VLBA Requirements for Live-Time Fringe Checks

The performance of the VLBA must be remotely monitored in order to minimize time lost to equipment failures. Unfortunately, the acid-test for an interferometer, the successful correlation of data tapes, does not occur until data-tapes arrive at the correlator site. Days, or sometimes months, can pass before a problem is revealed at the correlator. During this time, many experiments may be ruined before the problem is recognized and corrected.

Such disasters are easily circumvented by sending, via phone-link, small samples of data from each site to the central processor for immediate correlation. The correlated data can be compared against expected amplitudes, delays, and delay-rates for a given source/baseline combination to reveal problems with the interferometer system. If the transmited data is read from tape in a read-after-write mode, then almost every link the recording chain can be verified, including the computers, schedules, frequencies, pointing, tape-recorders, and clocks. The only aspects not checked (other than intermitent problems) are tape shipment and long term maser stability.

These so-called "real-time fringe tests" are regularly run on the exisiting network by the VLBI group at SAO. Experience shows that these tests are useless as a diagonistic unless the source is easily detected. In practice, this means that the correlated flux for a source must be at least 2 percent of the geometric mean system temperature for any given baseline, assuming that 10**6 bits (bandwidth x observing time) of data are correlated. Thus, under typical conditions (60 K system at 0.1 K/Jy), this requires that source fringe amplitudes be on the order of 10 Jy. A 1.5 percent observation is detectable (can be confirmed by closure with other baselines) but is unreliable.

There are only a handful of sources (eg 3C84) which meet this flux requirement. It is therefore important that fringe tests be scheduled when the source visabilities are maximum. Sensitivity can be increased by collecting more than the current 10**6 bits of data at the expense of increased transmission time. It takes about 20 minutes to collect 10**6 bits over standard phone lines at 1200 BAUD. Significant gains can be achieved by using a 4800 BAUD modem and a larger data-buffer to collect four times as much data. Increasing the data rate and transmiting for a longer period, it would be practical to transmit 16 megabits of data. The factor of four increase in sensitivity make many more sources suitable for fringe tests.

The larger data-buffer would permit simultaneous testing of several frequency bands. Also data taken with a narrow band filter at a low data rate, say 20 kHz bandwidth at 40 kHz rate, can be used to check the coherence of the frequency standard over a 7 minute period.

Currently the greatest failure of the fringe test system is that it is used too infrequently. Problems have eluded the tests because changes in observing setup have gone unchecked. Problems have also gone unchecked because the setup for the fringe test is sometimes different from the setup used during observing. More often than not we test the network's ability to run a fringe test rather than testing the network itself. The tests need to be scheduled frequently, the fringe test procedure be well established, and the source visiblities well understood.

Testing once or twice daily should be adequate. Each test will require less than ten minutes, all for source change. Often a program source can be used for fringe tests with no time lost. The data should be collected in a databuffer at each site from tape in read-after-write mode. Ideally the data should be transfered to an on-site disk at maximum baud rate for later collection at a leisurly rate. For example, the data can be imbedded and transmitted in routine communications to and from the remote sites in order to make efficient use of dead-time in the phone connection.

Currently the fringe tests are correlated in software but this approach is totally impractical. If the data is stored in a format compatible with the hardware correlator then the correlation can be done in seconds. Using the hardware correlator also permits examination of the autocorrelation spectra of strong maser lines, an excellent remote diagonistic tool. Bandpass shapes may also be examined for interference etc.

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	Current System	Proposed VLBA System
Tests every	2 days	12 or 24 hours
Duration	1 hour	10 min (0 min if test uses a program source)
Transmission Rate	1200 baud	4800 baud
Transmission Time	20 minutes	60 minutes
Data Buffer Size	10**6 bits	16x10**6 bits. Should allow transmission of 4 bands at 4*10**6 each.
Sensitivity	2% Tsys 10 Jy	0.4 % Tsys 2 Jy
Coherence test	4 sec .125 kHz BW	7 min 20 kHz BW
Correlator	software	VLBA 10 station correlator required for about 2 seconds.