VLBA COMPUTER CONTROL FOR OBSERVING: THE MARK III EXPERIENCE

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This memo is an initial proposal for the VLBA control computer configurations and functions. This proposal is based on the Mark III experience with VLBI experiments and data acquisition. It is not necessarily the best plan for the VLBA, however, it is offered in the spirit of describing a system we are using now with the aim of stimulating discussion about the best way to do things for VLBA operations.

The discussion below follows the general data flow for a VLBI experiment starting with scheduling the observations, followed by data acquisition, and ending with processor input. The proposed activities and responsibilities of both the central computer and field computers are considered in the proposal.

1. Scheduling

The term "scheduling" means the preparation of the sequence of observations to be followed during data acquisition. This task is comparable to the VLA's OBSERV program and the Mark III's SKED program, and would be done at the central control computer. The scheduling could be done in absentia by array operators for the more straightforward observing programs. The software could also be accessed via modem by PIs if desired. The latter would be required for complex observing programs or for other special cases.

The capabilities of the VLBA scheduling task should include as a minimum the features provided by SKED such as mutual visibility calculations, consideration of antenna cable wrap and slewing speeds, automatic accounting for video tape usage, and so forth. The scheduler should also be able to specify when and what types of calibration data are required. This may be a built-in function of the VLBA but special requirements may need to be met for some observing programs. Or, more frequent monitoring of system temperatures may be required for certain programs. For astrometry programs, additional correlative data is required such as surface meteorology measurements, water vapor radiometry, cable calibration data -- these may not be gathered regularly and indeed are not needed by many programs. The scheduler should be able to request that such ancillary measurements be taken as frequently as required.

There should be a catalog of sources that can be augmented by any user and a catalog of all VLBA station locations and other collaborating stations. The scheduling task should have the capability to use only a subset of the available stations depending on the mutual visibility of a source or on other desires. As they are scheduled, observations should be checked for validity. There should of course be listings and displays of the schedule and summaries.

Some ability for automatic scheduling would be useful. It would be nice to be able to provide a minimum of information to the software (e.g. observe 3CXYZ from 12H UT to 6H UT and calibrate with 1234+567 once per hour) and have a schedule prepared without having to enter each individual observation.

The result of the scheduling session would be a file that resides on disk at the central computer. All of the information needed to execute the observing program would be contained in this file and all of the PI's needs and requests would be contained therein. This file would then form the basis for data acquisition activities and also be a part of the input to the processing stage. For schedules prepared by PIs, array operators should review the file in order to make certain that unreasonable requests were not being made.

2. Transmitting the Schedule

After preparation at the central control computer, the schedules would be sent to each field computer. This could be done by modem or by mail. If schedules are not prepared sufficiently in advance, then the modem route would be mandatory. In order to guarantee that schedules reach the field sites in time for the observations, they should be prepared early enough to transmit them via mail. At that time, assuming the modem is working, the schedule could be transmitted by phone and thus be present at the field sites in case communications are lost later. Up until the actual start of the observations, or even during observations, the schedule could be modified via modem. If the modem links are down, then the schedule last transmitted would have to be followed at the field sites. If this schedule is not acceptable, then the sites that have lost communications could be ignored and those with modems still working would be used. These options could be decided during the observing period. A policy about contingency situations would have to be formulated.

The same schedule file would be transmitted to every field site that is to participate in the observations. Individual field sites would record data based on information in the schedule as to when they are to be observing. The schedule file would contain

complete instructions as to what data is to be acquired and when, and the field computers would not be expected to make any decisions about the observation schedule.

3. Field Site Operations

The field computer should be responsible for two major tasks: 1) verifying and maintaining the health of the hardware and 2) acquiring "good" data according to the schedule. The field computers should have the capability of carrying out the entire schedule independently of the central control computer.

First is the task of certifying the equipment for operation. The field computer should be capable of acquiring enough "monitor" data and diagnosing it so that the ability of the hardware to acquire useful VLBI data can be verified. This means that the computer should have access to information about all subsystems at the site: antenna, front end, back end, hydrogen maser, radiometers, and other ancillary equipment. If a problem is diagnosed, the computer would correct the fault, if it can, or else notify either the local operator (if there is one) or the array operations center.

In addition, the field computer should be able to verify data quality. This task should be done in the field because there would be too many bits of data to be transmitted via phone. Currently, the Mark III system performs this task by using the data buffer module to capture a portion of the data stream and transfer it to the field computer where it is checked for correct format and the presence of a calibration tone. For the VLBA, a hardware module such as the JPL Digital Tone Extractor (DTE) that decodes a data stream, checks format, and extracts the calibration tones would be preferable because it takes a burden off the general-purpose computer.

The other major task for the field computer should be the execution of the schedule to acquire data. The computer controls the electronics modules, starts and stops the tape, sends commands to the antenna for pointing and logs events as they happen. Meanwhile, the task of monitoring all equipment continues. The detailed antenna servo control and coordinate conversion should be located in a microcomputer because the field computer will be busy checking equipment, controlling data acquisition, and monitoring data quality.

During observations, the central control computer should have access to the same information and controls as the field site computer, assuming the phone lines are operating. Thus array operators could monitor events at field sites and examine the log files during operations. It should also be possible for the array operators to take control of the schedule and override the field

computer control. There should be complete parallel capability between the field and central computers.

5. After the Observations

At the end of the scheduled observations, the tapes and log files should be shipped to the central control site.

After the log files are received at the central computer, the relevant information from them would be "delogged" and merged with the original schedule. The schedule-as-executed should form the control file for the processing operation. The complete log files would be archived in case they should be needed for reference during analysis or to provide feedback to field operators.

6. Conclusions

The proposed division of responsibilities and functions between the central control computer and field computers is based on the current Mark III operating conditions. This same philosophy is possible for VLBA operations as outlined above.