

OVLBI-ES MEMO NO. 69

## DOPPLER FILE TIME TAG OFFSET

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In accord with earlier agreements [1], tracking data from the NRAO OVLBI Earth Station at Green Bank will be supplied to the JPL Multi-Mission Navigation Team in files conforming to JPL specification TRK-2-30 [2], here called "doppler files." The main observable contained in each record of such a file is the "integrated doppler" derived from the measured residual phase in the doppler-compensated two-way link. Each record also contains a time tag, but the file format restricts this to be an integer number of seconds of UTC. However, measurements made at the NRAO station, when referred to the time of arrival of the signal at the antenna reference point (intersection of the azimuth and elevation axes), are not sampled on the integer UTC second, although the actual time of sampling is accurately known. This memo describes the method chosen to ensure accurate time tagging in spite of this difficulty.

Measurements of residual phase are made at precise intervals of 0.1 sec, and the results are sampled at times that include the UTC second marks. But this sampling occurs after a processing delay which is large but accurately known. Careful accounting [3] causes us to estimate that the delay between arrival of a wavefront at the reference point and the (internal, raw) time tag given to the sample of residual phase associated with that wavefront is:

$$T1 = 2.673478892 \pm .000001 \text{ seconds.}$$

To each sample with raw time tag  $t$ , we assign a corrected time tag  $t - T1$ , representing the arrival time at the reference point.

Not every residual phase sample is used to compute an integrated doppler sample. The TRK-2-30 format prevents reporting a value more often than once per second, and it is expected that values every 60 seconds will be sufficient for VSOP. The time tag given to the integrated doppler sample in the doppler file is the integer UTC second \*nearest\* to the corrected time tag of the corresponding residual phase sample. No interpolation is done. To minimize the difference between the doppler file time tag and the arrival time at the reference point, we select 0.1 second samples whose corrected time tags are nearest to an integer second; with the above value of  $T1$ , this means that the raw time tags will be of the form  $(n+0.7)$  seconds, for integer  $n$ . It follows that the arrival time can be obtained by adding

$$T2 = +0.026521108 \text{ sec}$$

to the doppler file's time tag. Note that, regardless of the value of  $T1$ , the magnitude of  $T2$  should never exceed 0.05 sec.

The corrected time tag  $(t-T1)$  is always used in the computations for converting residual phase to integrated doppler; in particular, these calculations involve evaluating the predicted orbit at appropriate times. It is the tracking station's responsibility to ensure that the predicted orbit used to drive the doppler compensation during each tracking pass is identical with that used to compute integrated doppler; this includes the times at which the orbit is evaluated for each purpose. Additional details are given in [4].

It is expected that the value of  $T1$ , and hence of  $T2$ , will be stable. However, two kinds of change could occur: (a) a station design change or modification might cause the actual value of the

processing delay to change; or (b) the actual delay is unchanged, but an improved estimate of its value might be obtained. If either type of change occurs, it is the responsibility of NRAO to notify specific persons at JPL via electronic mail. In addition, a log of such changes will be maintained as an ASCII file (name TBS) in the same directory as the doppler files. Each line of the log will give the effective date and time of each change, the new values of T1 and T2, and whether this represents a change in the actual delay value or not. All doppler files \*computed\* after the given time use the new value, regardless of the time of the affected tracking pass.

[1] G. Langston, "JPL doppler file format description." Memo dated 93/08/23. [ftp.gb.nrao.edu:ovlbi/doc/JPLDopMemo.tex].

[2] K. M. Liewer, "TRK-2-30, DSN Tracking System, DSN Tracking Data Interface." JPL Document No. 820-13, Rev. A, dated 95/02/28.

[3] L. D'Addario, "Details of post-pass processing of time correction data," Appendix A: Calculation of the phase processing delay. Document in preparation, draft available from the author; future OVLBI-ES Memo. See also 'ftp.gb.nrao.edu:ovlbi/doc/signalDelay.txt'.

[4] A. Minter, "Conversion of two-way timing data to doppler data." OVLBI-ES Memo No. 66, 96/11/26.  
[ftp.gb.nrao.edu:ovlbi/memoseries/es66\_dopplerConversion.tex]