EVLA Project Book, Chapter 11

Transition Plan

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Summary

11.1 Introduction

A primary requirement of the implementation of the EVLA is that the current VLA continue observing and producing forefront science during the long period of construction and phasing in of the EVLA. This requirement has been specified over a period of several years by NRAO Users and Visiting Committees. Although it is expected that there will be some periods when the amount of observing time is reduced, and the average number of antennas available may be less than for the nominal VLA, these periods should be minimized in order that scientific observers reap the maximum benefit from the VLA during the period between 2002 and 2009. This transition plan addresses only Phase I of the EVLA Project, as described in the proposal to the National Science Foundation that was submitted in May 2000. Extension to Phase II of the EVLA Project will be addressed at a later time, if appropriate.

Here, we summarize the scientific and operational requirements for the transition from the VLA to the EVLA, as well as the plans for the transition of a few key subsystems. This chapter emphasizes the requirements rather than going into great detail on the transition plan for individual subsystems. More details on both the designs and the transition plans for several subsystems can be found in earlier chapters of this Project Book.

11.2 Scientific & Operational Requirements

We can define a series of scientific and operational requirements that will enable the VLA to maximize its scientific return while antennas, electronics, computing, and correlator are being brought up to the standards described in the Phase I proposal and in earlier chapters. These requirements have evolved via negotiation among the various divisions of the project and the scientific staff, and are stated succinctly in the succeeding subsections.

11.2.1 Scientific Availability

11.2.1.1 Stand-alone Observing

The VLA currently performs scientific observing for an average of about 77% of the hours in a year. We require that the fraction of time that the array is available for scientific observing be maintained at 60% or greater throughout the transition period, averaged over periods on the order of six months to a year. In addition, a period of substantial or complete shutdown lasting not longer than three months would be acceptable, though not desirable. If it is found that a greater degree of VLA down-time during the transition period could reduce significantly the cost and/or timescale for completion of the EVLA, NRAO will solicit recommendations from its advisory committees, including the EVLA External Advisory Committee, about the proper course of action.

11.2.1.2 VLBI Observing

The VLA shall remain capable of participating in scientific VLBI observations, either as a phased array or with a single antenna, with capabilities similar to those available in 2001. If necessary, it is permissible for this capability to be removed for a maximum of two observing trimesters, or approximately eight months.

11.2.1.3 Pie Town Link Observing

Scientific observing with the VLA using the fiber optic link to the Pie Town VLBA antenna shall be supported during the first trimester of 2002 and the second trimester of 2003. Continued use of the Pie Town link after 2003 will be subject to future negotiation and planning.

11.2.2 Antenna and Array Availability

In the text below, "VLA antennas" refers to antennas with the existing IF/LO system communicating through the waveguide. "EVLA antennas" refers to antennas with the new IF/LO system communicating through fiber optics. An "available" antenna is defined as one that supports the full range of capabilities necessary for scientific observing, including monitor/control (M/C), round-trip phase lock, fringe rotation, the full range of delay settings, and normal VLA observing modes such as reference pointing, rapid frequency selection, and fast switching. There is an important complication in that the EVLA antennas will still have a mix of old and new front-ends for a limited period, so the new IF/LO system should be compatible with both types of front end.

11.2.2.1 General Availability

Currently, the VLA operates with a "3-antenna rule," whereby loss of more than three antennas from the array of 27 antennas either for test purposes or because of "broken" antennas is unacceptable. Loss of more than three antennas during a scientific observing program constitutes sufficient cause for an after-hours callout of personnel to fix misbehaving antennas. During the EVLA construction, it is possible that subarrays of three or four antennas may be used for tests, while individual antennas also may be undergoing extensive checkout. Therefore, the 3-antenna rule shall be relaxed to a 5-antenna rule; i.e., no more than five antennas may be missing during a normal scientific observing run. In general, all other things being equal, it is desirable that VLA outages for EVLA testing should take place during less desirable observing periods, such as daytime and/or bad weather, and away from “popular” Local Sidereal Times (e.g., when the Galactic Center is up). It is also permissible to create a new class of contingency observations (e.g., surveys, monitoring experiments, and observations of strong isolated point sources), where astronomers are granted observing time that can be used during tests, with the understanding that more than five antennas may be missing. The “adjacent antenna” rule, whereby the antennas adjacent to the North arm gap in C are designated as “critical antennas,” may be relaxed.

11.2.2.2 EVLA Antennas

In 2003, an EVLA test antenna will be instrumented with a new IF/LO/FO system. Installation of new systems on all antennas will begin in 2004 and continue through 2008. During this period, it is required that the EVLA antennas be capable of scientific operation in conjunction with the "old" VLA. In other words, there must be the capability to operate these new antennas with an available monitor/control (M/C) system (either "new" or "old") and to feed their data into the old (or the new, depending on final delivery schedule) correlator in such a way that the identity of an antenna as "VLA" or "EVLA" is transparent to the end scientific user.

11.2.2.3 VLA Antennas

VLA antennas must be operable by either the old or the new M/C system, with a full range of monitor points and information available to the on-duty telescope operator. There is no requirement that the VLA antennas be able to feed the "new" WIDAR correlator.

11.2.3 Array Operations and Documentation

11.2.3.1 Routine Operations

During the transition period, the VLA, including both VLA and EVLA antennas, must be operable routinely by a single telescope operator, for a full range of normal VLA functions. This includes (but is not limited to) such activities as array calibration (e.g., delay, pointing, and baseline runs), holography, and all significant scientific observing modes of the VLA. Control and data output from ancillary equipment such as the Atmospheric Phase Interferometer, possible water vapor radiometers, ionospheric monitors, and other such devices must have availability consistent with that before the transition begins.

11.2.3.2 EVLA Tests
Computer-controlled tests that make use of the operable M/C system and operational VLA capabilities shall be carried out by the on-duty telescope operator. Special tests of EVLA systems will, in general, require the active participation of EVLA software and/or electronics personnel.

11.2.3.3 EVLA Documentation
The Array Operations Division shall be supplied with sufficient documentation and training so that they can operate VLA and EVLA antennas simultaneously for scientific observing, with fractional downtimes consistent with those achieved in 2001. This downtime refers to unscheduled downtime of antennas or the array, and is not to be confused with the fractional availability discussed previously.

11.2.4 Data Management and Data Analysis

11.2.4.1 Scheduling
Scientific users of the EVLA must continue to be able to create schedule files routinely for the EVLA when it contains both VLA and EVLA antennas, and a mix of receivers. Telescope parameters, available frequency ranges, and similar evolving items must be kept up to date in the software, with appropriate selections available and warnings issued about available resources. Requirements on dynamic scheduling are not yet determined.

11.2.4.2 Data Pipeline and Analysis Software
Any data pipeline that is in place during the transition period must be capable of appropriately handling VLA and EVLA antennas in various states, with correct calibration and ancillary information supplied to the data-reduction scripts or programs.

11.2.4.3 Data Calibration
VLA antennas will continue to operate with their 19.2-Hz calibration-switching cycle. Comparable amplitude calibration information shall be supplied on-line for both types of antennas, implying that the EVLA antennas must be able to “mimic” the performance of a VLA antenna with regard to items such as noise-diode switching, Walsh functions, and fringe rotation. The Monitor/Control system must capable of applying this information correctly from an array with mixed types of antennas. Note that it is assumed that pointing calibration and assessment will make use of servo encoders upgrades that are to be implemented by Socorro Operations prior to the outfitting of EVLA antennas.

11.2.4.4 Data Archive
The data archive shall be capable of coping with data sets that are combinations of VLA and EVLA antennas, and shall include all appropriate ancillary information to decipher the antenna properties necessary to analysis of data that are retrieved from the archive at some (considerably) later date.

11.2.5 VLA Infrastructure
EVLA activities during the transition period shall be coordinated with activities required to maintain the VLA infrastructure (e.g., track repairs and antenna painting). Systems such as the waveguide shall be maintained as required to support scientific observing and equipment health.

11.2.6 Personnel Safety
Current VLA requirements for personnel safety (e.g., use of hard-hats and other personal protective equipment) shall be maintained during the transition period.

11.3 Antenna/Feed/Receiver Plan

There is a general desire to have two EVLA test antennas. This is subject to the "5-antenna rule" discussed above in Section 11.2.2.1. If the EVLA Project decides that three or more test antennas are needed, the 5-antenna rule and related parts of the transition plan will be opened up for further discussion.

Mechanical changes to the antennas include completion of the project to modify the feed cones of the VLA antennas, and modification of the structures to fit in the 1-2 GHz horn. The schedule and impact of these modifications on observing are not yet determined. Note that it is assumed here (see also Section 11.2.4.3) that the servo encoder upgrade is accomplished by Socorro Operations prior to the transition.

The IF/LO/FO systems in EVLA antennas will be modified in the antenna barn during the period from 2004 through 2008. However, new/modified receiver systems will, in general, be mounted in the field. The schedule for replacing receiver systems in the field, and the means of meeting the requirements on scientific observing capabilities, are not yet determined.

11.4 Electronics Plan

11.4.1 EVLA Antennas with VLA Correlator

The signal from an EVLA antenna will be input to the old VLA correlator by taking a wideband digital IF from the EVLA antenna and reconstituting an analog IF using a narrow-band, multi-bit digitizer in the VLA control building.

11.4.2 New/Old IF/LO Systems

The IF/LO/FO systems in VLA antennas will be modified in the antenna barn during the period from 2004 through 2008, with approximately seven antennas modified per year. These antennas will enter the barn as "VLA antennas" and leave the barn as "EVLA antennas" (see definition in Section 11.2.2).

There is concern about the ability to observe with mixed arrays of VLA and EVLA antennas that are transparent to the scientific observers (see requirement in Section 11.2.2.2). For example, closure errors could seriously compromise the observations with such mixed arrays. Therefore, the option to keep both IF/LO systems running in parallel will be preserved as long as possible.

More work is required to determine how to maintain compatibility between old front-ends and the new IF/LO system. A significant concern is the desire to remove the old A rack when the IF/LO system is converted from VLA to EVLA design, which is likely to be an issue for a period of 6 to 12 months.

Fringe rotation on the EVLA second LO will have sufficient range and accuracy to provide the fringe-rotation rates required for the old correlator, at the longest baselines and at frequencies up to 50 GHz.

11.5 Monitor & Control Plan

A crucial part of the transition plan is the need for the new M/C system to provide full monitor and control capability simultaneously for both VLA and EVLA antennas. A preliminary step in this regard is the complete replacement of the current Modcomps, the correlator controller, and the 9-track tape recording of real-time data. These replacements are scheduled to be finished by May 2002. Functional system tests of the new M/C system are expected by mid-2003, in time for use with the initial EVLA test antenna. Details of how the M/C system will function with both types of antennas, and the interface that will be presented to the telescope operator, remain to be determined. These will be presented in the M/C Chapter of this Project Book, with appropriate entries abstracted for the transition plan.

11.6 Correlator Plan

The new WIDAR correlator will be supplied by the DRAO, under funding by the Canadian National Research Council. The general plan is to install the new correlator in the tape/computer/electronics room located immediately to the east of the VLA Control Room. By doing so, it will be possible to run both the old and the new correlators contemporaneously (i.e., the old correlator will not have to be removed in order to install the new correlator). This should enable considerable testing in place, and may prevent a long downtime that would be required if one correlator were to directly replace the other. Note that there is no requirement that the two correlators be fed in parallel (i.e., with data acquired at exactly the same time and split into two simultaneous paths). However, it should be possible to switch between the correlators on a time scale of a few minutes or less, so that comparisons can be made under similar weather conditions.

The first appearance of WIDAR correlator hardware at the VLA site is scheduled for the third quarter of 2005. This will be a prototype correlator that will be available for testing with three Baselines (three EVLA antennas). Between late 2005 and the end of 2007, the new correlator will be developed at Penticton, for installation at the VLA beginning in the fourth quarter of 2007. This means that the current VLA correlator will be used for all scientific observing through the end of 2007, incorporating both VLA and EVLA antennas. It also means that the room where the new Correlator is to be installed must be fully prepared (physical structure, HVAC, etc.) to accept the correlator by late 2007.

Test observations with the WIDAR correlator will begin in the first quarter of 2008, with approximately 26 EVLA antennas available. These test observations will continue throughout the year, as the new correlator is brought up to its full observational capability (including both hardware and software). Then, in late 2009, the new correlator will be declared operational and the old correlator will be shut down.

Note that there will be significant decisions to make about the exact hand-over to the new WIDAR correlator, such as how this is staged, and what fraction of the time the old and new correlators will be used for scientific observations. At this writing, it seems too early to make decisions on the detailed requirements or plan; those will be developed further as the schedules for the individual subsystems are fleshed out. Most likely, this will be an important topic for discussion by the External Advisory Board.

11.7 Interim Operations Plan

The interim operations plan for the EVLA will depend critically on the status of the M/C and Data Management developments, as well as any decisions to be made about reduced observing and increased test time. Philosophically, it is expected that considerably more test time (and less scientific observing) will be made available during daylight working hours. In the early years of the EVLA project, this time will be dominated by tests of the new M/C system and the EVLA antennas (including LO/IF/FO capabilities). In the last several years, tests involving the WIDAR correlator are likely to take precedence.

A requirement stated above is that the transitional VLA will be operable by a single VLA telescope operator working a normal shift, with sufficient M/C capabilities to operate both VLA and EVLA antennas simultaneously. The exact nature of the operational interface during the transition is yet to be determined. Development of a true plan for interim operations awaits solidification of the designs and schedule for the various electronic and software subsystems.

11.8 Commissioning Plan

A plan for the commissioning of new capabilities of the EVLA, and the transition from old to new capabilities for scientific observing, will be developed at a later date.

11.9 Schedule

May 02: Complete replacement of old Modcomps, correlator controller, and 9-track tape recording.
Aug 02: Start installing fiber on array.
Apr 03: Install new IF/LO/FO system on EVLA Test Antenna near array center. Test with prototype M/C system.
Jul 03: Start interferometry tests between EVLA Test Antenna and VLA.
Some new and some old front ends available. Installation of new receivers continues until project end.
Mar 04: Start installation of IF/LO/FO system on 7 antennas/yr.
Full M/C capabilities, including support of hybrid array. EVLA Test Antenna available for observing.
Q3 05: Test prototype of WIDAR correlator with 3 baselines.
Q4 07: Start installation of WIDAR correlator in new correlator room.
Q1 08: Start test observations with new correlator and up to 26 EVLA antennas.
Mar 08: Last antenna converted to EVLA design.
Q1 09: Full observational capability on WIDAR correlator. Old and new correlators used for testing.
Q4 09: New correlator operational. Old correlator shut down.
May 10: Last new receiver installed.