

SYSTEM REQUIREMENTS SPECIFICATION

EVLA Software System

Project Document:

Revision 1.0

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Revision History

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1 Introduction

1.1 Purpose

The primary goal of this document is to provide a complete and accurate list of requirements for the EVLA Software System. Upon completion, the document will act as a binding contract between developers and users and will provide a common point of reference for system expectations.

The primary audience of this document includes, but is not limited to, project leaders, the designers and developers of the system, projects scientists and engineers, and end users. The document may also be useful as a reference for individuals involved in similar projects with similar requirements.

The requirements contained in this document are numbered based on the section/subsection in which they appear.

Note: Text found between “<” and “>” indicates questions or comments to the author and/or readers. And In most cases, the phrase “The user” can be replaced with “An authorized user”.

1.2 Scope

The EVLA Software System encompasses all functions needed to support the collection of validated observational data with the EVLA Phase I and Phase II instruments.

The major functions the EVLA Software System must perform are as follows:

- Obtain observational parameters and instructions from the system users.
- Configure the Instrument’s hardware and perform the observations.
- Conduct user directed data processing and reduction.
- Make a permanent record of all results.
- Monitor the state of all hardware and software components and report on conditions.

This document will define those requirements that must be fulfilled by the EVLA Software System, plus requirements imposed on other external systems.

1.3 Definitions, Acronyms, and Abbreviations

1.3.1 Definitions

Administrator – An individual with unrestricted access to all aspects of the system.

Archive – A place in which records or documents are stored.

Data:

Astronomical – Visibility data (lags, spectra). Also referred to as Observational data.

Auxiliary – Data directly associated with some or all of the Astronomical Data such as flags, state counts, and data valid counts.

Derived – Results produced during Data Reduction.

Environmental – WVR, surface weather, and other atmospheric measurements.

Monitor and Control – Hardware monitor point and other system operations related output.

Project – Information submitted or created by the user in the course of preparing a proposal.

Data Base – A large and continuously updated collection of data that is organized especially to be used by computer.

Data Processing – Functions performed during the course of data collection.

Data Reduction – Functions performed post data collection.

Observation –

Parameters:

Hardware Settings – Actual instrument hardware settings needed to perform a desired observational function.

Instrument – Values directly related to the configuration and function of the instrument such as source location, frequency bands, polarizations, etc.

Observational – Values pertaining to the scheduling of Project and Program components.

System – Values that describe the instrument (Pad numbers, Antenna ids, etc.).

Processor – A physical computation device (hardware).

Process – A data processing procedure (software).

Program – Within each Project, observations in different configurations are each assigned to a separate Program.

Project – A scientifically independent subset of the observations derived from an approved Proposal. There will be one or more per Proposal.

Proposal – A submission by an observer to perform a set of observations.

Real-time – Pertaining to the performance of computation during the actual time a related process transpires such that results of the computation can be used in guiding the related process.

Sub-array -

1.3.2 Acronyms

AOC – Array Operations Center

GUI – Graphical User Interface

EVLA – The VLA Expansion Project

NMA – New Mexico Array

VLA – Very Large Array

VLBA – Very Long Baseline Array

WVR – Water Vapor Radiometer

1.4 References

- 1) ANSI/IEEE Std 830-1998, IEEE Recommended Practice for Software Requirements Specifications
- 2) ANSI/IEEE Std 1233-1996, IEEE Guide for Developing System Requirements Specifications
- 3) EVLA Memo No. 15, Scientific Requirements for the EVLA Real-Time System, September 26, 2000
- 4) EVLA-SW-001, EVLA e2e Science Software Requirements, April. 15, 2003
- 5) EVLA-SW-002, EVLA Engineering Software Requirements, July 18, 2003
- 6) EVLA-SW-002, Draft – EVLA Data Post-Processing Software Requirements, July 3 2003
- 7) EVLA-SW-003, EVLA Array Operations Software Requirements, June 6, 2003
- 8) System Requirements Specification, EVLA Correlator Backend, December 20, 2002
- 9) E2E Project Book

1.5 Overview

The remainder of this document contains a more detailed description of the EVLA Software System as well as the requirements necessary to design and build the system. Section 2 provides a general description of the EVLA Software System. Section 3 details the requirements of the product and the requirements imposed on external systems. Section 3 is the core of this document.

The format of the document follows that outlined in the IEEE STD 830 document, IEEE Recommended Practice for Software Requirements Specifications.

2 Overall Description

2.1 Product Perspective

2.2 Product Functions

2.2.1 Submission of Observation Parameters and Instructions

The scientific users wish to be able to submit a proposal for a set of observations in electronic form to an automated system. This system must be able to provide to and/or assist the user in the determination of the correct physical parameters and instrument configurations and scheduling information needed to satisfy the proposed scientific objects.

2.2.2 Configuring and Controlling the Instrument

Given a valid set of physical parameters and instrument configurations, the system must be able to automatically setup and guide the instrument through the duration of a Project. The project may be made up of a number of separate programs with different configurations. These must be scheduled and run in the presence of Programs from other Projects. Manual instrument control must be available as well.

2.2.3 Data Processing and Reduction

The system must be able to perform a variety of numerical processing tasks to support configuration, control, signal conditioning and data quality assurance objectives. Some of these processes will produce real-time results that must be delivered to specific system components.

2.2.4 Recording Results

All data products generated by the fixed parts of the system (portable elements such as test equipment and engineering laptops are specifically excluded) will be permanently stored in a manner that allows easy, flexible and quick retrieval of desired data. This includes, but is not limited to, spectra, lags, derived observational data products, auxiliary data, applied corrections, flagging information, configuration and observational parameters, monitor values, and error reports.

2.2.5 System Software and Hardware Monitoring

All hardware system components that are capable of supplying status information will be monitored at regular intervals. This same information will be available on demand for operations, maintenance and troubleshooting. All EVAL software will be constructed with built-in monitor points that can be activated/deactivated on demand. Non-EVLA build supporting software will be debuggable and preferably have source code available. In cases where it is possible to trap failures of non-EVLA software, the EVLA software shall do so. Detected failure and out of spec conditions will be reported.

2.3 User characteristics

2.3.1 Array Operator

2.3.2 Engineers and Technicians

2.3.3 Astronomer/Scientist

2.3.4 Software Developer/Maintainer

These individuals are responsible for developing the software and will interact with the system to ensure that it is functioning properly. They will need access to error and status data on an interactive basis and need to conduct debugging as well as recompilation and linking. The software developer requires remote access to the system so that troubleshooting can be accomplished away from the EVLA and during non-working hours.

2.3.5 Web User

A few authorized individuals may be allowed access to parts of the system that are usually considered restricted.

2.4 Constraints

2.4.1 Criticality of the Application

2.4.2 Computer Hardware Limitations

2.4.3 Computer Software Limitations

2.4.4 Communications Limitations

2.4.5 Processing Limitations

2.4.6 Reliability

2.5 Assumptions

3 Specific Requirements

3.1 External Interface Requirements (Including Requirements imposed on External Systems)

3.1.1 Scientific Users

Req. ID	Description
3.1.1.1	
3.1.1.2	
3.1.1.3	
3.1.1.4	
3.1.1.5	

3.1.2 Operational Users

Req. ID	Description
3.1.2.1	
3.1.2.2	
3.1.2.3	
3.1.2.4	
3.1.2.5	

3.1.3 Maintenance Users

Req. ID	Description
3.1.2.1	
3.1.2.2	
3.1.2.3	
3.1.2.4	
3.1.2.5	

3.1.4 Development Users

Req. ID	Description
3.1.3.1	
3.1.3.2	
3.1.3.3	
3.1.3.4	
3.1.3.5	

3.2 Functional Requirements

(Note: Supporting requirements documents are referenced in parentheses after each listed functional requirement. The document number from section 1.4 above is followed by the relevant document section or subsections.)

3.2.1 Proposal Preparation and Submission

Req. ID	Description
3.2.1.1	Electronic submission via GUI (4; 1-R2)
3.2.1.2	Storage in digital form (4; 1-R2)
3.2.1.3	Designation of Proposal type and confidentiality level (4; 1-R4, 1-R6.5, 1-R6.6)
3.2.1.4	Audit trail (4; 1-R3)
3.2.1.5	Editable (4; 1-R3.2)
3.2.1.6	Automatic checking/verification/evaluation (4; 1-R12, 1-R13)
3.2.1.7	Transportable (for collaboration and review) (4; 1-R3.1)
3.2.1.8	Printable (4; 1-R16)
3.2.1.9	Access to astronomical community data (4; 1-R6.2.2)
3.2.1.10	Access to source lists (4; 1-R7)
3.2.1.11	Generation of observational parameters (4; 1-R11)
3.2.1.12	Generation of instrument control parameters (4; 1-R15)
3.2.1.13	Automated assistance with default settings (4; 1-R11.3)
3.2.1.14	Automated referee selection and review process (4; 1-R17)
3.2.1.15	Specification of allowable observing conditions (4; 1-R9)

3.2.2 Instrument Configuration and Control

Req. ID	Description
3.2.2.1	Manual interface via GUI (4; 2.1-R4.1) (5; 2-R6)
3.2.2.2	Initialize (including optional default state) all instrument parameters and hardware settings (4; 2.1-R9)

3.2.2.3	Request and initialize data processing and reduction functions (4; 2.1-R11)
3.2.2.4	Automatic calibrator selection (4; 2.1-R10)
3.2.2.5	Manual calibrator selection (4; 2.1-R7.3)
3.2.2.6	All settings accessible to authorized users (4; 2.1) (7; 6-R2)
3.2.2.7	All settings manually over-rideable (7; 6-R7)
3.2.2.8	Automatic checking, verification and evaluation (4; 2.1-R8.5, 3.1-R10, 3.2.2.8)
3.2.2.9	Automated dynamic scheduling (4; 2.2-R1) (4; 3.2)
3.2.2.10	Manual insertion into the schedule queue (7; 6)
3.2.2.11	Manual interrupt (4; 3.1-R6)
3.2.2.12	Interactive control of the instrument (3; 3.1.3) (4; 3.1-R3.1, R3.3) (5; 2-R2) (7; 3.4.4-R2)
3.2.2.13	Remote Access to displays (5; 2-R5)
3.2.2.14	Internal communications with operations (4; 3.1-R15)
3.2.2.15	Multiple sub-array support (3; 3.2.6) (4; 3.1-R4)
3.2.2.16	Observer notification of Project status (4; 3.1-R5)
3.2.2.17	Offline simulation using pre-recorded inputs (4; 3.1-R8)
3.2.2.18	Capable of handling existing VLA antennas (3; 3.1.1)
3.2.2.19	Capable of handling VLBA antenna recordings (3; page 5)
3.2.2.20	Audit Trail (4; 2.1-R6) (5; 2-R9)
3.2.2.21	Access to backup safety path (7; 3.4.4-R4)
3.2.2.22	Manage observing schedules manually (7; 6)

3.2.3 Data Processing and Reduction

Req. ID	Description
3.2.3.1	Auto-phasing determination with feedback to configuration and control (3; 3.2.9) (4; 5.1-R2)
3.2.3.2	Antenna-based complex gain functions (3; 3.2.10) (4; 5.1-R3)
3.2.3.3	Phase stability (4; 5.1-R4)
3.2.3.4	Bad data recognition and auto-flagging (3; 3.2.10) (4; 5.1-R5)
3.2.3.5	Antenna location determination (4; 5.1-R7.1)
3.2.3.6	Global pointing model (4; 5.1-R7.2)
3.2.3.7	Pointing offset determination (3; 3.2.9) (4; 5.1-R7.3)
3.2.3.8	Complex bandpass (4; 5.1-R7.4)
3.2.3.9	Focus (3; 3.2.9) (4; 5.1-R7.5)
3.2.3.10	Delays (4; 5.1-R7.6)
3.2.3.11	Polarization calibration terms (4; 5.1-R7.7)
3.2.3.12	Flux density scale determination (4; 5.1-R7.8)
3.2.3.13	TIP analysis (3; 3.2.9) (4; 5.1-R7.9)
3.2.3.14	Antenna aperture efficiency (4; 5.1-R7.10)
3.2.3.15	Fourier Transform (8; 3.2.2.14)
3.2.3.16	Integration (3; 3.2.8) (8; 3.2.2.16)
3.2.3.17	Quantization Corrections (8; 3.2.2.10)
3.2.3.18	Amplitude and Phase Corrections (3;3.2.8) (8; 3.2.2.13, 3.2.2.15)
3.2.3.19	Images and spectra in near real-time (4; 5.2-R4, 5.5-R3) (7; 3.4.2-R1)
3.2.3.20	Atmospheric modeling (4; 5.4)
3.2.3.21	User controlled results display (4; 5.5-R2.9)
3.2.2.22	Remote access to displays (4; 5.5-R6)
3.2.2.23	Automatic or Manually constructed processing sequences (4; 5.2-R2, 5.3)

3.2.3.24	Integrated manual feedback to instrument configuration and control (4; 5.2-R14, 5.5-R5)
3.2.3.25	Engineering analysis functions (5; 1.3, 1.4)
3.2.3.26	Source calibration (search and evaluation) (4; 2.1-R10)
3.2.3.27	Fault tolerance (8; 3.3.1.2, 3.4.1)
3.2.3.28	Audit trail
3.2.3.29	RFI Excision (3; 3.2.12)
3.2.3.30	VLBA Compatible

3.2.4 Results Recording

Req. ID	Description
3.2.4.1	Store all astronomical data obtained with the EVLA, VLBA, and NMA (4; 4.1-R1.1)
3.2.4.2	Store all instrument configuration parameters (5; 1.1.1-R2, 1.2.1.3)
3.2.4.3	Store all observation parameters (4; 4.1-R1)
3.2.4.4	Store all environmental data (4; 4.1-R1.2) (5; 1.2.1-R1.1) (7; 3.4.1)
3.2.4.5	Store all monitor and control data (4; 4.1-R1.3) (5; 1.2.1-R1.2) (7;3.3-R1)
3.2.4.6	Store all project data (4; 4.1-R1.4)
3.2.4.7	Store all derived data products (4; 4.1-R1.5 & 4.5-R1) (6; 3.2)
3.2.4.8	Store all maintenance data (4; 4.6-R5) (7; 4.6)
3.2.4.9	Store all system descriptive parameters (7; 5)
3.2.4.10	Retrievable (4; 4.8) (4; 1.2.1-R3) (6; 3.1-R1.1) (7; 4.6)
3.2.4.11	Searchable (4; 4.7) (5; 1.2.1-R3) 6; 3.1-R1.1 & 3.6-R1) (7; 4.6)
3.2.4.12	Loss protected (4; 4.1-R3) (6; 3.6-R3)
3.2.4.13	Compatible with Virtual Observatory (4; 4.9)
3.2.4.14	Proprietary data protections (4; 4.10)
3.2.4.15	Report generation (7; 4.7)
3.2.4.16	Store data and measurements in real time (3; 3.2.10)
3.2.4.17	Scheduled storing of data (7; 4.4)
3.2.4.17	Compatible with post processing system (6;1.1-R2)

3.2.5 System Monitoring

Req. ID	Description
3.2.5.1	Determine the state of all systems components (5; 2-R2) (7; 3.3-R2, 3.3-R3)
3.2.5.2	Control the function of all components of the system (5; 2-R8) (7; 3.4.3-R1)
3.2.5.3	Permit manual access and operation of the system via a GUI (5; 1.1)
3.2.5.4	Manage system access and privileges (5; 2-R7) (7; 1.3)
3.2.5.5	Perform tests on all components of the system (7; 3.3)
3.2.5.6	Manage system descriptive parameters (7; 5)
3.2.5.7	Report system status on a regular basis (5; 1.2.1.1)
3.2.5.8	Issue warning and error messages upon occurrence (5; 1.2.1-R6.1) (7; 3.2)

3.2.5.9	User controlled display and plotting (5; 1.4) (7; 3.5)
3.2.5.10	Notes and reminder facility (7; 4.3)
3.2.5.11	User determined storage of test output (5; 1.1.1-R6)
3.2.5.12	Retrieval of monitor data in near real time (5; 1.1)
3.2.5.13	User selection of monitor points (5; 2-R3)
3.2.5.14	User selection of monitor point output rate/interval (5; 1.1.1.1, 1.2.1.1)
3.2.5.15	User direction of monitor output to external systems (5; 2-R9)

3.3 Performance Requirements

3.3.1 General

Req. ID	Description
3.3.1.1	Data Integrity –.
3.3.1.2	Error Handling –

3.3.2 Hardware

Req. ID	Description
3.3.2.1	Input –
3.3.2.2	Output –
3.3.2.3	CPU –
3.3.2.4	Memory –
3.3.2.5	Storage –

3.3.3 Software

Req. ID	Description
3.3.3.1	Applications – <i>all math/science application software shall take optimal advantage of all language, compiler, and system computational features and resources to reduce run times to the minimum practical level. They shall be coded in such a manner as to minimize the possibility of floating point exceptions during processing.</i>
3.3.3.2	Management – <i>all management software functions shall take optimal advantage of all language, compiler and system features and resources to reduce overheads to the minimum practical level.</i>
3.3.3.2	I/O – <i>all input and output, and storage and retrieval operations shall take optimal advantage of all system resources to reduce overhead and latency to the minimal practical level.</i>
3.3.3.4	Processing –
3.3.3.5	General - <i>Operating system, message passing and other middle-ware, and programming language(s) used shall follow industry standards and be commonly available and widely used. Availability of source code for the OS will be very important.</i>

3.4 Reliability/Availability

Req. ID	Description
3.4.1	Auto-correction – <i>the System shall be self-monitoring.</i> It will be capable of detecting, reporting on and automatically taking action to remedy or lessen the impact of, at a minimum, the following types of abnormal conditions: processor hardware failure, operating system hangs or crashes, computational performance below minimum specifications, computational error rates above maximum specification, internal communications failures, and external communications disruptions.
3.4.2	Software – <i>the software part of the system shall be able to perform without total system restart due to internal failure between system maintenance windows.</i>
3.4.3	Hardware – <i>the hardware part of the system shall be able to perform indefinitely without complete loss of service, except in the event of total failure of primary and backup power.</i>
3.4.4	Network – .

3.5 Serviceability

Req. ID	Description
3.5.1	Hardware Accessibility – <i>all system processing and interconnect hardware shall be readily accessible for maintenance, repair, replacement and/or reconfiguration.</i>
3.5.2	Software Accessibility – <i>all systems and application source code shall be available to or on the systems that execute it.</i>
3.5.3	Debugging – <i>all software application modules shall be debuggable.</i>
3.5.4	Processes

3.6 Maintainability

Req. ID	Description
3.6.1	Software tools – <i>software tools and pre-built applications that do not have source code available shall come with a complete diagnostic package and customer support.</i>
3.6.2	Operating Systems – <i>operating system software shall either have source code available or come with sufficient diagnostics and customer support.</i>

3.7 Scalability

Req. ID	Description
3.7.1	Hardware – <i>I/O, communications, and processing hardware shall be easily expandable, reconfigurable, augmentable and replaceable to meet increasing data transfer and processing demands imposed by EVLA science, and availability of new technology.</i>

3.7.2	Transparency – 3.7.1, above, shall be accomplished in manner that is transparent to processing, communications and I/O software functions with the possible exception of recompilation of executables.
3.7.3	Seamlessness – 3.7.1, above, shall be accomplished in a manner that is seamless, in that it does not affect hardware modules or software functionality that it meets at interfaces.
3.7.4	Performance – the system shall be scaleable to an extent limited only by hardware technology and budget constraints

3.8 Security

The System needs a robust security mechanism in place so that unauthorized users are not allowed access. Authorized users are expected to be restricted to software and hardware development, testing, maintenance and operations personnel.

All users of the System must be uniquely identified. This could be done via a username and associated password scheme that would authenticate and authorize the user access to the system and, if applicable, grant the user access to restricted or controlled parts of the system. If a user cannot be identified, they will not be given access. In order to monitor all past access to the system, all attempts to access the system should be logged.

Users' needs and expectations from the system will be different. Systems operations should be given unrestricted access to all aspects of the system and should have the authority to grant and revoke privileges on a per-user basis. Development, testing and maintenance personnel, on the other hand, require access to some parts of the system, but not all, indicating that an access level is needed that allows privileges to be granted on a per-user and what-do-you-need-to-do basis.

Req. ID	Description
3.8.1	All users of the system shall login using some form of unique identification. (e.g., username and password)
3.8.2	All login attempts shall be done in a secure manner. (e.g., encrypted passwords)
3.8.3	A system administrator shall have unrestricted access to all aspects of the system.
3.8.4	Each user shall have a set of system access properties that defines the user's privileges within the system. (e.g., the subsystems a user may control or system tools the user may access).
3.8.5	The administrator shall have the ability to create and add a new user to the system.
3.8.6	The administrator shall have the ability to remove a user from the system.
3.8.7	The administrator shall have the ability to edit a user's system access properties.
3.8.8	The administrator shall have the ability to block all access to the system for all users or selectively by user. (All blocked users with active sessions

	shall automatically be logged off.)
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3.9 Installation and Upgrades

Req. ID	Description
3.9.1	Operations Activities – <i>the system shall continue operations, although not necessarily at full capacity, on all unaffected resources during partial shutdowns for maintenance, repair and/or upgrade.</i>
3.9.2	Test Mode – <i>the system shall be able to handle non-real-time operations in a transparent fashion (i.e., as if real-time).</i>
3.9.3	Replaceability – <i>modular design principles shall be employed to the maximum extent possible. Maximal practical use of available “hot-swappable” devices and components shall be made.</i>

3.10 Documentation

Req. ID	Description
3.10.1	Hardware – <i>complete and comprehensible hardware systems specifications and configuration information shall be readily available.</i>
3.10.2	Software Coding Practices – <i>software system and application code shall be well documented and written in a generally familiar language or languages (preferably not more than two). Software shall be written in a style that is easily readable and using practices that allow for minimal confusion.</i>