

The Long Wavelength Array (LWA) Program Charter Version 2

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Contents

<u>1.0 Introduction.....</u>	<u>2</u>
<u>2.0 Scope.....</u>	<u>2</u>
<u>3.0 Organization.....</u>	<u>4</u>
<u>3.1 The Southwest Consortium (SWC).....</u>	<u>4</u>
<u>3.2 LWA Scientific Director (SD).....</u>	<u>5</u>
<u>3.3 LWA Project Scientist (PS).....</u>	<u>6</u>
<u>3.4 Program Office</u>	<u>6</u>
<u>3.5 LWA System Architect (SA)</u>	<u>8</u>
<u>4.0 Program Controls.....</u>	<u>8</u>
<u>4.1 Program Execution Plan (PEP).....</u>	<u>8</u>
<u>4.2 Technical Advisory Committee (TAC).....</u>	<u>9</u>
<u>4.3 Control Plans.....</u>	<u>9</u>
<u>4.4 Independently Funded Efforts.....</u>	<u>9</u>
<u>5.0 Project Milestones.....</u>	<u>9</u>
<u>5.1 Interim Development Plan (IDP).....</u>	<u>10</u>
<u>5.2 System Requirements Review (SRR).....</u>	<u>10</u>
<u>5.3 Preliminary Design Review (PDR).....</u>	<u>10</u>
<u>5.4 Critical Design Review (CDR).....</u>	<u>11</u>
<u>6.0 Program Plan Modifications.....</u>	<u>11</u>
<u>6.1 Major Modifications.....</u>	<u>11</u>
<u>6.2 Engineering Changes.....</u>	<u>11</u>

1.0 Introduction

This Program Charter represents a Statement of Work between the Long Wavelength Array (LWA) Program Office (defined below) and the University of New Mexico, represented by the Principal Investigator of the Long Wavelength Array Project. It establishes the project scope, its authority structure, responsibilities of project staff, key milestones and their associated procedures, measures of success, and the role of external advisory groups.

2.0 Scope

The Long Wavelength Array (LWA) project will design, construct, and operate a next generation radio interferometer for the international scientific community, with astronomical imaging power 2-3 orders of magnitude better than current or past capabilities below the FM bands.

The LWA will be a premier US facility for exploring the low-frequency radio spectrum over the next 15 to 20 years, and will provide fundamental advances in knowledge, particularly in the areas of ionospheric physics and astrophysics. This facility will also be important for educating US students and for creating an expert academic user community that can achieve future scientific advances in important areas of ionospheric and astrophysical research. Observing projects for the LWA will generally be open to the US and international communities and selected according to scientific merit. It is hoped that, by breaking open the last poorly explored region of the spectrum still accessible from the Earth's surface, the LWA may enable new, unanticipated fundamental discoveries.

In addition to its role in basic research, the LWA will support applied research in space physics, interferometric imaging, analysis of remotely sensed data, and the broad variety of technical areas involved in its development. Research related to understanding the ionosphere has particular utility to the operation of commercial, civil, and national space systems, as well as other applications to national security.

The LWA Project is currently anticipated to encompass an array of ~53 stations providing a large field of view, excellent sensitivity, and high angular resolution. It includes: the LWA Intermediate Array, designed to provide a significant new capability to probe the ionosphere along with important astronomical objectives, and funded at a level of ~ \$30M; and other intermediate projects within the scope and direction of the LWA Project, as required by technical, scientific, or resource considerations.

3.0 Organization

The LWA effort is being led by the University of New Mexico (UNM), representing the Southwest Consortium for Radio Astronomy (SWC), with cooperation from the National Radio Astronomy Observatory (NRAO). All contractual and fiscal responsibility for the LWA Project lies with the Regents of The University of New Mexico. The Principal Investigator and Co-Investigator at UNM will oversee a dedicated LWA Program Office with personnel and authority to execute the project. The PI also chairs the SWC Executive Committee, so that he may work directly with the partner organizations at the executive level. The organizational structure of the LWA project is shown in Figure 1.

3.1 *The Southwest Consortium (SWC)*

3.1.1 Definition: The LWA project has its history and genesis in a group of institutions, the Southwest Consortium (SWC), each with a strong interest in the scientific potential of the LWA, and each committed to support the design, construction, and operation of the LWA in the Southwestern US (hence the name). The SWC currently consists of the University of New Mexico, the Naval Research Laboratory, the University of Texas at Austin, and the Los Alamos National Laboratory. The SWC is not a legal entity; however, it represents the interests of the wider scientific community in building and operating the LWA and is a source of scientific and technical expertise. The relationships, responsibilities, and procedures of the SWC are established in a Letter of Understanding signed by the participants.

3.1.2 Executive Committee (EC): An Executive Committee (EC) that consists of senior University or Laboratory executives represents the Southwest Consortium in advising the LWA project. Each member of the Consortium has one representative on the Executive Committee, appointed by the respective organization. The Executive Committee advises the LWA project in setting policy and direction, including advising the PI on the appointing the LWA Executive Project Director and System Scientists. Any EC member can call for an EC meeting to seek remediation of issues arising in program reviews (cf. §5).

3.1.3 External Visiting Committees: The EC convenes external SWC Visiting Committees as necessary to provide objective assessments of the LWA project status directly to the EC and to the PIs. The most important of these is the Technical Advisory Committee (defined below).

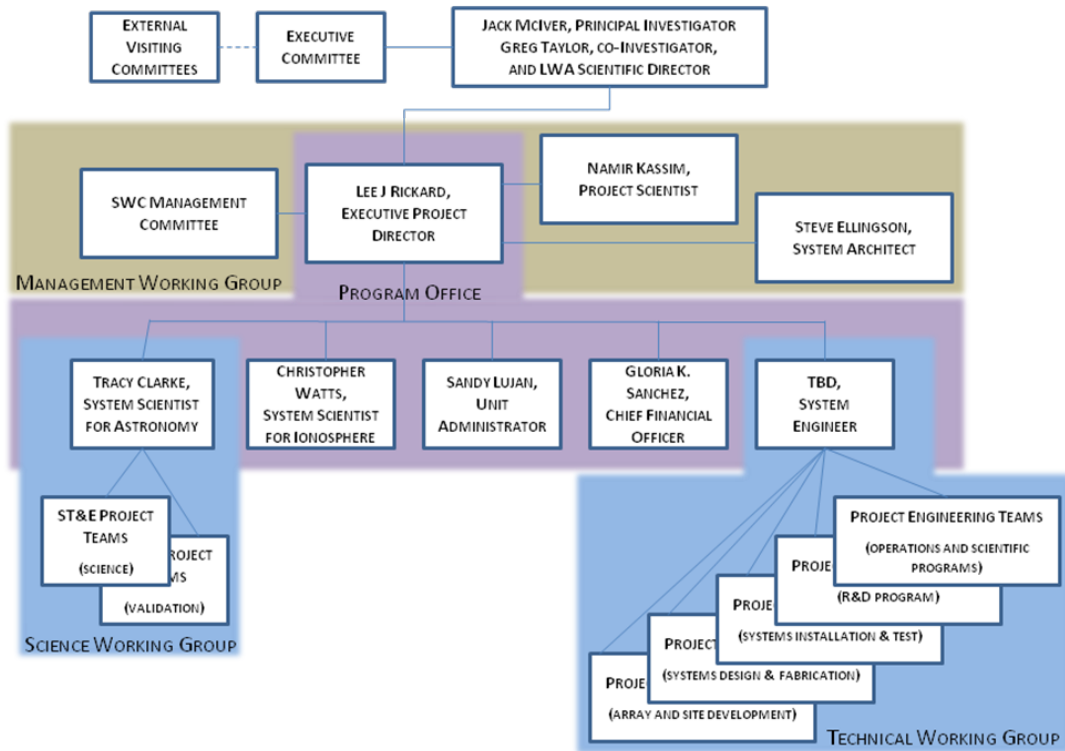


Figure 1. Organization of the Long Wavelength Array Project

3.2 LWA Scientific Director (SD)

3.2.1 Definition: The LWA Scientific Director (AKA ‘LWA Director’) oversees strategic direction for the LWA Project, and thus is especially concerned with understanding external factors and future developments, and their possible influence on the LWA Project. The LWA Director promotes the LWA within the international scientific community, and acts as the primary point of contact between that community and the LWA project, with the support of the Project Scientist (PS), the Executive Project Director (EPD), and the System Scientist. Any scientific teaming agreements instigated by the Director are expected to be made in consultation with the EPD, and approved by the EC. As a member of the UNM faculty, the Director represents the LWA to the UNM faculty and administration, and recruits students, post-docs, and faculty to work on the Project. The Director also participates in the hiring of key positions in the Program Office, and participates in proposals for funding, both for construction and for supplemental efforts. The Director is responsible for programs related to user support for the community and other aspects related to establishing the LWA as a world-class facility instrument. In the current development phase, the Director reports to the Principal Investigator of the LWA Project.

3.2.2 SWC Management Committee: The SWC Management Committee consists of representatives of each of the member institutions of the Southwest Consortium, the Project Scientist, and a representative from NRAO. The Project

Scientist, System Architect and NRAO representative are ex-officio members. This committee is chaired by the LWA Scientific Director and advises the Executive Project Director on scientific, technical issues, and appointments. The institutional Management Committee members will be the primary representatives to the LWA from their institutions, and are responsible for ensuring that the institutional EC member and his/her senior management is kept informed of LWA activities. Members are appointed and serve at the pleasure of their institutional EC member.

3.3 LWA Project Scientist (PS)

3.3.1 Definition: The SWC/LWA Project Scientist (PS) has the lead responsibility for defining the top-level requirements for the scientific performance of the LWA instrument, and works closely with the Program Office to ensure that the LWA, as designed and built, will meet them. The SWC/LWA Project Scientist also advises the LWA PIs, Executive Project Director, and System Scientist on scientific aspects of the LWA.

3.3.2 Science Working Group: The Science Working Group is made up of scientists with a vested interest in the LWA, but may also include interested outsiders as deemed appropriate by the Project Scientist. Its membership includes scientific leaders of the ST&E Project Teams, the Ionospheric Scientist, and the System Scientist. It is chaired by the Project Scientist, with the Ionospheric Scientist as vice-chair.

3.4 Program Office

3.4.1 Definition: The LWA project is directed by a dedicated Program Office. The Program Office oversees the design, construction, testing, and initial operations and maintenance of the LWA during the construction phase of the instrument. The Program Office is located at UNM, and most of the members of the Program Office are expected to be in residence there.

3.4.2 Authority and Responsibilities: The authority and responsibilities of the Program Office include:

- ∇ Establishing broad project goals and implementing top-level scientific requirements;
- ∇ Supervision of the design, development, implementation, and operation of the LWA instrument;
- ∇ Acquisition of land and management of contracts to provide power and communications to the LWA stations;
- ∇ Implementation and operation of program management controls, processes, analyses, and reporting;

- ∇ Identification and coordination of stakeholders, their goals and involvement; and
- ∇ Coordination and support of LWA research projects and use of the LWA by the international scientific community.

3.4.3 Executive Project Director (EPD): The Program Office is led by an LWA Executive Project Director (EPD), who has day-to-day authority and responsibility for management of the project. The EPD is responsible for the budgeting, work breakdown, and program planning, including setting major project milestone dates, for the development of needed engineering capabilities and hiring of relevant personnel, and for the direction of the R&D and design efforts, construction, and testing and verification necessary to build the LWA. The EPD is also responsible for reviewing and summarizing the project status with oversight bodies, including federal agencies, and for identifying problem areas, or areas of high risk for the project. The EPD participates in preparing and presenting proposals for funding. The EPD is responsible for resolution of disputes between members of the Management Working Group and members of the Program Office. The EPD works closely with the LWA Scientific Director and reports to the Chair of the Executive Committee.

3.4.4 System Engineer (SE): The LWA System Engineer (SE) has decision-making authority in engineering matters; acting within the scope of technical decisions approved by virtue of the SRR/PDR/CDR process, the SE provides overall technical guidance for engineers focusing on specific areas of radio astronomical instrumentation, construction, algorithm development, and other needed networking and computing components.

3.4.5 System Scientist for Ionosphere (SSI): The System Scientist for Ionosphere (SSI) assists the Project Scientist in overseeing the scientific goals and applications of the LWA. The SSI has the lead responsibility for defining the top-level requirements for the scientific performance of the LWA instrument relating to the ionosphere, advises the LWA PIs, EPD, and PS on scientific aspects of the LWA, and serves on the Science Working Group. The SSI works with the System Scientist for Astronomy (cf. §3.4.6) in coordinating the efforts of the Project Engineering Teams and the Scientific Testing and Evaluation (ST&E) Teams (defined below).

3.4.6 System Scientist for Astronomy (SSA): The System Scientist for Astronomy (SSA) assists the Project Scientist in overseeing the scientific goals and applications of the LWA. The SSA works with the SSI, Project Scientist and the Program Office to ensure that the scientific requirements for the LWA are met. The SSA works with the SSI in coordinating the efforts of the Project Engineering Teams and the Scientific Testing and Evaluation (ST&E) Teams (defined below), and serves on the Science Working Group.

3.4.7 Project Engineering Teams: Individual aspects of the engineering design of the LWA instrument are the responsibility of the Project Engineering Teams. The team definitions and memberships are determined by the EPD and SE.

3.4.8 Technical Working Group: The Technical Working Group is the central engineering organization of the project, the engineering analog of the Management Working Group. It is chaired by the System Engineer, and includes the Project Engineering Team leaders. The technical leaders of the ST&E Project Teams (defined below) are also members.

3.4.9 ST&E Teams: In order to ensure broad input from the outside community, the LWA program will encourage the establishment of university and institute-based Scientific Testing and Evaluation (ST&E) teams. Such teams with different areas of concentration will provide input to assure that the science objectives of the LWA are met as the instrument develops, with concentration on such issues as algorithms to handle wide field imaging, ionospheric calibration, RFI rejection, etc. The ST&E teams will be distributed at participating universities and institutions over the entire US, to establish a community engaged in long wavelength astronomy, ionospheric physics, and space science research. The team definitions and memberships are determined by the EPD and PS.

3.5 LWA System Architect (SA)

3.5.1 Definition: The SWC/LWA System Architect (SA) has the lead responsibility for defining and maintaining the top-level architecture of the LWA instrument, and works closely with the Program Office to ensure that the technical implementation of the LWA is consistent with the approved LWA architecture. The SWC/LWA System Architect (SA) also advises the LWA PIs, Executive Project Director, and System Scientist on technical aspects of the LWA.

3.5.2 Responsibilities: The specific responsibilities of the System Architect include:

- Maintenance of the top-level System Architecture document;
- Review of documents for program reviews;
- Review and approval of contributions to the LWA Memo Series;
- Review of proposed engineering changes;
- Participation in the Management Working Group and Technical Working Group.

4.0 Program Controls

4.1 Program Execution Plan (PEP)

The Program Office will prepare a detailed Program Execution Plan (PEP), with tasks to be performed by all project participants. This Execution Plan will provide the baseline for

total program cost estimates and will be used as the reference for future program control assessments. We anticipate the PEP will identify tasks that will need to be completed with funding from other sources. These tasks will be clearly identified in order to separate them from the funded efforts. The EPD will establish an appropriate method for monitoring and reporting on the status of executing the PEP. The overall program status thus reflected will be reported on a monthly basis. Cost and schedule variances thus revealed will be controlled and benchmarked against the PEP.

4.2 Technical Advisory Committee (TAC)

Formal milestones (discussed below) have been established at which the system specifications may be refined or even rebaselined to reflect the impact of severe schedule or cost issues. Essential to the completion of these milestones will be the advice of the Technical Advisory Committee (TAC). The TAC is an External Visiting Committee, selected by the Executive Committee to provide objective assessments at the System Requirements Review (SRR), the Preliminary Design Review (PDR), and the Critical Design Review (CDR). The EC selects candidate members of the TAC; the PIs arrange for their participation in the review process. TAC membership is selected at least 6 weeks before the review, to facilitate document review.

4.3 Control Plans

The Program Office will also establish: a Risk Management Plan, to address significant uncertainties in the developing system; a Change Control Plan, to provide disciplined management of alterations in the physical or functional characteristics of the design; a Configuration Control Plan; Documentation and Communication Plans; and other procedures as required for the successful completion of the project.

4.4 Independently Funded Efforts

For work that cannot be pursued under this contract, the Program Office will promote the development of independently funded efforts. The long-term role of the Program Office in these instances will be as a coordinator of these independent efforts with ongoing project activities. Close collaboration between the project staff and the independently-funded researchers and engineers will be important to maximize the value of these efforts.

5.0 Project Milestones

5.1 Interim Development Plan (IDP)

The Interim Development Plan (IDP) specifies tasks through the System Requirements Review (SRR, discussed below), including long-lead tasks. The Program Execution Plan takes over after approval at SRR. The IDP is developed jointly by the Executive Project Director and the System Engineer, adapting from the draft Long-term Development Plan established in the initial proposal, and in consultation with the funded participants. The IDP is submitted directly to the EC, and is simultaneously disclosed to the funded participants. The EC allows two weeks for comment. After one additional week of review, the EC approves the IDP, possibly with remedial actions specified. Approval can take the form simply of an absence of a call for possible remediation.

5.2 System Requirements Review (SRR)

5.2.1 Definition: The System Requirements Review (SRR) is the process for approval of specifications and architecture at the system and station levels (as defined by the SE); task definitions through CDR (as defined by the EPD); cost models and spending profile (as defined by the EPD); and revisions to the Science Requirements Document (SRD, defined by the PS) necessitated by the above.

5.2.2 Science Requirements Document: The Science Requirements Document (SRD) is produced by the Project Scientist, with the assistance of the LWA System Scientist, the Ionospheric Scientist, and the Science Working Group. The process for formal approval of the SRD begins when the Project Scientist submits it to the EC for consideration, and simultaneously discloses it via the LWA memo series. The EC allows one week for public comment. After one further week of review, the EC either approves or rejects the SRD. This approval need not be a formal document; absence of a call for possible remediation suffices.

5.2.3 SRR Process: Specifications and architectures are developed by the SE using the SRD, in consultation with the project participants. Task definitions and cost data are developed by the EPD in consultation with the SE and project participants. The PS reviews the SRR material before its release to the TAC to ensure conformance with SRD and to deal with possible scaling down or compromise of science requirements. The SRR material is reviewed by TAC, not necessarily by an in-person review. The individual TAC members then provide reports directly to the EC. The EC considers the TAC comments and issues its approval within one week, possibly with remedial actions; approval may be simply the absence of a call for possible remediation.

5.3 Preliminary Design Review (PDR)

The Preliminary Design Review (PDR) is the process for approval of the preliminary design and associated cost data (as prepared by the SE, consolidated from task outputs);

re-approval of cost models and spending profile (as prepared by the EPD); and revisions to the SRD necessitated by the above (as prepared by the PS). The PS reviews the PDR material before release to the TAC to ensure conformance with the SRD and to deal with possible scaling down or compromise of science requirements. The PDR material is reviewed by TAC (not necessarily in person); TAC members individually provide reports directly to the EC. The EC considers the TAC comments and issues its approval within one week, possibly with remedial actions. Approval may be simply an absence of a call for possible remediation.

5.4 Critical Design Review (CDR)

The Critical Design Review (CDR) is the process for approval of the final design. The final design and associated cost data, results of issue analyses and trade off studies, etc., are consolidated from task outputs by the SE. A revised budget is developed by the EPD. The CDR materials are reviewed by the TAC (not necessarily in person); TAC members individually provide reports directly to the EC. The EC considers the TAC comments and issues its approval within one week, possibly with remedial actions. Approval may be simply an absence of a call for possible remediation.

6.0 Program Plan Modifications

6.1 Major Modifications

Anything explicitly approved by the EC requires EC approval to be changed. Program modifications are normally done in the context of the primary milestones – the SRR, PDR, or CDR. If this is not possible (e.g., in the case of unanticipated or emergency situations or opportunities), then any project participant may submit a request for a modification to the EC in writing. EC policy must be to decline approval automatically if the situation addressed is not both “extraordinary” and “urgent”. Otherwise, the EC must allow 2 weeks for the EPD, SE, and PS to review the request and provide written comments and recommendations. The EC then considers the modification request together with the comments and recommendations, and renders a decision within one week.

6.2 Engineering Changes

6.2.1 Engineering Change Notices: Design changes that are too minor to be considered a variance to SRR/PDR/CDR decisions, but which are nevertheless changes to design elements which have been "frozen" or otherwise under some form of configuration control, are handled by engineering change notices (ECNs) that are approved by the Engineering Control Board (ECB, cf. §6.2.2).

6.2.2 Engineering Change Board (ECB): The ECB is currently composed of the EPD, the SA, the SE, and the Co-PI (representing UNM). They may choose to include managers of significant subsystems as required. The ECB is also responsible for management of the Project Book, which documents the full LWA Project.