National Radio Astronomy Observatory
Socorro, New Mexico
Very Large Array Program

VLA Computer Memorandum No. 177

VOYAGER CONSIDERATIONS FOR THE VLA ON-LINE SYSTEM

Gareth Hunt and Kenneth Sowinski

September 1987

1. New Computer Hardware

1.1 Procurements

The computer hardware for the backup system was ordered in December 1986.

With this procurement, NRAO now has sufficient general purpose controllers to be able to implement all necessary custom interfaces in the new peripheral controller enclosures (PCE).

The tape drives which were originally delivered with the ModComp computers have been replaced with a new model. With the new procurement, there is a complete backup for these drives.

Display terminals for operation with the new system were acquired in January.

1.2 Installation

The projected date for the installation of the new computer system is October 31st. After the system has been in successful operation for 2 months, the old system will be totally removed. This will require 2 weeks' downtime to recable.

2. New Computer System Operation

2.1 Monitor in Parallel with Old System

It is possible to monitor data on the new computers while the old system has control of the array. It is proposed to use this extensively during the debugging phase.

2.2 Control in Parallel with Old System

At the later stages of the debugging, it is proposed to allocate a few antennas to the new system during test periods. In this mode these antennas would be fully controlled by the new system. The data gathered by these antennas would also be passed to the new system.

2.3 Removal of Old System

The old system will be disconnected and put on surplus after the new system has been in operation for 6 weeks. The removal of the old computers, the relocation of the new computers in the computer room, recabling, etc. is expected to take 2 weeks. A detailed plan for this will be prepared in the fourth quarter.

3. Autophasing relative to single antenna

3.1 Algorithm

The present algorithm computes the phase of a given antenna from its single baseline with the reference antenna. The reference antenna is defined in a system band-dependent file.

The prediction of phases is based on the current antenna phase and the previous phase only.

The new system will use the standard Antsol solution to determine the phases from all baselines. Antsol produces the complex antenna gain (i.e. gain and phase) for each IF of all antennas from a least squares solution of all unflagged measured visibilities involving that IF. (See section 4)

3.2 New Algorithms

New predictor methods should be investigated, perhaps using a history of the antenna phase. (See section 4)

4. Global Autophasing with all Baselines

4.1 Algorithm

The new system will use the standard Antsol solution to determine the complex antenna gain from all baselines.

The initial predictor used will be as at present. New predictor methods should be investigated.

4.2 Continuum

Autophasing will be fully implemented.

4.3 Spectral Line

Antsol will be able to accept input from any channel, or any set of n contiguous channels, where n is a power of 2. The default is to use "channel 0" (the sum of the inner 3/4 of the baseband).

4.4 IF selection

By default IFs A and D will be properly phased, as seen in the analog sum output, by the fringe rotators. The control software will have the ability to have C or B phased by the hardware and the software in the array processor which applies the phase calibration will have the appropriate capabilities; however, initially there will be no mechanism for specifying C or B by the observer.

4.5 Phase Jumps

These are a nuisance. The average phase of all antennas should not vary by more than 15 degrees from one 10 second integration to the next. A tolerance will be built into the Antsol output evaluator to avoid this where possible. (See section 4.6)

4.6 Bad Antennas or Correlators

A program will be written to evaluate the Antsol results for gain changes, closure errors, and phase jumps.

There is no software to eliminate individual correlators. Closure errors can be caused by crosstalk, shadowing, or a broken correlator path. This last will be detected in the correlator hardware. The system will deal with flags on individual correlator, but there is no task yet producing these flags.

4.7 Specifications

We need to know the criteria for servo loop stability and output loop stability, in addition to the specification for phase jump detection. We understand that the rms phase should be such that the signal degradation is less than 0.2 dB.

5. Re-initialization

5.1 Array Phase

While in the phased array mode, antenna phases are remembered from the previous scan; they are not and will not be remembered after a computer reload.

5.2 IAT Midnight

We propose to introduce the concept of a reference day in addition to a reference time. Internally this means keeping times of greater then 24 hours, which is not possible at present. This will be done after the new system is installed.

6. Analog Sum Control & Monitor

6.1 Select IF A, B, C, or D

There will be a software controlled switch to select the IF being used in the analog sum. This has not yet been designed, built or programmed. It does not entail much software effort.

6.2 Synchronize with Data Invalid

The transition of the analog sum between IFs must be done during data invalid. This will be part of hardware specification. There will be no impact on software.

6.3 Drop bad antennas

The removal of an antenna from service requires manual intervention by the operator; there is no requirement for automatic deselection. A deselected antenna is always dropped from the contribution to the analog sum.

6.4 Monitor Total Power

There will be an analog sum power detector. This will be made available to the computers via the monitor and control system. This has not yet been designed, built or programmed.

7. Special Observing modes

7.1 Specifications

There are none explicitly required by JPL. However, NRAO will implement special modes for JPL. This will be for NRAO's convenience. In particular the control of the Analog sum selector and the IF selection for autophasing will be via the observing mode.

8. X-Band checker

8.1 Standard

The existing software does check for standard operational correctness where the data is available. This will be part of the initial new on-line system software. In particular the following are checked: LO locks, cryogenic temperature, receiver parameters including system temperature, and the status of all computer controlled switches.

8.2 JPL Specials

If other checks are necessary, NRAO will have no difficulty in responding to JPL's needs.

9. Displays

9.1 Standard

The standard displays will be available when the new system is operational.

9.2 JPL Specials

Displays corresponding to special hardware, special checks, and JPL control may be necessary. For example, it may be necessary to display measures of the performance of individual antennas compared to the average of all antennas, in particular for the antenna system temperature and the phase error. NRAO will have no difficulty in responding to JPL's needs.

9.3 Special Hardware

There will be one terminal dedicated to the JPL operation over and above the normal ones. Additional display terminals can be added easily if necessary; at least one such will be needed in the electronics room.

10. Reliability

10.1 Crashes

The new operating system is more mature. Most of the tasks are written in a high level language (Fortran). It is expected that the system will be more reliable than the present one because of fewer CPUs with concomitantly fewer links.

10.2 Other Failures

All failures that will cause degradation of data are monitored. A list of the possible failures that are currently checked will be provided separately. There may need to be some special additional monitoring. There are several single points of failure. For these the replacement modules should be tested in the operational system.

10.3 Possible new equipment

There was some concern about a rash of failures of the embedded array processor; it was feared that this might be indicative of a trend. However, these have not continued; it is therefore concluded that this was a statistical aberration.

The array processor will therefore not be replaced. A new system controller for the correlator will also be delayed.

11. Documentation

11.1 Observing files

Initially the observing files will be exactly as they are today. There will be modifications as new features are added to the VLA capabilities.

11.2 Observ program

A new Observ program will be written. This will be done on the same timescale as the necessary changes in the new on-line system.

12. Configuration Freeze for VGTA telemetry

12.1 Hardware

Computer hardware will be stable by July 1988.

12.2 Software

All major designs will be complete by July 1988. For NRAO use there will have to be periodic updates to add features for which the new system was procured. A suite of tests must be devised to verify the necessary functionality for JPL. This should be performed after each update. We currently propose that this be the state until the end of 1988. Negotiations between NRAO and JPL management should set the policy for 1989 from January until the fly-by.

13. Response to JPL operator

13.1 Failure

The software failure of a computer or the failure of a component which requires the reload of the computers will cause a delay of no more than 10 minutes before the array is rephased.

13.2 Failure of a computer

The failure of a computer or a component that is a single point of failure will cause downtime to replace the component plus 10 minutes to rephase the array from scratch after a computer reload.

13.3 Parameter and scheduled observing changes

Any change of parameters in the observing will cause a maximum interruption of less than 30 seconds. If the new parameters are sufficiently different to require re-phasing, then the delay will depend on the speed of the phase servo algorithm.

It is possible that a "simple" source change may take less than 10 seconds. This will only be for changes that cause no change in the antenna pointing, the subreflector, and the correlator configuration. This latter includes the reassignment of IFs, antennas, and changes in integration times.

13.4 Removal of a single antenna

At the request of the JPL operator an antenna may be removed from the analog sum by intervention of the VLA operator within 30 seconds.

14. Manpower

14.1 Hardware

There is sufficient manpower available to provide the necessary special hardware devices for the new computers. The computers themselves will be maintained by NRAO staff. One additional person is being sought to build the technical maintenance group to three. These people will be responsible for all non-contract computer maintenance at the VLA and in Socorro.

14.2 Software

The necessary manpower to design and implement the software is available. One quarter programmer has been and will continue to be charged to the VLA Voyager account. We will need people to work on detailed specifications and test procedures. We will need help in the execution of the tests.

15. Tests

15.1 Phase stability of antenna phase solution

15.2 Flagging due to low sensitivity or closure errors

15.3 Continuity of phase solutions

The phases must be tested after operator re-initiallization and after IAT midnight.

15.4 Analog sum

The removal and addition of antennas to this sum must be verified. The transition must be demonstrated to occur during data invalid. Tests of the total power monitor are also necessary.

15.5 Half correlator

The independence of the half correlators should be tested. The procedure would be to power down one half while normal observing is proceeding.

15.6 Operational procedures

After software updates standard operational procedures should be performed to verify that all aspects of the Voyager operations are functional. This may involve observing the spacecraft on a day not normally scheduled for JPL support.

16. Summary

16.1 Software needed after installation

Selection of IFs C & B (4.4)
Antsol solution analysis (4.6-4.7)
Continuity through IAT midnight (5.2)
Analog sum switch control (6.1-6.2)
Analog sum power detector (6.4)
Special observing modes (7.1)
Special X-band checker (8.2)
Special displays (9.2)
Alterations of system file structure (11.1)
Observ program (11.2)

16.2 Milestones

1987 October	New system operational
1987 December	Old system removed
1988 January	Selection of IFs C & B
1988 January	Special observing modes
1988 June	Continuity through IAT midnight
1988 July	Analog sum control and monitor
1988 July	Special displays and checker
1988 July	Observ
1988 October	VLA on-line system tests with JPL receivers