

IOAG Action Item 7 Delta DOR Interface Standard

1. Background

Navigation tracking normally involves the collection of two-way Doppler and ranging data. In order to provide additional information for navigation, and in particular for the angular measurements the so-called Differential One-way Ranging (DeltaDor) will improve this. Delta DOR measurements are interferometric measurements between two radio sources. In this case, one of the radio sources is the spacecraft transponder signal and the second source will be a natural radio source like a quasar. Each source is recorded simultaneously at two radio antennas. The received signals are correlated with an accurate time reference, allowing the location of the spacecraft to be calculated. If the quasar is angularly close to the spacecraft and with a known location, several sources of error can be reduced, in particular the 'clock' and the media through which the electromagnetic wave travels.

2. Problem Statement:

A standardized approach for Delta-Differenced One-Way Range (Delta-DOR) is required in view of the increased need for improved navigation accuracy for deep space missions, applying methods other than the traditional ranging and Doppler data. Delta-DOR is one such data type that has been demonstrated to substantially improve navigation accuracy. As with the initiatives described above, unless a standardized approach is developed, cross-support will become impractical. CCSDS shall provide the rationale and requirements, but not the design, for establishing a standardized method for implementing a Delta-DOR capability.

3. Overall Set-up:

A summary of logical components needed for the overall system as currently foreseen in the ESA delta-DOR implementation is depicted in Fig. 1 below, but shall not necessarily be seen as a physical set-up.

The system consists of 4 logical elements:

- i) Raw Data Collector that will perform the sampling at the station. This unit is also called the VLBI Science Receiver (VSR) in JPL
- ii) DeltaDor Station Server that will collect the raw sampled data and stores them in files to be transferred to place where the processing will take place.
- iii) DeltaDor Server that is located at the processing center. The purpose of this server is to collect the data files from the two stations used.

- iv) Correlator that interfaces to the DeltaDor Server and its main function is to process the data.

In addition there are a number of supporting elements such as Station Computer, WAN/LAN and Monitoring & Control

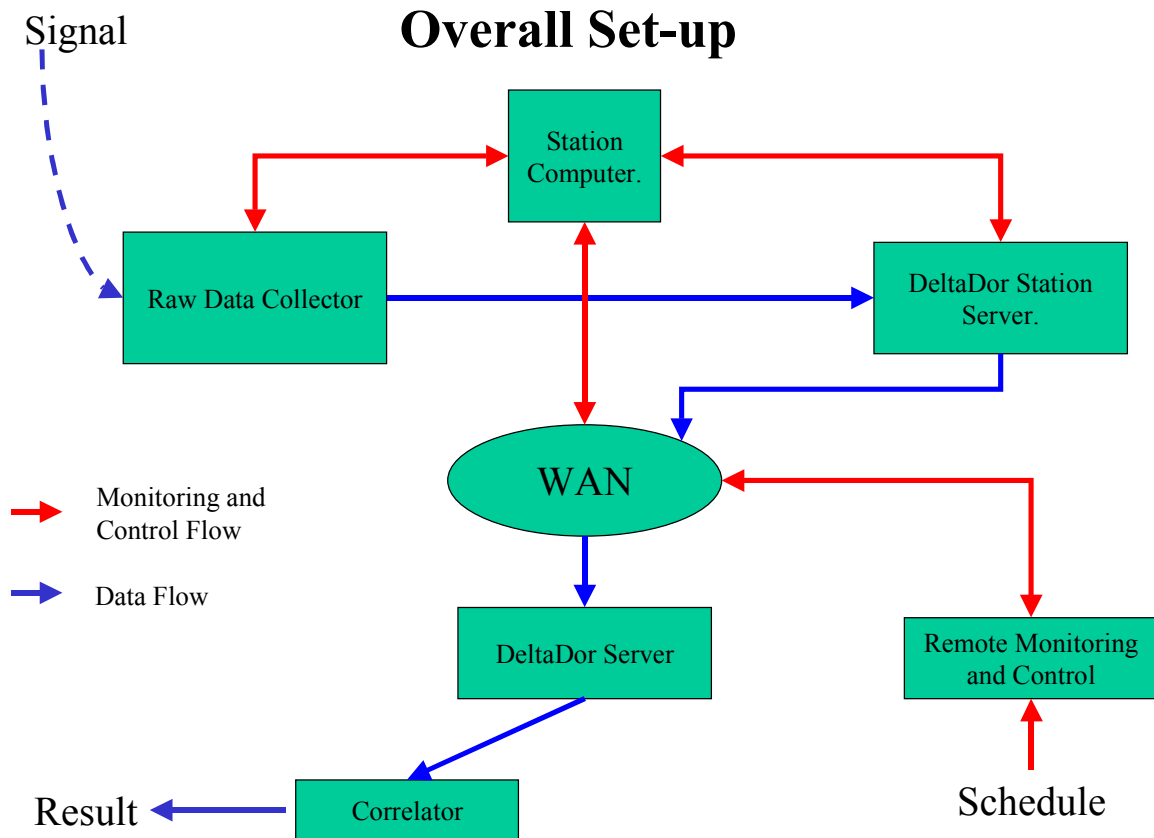


Figure 1 Overall delta DOR Set-up

4. Interfaces to be standardized:

The interfaces that are to be standardized are identified in Fig. 2. These are the

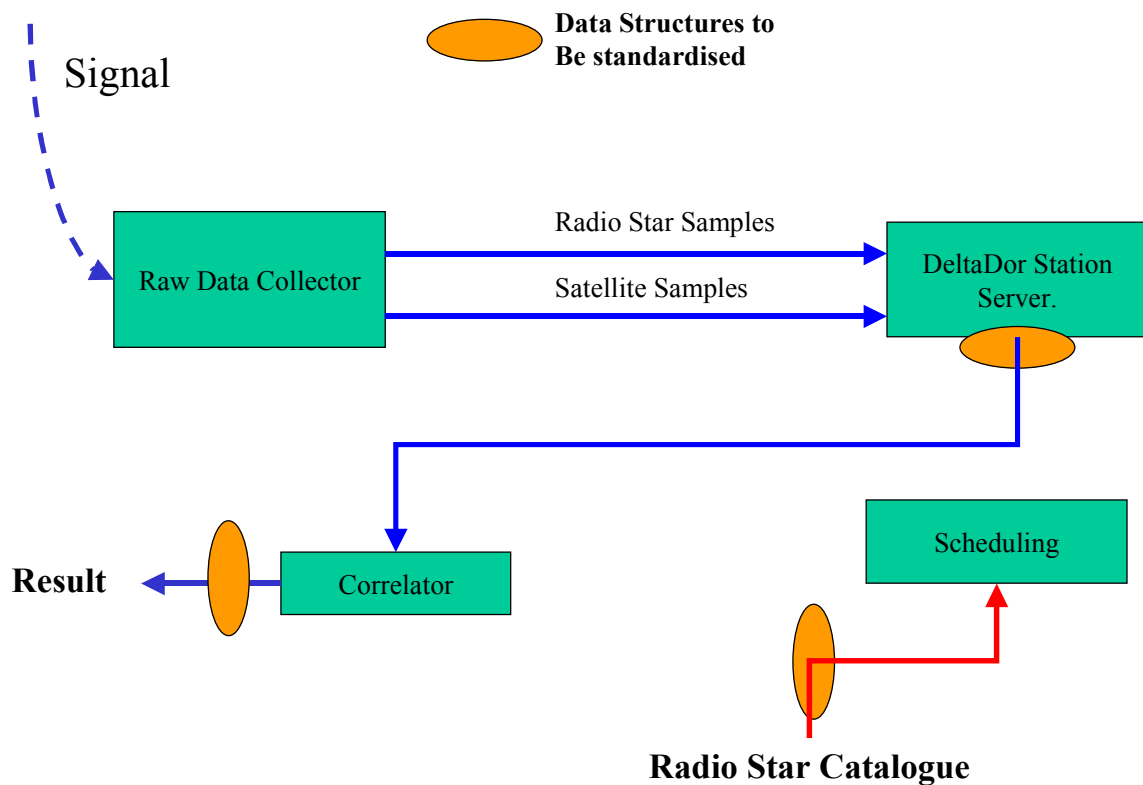
- a) Radio Star Catalogue
- b) Raw deltaDOR data files collected on the DeltaDor Station Server and
- c) Delta DOR Results (final output of the correlator).

The Raw Data Collector will collect data from the Radio Star and from the Satellite and this will result in individual files on the DeltaDor Station Server. Such a standard shall cover the format of the files and the individual record structure.

It is not proposed to define a standard for the raw measurements as sampled by the Raw Data Collector (or the VLBI Science Receiver [VSR]) as these samples may have equipment specific data and therefore it may be difficult to standardize these. Also for configuration files needed for setting up the station is also proposed to be station specific and should not be standardized. It might however be necessary to provide files describing the station configuration and this type of files shall also be standardized and available on the DeltaDor Station Server.

It is assumed that the information required for the position of the satellite is provided using the approved standard based on the exchange of an OPM.

Interfaces to be standardised



Below is a short description of the proposed elements to be standardized.

a) Radio Star Catalogue

The Radio Star Catalogue should be subject to be standardized or there should be an agreement of which catalogue to be used. This should be studied further if this is necessary.

b) Raw DeltaDor Data Files

It should be studied if the Raw DeltaDor Data Files could be standardized and if it is possible to remove station/equipment specific equipment parameters from the sampled

raw data. The Raw DeltaDor Data Files contains files with samples from the Radio Star Samples and files containing the Satellite Data This might require some pre-processing to be performed on the Raw Data Samples and the output of such pre-processing could be a standard format that could be exchanged in a cross support set-up.

It may also be necessary to provide a file containing station configuration data such as the value for the differential clock error and the ground delay because antennas might be very far away from the electronics. Therefore this information shall be provided together with the DeltaDor Data Files and should be standardized.

c) DeltaDor Result

The result from the DeltaDor process as provided from the correlator should also be standardized. These data could be provided in a TBD format in such a way that it can accommodate any tracking measurement type.

5. Cross Support Considerations

NASA/JPL have already successfully implemented the DeltaDor and today it is operational. Therefore it should be considered to ensure that we could make use of an ESA station and an external station such as a DSN station to perform a DeltaDor campaign. This could be a future working item in CCSDS. To support such cross support the following interfaces should be standardized:

6. Recommended Action:

The IOAG recommends that CCSDS initiate a work item to aim a standardization of the delta DOR correlator input, and output formats and related Radio Star Catalogue.