VLBI Array Computer Useage: Fringe Fitting

W. COTTON

June 1982

I. INTRODUCTION

The purpose of this memo is to update the estimates of the computer requirements of the VLBA given in VLBA memos #4 and #18. The principal changes that have occurred since the release of these memos are the increased ability of the NRAO Astronomical Image Processing System (AIPS) to process VLBI data and the implementation in AIPS of the global fringe fitting method (Schwab, VLBA memo #82). This memo will give the results of timing tests using the AIPS software.

II. TIMING TESTS

Since the global fringe fitting method is relevant only to continuum data, all of the timing tests have been done on continuum data using the Charlottesville VAX computer with an FPS 120-B array processor(AP). The data set used for the tests here was obtained from an 8 station Mk II VLBI experiment and contains 37,383 visibility data points (10 second averaging). The amount of data in this data set is about the amount used in the timing measurements described in VLBA memo #4.

In these tests the self calibration and fringe fitting have been done with a two minute solution interval and using 200 CLEAN components. Mapping and CLEANing was done using a 512×512 image. The map was CLEANed 500 iterations requiring six major cycles. The timing results are given in Table 1. During these tests the VAX was moderately busy but there was no competition for the array processor so real elapsed times for the execution are given in Table 1. The real elapsed time is an important consideration, as the use of the array processor is not reflected in the CPU times.

Table 1
Software Timing: VAX + AP

Step	CPU time (min)	Real time (min)
Fringe fitting	18.1	43.9
Self Calibration	2.16	4.78
Sorting	1.92	3.66
Mapping	1.79	4.73
CLEANing	5.22	13.5

III. Array Computing Requirements

In order to estimate the array computing needs we have assumed that the amount of data used in the timing test described above corresponds to 10 hours of array time. In addition, we have assumed that the data is processed 10 times through the self calibration loop and that the fringe fitting is done twice. The actual amount of processing needed depends strongly on the specific experiment. The estimates of the array computing needs are shown in Table 2

Table 2
Computing Need per Array Hour: VAX + AP
(2 MHz bandwidth and single polarization)

Step	CPU time (min)	Real time (min)
Fringe fitting	3.62	8.77
Self Calibration	1.73	3.82
Sorting	1.92	3.66
Mapping	1.79	4.73
CLEANing	5.22	13.5
Total	14.3	34.5

The above results as well as those quoted in VLBA memos #4 and #18 are valid for a Mk II (2 MHz) recording system and a single polarization. The normal use of the VLBA will probably use full polarization (at least both circular polarizations) so the amount of data processed will probably be four times that in the tests described above. Fortunately, the cross–polarized data will not have to be fringe fit and can be ignored until the last cycle of self calibration.

The increase in the amount of data due to the wider bandwidth depends on the accuracy to which instrumental delays can be controlled and on the size of the source to be mapped. If the residual instrumental delays can be kept well under 100 nsec. then 5 MHz frequency channels are useable, requiring 10 channels for a 50 MHz bandwidth. The results quoted in Table 2 used 4 channels so the wideband system would probably produce 2.5 times the data per polarization.

The computing time required for pre–fringe fit processing and fringe fitting is roughly proportional to the amount of data. In VLBA memo #18 the pre–fringe fit processing used 32 delay channels rather than the 10 frequency channels postulated for the VLBA. The computing time for self calibration and mapping do not depend on the number of frequency channels and the time for CLEANing is independent of the amount of data. In the current implementation of the self calibration and mapping programs the computing time used is nearly independent of the number of parallel polarizations used (1 or 2). Thus, the pre–fringe fitting requirement for a VLBA is on the order of 10 times the Mk II estimates from VLBA memo #18 and the computing required for fringe fitting should be approximately 5 times that given in Table 2. The updated, adjusted VLBA post correlation computing need estimates for a full polarization, 50 MHz bandwidth system are given in Table 3.

Table 3
Total Computer Useage Requirements

Process	No. Minicomputer + AP
Cont. pre-fringe fitting	1.0
Cont. fringe fitting and mapping	1.5
Spectral pre-mapping*	1
Spectral mapping*	1
Total	4.5

* Spectral line observations assumed 20% of the time.