded at the receiver.

5.3.2 Samples shall be packed into 32-bit words.

5.3.3 The quadrature-phase (Q) data and the in-phase (I) data for a given time sample shall be adjacent. Between 1 and 16 complex samples shall be packed into each 32-bit word, depending on how many bits per sample are used. Table 5.3-1 shows all possible cases.

Table 5.3-1 Sample 32-bit word packing

MSB 16-Bit Samples LSB

Q1	I1

MSB 8-Bit Samples LSB

Q2	I2	Q1	I1

MSB 4-Bit Samples LSB

Q4	I4	Q3	I3	Q2	I2	Q1	I1

MSB 2-Bit Samples LSB

Q8	I8	Q7	I7	Q6	I6	Q5	I5	Q4	I4	Q3	I3	Q2	I2	Q1	I1

MSB 1-Bit Samples LSB

[Q16,I16], [Q15,I15], … [Q2,I2], [Q1,I1]

5.3.4 The time order of the packed bits shall be from LSB (Least Significant Bit) to MSB (Most Significant Bit).

5.3.5 Truncation shall be used, to reduce the number of bits per sample to the desired value. This truncation creates an offset of –0.5 in the output data stream values that must be corrected in post processing software. To compensate for this offset each sample shall be put through the transformation 2*k + 1 where k is the 2's complement value of the 1, 2, 4, 8 or 16 bit sample. Note that the value zero is not present in this data representation. However, all bits are used and the data are symmetric about zero.

5.3.6 A generic description of the Data section of each Record is given in Figure 5.3-2.

```
     BIT
     +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
     |1 |2 |3 |4 |5 |6 |7 |8 |1 |2 |3 |4 |5 |6 |7 |8 |1 |2 |3 |4 |5 |6 |7 |8 |1 |2 |3 |4 |5 |6 |7 |8 |
     +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
     +                                          SAMPLE WORD 1                                         +
     +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
     +                                          SAMPLE WORD 2                                         +
     +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
     ...                                                                                            ...
     ...                                                                                            ...
     |                                                                                                |
     +                                                                                                +
N-3  |                                                                                                |
     +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
     |1 |2 |3 |4 |5 |6 |7 |8 |1 |2 |3 |4 |5 |6 |7 |8 |1 |2 |3 |4 |5 |6 |7 |8 |1 |2 |3 |4 |5 |6 |7 |8 |
     +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
```

Figure 5.3-2 General structure of the Data section of the Record

6 FILE NAMING CONVENTIONS

6.1 GENERAL

In general, the file name syntax and length should not violate computer constraints for those computing environments in use by Member Agencies for processing Delta-DOR raw data.

One observation file is provided per measurement session for each station. A separate Product File is used to contain the data for each scan, for each channel, and for each station. Since this typically results in a large number of files being used for each measurement session, a naming convention is defined to help with managing the Product Files.

6.2 FILE NAMES

6.2.1 The file name shall uniquely define the receiver used to record data, the frequency channel, the spacecraft, the station, the scan, the file type, and the nominal scan start time.

6.2.2 Each file shall be named according to the following convention:

MMMMnNNNtTsSSSSrRRcCC-YYDDDHHMMSS.XXX

where:

1) MMMM is the mission ID (4 characters. The mission ID is the spacecraft ID of the mission requesting the service. This is defined in the Service Request contained in [5]);

2) n is a token to indicate that scan identifier follows;

3) NNN is the scan number (3-digit integer) starting from 001;

4) t is a token to indicate file type;

5) T is the file type (1 character):

   a) I for an Observation File,

   b) S for spacecraft scan or Q for quasar scan, for a Product File;

6) s is a token to indicate that station identifier follows;

7) SSSS is the station identifier (4 characters); this identifier shall be the same as the receiving station name in the Observation File (4.2.3) for the given station;

8) r is a token to indicate that the receiver identifier follows;

9) RR is the receiver identifier (2 characters);

10) c is a token to indicate that channel identifier follows;

11) CC is the channel identifier (2 characters);

12) - is used to indicate that date follows;

13) YY is the last two digits of the year for nominal scan epoch (2-digit integer);

14) DDD is the day of the year for nominal scan epoch (3-digit integer);

15) HHMMSS is the hour-minute-second for nominal scan epoch (6-digit integer);

16) .XXX is the file extension: .obs for an Observation File, .prd for a Product File.

6.2.3 All character IDs shall be capital and alphanumeric symbols.

6.2.4 It is assumed that each specific tracking pass for each tracking station is scheduled for a specific mission. The mission identifier shall refer to the mission that has scheduled the tracking pass.

Note that the object observed during a scan may be the spacecraft that has scheduled the tracking pass, a different spacecraft, or a quasar. The contents of the Observation File (see Section 4) must be read to obtain this information.

6.2.5 Special conventions are used for some values in the Observation File name:

1) The observation file channel identifier shall be '00';

2) The observation file scan number shall be '000';

3) The observation file nominal epoch time shall be at or before the nominal epoch for scan 001.

7 SECURITY

7.1 OVERVIEW

This section presents the results of an analysis of security considerations applied to the technologies specified in this Recommended Standard.

7.2 SECURITY CONCERNS RELATED TO THIS RECOMMENDED STANDARD

7.2.1 DATA PRIVACY

Privacy of data formatted in compliance with the specifications of this Recommended Standard should be assured by the systems and networks on which this Recommended Standard is implemented.

7.2.2 DATA INTEGRITY

Integrity of data formatted in compliance with the specifications of this Recommended Standard should be assured by the systems and networks on which this Recommended Standard is implemented.

7.2.3 AUTHENTICATION OF COMMUNICATING ENTITIES

Authentication of communicating entities involved in the transport of data which complies with the specifications of this Recommended Standard should be provided by the systems and networks on which this Recommended Standard is implemented. The likelihood of any intentional data corruption involving the RDEF transfer is considered negligible. Moreover, the effects of such corruption will be easily recognisable within the data processing.

7.2.4 DATA TRANSFER BETWEEN COMMUNICATING ENTITIES

The transfer of data formatted in compliance with this Recommended Standard between communicating entities should be accomplished via secure mechanisms approved by the IT Security functionaries of exchange participants.

7.2.5 CONTROL OF ACCESS TO RESOURCES

This Recommended Standard assumes that control of access to resources will be managed by the systems upon which provider formatting and recipient processing are performed.

7.2.6 AUDITING OF RESOURCES USAGE

This Recommended Standard assumes that auditing of resource usage will be handled by the management of systems and networks on which this Recommended Standard is implemented.

7.3 POTENTIAL THREADS AND ATTACK SCENARIOS

There are no certain threats or attack scenarios that apply specifically to the technologies specified in this Recommended Standard. Potential threats or attack scenarios applicable to the systems and networks on which this Recommended Standard is implemented should be addressed by the management of those systems and networks. Protection from unauthorized access is especially important if the mission utilizes open ground networks such as the Internet to provide ground station connectivity for the exchange of data formatted in compliance with this Recommended Standard.

7.4 CONSEQUENCES OF NOT APPLYING SECURITY TO THE TECHNOLOGY

There are no known consequences of not applying security to the technologies specified in this Recommended Standard. The consequences of not applying security to the systems and networks on which this Recommended Standard is implemented could include potential loss, corruption, and theft of data.

7.5 DATA SECURITY IMPLEMENTATION SPECIFICS

Specific information-security interoperability provisions that may apply between agencies involved in an exchange of data formatted in compliance with this Recommended Standard should be specified in an ICD.

ANNEX A

ABBREVIATIONS AND ACRONYMS

(INFORMATIVE)

ASCII	American Standard Code for Information Interchange
CCSDS	Consultative Committee for Space Data Systems
Delta-DOR	Delta Differential One-Way Ranging
DOR	Differential One-Way Ranging
DOY	Day Of the Year
LSB	Least Significant Bit
MSB	Most Significant Bit
RDEF	Raw Data Exchange Format
SEA	Systems Engineering Area
SFTP	Secure File Transfer Protocol
SOD	Second Of the Day
VLBI	Very Long Baseline Interferometry

ANNEX B

INFORMATIVE REFERENCES

(INFORMATIVE)

NOTE – Normative references are provided in 1.6.

[C1] *Procedures Manual for the Consultative Committee for Space Data Systems*. CCSDS A00.0-Y-9. Yellow Book. Issue 9. Washington, D.C.: CCSDS, November 2003.

[C2] *Delta-DOR — Technical Characteristics and Performance*. Draft Report Concerning Space Data System Standards, CCSDS 500.1-G-0. Green Book. Issue 0.

[C3] *Navigation Data—Definitions and Conventions*. Report Concerning Space Data System Standards, CCSDS 500.0-G-2. Green Book. Issue 2. Washington, D.C.: CCSDS, November 2005.

[C4] *The Application of CCSDS Protocols to Secure Systems*. Report Concerning Space Data System Standards, CCSDS 350.0-G-1. Green Book. Issue 1. Washington, D.C.: CCSDS, March 1999.

[C5] Catherine L. Thornton and James S. Border. *Radiometric Tracking Techniques for Deep-Space Navigation*. JPL Deep-Space Communications and Navigation Series. Joseph H. Yuen, Series Editor. Hoboken, N.J.: Wiley, 2003.

[C6] XML Specification for Navigation Data Messages. Draft Recommendation for Space Data System Standards, CCSDS 505.0-R-1. Red Book. Issue 1. Washington, D.C.: CCSDS, November 2005.

[C7] Theodore D. Moyer. *Formulation for Observed and Computed Values of Deep Space Network Data Types for Navigation*. JPL Deep-Space Communications and Navigation Series. Joseph H. Yuen, Series Editor. Hoboken, N.J.: Wiley, 2003.

[C8] "Delta Differential One-way Ranging." July 15, 2004. Module 210 in *DSN Telecommunications Link Design Handbook*. DSN No. 810-005, Rev. E. Pasadena California: JPL, January 15, 2001. http://eis.jpl.nasa.gov/deepspace/dsndocs/810-005/

[C9] Timothy McElrath, et al. "Mars Exploration Rovers Orbit Determination Filter Strategy." AIAA/AAS Astrodynamics Specialist Conference and Exhibit, August 16-19, 2004 (Providence, Rhode Island). Pasadena, CA: JPL, 2004. <http://trs-new.jpl.nasa.gov/dspace/bitstream/2014/39005/1/04-2575.pdf>

ANNEX C

EXAMPLE OF RDEF OBSERVATION FILE

(INFORMATIVE)

File Name: M01On000tIsDS24r02c00-08001170000.obs

<pre># Observation File 	
#
# Comments 	
#
#
#
#
#
R STATION = 24
T STATION = 0</pre>
	Observation Header

<pre>Z
#
# SCAN_NUM SRC_ID START_TIME STOP_TIME RA DEC TFREQ 	
# --- 	
S 001   CTD_26   2008-001T17:00:00 2008-001T17:04:00 60.797422 26.005385   0.0000
#
# DATAFILE COH_FLAG DOR_MULT FSUB HARMONIC 	
# --- 	
D M01On001tQsDS24r02c01-08001170000.prd   T   0   375000.0   0
D M01On001tQsDS24r02c02-08001170000.prd   T   1/440   375000.0   1
D M01On001tQsDS24r02c03-08001170000.prd   T   1/440   375000.0   -2
D M01On001tQsDS24r02c04-08001170000.prd   T   1/440   375000.0   2</pre>
	Scan Section # 1

Z # # SCAN_NUM SRC_ID START_TIME STOP_TIME RA DEC TFREQ # -- S 002 053 2008-001T17:06:00 2008-001T17:10:00 69.849538 22.975839 8403456000.0000 # # DATAFILE COH_FLAG DOR_MULT FSUB HARMONIC # -- D M01On002tSsDS24r02c01-08001170600.prd T 0 375000.0 0 D M01On002tSsDS24r02c02-08001170600.prd T 1/440 375000.0 1 D M01On002tSsDS24r02c03-08001170600.prd T 1/440 375000.0 -2 D M01On002tSsDS24r02c04-08001170600.prd T 1/440 375000.0 2	Scan Section # 2
Z # # SCAN_NUM SRC_ID START_TIME STOP_TIME RA DEC TFREQ # --- S 003 P_0507+17 2008-001T17:12:00 2008-001T17:16:00 77.533972 18.013694 0.0000 # # DATAFILE COH_FLAG DOR_MULT FSUB HARMONIC # --- D M01On003tQsDS24r02c01-08001171200.prd T 0 375000.0 0 D M01On003tQsDS24r02c02-08001171200.prd T 1/440 375000.0 1 D M01On003tQsDS24r02c03-08001171200.prd T 1/440 375000.0 -2 D M01On003tQsDS24r02c04-08001171200.prd T 1/440 375000.0 2	Scan Section # 3
Z F LOGfile E *=END=*	Ending Section

ANNEX D

PARAMETERS THAT NEED CONVENTIONS TO BE SPECIFIED

(INFORMATIVE)

The parameters included in this Annex shall be agreed on whenever an Interagency Implementing Arrangement is set up.

This should be done in line with the Recommendation contained in Annex A of *Delta DOR - Operations* [5]

Observation File Parameters:

- 4 character Station ID(s) to be used for the Receiving stations

- 4 character Station ID to be used for the Transmitting station

- 4 character Source ID for spacecraft. Syntax to be agreed in the Interagency Implementing Arrangement.

- up to 16 characters Source ID for Quasar. Syntax to be agreed in the Interagency Implementing Arrangement.

File Name Parameters:

- 4 character Mission ID

- 4 character Station ID

- 2 character Channel ID