



Title: Computing and Software System: Overview	Owner: Rosen	Date: 2025-08-13
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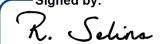
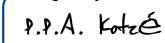


Computing and Software System: Overview

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Change Record

Version	Date	Author	Affected Section(s)	Reason
I	2025-08-11	R. Rosen	All	Initial draft
A	2025-08-12	M. Archuleta	All	Minor formatting, edits; prepared for release.



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I Purpose of the Document

The Next Generation Very Large Array (ngVLA) is designed to be a transformative astronomical observatory, delivering high-level data products to a broad community of users. The Computing and Software System (CSS) is the backbone of this vision, encompassing all the software and hardware required to control the telescope, manage the flow of data, execute processing pipelines, and provide user-facing services.

The CSS conceptual architecture is guided by key principles derived from decades of operational experience at NRAO and modern large-scale data processing paradigms. These include modularity, scalability, reliability, and a strong emphasis on a user-centered design to ensure accessibility for both expert and non-expert users. The system is decomposed into several major systems, each with a distinct role in the data lifecycle, from observation planning to final data analysis.

The purpose of this document is to outline the documents used in the process of defining the CSS conceptual architecture and the resulting set of CSS conceptual design documents.

2 The Design Derivation Process

The design of the ngVLA Computing and Software System is the result of a deliberate, structured systems engineering process designed to ensure that the final architecture is directly traceable to the scientific goals and operational needs of the observatory. This process began with the foundational system-level requirements [REF03], which were themselves derived from the Science Requirements [REF02] and Operations Concept [REF01].

Table I shows the documents [REF01-03] used to establish the initial CSS high-level structure which includes the following systems [REF04]: Proposal Management (PMN), Online Data Acquisition (ONL), Monitor and Control (MCL), Science Data Processor (SDP), Science Data Archive (SDA), Science Interface and Tools (SIT) and Technical Infrastructure (TI). This decomposition is consistent with the baselined ngVLA System Architecture [REF04]. However, these documents did not capture all the stakeholder needs at a sufficient level of detail for full CSS subsystem requirements derivation.

A key milestone in the Computing and Software System Conceptual Design phase was the identification of L2 Stakeholder Needs, as depicted in Figure 1. Telescope System-level Requirements (L1) imply software functional systems, but the L2 Stakeholder Needs are not directly ascertainable solely from the L1 System Requirements. The ngVLA project has used Conceptual Narratives [REF08-18] to elaborate the stakeholder needs and use cases across the system lifecycle. The Conceptual Narratives capture what the ngVLA telescope must do from the perspective of future users and operators - including scientists, engineers, and support staff.



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To ensure a rigorous and traceable design, the Conceptual Narratives were systematically analyzed to derive an integrated set of stakeholder needs [REF05-07], following established INCOSE (International Council on Systems Engineering) principles. This effort translated the high-level, narrative-based descriptions of what the system must do into a formal, structured set of stakeholder needs that can be tracked, validated, and verified. An external review (Nov 2024) and internal review (March 2025) of the Stakeholder Needs were conducted to ensure completeness and identify gaps (See 3.1). The technical requirements will be iteratively derived from the needs as part of the Agile development process.

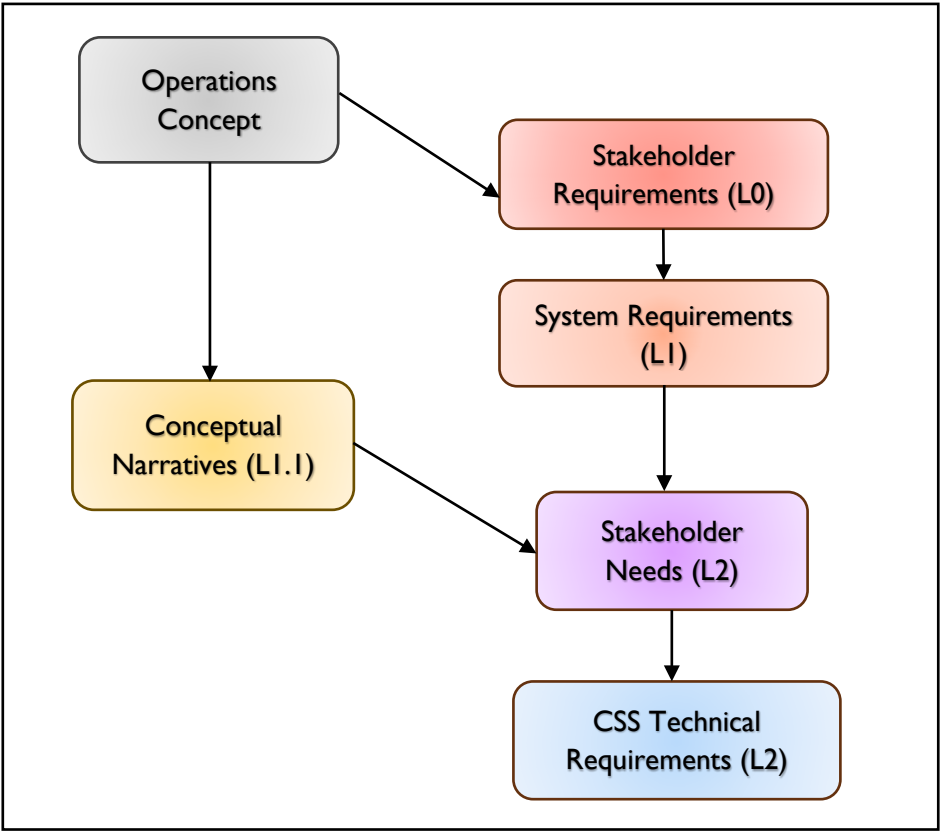


Figure 1. Relationship between the Operations Concept, L0 stakeholder requirements, L1 system requirements, and L2 subsystem needs and requirements.



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Table 1. Documents used in producing the CSS conceptual design descriptions and use cases.

Ref. No.	Document Title	Rev/Doc. No.	Relates to
System Documents			
REF01	Preliminary Operations Plan	020.10.05.05.00-0001 PLA	All
REF02	L0 Science Requirements	020.10.15.05.00-0001 REQ	All
REF03	ngVLA System Requirements	020.10.15.10.00-0003 REQ	All
REF04	ngVLA System Architecture Description	020.10.20.00.00-0002 REP	All
Stakeholder Needs			
REF05	CSS Stakeholder Needs – PMN	020.50.00.00.01-0007 REQ	CSS03, CSS04
REF06	CSS Stakeholder Needs – ONL, MCL, MSS	020.50.00.00.01-0008 REQ	CSS03, CSS05
REF07	CSS Stakeholder Needs – SDA, SDP, SIT, TI	020.50.00.00.01-0009 REQ	CSS03, CSS06, CSS07, CSS08
Conceptual Narratives			
REF08	ngVLA Proposal Process Concept	020.10.05.05.00-0011 PLA	CSS03, CSS04
REF09	Observation Preparation Concept	020.10.05.05.00-0010 PLA	CSS03, CSS04
REF10	Observation Scheduling Concept	020.10.05.05.00-0012 PLA	CSS03, CSS05
REF11	ngVLA Calibration Concept	020.10.05.05.00-0015 PLA	CSS03, CSS05
REF12	ngVLA Subarraying Operational Concept	020.10.05.05.00-0014 PLA	CSS03, CSS04, CSS05
REF13	Observation Execution Concept	020.10.05.05.00-0013 PLA	CSS03, CSS05
REF14	ngVLA Data Processing & Archive Workflow Concept	020.50.55.00.00-0001 DSN	CSS03, CSS06, CSS07, CSS08
REF15	Scientific User Support and Outreach Concept	020.10.05.05.00-0009 PLA	CSS03, CSS06, CSS07
REF16	Telescope Support Concept	020.10.05.05.00-0008 PLA	CSS03, CSS05
REF17	Conceptual Narrative for Time Domain Science	020.10.05.05.00-0016 PLA	CSS03, CSS04, CSS05
REF18	Maintenance and Support Concept	020.10.05.05.00-0007 PLA	CSS03, CSS05
Technical Memos			
REF19	TTA System Design Description		CSS04
REF20	ngVLA Data Rates and Computational Loads	R. Hiriart	CSS08
REF21	System Considerations for ngVLA Data Processing, Transport, and Storage	R. Hiriart	CSS08
REF22	ngVLA Multi-subarray Scheduling Algorithm	R. Hiriart	CSS05
REF23	Baseline HPG Runtime Performance for Imaging	S. Bhatnagar, F. Madsen, J. Robnett	CSS06, CSS08
REF24	Time Averaging Limits and Baseline Dependent Averaging for the ngVLA	J.-W. Steeb, Z. Gillis	CSS06, CSS08



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Ref. No.	Document Title	Rev/Doc. No.	Relates to
REF25	Telescope Time Allocation: System Description	688-TTAT-004-MGMT	CSS04
REF26	Telescope Time Allocation Tools Conceptual Architecture		CSS04
REF27	TTA Tools Gap Analysis		CSS04

3 The Conceptual Design Review

The purpose of the conceptual design phase is to ensure there is a robust set of performance and cost-driving requirements that meet the stakeholder needs, evaluate solutions and trade off studies, define concepts of operation and scope of the effort, and describe a conceptual design of the system that will satisfy key requirements.

The first major milestone in the ngVLA design phase is the Conceptual Design Review (CDR). This document provides the overview of the documents to be reviewed as part of the CDR: the use cases, a design description of each of the computing systems, and the software development plan.

3.1 Work To Date

The CSS and DMS teams have made significant progress over the last few years, with notable achievements:

External Stakeholder Needs Review (Dec 2024) – The Stakeholder Needs were derived from the Conceptual Narratives [REF08-18]. Over 1000 stakeholder needs were identified, with varying levels of detail. These, combined with the System Requirements [REF03], were presented to an external panel for review. The panel ultimately found that the stakeholder needs, grouped by computing system [REF05-07], were too disparate to understand without fully reading all the Conceptual Narratives and were out-of-context without the conceptual design. The panel recommended internal stakeholder review of the needs and that any external review of the needs be coupled with a review of the associated conceptual design.

This outcome led to an internal review of the stakeholder needs (below) as well as identification and enumeration of the Architecturally Significant Requirements (ASRs) in the conceptual design documents so that future panel members would not need to review all stakeholder needs as part of the CDR.

NRAO-Internal Stakeholder Needs Review (Mar 2025) – An internal review was conducted with members of the Science IPT and authors of the Conceptual Narratives to review all the stakeholder needs. This resulted in a largely complete and accurate stakeholder needs capture from which technical requirements can be derived. Another outcome was an update to the glossary with more refined and updated nomenclature and a set of high-level use cases.

NRAO-Internal Conceptual Design Review (July 2025) – An internal CDR was held with scientific and software staff to review all documents as a complete set and iterate through presentations. This resulted in useful feedback which was incorporated into the final documentation package.



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3.2 Maturity Levels of CSS Design Documents

The maturity levels of the CSS design description documents in or Online Data Acquisition (ONL) and Monitor and Control (MCL), Science Data Processor (SDP), and Science Data Archive (SDA) vary due to several factors.

CSS Conceptual Design Description – ONL and MCL: The advanced, almost Preliminary Design Review (PDR)-level state of this document reflects NRAO's long history and established expertise in building telescopes and their control systems for over 50 years. This allows the project to leverage deep institutional knowledge in areas like control systems and telescope operations. The architectural decisions often draw from past experiences, such as comparing the Executor's direct communication with hardware (VLA architecture) to using supervisory components (ALMA architecture). In addition, the early Assembly, Integration and Verification (AIV) and Commission Science Validation (CSV) milestones are largely ONL and MCL deliverables.

CSS Design Description - SDP: This document is at the conceptual design phase, largely due to a knowledge gap within the Data Management and Software (DMS) Department staff regarding large-scale, distributed data processing. To address this, DMS staff are focusing on domain expertise while engaging external experts in large-scale, distributed data processing to guide the Technical Infrastructure design. NRAO has partnered with the Texas Advanced Computing Center (TACC) to provide high-level design options and guidance for evolving the design, optimizing algorithm performance, and achieving reliability. Collaboration with CI Compass is also planned to address pipeline reliability and data lifecycle management for large-scale compute resources.

CSS Design Description - SDA: This document is also a conceptual design, but it outlines a significant amount of future work required before PDR, including defining data architecture, refining technical infrastructure, and developing quality attribute scenarios. The current NRAO Science Archive is a "brownfield system" that needs to be modified and integrated to support ngVLA. The SDA design description needs a comprehensive data architecture blueprint, refinement of technical infrastructure concepts, and the development of testable quality attribute scenarios. Progress in the SDA design has largely been hindered by lack of resources.

Table 2. Documents provided at the CSS CDR.

Doc. No.	Document ID	Title	Review / Context / Notes
CSS01	020.50.00.00.00-0007 GEN	CSS Overview	Context
CSS02	020.50.00.00.00-0008 LIS	CSS Glossary	Context
CSS03	020.50.00.00.00-0006 USC	CSS Use Cases	Review
CSS04	020.50.05.00.00-0001 DSN	CSS Conceptual Design Description - PMN	Review



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Doc. No.	Document ID	Title	Review / Context / Notes
CSS05	020.50.10.00.00-0002 DSN	CSS Conceptual Design Description – ONL and MCL	Review
CSS06	020.50.15.00.00-0001 DSN	CSS Conceptual Design Description – SDP	Review
CSS07	020.50.30.00.00-0001 DSN	CSS Conceptual Design Description – SDA	Review
CSS08	020.50.20.00.00-0001 DSN	CSS Conceptual Design Description – TI	Review
CSS09	020.50.00.00.00-0009 PLA	Software Development Roadmap	Context

In the period between the Conceptual Design Review (CDR) and the Preliminary Design Review (PDR), these stakeholder needs and conceptual design descriptions will be used to derive the detailed technical requirements for each subsystem. This will be accomplished through an Agile process, allowing for iterative refinement and ensuring that the final, detailed design of the CSS is robust, responsive, and directly aligned with the original scientific and operational vision for the ngVLA.

4 Data Catalog

A data catalog is an organized inventory of the data assets of an organization, acting much like a library catalog for information. Given the breadth of ngVLA, the CSS and DMS have started a data catalog. The data catalog is meant to enumerate all the different types of data used by the project, such as:

- why the data are needed
- data format
- origin and lineage
- who needs access to the data (both people and systems)
- when the data are accessed
- attributes that describe the data

Establishing a data catalog at the very start of a project is critically important because it forces stakeholders to define and agree upon data requirements, access rules, and management policies in the design phase of the project. In addition, it enables methodical and sensible design options and down-selects for managing the data. This proactive approach acts as a foundational blueprint for the entire system, ensuring that data is managed consistently and effectively as the project grows, which prevents the costly and chaotic process of trying to make sense of disorganized data when the project is already underway.



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Figure 2. The start of a data catalog for ngVLA.

The data catalog¹ for ngVLA is still under development and is shown in Figure 2. While there are references to databases in various conceptual design document descriptions, these are meant to acknowledge data flow, data usage, and data inputs/outputs. They are only one possible implementation. A holistic approach to defining and managing all the data will occur during the period between the CDR and Preliminary Design Review (PDR).

5 Computing Systems Overview

The ngVLA computing systems are shown in Figure 3 and described below.

¹ A digital version of the data catalog is here, and will continue to be updated as the project progresses: <https://link.excalidraw.com/readonly/P2NO82duD0tKTD9rGNf>



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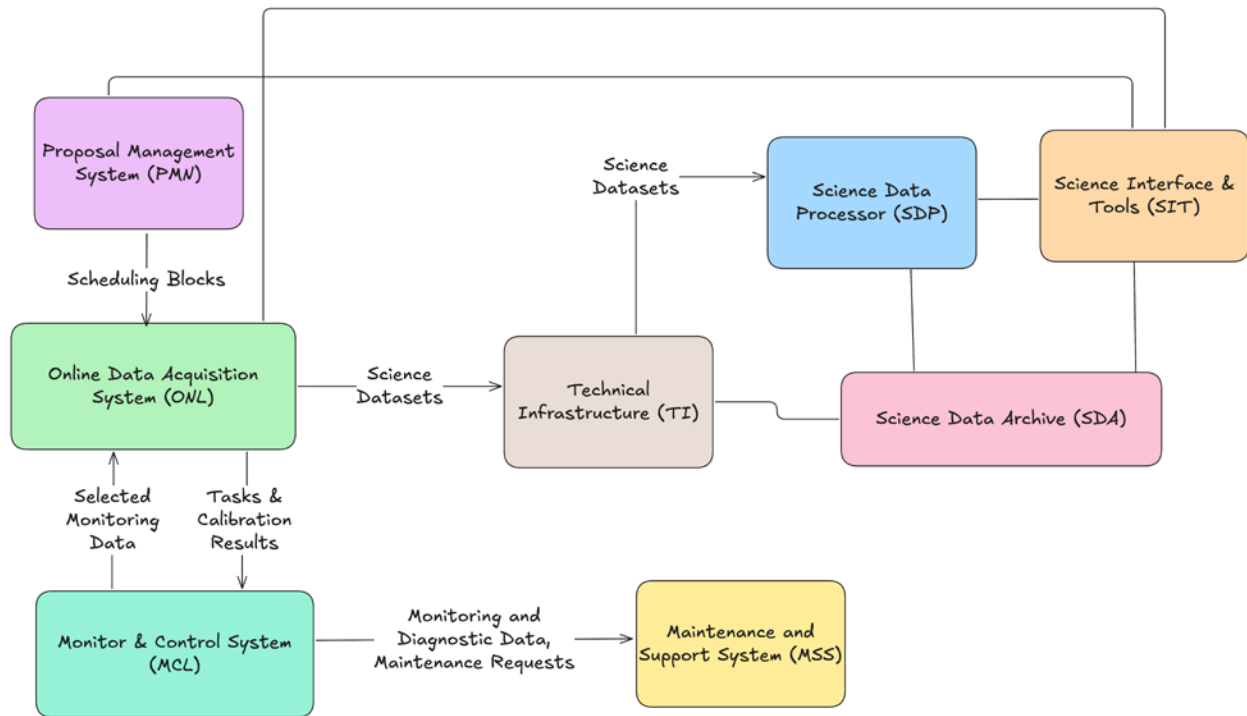


Figure 3. General overview of the ngVLA Computing and Software System (CSS).

5.1 The Proposal Management System (PMN)

The Proposal Management System is the entry point for all scientific and technical use of the ngVLA. It manages the entire lifecycle of an observing proposal, from initial submission to the creation of an executable project.

- Telescope Time Allocation (TTA) Tools: PMN is built upon NRAO’s existing TTA Tools, which are being augmented to meet ngVLA-specific requirements. This approach leverages a mature, existing system while allowing for new development where necessary.
- Science-Focused Interface: Researchers define their observations in scientific terms (e.g., target, desired sensitivity) rather than telescope-specific parameters. The PMN system then uses internal algorithms and heuristics to translate these science goals into a concrete, technical Scheduling Block (SB).
- Observation Preparation: An ngVLA-specific Observation Preparation System will bridge the gap between the proposal (TTA) and execution (ONL). It assembles the final, validated SBs, which contain all the instructions needed for the ONL to carry out the observation. For standard modes, this process is fully automated.

5.2 Monitor & Control (MCL) and Online Data Acquisition (ONL) Systems

The MCL and ONL systems are the “online” components that manage the telescope during an observation. They are designed as two decoupled but highly cohesive systems that separate static, supervisory hardware control (MCL) concerns from dynamic, per-observation science logic (ONL).



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5.2.1 Monitoring and Control (MCL)

The MCL is the supervisory system that provides a stable, hardware-agnostic layer for the rest of the software. It translates high-level commands into low-level hardware operations.

- **Architecture:** The MCL adopts the Purdue Model for network security, creating segmented layers to protect critical hardware control systems from the wider observatory network and the internet.
- **Supervisory Communication:** It uses the OPC UA standard protocol to communicate with all hardware controllers (e.g., antennas, CSP, digital back-ends). This choice promotes interoperability and allows for the integration of third-party and commercial-off-the-shelf (COTS) components, such as SCADA systems for operator interfaces.
- **Event Broker:** All monitoring data, alarms, and events from the hardware are collected and streamed through a central Event Broker (e.g., Kafka). This provides a persistent, scalable, and fault-tolerant "single source of truth" for the real-time state of the observatory, which is then consumed by other systems like the ONL and the Maintenance and Support Subsystem (MSS).

5.2.2 Online Data Acquisition (ONL)

The ONL system manages the dynamic execution of scientific observations and is comprised of the following subsystems:

- **Observation Scheduling:** Scheduling creates both long-term, mid-term, and dynamic schedules for the management of telescope operations. Scheduling continuously creates an optimized schedule for the immediate future by selecting from a pool of approved observations (Scheduling Blocks, from the Proposal Management System) and considering live inputs like weather conditions and hardware status to maximize scientific productivity. This process is highly adaptive; the system breaks down large observations into smaller, executable "Calibratable Scan Blocks" (CSBs), which allows the scheduler to intelligently pause, re-prioritize, or modify observations in response to changing conditions, thereby ensuring the most efficient and scientifically valuable use of telescope time.
 - **Subarray Management:** The Observation Scheduling is responsible for dynamically creating and destroying "subarrays"—logical groupings of antennas and processing resources for a specific observation. Each subarray is managed by its own set of dynamic, containerized services, ensuring that faults in one subarray do not affect others.
- **Observation Execution:** The Observation Execution receives the CSBs from Observation Scheduling. The "Executor" component translates the CSBs into a sequence of time-stamped hardware tasks. This architecture supports fault tolerance and complex scheduling, allowing observations to be paused, resumed, or modified in response to changing conditions.
- **Data Reception and Analysis:** The ONL receives the high-throughput data stream (up to 320 GBytes/sec) from the Central Signal Processor (CSP). A telescope calibration (TelCal) component processes this data in real-time to perform tasks like RFI flagging and solving for calibration terms (e.g., complex gains for array phasing), which can be fed back into the control system.

5.3 Science Data Processor (SDP)

The Science Data Processor (SDP) is the data processing system responsible for converting raw data products generated by the ONL and stored in the archive into high-level data products. The SDP design



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is driven by a strict separation of concerns to ensure maintainability, reusability, and scalability over the observatory's 20+ year lifespan. This is achieved by decoupling the core science algorithms from the underlying computing infrastructure. The SDP is composed of four subsystems:

- **Workflow Management:** Orchestrates the sequence of processing tasks (e.g., using Prefect).
- **Parallel Compute Engine:** Manages the distributed execution of tasks across many nodes (e.g., using Dask).
- **Domain Application:** Contains the core radio astronomy algorithms (e.g., CASA libraries for calibration and imaging).
- **Infrastructure Management:** Provisions and manages the underlying hardware resources.

The SDP is designed to be highly performant, reliable, and flexible. Key decisions include using horizontal and vertical scaling and data parallelism to meet throughput demands, rollback recovery (checkpointing) for fault tolerance, and multitenancy to allow multiple user groups to share compute and storage resources securely and efficiently

5.4 Science Data Archive (SDA)

The Science Data Archive provides the software services needed to manage the ngVLA's vast repository of science data, ensuring its integrity, accessibility, and long-term scientific value.

- **Service-Based Architecture:** The SDA is designed as a collection of coarse-grained services organized by function: Ingest, Access, Query, Retrieve, and Curate. This modular design allows the system to evolve and potentially migrate to a more advanced architecture like a Data Mesh in the future.
- **Core Functionality:** The SDA handles the entire data lifecycle post-observation. This includes ingesting raw and processed data products, enforcing access policies (e.g., proprietary periods), providing powerful query interfaces to search metadata, enabling efficient data retrieval, and curating the data to maintain its long-term usability.
- **High Availability:** As the central repository for all ngVLA data, availability is the primary technical driver and highly dependent on the Technical Infrastructure (TI). The architecture is built for fault tolerance, redundancy, and scalability to provide consistent and responsive access to the global scientific community.

5.5 Science Interface and Tools (SIT)

The Science Interface and Tools system is the user-facing gateway to the ngVLA for external science users and operations staff, providing an integrated, browser-based suite of tools for data interaction, analysis, and project management.

- **User-Centered Design:** The SIT is designed with a strong focus on usability and cohesion to support a diverse range of users, from seasoned experts to scientists new to radio astronomy. The goal is to provide a streamlined, intuitive experience.
- **Key Features:**
 - **Lifecycle Tracking:** Allows Principal Investigators (PIs) to monitor their projects from proposal acceptance through data processing to final data delivery.
 - **Open Environment:** Provides a "sandbox" environment (likely based on Jupyter notebooks) where users can run custom analysis scripts and tools on the data without needing to download it.



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- Science Platform: A cohesive platform that allows access not only to ngVLA data but also to data from other facilities, fostering multi-wavelength and multi-messenger astronomy.
- Standard Views: To support routine tasks, the SIT will provide a set of standard user interfaces, including a Pipeline Queue View for monitoring processing jobs, a User Projects View for tracking project status, and a QA View for assessing data quality.
- Science Commissioning Tools: Scientists have developed, and will continue to develop, a host of scripts, tools, and graphical user interfaces for Assembly, Integration and Verification (AIV) testing and Commissioning Science and Validation (CSV). These key pieces of software will comprise the Science Commissioning Tools and are expected to evolve throughout the lifetime of the project.
- User interfaces for array operators and other staff: These tools include functionality to operate, debug, and monitor the telescope.

5.6 Technical Infrastructure (TI)

The Technical Infrastructure (TI) is the foundational layer of the Computing and Software System, providing all the physical hardware and essential software middleware upon which all other CSS subsystems operate. The TI is not a single, monolithic entity but a distributed collection of resources located at the Science Data Center (DSC), the ngVLA Site Buildings (NSB), and the Operations Buildings (OPS). Its primary role is to provide a reliable, scalable, and high-performance platform, abstracting the complexities of the underlying hardware from the application-level software.

The TI can be broken down into two main categories:

5.6.1 Hardware Infrastructure

- Computing Infrastructure: This includes all the physical servers, CPUs, and GPUs required to meet the demanding computational needs of the observatory. This hardware will be provisioned to support everything from real-time control and data reception to large-scale offline processing and data analysis.
- Storage Infrastructure: TI manages a hierarchical storage system to handle the immense data volumes. This includes high-speed, low-latency storage buffers at the central site to receive data directly from the CSP, as well as the petabyte-scale, long-term archival storage at the Science Data Center for both raw visibilities and processed data products. It also hosts all system databases (e.g., Calibration, Engineering Support, etc.).
- Networking Infrastructure: This comprises the physical fiber optic network, switches, and routers that connect all components of the ngVLA. It includes the high-bandwidth links from the central processing site to the data center, as well as the connectivity required for the Monitoring and Control system.

5.6.2 Middleware Infrastructure

- Container Orchestration: The TI provides and manages a container orchestration platform (e.g., Kubernetes) that automates the deployment, scaling, and management of all other CSS software systems. This enables a resilient, microservices-based architecture where applications can be updated, restarted, or moved without disrupting the entire system.



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- **Data Transport Middleware:** This specialized middleware handles the high-performance transfer of science data from the Central Electronics Building to the Science Data Center, utilizing standard protocols to achieve the necessary throughput and low latency.
- **Event Broker Middleware:** The TI provides a central Event Broker (e.g., Kafka) that serves as the observatory's messaging backbone. It handles the persistent, fault-tolerant streaming of all monitoring data, control commands, and alarms between the various subsystems, effectively decoupling them and enhancing system-wide reliability.
- **Supporting Services:** The TI also manages other cross-cutting infrastructure, including centralized logging, IT monitoring systems, and software development platforms (e.g., for continuous integration).

5.7 Maintenance and Support System (MSS)

The Maintenance and Support System (MSS) encompasses the tools and processes required to ensure the long-term operational health, reliability, and maintainability of the entire ngVLA observatory. It acts as the central hub for all engineering and support activities, providing a complete and historical record of the telescope's functioning. The MSS is a primary consumer of the data streamed by the Monitor and Control (MCL) system.

- **Engineering Support Database:** This is the long-term repository for all observatory health data. It ingests and archives monitoring streams, system logs, alarms, and maintenance tickets generated across the system, creating a rich dataset for troubleshooting and analysis.
- **Computerized Maintenance Management System (CMMS):** This system supports proactive maintenance by managing scheduled activities, tracking physical assets and their service history, and implementing reliability-centered maintenance strategies.
- **Issue Tracking System:** This component manages the lifecycle of maintenance requests. It allows operators and automated systems to report faults, assign tickets to support staff, track the resolution process, and document the solution.
- **Inventory Management System:** This system tracks the location and status of all spare parts, including Line Replaceable Units (LRUs) and other critical components, across the observatory's various logistic centers (e.g., warehouses, repair depots).
- **Configuration Management System:** This crucial system maintains a version-controlled record of the configuration of every hardware and software component in the array. This ensures that any changes are tracked, allowing engineers to understand the exact state of the system at any point in time, which is essential for reproducible science and effective troubleshooting.
- **Engineering Dashboards:** The MSS provides a suite of user interfaces that allow support staff to visualize the health of the observatory. These dashboards enable engineers to query the Engineering Support Database, plot time-series data, and correlate different monitoring streams to diagnose and resolve issues.

6 Future Plans

Following the Conceptual Design Review, the project enters a critical phase leading up to the Preliminary Design Review (PDR). Using the foundation of Attribute-Driven Design, this period is dedicated to translating the high-level concepts and Architectural-Significant Requirements (ASRs) into concrete design options through targeted prototyping and formal trade studies. This is a highly collaborative effort, where



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group leads, developers, and product owners engage in agile prototyping and development to iteratively refine the architecture. The preliminary design decisions emerging from this work will be based on a comprehensive evaluation of many factors, including technical feasibility, performance, risk, and overall cost-effectiveness. A central challenge during this time is coordinating product owner backlogs across systems to deliver coherent, incremental functionality, ensuring the prototypes and development sprints align with a unified vision. This rigorous analysis ensures the project remains open to selecting less-performant but more cost-effective solutions if more advanced alternatives are prohibitively expensive or complex.



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7 Acronyms

Term	Meaning
AD	Applicable Document
AUI	Associated Universities Incorporated
CDR	Conceptual Design Review
CMMS	Computerized Maintenance Management System
CSS	Computing and Software System
DSC	Science Data Center
IPT	Integrated Product Team
LRU	Line Replaceable Units
MCL	Monitor and Control
MSS	Maintenance and Support
ngVLA	The Next Generation Very Large Array Project
NRAO	National Radio Astronomy Observatory
NSB	ngVLA Site Buildings
NSF	National Science Foundation
ONL	Online Data Acquisition
OPS	Operations Building
PDR	Preliminary Design Review
PMN	Proposal Management
RID	Review Item Discrepancy
SDA	Science Data Archive
SDP	Science Data Processor
SIT	Science Interface and Tools
TI	Technical Infrastructure
VLA	Very Large Array
VLBA	Very Long Baseline Array