Telescope Time Allocation (TTA): System Description

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Abstract

We discuss the system level (level 1) software requirements for a new set of telescope time allocation tools for the proposing process. The following facilities are included: VLA, VLBA, HSA, GMVA, and GBT. Here we provide the system description.

History

0.1 Original draft—18 June 2019 (jsk).

1.0 Updates of section 2 and 3—20 March 2020 (dsb).

2.0 Updates based on CoDR feedback—22 June 2020 (dsb).

3.0 Expand Capability and Observation Specification concepts—September 12, 2022 (dsb).

Preface

During discussion of the TTA system description, several issues with the concept document (Balser, Claussen, et al., 2019) were revealed. Most of these issues consisted of concepts that were missing from the TTA concept document and not necessarily changes in any of the concepts developed. Nevertheless, to provide continuity between the TTA concept and system description documents we list here some of the differences.

1. We added the concept of *Proposal Class*. This, in part, replaces the concept of an ALLOCATION TYPE in §4.2, number 7 in the concept document listed under *Allocation Request*. This needs to be at the proposal level since a "Large" proposal, for example, is tied to the proposal and not the *Allocation Request*. Moreover, a DDT proposal is now related to the *Solicitation* (see below).

2. We added the concept of a *Facility*, instead of using telescope to be more general. For example, a *Facility* could be a computing cluster. This also replaces REQUEST TYPE in the concept document (see §4.2, number 3).

3. We added the concept of a *Solicitation*. The user community is notified when and how to create and submit a proposal to use AUI/NA *Facilities*, but these "call for proposals" have different needs and therefore configurations within the TTA Tools. We therefore created the concept of a *Solicitation*. For example, the semester deadline proposal compared to the DDT proposal.

4. We added the concept of a *Proposal Process*. Depending on the type of *Solicitation* a proposal will be processed differently. For example, a DDT proposal will not go through the normal TAC process.

5. We added the concept of a *Capability* to help define what is available for a specific *Solicitation*. For example, we needed to be able to define the different types of observing modes (e.g., on-the-fly) since the available resources may depend on these modes.

6. We added the concept of *Specification Constraints* since we needed a way to put restrictions on the *Capabilities*.

7. We added the concept of *Request Specification* to generalize that we can have *Observation Specifications* when observing with telescopes or *Data Processing Specifications* when processing data on a computing cluster.

8. We changed the name "*Allocation Award*" to "*Allocation Request*" because sometimes the result is not an "award"; that is, time is not approved.'

Contents

1 Introduction

1.1 Scope of Document

Following the conceptual description in Balser, Claussen, et al. (2019), this document, in part, details the behavior and requirements for the system (Level 1). In particular, it describes the high-level system description. More details are given in the Subsystem Description document (Balser, Kern, and Whitehead, 2021). System requirements for Metrics (Crossley, 2021) will follow. The overall structure of this document is expected to remain unchanged, but the details of sections may be deferred until necessary for implementation. The detailed definition of portions of the system may be better defined through separate documents, in which case those documents must be referred to from the appropriate section. This document is authoritative on the topics it addresses and supersedes other documents.

1.2 Related Documents

- TTA Concept (Balser, Claussen, et al., 2019).
- TTA Subsystem Description (Balser, Kern, and Whitehead, 2021).
- TTA Algorithms (Costa, 2021).
- TTA Metrics Description (Crossley, 2021).
- User Account System

1.3 Abbreviations & Acronyms

AAS: American Astronomical Society

DDT: Directors Discretionary Time

EPO: Education and Public Outreach

GBT: Green Bank Telescope

GMVA: Global Millimeter VLBI Array

GDPR: General Data Protection Regulation

HSA: High Sensitivity Array

NRAO: National Radio Astronomy Observatory

PDF: Portable Document Format

PI: Primary Investigator

PII: Personally Identifiable Information

RSRO: Resident Shared Risk Observing

SRDP: Science Ready Data Products

SRP: Science Review Panel

TAC: Time Allocation Committee

TTA: Telescope Time Allocation

VLA: Very Large Array

VLBA: Very Long Baseline Array

VLBI: Very Long Baseline Interferometry

1.4 Definitions

Allocation Disposition: The disposition of a given *Allocation Request* to use observatory resources. This includes scheduling priorities, approved time, disposition comments, disposition constraints, and proprietary periods.

Allocation Request: The part of a *Proposal* that specifies the details of the requested observatory resources. An *Allocation Request* consists of one or more *Observations Specifications*.

Back End: The instruments that exist on a telescope that usually reside at the end of the signal path. Primarily this refers to the detector, often a correlator.

Calibration Strategy: Instructions on how best to calibrate the *Science Targets*.

Call Period: The time period during which a user can created, edit, and submit a proposals for a given *Solicitation*.

Capability: The different ways a *Facility* may be operated. Examples are OBSERVING TYPES and sub-arrays. OBSERVING TYPES consist of Continuum, Spectral Line, Pulsar, and Radar. Each *Capability* is associated with one *Facility*.

Capability Parameter Specifications: Information provided by a TTA Group member that specifies the parameters that make up a *Capability* for a *Solicitation*. There can be different types of parameters. For example, FIELD SOURCES, SPECTRAL SPECS, PERFORMANCE PARAMETERS, and CALIBRATION PARAMETERS.

Capability Request Parameters: The proposer's response to the *Capability Parameter Specification*.

Capability Request: Information supplied by the proposer that specifies the observations being proposed. The *Capability Request* is composed of the *Capability Request Parameters*.

Consensus Science Review: A scientific evaluation of a proposal based on a consensus of the SRP formed during a discussion of the proposal by all reviewers using information from the individual science review. This includes internal (e.g., TAC) and external (P.I.) comments, plus an SRP SCORE.

Directors' Review Report: A report written by the TTA Group for the NRAO/GBO Director that summarizes the recommendations made by the TAC for semester *Solicitations*.

Disposition Letter: A letter (or email) sent to the authors of a submitted proposal that summarizes the results of the review process.

DSS Session: Information to schedule a continuous block of time on the GBT.

Execution Blocks: The results of *Scheduling Blocks*.

Execution Periods: The nominal time period during which a proposal will be observed for a given *Solicitation*.

Facility: One or more antennas that coordinate to perform observations. For example, the VLA consists of 27 antennas but is typically one *Facility*. The HSA may consist of all 10 VLBA antennas and all 27 VLA antennas but is considered as one *Facility* since the signals from all telescopes are correlated together. A *Facility* may also be a computing cluster to reprocess data.

Facility Report: A report created by a TTA Group member for each *Facility* that provides a narrative for the TAC and identifies any technical, resource, or scheduling issues. The report includes an LST (or GST) pressure plot.

Feasibility Review: A review of the feasibility (technical or data management) of a given *Allocation Request*.

Feasibility Review Group (FRG): An alias to allow more than one feasibility reviewers to be assinged to a given *Allocation Request*.

Field Source: Coordinate information for an observation that includes position, field size, velocity, and time (when ephemerides are required).

Front End: The instruments that exist on a telescope that usually reside at the beginning of the signal path. Primarily this refers to the receiver.

Hardware Configuration: The specific details of the FRONT-END, BACK-END, and *Facility* configurations. An example of a *Facility* HARDWARE CONFIGURATION is the VLA configuration.

Individual Data Management Review: An assessment of the data management plan of the *Allocation Requests* that includes internal (e.g., TAC) and external (e.g., PI) comments.

Individual Science Review: A scientific evaluation of a proposal that includes internal comments and an INDIVIDUAL SCORE.

Individual Technical Review: A technical assessment of an *Allocation Request* that includes internal (e.g., TAC) and external (e.g., PI) comments.

Joint Proposal: A proposal that requests time on multiple *Facilities*. This is handled by having different *Allocation Requests* for each *Facility* and therefore the term joint will not longer be used here. But this nomenclature is well established in the astronomical community (e.g., joint HST-NRAO proposals) and therefore will continue to be used in the documentation (e.g., the call for proposals).

LST (or GST) Pressure Plot: A plot of the allocated hours as a function of LST (or GST) for a given *Facility*, broken down by scheduling priority and weather.

Observation Planner: The algorithm or heuristic that converts the *Science Target List* into the *Observation Specification*. To do this the *Observation Planner* uses the selected *Calibration Strategy* and *Scheduling Strategy*.

Observation Specification: A *Scan List*, and *Facility* specific information (e.g., OBSERVING CONDITION, VLA array configuration, etc.). Note—we probably want to include a repeat counter here. This is currently a concept in the clustering algorithms. That is, we do not want multiple, identical Observation Specifications.

Observing Condition: Indicates whether the proposed observing is standard or has some shared risk. For example, general observing (GO), shared risk observing (RSO), or resident shared risk observing (RSRO).

Observing Strategy: The algorithm or heuristic that translates the *Capability Request* into a *Science Target List*. To do this the *Observing Strategy* needs to decide how to observe the FIELD SOURCE (e.g., pointed map instead of OTF), and to select the appropriate *Calibration Strategy* and *Scheduling Strategy*.

Observing Type: High level concept to distinguish different *Capabilities*. For example, Continuum, Spectral Line, Pulsar, etc.

Open-skies Proposals: Proposals that are submitted under a *Solicitation* that is open to the overall community.

Pointing Pattern: Describes the trajectory of the antenna over the course of an observation of a FIELD SOURCE. For example, single pointing, OTF, etc.

Program: Information provided in the *Proposal* that specifies the knowledge of how/when to combine *Execution Blocks* to produce *Science Ready Data Products*.

Project: An observatory construct to execute each approved *Allocation Request*.

Proposal: A request to use observatory resources that includes a scientific and technical justification. Here, observatory resources is typically telescope time but may also include other types of resources (e.g., correlator or computing cluster time). The information contained within a *Proposal* is sufficient for evaluating the request and for scheduling, executing, and processing of any approved requests.

Proposal Class: Provides a set of different validation rules within a *Solicitation*. For example, Regular versus Large proposals.

Proposal ID: An ID that is associated with the proposal *Solicitation*. The PROPOSAL ID is created once the proposal is submitted.

Proposal Information: The part of a *Proposal* that includes identifying information, title, abstract, and the scientific justification. The *Proposal Information* is independent of the resources that are being requested.

Proposal Process: How a proposal is processed through the system.

Proposal Review: An evaluation of the scientific merit and feasibility of the proposal. A proposal review consists of comments for the PI, internal comments, and a scientific merit metric.

Proposal Serial Number: A unique global number that is associated with a proposal when it is created.

Request Specification: Specifies the resources that are being requested in the *Allocation Request*. There are different types of *Request Specification*. For example, *Observation Specification* is the common type of *Request Specification* where the *Facility* involves telescope. But the *Request Specification* could be a *Data Processing Specification*, where the *Facility* is a computing cluster.

Requested Time: The time spent on the SOURCE to account for the requested rms sensitivity, POINTING PATTERN, and additional considerations.

Proposal Summary: A summary of each proposal that provides an abridged view of the proposal that aids in the discussion during the TAC meeting. Specifically, the PROPOSAL ID, NORMALIZED LINEAR-RANK SCORE, SRP NAME, TELESCOPES, PRINCIPAL INVESTIGATOR, CO-INVESTIGATORS, TITLE, ABSTRACT, PRELIMINARY PRIORITIES, COMMENTS FOR THE PI, and INTERNAL COMMENTS.

Resource: Equipment and/or staff. Effectively the dictionary definition.

Review State: For individual science reviews this corresponds to the state of the review in time (e.g., blank, saved, completed, or closed).

Review Type: For individual science reviews this corresponds to the type of review that is assigned (e.g., primary, secondary, tertiary, or none).

Scan: A group of *Subscans* that share scan intent. All *Scans* have at least one *Subscans*.

Scan List: An ordered list of *Scans*.

Scheduling Block: Information to schedule a continuous block of time on the VLA.

Scheduling Priorities: a grade that is assigned to each *Allocation Request* that sets the priority that the observations will be scheduled. This may also be to schedule a computing cluster to reprocess data.

Scheduling Strategy: Instructions for creating the *Scan List*.

Science Category: The astronomical sub-field of the science related to a *Proposal*.

Science Ready Data Products: Processed data that in principle can be used for scientific analysis.

Science Review Panel (SRP): A group of people who are tasked to review the scientific merit of a *Proposal*. Each SRP has a chair and, potentially, a chair pro tem.

Science Target: One SOURCE, one HARDWARE CONFIGURATION, the REQUESTED TIME, *Calibration Strategy*, *Scheduling Strategy*, and a repeat counter. Note—we probably do not need a repeat counter. This information should be included in the Calibration/Scheduling Strategies. For example, pulsar monitoring or dynamic range.

Science Target List: A data structure that contains the fundamental user request. Consists of a list of *Science Targets*.

Scientific Merit Metric: A quantitative assessment of the scientific merit of the proposal. For a Panel-based review this is the NORMALIZED LINEAR-RANK SCORE. For an observatory site review this is binary.

Segment: Information to schedule a continuous block of time on the VLBA.

Solicitation: An announcement from the observatory to the community to submit a request to use observatory resources. Each *Solicitation* is composed of *Capabilities* and a *Proposal Process*. A *Solicitation* has attributes (e.g., call period).

Solicitation Capability: The *Capability* for a specific *Solicitation*.

Source: A normalized data structure that contains a name, POINTING PATTERN, and a nominal position for the POINTING PATTERN. A SOURCE is derived from a FIELD SOURCE or created for a calibrator.

Specification Constraints: The restrictions on the available resources within a *Capability* for a *Solicitation*.

Sponsored Proposals: Proposals that are submitted under a special *Solicitation* that is sponsored by a particular organization and is therefore not open to the community at large.

Subscan: Specification of the shortest unit of observation considered in the TTA Tools. Each *Subscan* consists a single SOURCE, HARDWARE CONFIGURATION, and time (e.g., acquisition and setup times). Also included is information about the antenna trajectory and the scientific intent.

Validation Constraints: The information necessary to check that the inputs to a *Proposal* are valid (e.g., the frequency range of a receiver).

TAC Report: A report written by the TTA Group for the public that summarizes the results of the TAC meeting for semester *Solicitations*.

Telescope: An instrument used to gather light from distant objects. The dictionary definition.

Triggered: An observation that is observed at an unknown time based on a precipitating event.

TTA Group: Authorized observatory TTA staff who are responsible for administering the TTA process.

1.5 Document Conventions

Here we list several conventions used in this document. Structures within the system will be *italicized*. When referring to a specific field or value in the structure SMALL CAPITALS will be used. This document is intended to be a living document where requirements can be refined as they are needed and staff are available for detailed requirement definition. Sections that are to be addressed are labeled at **ToDo**.

1.6 Overview

The suite of tools satisfying these requirements will support

- Specification of an Observing Proposal Solicitation
- Preparation and Submission of Proposals
- Proposal Review
- Time Allocation Committee Meeting
- Directors Review and Time Award

The TTA software tools encompass the proposing process and not the observing process. So the suite of tools discussed here does not include the creation and execution of the observing program, or subsequent data processing steps. But tight integration between proposing and observing is strongly preferred. For example, we should not have to enter FIELD SOURCE coordinate information into both the proposing software and observing software. For telescopes where science ready data products (SRDPs) are in scope, sufficient information must be gathered through these tools that the observations and reduction could be executed based solely on the information provided through this suite of tools (and additional observatory information such as scheduling).

The DMS architect has selected an anti-corruption layer design to mediation between the TTA software tools and the Telescope specific Observing Software. The encapsulation of this translation provides for both facility specific customization and selective transport of information in both directions. To prevent drift between the systems the anti-corruption layer will be prototyped early in the system implementation and maintained throughout the project lifecycle.

The concepts developed in Balser, Claussen, et al., 2019 are summarized here to provide context for the following sections. From the user's perspective the process begins with the preparation of a proposal in response to a proposal *Solicitation*. We refer to the proposal preparation and submission process as Phase 1.

The objects created and tracked by the system have a high level structure as shown in Figure 1. This diagram is intended to be conceptual and although it borrows from the symbology of UML is not intended to be a formal

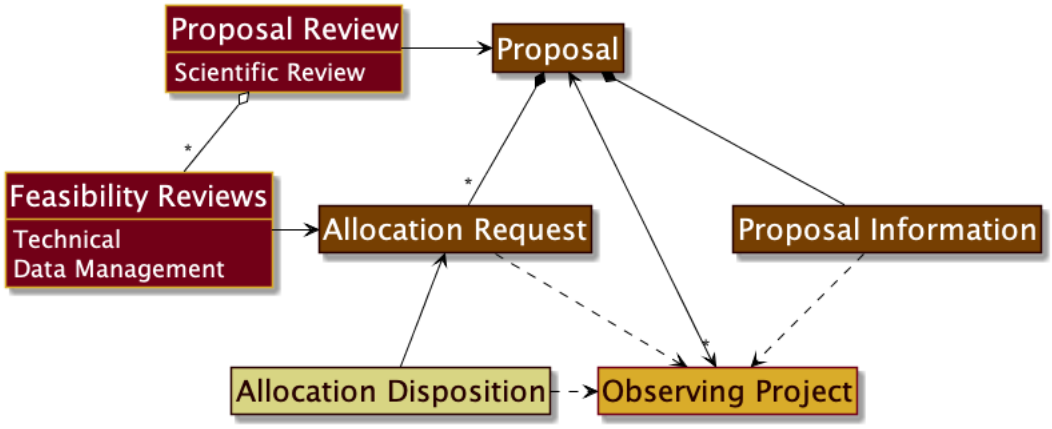

Figure 1: A conceptual representation of the system (see text for description).

specification. Like other similar figures in this document the intent is to depict the "notional relations." In this diagram the colors depict the process which creates the object (brown is the proposal creation, maroon is the review process, yellow-green is created by the time allocation process, and the observing project is created through the closeout process). In this diagram unless otherwise specified the multiplicity of links is unity. Arrows denote links between conceptual objects and can be characterized by a "relates to" relation. Filled and Open diamonds denote a more hierarchical "belongs to" relation with open diamonds denoting that the object's lifecycle is not fully dependent on the parent (aggregation). Dashed lines denote that information from each of these objects is used to create the Observing Project, but the only linkage is to the proposal.

A *Proposal* is composed of *Proposal Information* and one or more *Allocation Requests*. *Proposal Information* consists of identifying information (title, investigator names and affiliations, science category, etc.) and the scientific justification. Reviews of the scientific merits of each proposal are performed based on the *Proposal Information*. Best practices for ensuring an equitable and fair review process shall be supported by the tool suite (e.g., we shall support a dual-anonymous process where the authors will not know who is reviewing the proposal and vice versa).

All proposals contain one or more *Allocation Requests*. The *Request Specification* indicates whether the *Allocation Request* is for observing time on one of the supported telescopes (*Observation Specification*) , or other observatory resources (e.g., *Data Processing Specification*). Note that the latter does not include the "standard" data processing that goes along with observing time; that is, the standard data processing does not have to be **independently** requested. We envision a "non-standard" data processing that requires a separate request and need not be tied to any specific observation. Feasibility reviews, which include technical and data management reviews, may be performed for each *Allocation Request*. Whether a review is performed or not shall be configurable and may depend on the telescope, type of *Solicitation*, or even the requested resources.

An *Allocation Disposition* is recommended by the Time Allocation Committee and approved by the Director at the Directors' review. Since dispositions are primarily tied to the *Allocation Request*, a proposal may be awarded time or an approved scheduling priority on only some of the *Allocation Requests* within a proposal.

At the conclusion of the review process *Observing Projects* are created at each Telescope for proposals with positive *Allocation Dispositions*. How this is performed and subsequent steps are telescope dependent. The observing preparation process will be referred to as Phase 2.

In the remainder of this document the Level 1 requirements are developed. We use *Stakeholder Use Cases* to capture the overall intent of each section of the system, and more traditional Functional and Non-Functional requirements to further refine the intended behavior of the system. In Section 2, an overall description of the system is presented, while more detailed requirements for each phase are elucidated in Section 3. Balser, Kern, and Whitehead (2021) describes sub-systems used by the suite of tools; in this context a subsystem is considered to be a set of functionalities incorporated in the overall suite that manages or provides services related to a specific aspect of the *Proposal Process*. The user interfaces will be developed interactively and not specified in a document. The

separation of user interface behavior from system behavior helps to map requirements to appropriate layers in the system architecture.

2 System Description

The process begins when the observatory announces a *Solicitation* to use observatory resources, typically a call for proposals to request time on one or more of Associated Universities Inc. (AUI) North American (NA) telescopes. There are several different types of *Solicitations*. The most common is the semester *Solicitation* whereby a call for proposals is made twice a year (see §2.1.1). There also exists *Solicitations* from external *Facilities* where time is allocated by an external TAC (see §2.1.9).

A *Solicitation* is composed of available *Capabilities*, the various ways a *Facility* can be operated, and a *Proposal Process*, how the proposal will be processed through the system. Each *Capability* has associated *Specification Constraints* that are restrictions on the available resources. Here we use the word "resources" in a generic, dictionary, way to refer to the supply of materials, staff, and other assets that can be drawn on by the Observatory to function effectively. Not all *Capabilities* can be executed simultaneously due to resource constraints. We allocate the task of executing the defined *Capabilities* in an efficient manner, subject to resource constraints, to the telescope scheduling system and therefore this is out of scope for this project.

2.1 Stakeholder Use Cases

2.1.1 Proposal in Response to a Semester Solicitation

A proposal requesting time on one or more telescopes for a semester *Solicitation* is the most common method of accessing AUI NA telescopes. These consist of the VLA, VLBA, and GBT. A scientist will create a proposal through one of the provided tools. Collaborators may be added to the proposal as Co-Investigators without any direct permission, but all authors shall receive notice when a proposal is submitted. All authors on a proposal shall have read/write privileges and there shall be no locking for editing; we assume the collaborators are communicating about the proposal. Moreover, appropriate administrators (e.g., TTA Group) will also have read/write privileges to be able to provide technical and scientific support.

Many users will be working on multiple proposals at once, so a user interface to allow them to see all of their proposals and the current state of the proposals shall be provided. They shall also be able to view and access previously submitted proposals. A mechanism to download a PDF of the proposal at any stage is required.

Before the deadline the PI (or any author) shall be able to submit the proposal through an option in the user interface. The proposal shall pass a validation process before being accepted for submission. Once submitted a verification dialog shall immediately appear providing the assigned PROPOSAL ID and the time of submission. All authors shall be notified of the submission. At this stage any author shall be able to continue to edit and submit the same proposal up until the deadline. The last version of the proposal submitted will be the final version. At this point the proposal may no longer be modified.

All proposals submitted before the deadline for an observing semester are reviewed at the same time. The proposal review and time allocation processes are described in detail below (see §3.4-§3.7). The output of this process is an *Allocation Disposition* response for each submitted *Allocation Request*. The time allocation process ends with a disposition letter being sent to all authors of each proposal.

A proposal is considered approved if one or more of its *Allocation Requests* are awarded F (fixed), A, or B scheduling priorities. A proposal is considered filler if one or more *Allocation Requests* are awarded a C scheduling priority but there exists no F, A, or B scheduling priorities. Filler proposals are not approved but are considered to have a positive disposition. Projects are created corresponding to positive *Allocation Dispositions*, as described in §3.9. Proposals without any positive *Allocation Dispositions* are not further processed. Proposals with at least one positive *Allocation Disposition* shall be made public using the following information: PROPOSAL ID, *Proposal Class*, TITLE, PI, CO-IS, ABSTRACT, SCIENCE CATEGORY, TIME SUBMITTED, and for each positive *Allocation Disposition*: the ALLOCATION REQUEST ID, the *Facility*, the APPROVED TIME, and if the proposal is TRIGGERED.

2.1.2 Directors Discretionary Time (DDT)

There are occasions when the semester cadence or review process described in §2.1.1 does not meet the needs of the PI. Examples are unexpected astronomic phenomena or a short exploratory observation to better prepare a standard proposal. These proposals are considered as Directors Discretionary Time (DDT) proposals. The proposal preparation process proceeds as described above, but the available *Capabilities* shall be those supported in the current observing semester since the intent is typically to execute the observations as soon as possible. There are situations, however, when DDT proposals are executed in a future semester.

The difference from the semester proposal *Solicitation* above occurs after the submission of the proposal, when instead of entering the panel-based review process the proposals are reviewed internally by observatory staff (an observatory site review). For proposals that request multiple *Facilities* communication between the different telescope personnel is required; the software has no role in this process.

The end result of this process is the creation of an *Allocation Disposition*. For proposals with a positive disposition, projects are created, typically (but not always) for the current observing semester, following standard procedures for the telescopes involved.

Often these types of proposals are time sensitive, and therefore the software shall utilize push semantics (e-mail notification for example) to notify actors of the need for a response. Steps requiring human intervention shall be minimized to avoid potential delays, and choke points shall have reasonable overrides provided (for example if the site director is unavailable their deputy shall be able to respond on their behalf).

2.1.3 Extra-Large Proposals

Extra-Large proposals are a different class of open-skies proposals for PIs who require more than 1000 hours of telescope time and/or extend over four or more observing semesters. To be accepted, Extra-Large proposals should demonstrate outstanding science impact, a high level of scientific and technical readiness, and excellent legacy science value (the potential to generate high science impact from community use of archival data and data products).

Extra-Large proposals are being solicited for the first time with the 20A call for proposals. The *Proposal Process* for Extra-Large proposals is uncertain and therefore will be not be considered here in detail but they should not be designed out of the system.

2.1.4 High Sensitivity Array (HSA)

The High Sensitivity Array (HSA) comprises the VLBA, phased VLA, GBT, Effelsberg, and Arecibo telescopes. To be considered a valid HSA *Allocation Request* at least one VLBA station must be selected together with at least one of the other telescopes.

The review process for HSA proposals is similar to regular proposals, but since HSA proposals sometimes use resources external to the AUI/NA *Facilities* additional negotiations are required to finalize the scheduling priorities in these cases (see Figure 2). Here we define the term “Super TAC” to the group of representatives who meet to make a final determination. Currently, there are three representatives: AUI/NA, Effelsberg, and Arecibo. (Arecibo does not perform an independent review.) The AUI/NA schedulers take the normalized linear-rank and the TAC recommendation and lobbies for the AUI/NA TAC in these negotiations to converge on a scheduling priority. There are many proposals, however, where the Super TAC is not necessary. Regardless, all of these committees provide recommendations to the Director who ultimately needs to approve the proposal.

2.1.5 Global Millimeter VLBI Array (GMVA)

The Global Millimeter VLBI Array (GMVA) comprises a network of telescopes across the globe. This includes the VLBA and GBT, but not the VLA which cannot observe at millimeter wavelengths. To be considered a

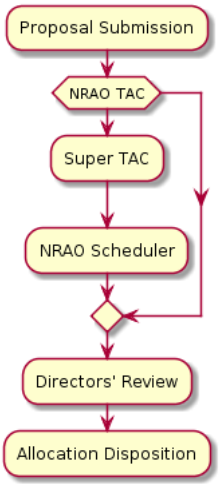

Figure 2: Process for HSA and GMVA proposals. The *Proposal Process* is the same as other semester *Solicitation* proposals except the AUI/NA TAC provides recommendations to both the Director and the Super TAC.

valid GMVA *Allocation Request* at least two telescopes must be selected. In principle there may be no AUI/NA telescopes, but in practice the VLBA is almost always included in the array. GMVA observations are scheduled during fixed periods during the Spring (April/May) and Fall (September/October).

GMVA *Allocation Requests* may only be submitted for semester *Solicitations*. The review process for GMVA proposals is similar to HSA proposals when external facilities are included. The structure of the "Super TAC" is more formal here since there are more telescopes involved in this *Facility*. Effectively there are three main groups that provide input during the Super TAC meeting: AUI/NA, Europe, and ALMA. Currently ALMA provides binary input (yes/no) that is non-negotiable.

2.1.6 Sub-Arrays

Interferometers can be divided in smaller arrays of telescopes, called sub-arrays, that can be instructed to perform completely different tasks. This functionality is available for the VLA and is expected to be a common mode of operation for the ngVLA. Therefore, the concept of sub-arrays needs to be clear.

Broadly, there are two different types of sub-array projects. (1) When an interferoemter is divided up in to multiple sub-arrays for a given *Project*. For example, when the VLA is divided into two sub-arrays observing FIELD SOURCES at L-band and X-band, respectively. Here the entire *Facility* is being used towards the goals of the *Project*, and therefore this is a *Capability* of the *Facility*. (2) When a *Project* only wants to use a subset of the *Facility*. For example, this is similar to the HSA when using only one VLA antenna. Therefore, there is a requirement that the proposer has the ability to specify a subset of a *Facility's* resources for any given observation.

2.1.7 Commensal Observing

Commensal observing is when multiple observing systems are used at the same time on a given *Facility* to support multiple science goals. For example, the "realfast" and "VLITE" systems on the VLA are commensal systems that piggy back on other *Projects*. Commensal observing systems are typically not included as being part of the *Capabilities*, but the scientific justification may make use of data from a commensual systems. We currently have no requirements to support commensal observing, but the design could be extended to cover them by capturing information about if and how the proposers intend to use the data from such systems.

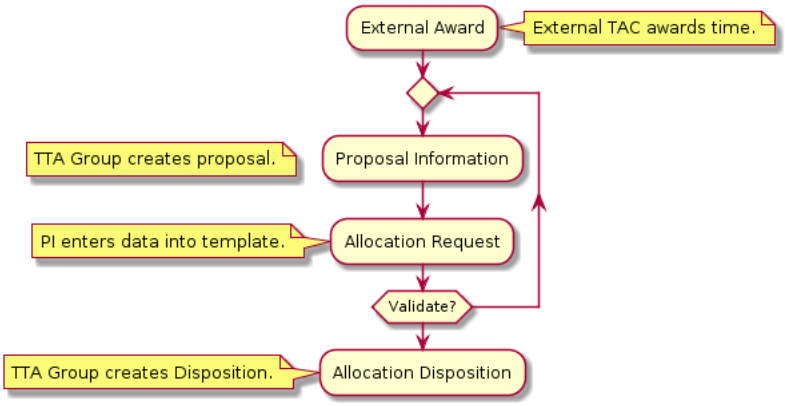

Figure 3: Process for an External TAC use case. An External TAC awards time on an AUI/NA telescope. A TTA Group member creates a proposal and then the PI populates an *Allocation Request* template. If this passes validation then the TTA Group creates an *Allocation Disposition*. At this point a *Project* can be created and the process proceeds as with normal proposals.

2.1.8 Resident Shared Risk Observing (RSRO)

Resident Shared Risk Observing (RSRO) allows for new *Capabilities* to be exploited or proposed for a given *Facility* by allowing proposers to visit the site to help commission the new *Capability*. Such *Capabilities* may or may not be included in the *Solicitation* and therefore the TTA Tools must provide a mechanism for the user to propose new *Capabilities*.

RSRO proposals will be evaluated by the Observatory to assess any resource and scheduling issues during the *Allocation Dispostion* phase. Since this discussion occurs after the TAC meeting, the RSRO process fits nicely into the "Super-TAC" model.

2.1.9 External TAC

As part of reciprocal agreements with other organizations, external TACs are permitted to grant limited amounts of time on AUI/NA telescopes. The NRAO portion of this use case begins when NRAO is requested to perform a technical assessment on the proposal. Because the requests for technical review are heterogeneous and not easily digested by the system this activity will not be supported by the new TTA tool suite.

Figure 3 summarizes the process once the external TAC has awarded time on an AUI/NA telescope. A notification shall be sent containing at minimum the name and contact information of the PI, the title of the project, and the total time awarded per *Facility*. For each such notification a proposal shall be created by the TTA Group with the provided title and PI. *Allocation Dispositions* and template *Allocation Requests* shall be created for the award made by the external TAC. Each project shall be assigned to an appropriate observing period by a TTA Group member. The PI shall be notified and requested to complete the *Allocation Request* within the constraints of the award. This process provides the information necessary for the Project to be created and enter the normal observing operations of the *Facility*. When the PI submits the proposal a validation step to ensure that the *Allocation Request* conforms to the award is performed. Once validated the appropriate project(s) are created and routine observing operations commence.

2.1.10 Sponsored Time

A fraction of telescope time is Sponsored time which has guaranteed telescope time because of support from external organizations (the sponsor). Sponsored time is significant for the VLBA and GBT, comprising roughly 50% of the available observing time. Broadly there are two types of sponsors: Public and Closed. Public sponsors

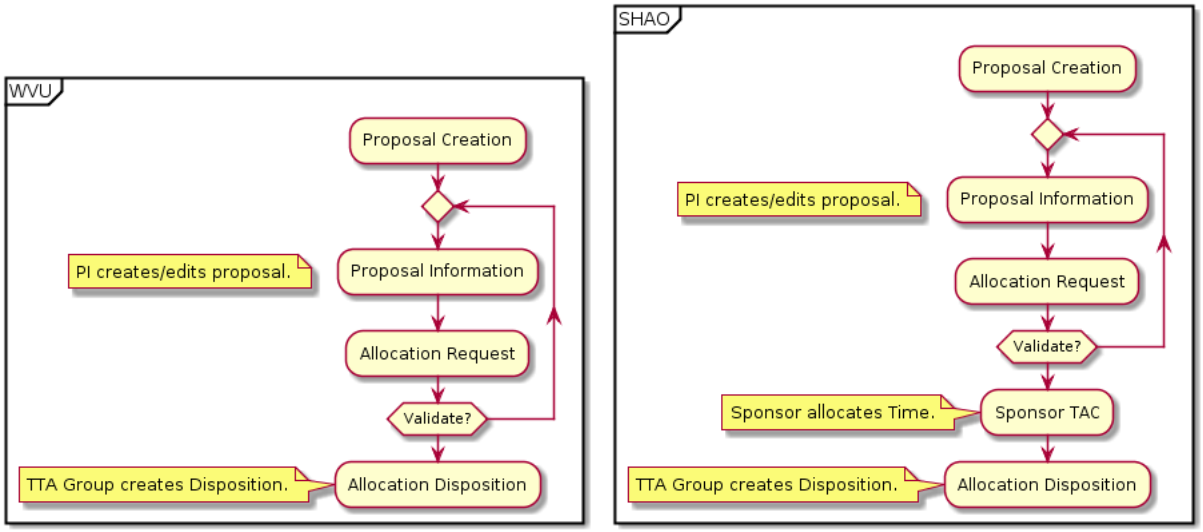

Figure 4: Process for WVU (left) and SHAO (right) Sponsored proposals. For these Public sponsors proposals are created and submitted as with regular proposals, but they are not reviewed. All WVU proposals that are submitted have already been vetted as appropriate by WVU before submission, whereas SHAO proposals are reviewed by the sponsor after submission.

agree to make at least the meta-data of their observations public, whereas Closed sponsors do not. In most cases Public sponsors also make their data available after an agreed upon proprietary period. The detailed agreements between the AUI/NA and the external *Facilities* vary on the process and how/when various meta-data and data become available.

The detailed behavior of all Public sponsors shall be configurable. Figure 4 shows examples for GBT WVU and VLBA SHAO sponsors. The GBT WVU sponsor requires that a proposal be submitted during a specified period. It does not go through the normal review process but a technical review is performed to check that the proposed observing is viable. As with External TAC proposals the technical reviews will not be supported by the TTA tool suite. The proposal meta-data is made public and the data are made public using the nominal proprietary time.

Closed sponsors shall not be visible to either the public or most observatory staff; only the personnel necessary for the observations to be executed shall be informed. The information in the TTA database will be an *Allocation Disposition* that contains the allocated time as a function of LST. This is necessary to derive the appropriate metrics.

2.1.11 Demo Proposals

There are situations where we want to simulate the *Proposal Process*. This includes the call for proposals, proposal submission, and proposal review. For example, a workshop at the AAS meeting where we have interested astronomers run through the *Proposal Process*. The Demo Call should behave the same way as the nominal *Proposal Process* but otherwise be independent. Proposals created with a Demo Call should not persist, they should never be observed, and they should have limited notification.

2.1.12 The TTA Group

The TTA Group is responsible for administering the TTA process. There are different TTA roles that provide certain permissions to the software system. These include USER, ASSISTANCE, ADMIN, and SUPER ADMIN. The USER role is the same as a normal user and allows one to create, modify, and submit a proposal. The ASSISTANCE provided read-only access to the system (e.g., see the status of the reviews). The ADMIN role allow write access

to most of the system. This excludes things like the definition of a role. Finally, the SUPER ADMIN has access to everything.

The TTA Group prepares for each *Proposal Solicitation*. They craft the call for proposals and provide documentation. During the proposal submission period the TTA Group is responsible for answering helpdesk tickets and monitoring the process.

The TTA Group prepares for the review process. This includes recruiting reviewers and providing documentation. Once proposals are submitted the TTA Group will vet the proposals. This includes checking that the proposals were submitted to the correct *Solicitation*, and that the science category that was selected is appropriate based on the scientific justification. The TTA Group will coordinate and administer the review process. This includes answering any helpdesk tickets, supporting any telecons, creating reports for the community, the TAC, and the Directors'.

2.2 Functional Requirements

1. The system shall support multiple concurrent proposal *Solicitations* with **different** *Capabilities*. For example, the 20B semester *Solicitation* occurred from 2 January 2020-3 February 2020. The DDT *Solicitation* during this period would use the *Capabilities* in 19B semester *Solicitation*.
2. The software shall maintain a state for each *Proposal* throughout the proposal life-cycle. These states shall consist of:
   - DRAFT: The proposal has been created but not yet submitted.
   - SUBMITTED: The proposal has been submitted. At this stage the proposal can still be modified and submitted again.
   - HIDDEN: The proposal has been created but deleted or never submitted.
   - IN REVIEW: The proposal has been submitted and can no longer be modified.
   - COMPLETED: The proposal has been reviewed and time allocated. A disposition letter has been sent.
   - WITHDRAWN: The proposal has been withdrawn after submission.
3. All states shall be visible to telescope users except the HIDDEN state.
4. The content of a proposal in the SUBMITTED state shall not be modified by an author unless the proposal is re-submitted. (This will require the software to manage different copies of the proposal.)
5. A TTA Group member shall be able to view and modify a proposal in any state.
6. After the proposal deadline (plus the grace period) a proposal in the DRAFT state will move to the HIDDEN state, whereas a proposal in the SUBMITTED state will move to the IN REVIEW state.
7. A proposal that is deleted will move to the HIDDEN state.
8. Proposals can only be withdrawn by the TTA Group. A TTA Group member shall be able to withdraw a proposal at any stage. That is, the withdraw functionality is global. Once a proposal is in the WITHDRAWN state it becomes stale; that is, the proposal can not go to any other state.
9. An *Allocation Disposition* consists of scheduling priorities, approved time, disposition comments, disposition constraints, and proprietary periods for each *Allocation Request*. The disposition comments consist of two components: COMMENTS FOR THE PI and INTERNAL COMMENTS. In practice, however, this information may be specified for each *Observation Specification*. Table 1 is an example showing how different *Observation Specifications* (OS1, OS1, etc.) can have different scheduling priorities. Here we show very simple *Disposition Constraints*, but in practice they can often be fairly complicated.
10. *Projects* shall be able to be created from *Allocation Dispositions* throughout the observing cycle by the TTA Group.

Table 1: Allocation Disposition Example

Observing Specification	Scheduling Priority	Approved Time [hr]	Disposition Constraints	Proprietary Period [yr]
OS1	A	5.0	None	1.0
OS2	A	5.0	None	1.0
OS3	A	5.0	None	1.0
OS4	C	10.0	LST: 08:14	1.0
OS5	N	0.0	NA	NA

11. A proprietary period shall be specified in the *Allocation Disposition* as (i) a specified duration after the last observation; (ii) a specified duration after the date of the observation; (iii) as soon as possible after the data are taken (i.e., no proprietary time); or (iv) a specified date. The proprietary period shall be tied to the *Observation Specification*; for example, different fields may have different proprietary periods.

2.3 Non-Functional Requirements

1. Migration of existing proposals. At a minimum the user shall have access to past (PST) proposal PDFs. We need a data model first to decide how best to import current data.
2. Migration of existing metrics data. For example, the generation of proposal metrics for a past semester (e.g., 17B).
3. Responsiveness. Use industrial standards for user experience guidelines.
4. Develop and conduct several user driven Quality Attribute Scenarios to assess performance metrics. Potential scenarios include the use of tutorials or STScI-like videos. Below are performance metrics in the PST a few hours before the 20A proposal deadline.
   (a) The PST performed okay if the server load was below $3 - 4$.
   (b) There was a peak of 140 simultaneous users.
   (c) There were 60 proposals submitted within a two hour period.
   (d) There were 10,000 pages served within a two hour period.
5. Support browsers that are commonly used by our community.

3 Process Description

The following sections describe the process flow from origination of a proposal *Solicitation* through the submission, review, and allocation disposition process (Phase 1) and into the observation preparation phase (Phase 2). Figure 5 summarizes the main components that are described in detail below.

3.1 Proposal Solicitation Definition

All proposals are submitted in the context of a *Solicitation*, which often maps directly to a specific semester but not always (e.g. Demo Proposals). A *Solicitation* is initiated by a call for proposals (e.g., an ENews article that informs the user community about the *Solicitation* and links to software tools). A *Solicitation* is composed of available *Capabilities*, the various ways a *Facility* can be operated, and a *Proposal Process*, how the proposal will be processed through the system (see Figure 6). Each *Solicitation* will support one or more *Proposal Classes*, and

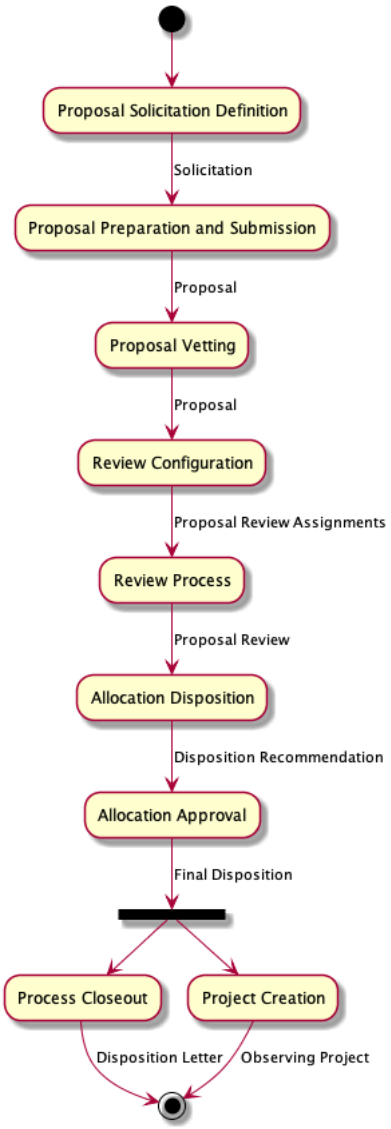

Figure 5: TTA process flowchart. The first step is to define the proposal *Solicitation*. Users create, edit, and submit proposals. Proposals are then reviewed and a recommendation is made as to their disposition, which is then approved by the Director or their delegate. The process is then closed out with a project created for positive dispositions.

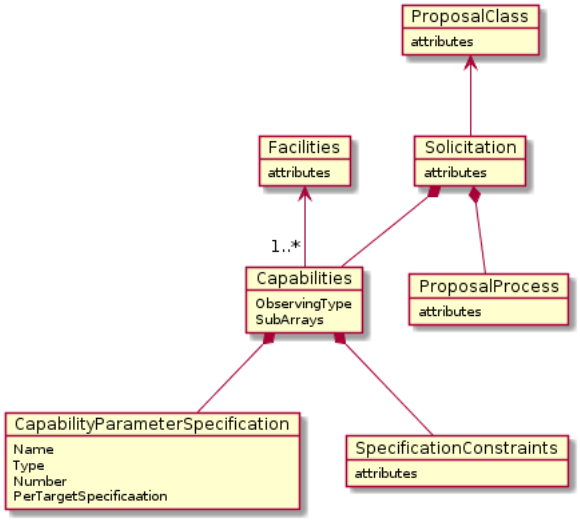

Figure 6: *Solicitation* object diagram. A *Solicitation* is composed of *Capabilities* and a *Proposal Process*. *Capabilities* consist of *Capability Parameter Specifications* and the *Specification Constraints*, which correspond to restrictions on the available resources. Each *Facility* can have one or more *Capabilities*. There are attributes associated with each of these objects.

each *Facility* can have one ore more *Capabilities*. The *Capability Parameter Specifications* provide a way to configure the inputs to a *Capability*. Examples of the *Capability Parameter Specification* are shown in Table 2. Some of these specifications are complex (e.g., FIELD SOURCES) and contain many parameters, whereas other specifications are simple (e.g., IMAGE RMS). There shall be a way to group the *Capability Parameter Specifications*. For example, the IMAGE RMS, ANGULAR RESOLUTION, and LARGEST ANGULAR SCALE are all *Performance Parameters*, and the POLARIZATION CALIBRATION are *Calibration Parameters*. This is not a complete list and will depend on the *Capability* (e.g., DYNAMIC RANGE will probably be needed for a VLA Continuum *Capability*).

Table 2: Capability Parameter Specification Examples

Name	Type	Number	Per Target Specification
FIELD SOURCES	Field Source	Many	False
SPECTRAL SPECS	Spectral Spec	Many	False
IMAGE RMS	Flux Density	1	True
ANGULAR RESOLUTION	Angle	1	False
LARGEST ANGULAR SCALE	Field Source	1	False
POLARIZATION CALIBRATION	Boolean	1	False

Each *Capability* has associated *Specification Constraints* that are restrictions on the available resources. Each of these objects may have one or more attributes. For example, a *Solicitation* has a call period and an execution period. The software shall support multiple concurrent *Solicitations* with different *Capabilities*. **Many components of the solicitation will be configurable and the configuration history should be stored.**

3.1.1 Stakeholder Use Cases

1. Semester Proposal Solicitation

   The semester *Solicitation* for proposals is one of the main *Solicitations* in the operations of AUI/NA telescopes. Prior to the call for proposals the TTA Group will specify the parameters for the observing call. The following *Solicitation* attributes need to be configured:

- A unique identifier (e.g., "19A") which will be used to identify all proposals submitted in response to this *Solicitation*.
- The call period or the period over which users may create, edit, and submit a proposal for the *Solicitation*.
- The nominal execution period or the the period over which the observations will be performed for the *Solicitation*.
- The list of science categories for selection by the user. There is not necessarily a one-to-one correspondence between science category and review panel.

Currently the *Proposal Classes* are "Regular" or "Large". These have the following configurable attributes:

- Size of the proposal title.
- Size of the abstract.
- Size of the scientific justification
- Available semesters to execute the observations.

Each *Facility* will have the following configurable attributes:

- The technical justification cues.
- If triggered observing is available and the list of triggered criteria cues.
- A list of programmable scheduling constraints.

A configurable list of *Capabilities* shall be selected by the TTA Group. These will be organized by *Facility* into different categories that reflect broad types of observing or OBSERVING TYPES. For example,

- Continuum. Observations of emission that is continuous over a large frequency span (e.g., blackbody, free-free, synchrotron, etc.). Such observations require large bandwidths.
- Spectral Line. Observations of emission from atoms and molecules that have narrow spectral features. Such observations require good spectral resolution and often many spectral channels.
- Pulsar. Compact objects that rotate fast and produce pulsed emission. Such observations require fast sampling.
- Radar. Radio waves are transmitted by a *Facility*, reflect off an astronomical object of interest (e.g., asteroid) back toward the Earth, and are received on one or more *Facilities*.

Each *Facility* may have a different set of *Capabilities*. For example, the GBT has a Radar *Capability* but the VLA does not. For each *Capability* a TTA Group member shall be able to specify the available instrumentation (FRONT-ENDS and BACK-ENDS) and the *Specification Constraints*. This includes the observing modes that can be employed (e.g., OTF). The *Specification Constraints* shall be organized into different OBSERVING CONDITIONS: General Observing (GO), Shared Risk Observing (SRO), and Resident Shared Risk Observing (RSRO). It is expected that the *Capabilities* will changes slowly from one semester to the next so provision to modify a previous semester's *Solicitation* to create new *Solicitation* shall be made.

Once a *Solicitation* has been created the TTA Group may create test proposals to validate that the *Capabilities* are functioning correctly. During this period the specification may be updated, existing proposals may no longer properly validate but the system shall allow their modification and validation to enable efficient testing of the system.

After validation, the call for proposals is officially "opened" by the TTA Group through a provided user interface. That is, the user can now create and submit a proposals for the *Solicitation* in question. At this point all "validation proposals" are removed from the system and no further changes to the *Solicitation* parameters are permitted.

2. DDT Proposal Solicitation

   There is no formal call for proposals for a DDT *Solicitation* since from a user's perspective a DDT proposal can be submitted at any time. DDT *Capabilities*, however, are connected to the semester *Capabilities*. We implicitly assume that DDT proposals will be executed in the semester they are submitted. The main identifier is the submission date of the proposal. This will determine the semester and therefore the proposal ID identifier (e.g., '19A'). The following *Solicitation* attributes need to be configured:

   - A unique identifier (e.g., "19A") which will be used to identify all proposals submitted in response to this *Solicitation*.
   - The call period or the period over which users may create, edit, and submit a proposal for the *Solicitation*.
   - The execution period or the the period over which the observations will be performed for the *Solicitation*.
   - The list of science categories for selection by the user. There is not necessarily a one-to-one correspondence between science category and review panel.

   Currently the *Proposal Classes* are "Exploratory", "Target of Opportunity", or "EPO". These have the following configurable attributes:

   - Size of the proposal title.
   - Size of the abstract.
   - Size of the scientific justification
   - Available semesters to execute the observations.

   Each *Facility* will have the following configurable attributes:

   - The technical justification cues.
   - If triggered observing is available and the list of triggered criteria cues.
   - A list of programmable scheduling constraints.

3. Sponsored Proposal Solicitation

   Sponsored proposals are not competing for open-skies time since the sponsor has made agreements with AUI for guaranteed use of NA *Facilities*. Sponsored proposals are a special *Solicitation* since the available resources may depend on this agreement. In many cases, however, the *Capabilities* will be the same as under a semester *Solicitation* and therefore there should be a mechanism to use already defined *Capabilities*.

4. Resident Shared Risk Observing (RSRO)

   As new *Capabilities* are developed for each *Facility* they need to be tested. RSRO was developed as a way to allow the user community to help with this development. Because there is significant risk the *Capabilities* for RSRO are different.

5. Demo Proposal Solicitation at a Workshop

   Often for testing or training purposes it is useful to allow a set of proposals to be generated that are not intended to be reviewed or actually observed. Usually the *Capabilities* are based on the current or upcoming *Solicitation*. In setting up a proposal *Solicitation* the TTA Group lead will want to specify that this is not an official call and thus no review or time allocation processes will be created. Notifications usually sent to the TTA team should be suppressed (or optionally re-directed to the call lead) although e-mails generated to the PI should behave as in the case for a standard semester call for proposals.

   In the future it may be required to "simulate" the review and time allocation processes to generate first *Allocation Dispositions* and then *Projects* so that students may gain experience with the downstream tools based on their "accepted proposal." Currently this is not a requirement.

   At the end of the workshop, the proposals may be removed from the system and shall not be linked to the users account (i.e., show up in their personal list of proposals).

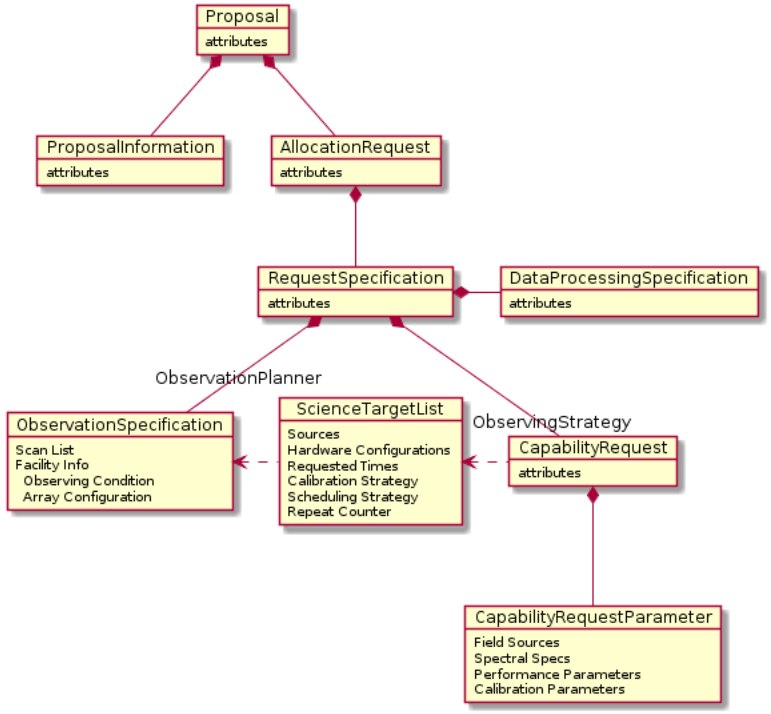

Figure 7: Proposal object diagram. A Proposal is composed of *Proposal Information* and one or more *Allocation Requests*. A *Capability Request* is generated from user input using the available *Capabilities* for the given *Solicitation*. The software generates an *Observation Specification* from the *Capability Request* via the *Science Target List*. The *Observing Strategy* and *Observation Planner* consist of algorithms and heuristics to make this happen.

3.1.2 Functional Requirements

1. Each proposal *Solicitation* is connected to a set of *Capabilities*.
2. *Capabilities* defined in a file and may be imported and exported.
3. The SCIENCE CATEGORIES for each *Solicitation* shall be able to specified as part of the configuration.
4. The number of SCIENCE CATEGORIES that the author may select shall be specified as part of the configuration.
5. There shall be notification groups that are configurable. The notifications will be a function of the *Solicitation*.

3.1.3 Non-Functional Requirements

3.2 Proposal Preparation and Submission

The proposal preparation and submission process is the first contact that most observers will have with the observatory. Use of jargon or detailed knowledge of the telescope operations should be avoided wherever possible. The output of this phase is a fully validated proposal capturing all necessary user information for the observing and processing to be conducted. Throughout this “proposal tool” should be interpreted as a tool used to enter proposal information and not any specific implementation.

3.2.1 Stakeholder Use Cases

1. Proposal in Response to a Semester Solicitation

   A proposal begins when a registered user logs into the proposal tool and selects "semester" for the *Solicitation*. The author who creates the proposal will automatically be assigned as the PI and contact person by default. Additional authors may be added to the proposal using the user interface. The AUTHOR PRIMARY AFFILIATION, AUTHOR PROFESSIONAL STATUS, and AUTHOR GENDER shall be taken from the authors profile when an author either creates a proposal or is added to a proposal. This information shall be updated when a proposal is submitted. Once added any author will have full privileges to modify and submit the proposal. Concurrent editing shall be allowed.

   A proposal is composed of *Proposal Information* (Title, Author, Abstract, Scientific Justification, etc.) and one or more *Allocation Requests* which describe the requested resources and the justification for the request (see Figure 7). Each *Allocation Request* is for a single *Facility* which has one or more available *Capabilities* for each *Solicitation*. The *Capabilities* are often distinguished by different OBSERVING TYPES (e.g., Continuum, Spectral Line, etc.), but also include sub-arrays for the VLA. The *Capability Request Parameters* are the user responses to the *Capability Parameter Specifications* defined in the *Solicitation* and make up the *Capability Request*. They include FIELD SOURCES, SPECTRAL SPECS, PERFORMANCE PARAMETERS, and CALIBRATION PARAMETERS.

   The goal is to produce the *Observation Specification* from the *Capability Request*. To do this a *Science Target List*, a data structure that contains the basic user information, is generated first as an intermediate step. The *Science Target List* contains the SOURCES, the HARDWARE CONFIGURATIONS, REQUESTED TIMES, the *Calibration Strategy*, the *Scheduling Strategy*, and a repeat counter. An *Observing Strategy* is required to produce the *Science Target List* from the *Capability Request*. An *Observation Planner*, which uses the *Calibration Strategy* and the *Scheduling Strategy*, transforms the *Science Target List* to the *Observation Specification*. The *Observing Strategy* and *Observation Planner* consist of detailed algorithms and heuristics that are used to produce the *Observation Specification* from the *Capability Request* (Costa, 2021).

2. DDT Proposal

   A proposal begins when a registered user logs into the proposal tool and selects "DDT" for the *Solicitation*. The available resources will be tied to the current semester. The proposal preparation and submission process for DDT proposals is very similar to proposals submitted in response to a semester *Solicitation*. The review process is, however, significantly different between semester and DDT proposals. The DDT *Solicitation* should always be available.

3. External TAC Proposal

   External TAC proposals consist of proposals that were submitted outside the NRAO system but are still requesting observing time on AUI/NA telescopes. For example, a proposal submitted to the HST TAC that request time on both the HST and VLA.

   The process starts when the TTA Group is notified by an external *Facility* that a proposal has been approved by their TAC for observations on an AUI/NA telescope. The TTA Group will create a *Proposal* and the corresponding *Allocation Dispositions*. A notification is then sent to the PI informing them to fill in the appropriate information; that is, the *Allocation Requests*. After the proposal is validated the Project can be created.

3.2.2 Functional Requirements

1. The first action in the proposal tool must be to select the *Solicitation* which sets the *Capabilities* and the *Proposal Process*. The *Solicitation*s consist of "semester", "DDT", and "Special". A "Special" *Solicitation* are for proposals that are reviewed by an external TAC or a sponsored proposal.

2. A global, unique SERIAL NUMBER shall be generated for all proposals at creation.

3. A sequential PROPOSAL ID shall be generated for all proposals at submission. . The proposal ID shall be constituted by the unique *Solicitation* identifier followed by a dash and then at least three-digit proposal ID number (e.g. Sem19A-023 or DDT18A-024). If more than three digits are required to uniquely identify all proposals additional digits shall be used.

4. AUTHOR LIST Entry

   (a) For each proposal a list of associated authors shall be entered through the proposal tool. Author information is maintained in the NRAO account system and shall be referenced from the proposal. The information associated with the authors at the time of submission must be persisted.

   (b) Provision shall be made to easily create user accounts for individual that do not yet have an account.

   (c) Exactly one author shall be designated as PRINCIPAL INVESTIGATOR; by default the author initially creating the proposal.

   (d) Exactly one author shall be designated as the Contact Author; by default the author initially creating the proposal. An e-mail address must be associated with this authors information in the account subsystem.

5. A text entry field defining the proposal TITLE shall be provided (word limit applies).

6. A text entry field used to enter a proposal ABSTRACT shall be provided (word limit applies).

   (a) Proposal ABSTRACTS become public when a proposal is approved for time (scheduling priority A, B, or C).

7. The authors shall be able to attach and update a SCIENTIFIC JUSTIFICATION for each proposal. The justification must be submitted in a PDF format and is subject to a page limit specified at the proposal *Solicitation* definition phase. PDF files may not use any font smaller than 11 point, and must conform to 1-inch margins.

8. The authors will specify a single SCIENCE CATEGORY from the list of categories defined for the observing cycle, through a drop down or similar user interface.

9. Observations related to students THESIS PROJECT shall be indicated. This is a check box or similar mechanism. If selected the student author should be identified, their projected graduation date retrieved from the *Account System*, and a check that a thesis plan is on record for the student performed.

10. A method of indicating any previous RELATED PROPOSALS shall be provided. To reduce the probability of mistakes, the title of any related proposal shall be displayed.

11. A method of specifying if this is a RE-SUBMISSION shall be available.

12. A method to add and remove *Allocation Requests* from the proposal shall be provided.

13. For semester *Solicitations* the author shall be able to specify the semesters for which the proposed observations are expected to be executed for each *Allocation Request*.

14. Provision should be made for an author to add one or more technical justifications or data management plans to a proposal as required. Jointly we will refer to these as "Feasibility Justifications." Each *Allocation Request* may link to at most 1 feasibility justification of each type and only *Allocation Requests* with a common *Facility* may link to the same feasibility justification. The system shall prevent the submission of proposals for which any *Allocation Request* does not have all required feasibility justifications (as defined in the *Solicitation*) linked.

15. All text entry fields shall be validated for content to ensure the integrity of the proposal system. Text entry widgets shall accept Unicode input unless otherwise specified. Text fields may indicate that they have a word limit, in this case the limit should only be applied during the validation stage (although a warning could be produced earlier) to allow users flexibility when drafting entries.

16. There shall be the ability to specify a subset of a *Facility's* resources for any given observation. For example, when a *Facility* has the *Capability* to use sub-arrays for different *Projects*.

17. There shall be a mechanism for users to propose for a new *Capability* that is not included in the *Solicitation*. For example, a RSRO project to exploit a new technique.

18. Notifications shall be sent for successful submission of a proposal to the authors and the TTA group. Included should be the PROPOSAL ID, *Proposal Class*, TITLE, PI, CO-IS, SCIENCE CATEGORY, TIME SUBMITTED, and for each *Allocation Disposition*: the ALLOCATION REQUEST ID, the *Facility*, and if the proposal is TRIGGERED.

19. For External TAC proposals, a notification shall be sent to the PI after the TTA Group has created a proposal informing them to complete the proposal.

3.2.3 Non-Functional Requirements

1. Saving of proposals, loss of data.

3.3 Proposal Vetting

After the deadline all submitted proposals move to the IN REVIEW state.

The first action is for a TTA Group member to vet the proposal. This includes checking that the proposal is appropriate for the specified *Solicitation* and that the SCIENCE CATEGORY is consistent with the proposed science. The TTA Tools shall help to facilitate this process by providing a user interface and functionality to the TTA Group.

3.3.1 Stakeholder Use Cases

1. Semester Proposal Submission

   Proposals submitted for a semester *Solicitation* should be vetted to check that they are indeed appropriate for such a *Solicitation*. For example, sometimes a proposal submitted under a semester *Solicitation* should be submitted as a sponsored proposal. A TTA Group member shall be able to flag such a proposal and move it to the WITHDRAWN state.

   The SCIENCE CATEGORY of each proposal needs to be vetted by the TTA Group. There shall be a user interface to help facilitate this process. A TTA Group member will be able to view a subset of the proposal content, update the SCIENCE CATEGORY, and then move the proposal to the next stage in the review process.

2. DDT Proposal Submission

   DDT proposals are intended to address targets of opportunity, high-risk/high-return exploratory time, or other science opportunities deemed sufficiently urgent to justify prompt action. The TTA Tools software shall allow a TTA Group member to flag any proposal that does not fit this characterization and move it to the WITHDRAWN state. For example, a proposal that plans to perform a large survey is not appropriate for a DDT proposal.

3.3.2 Functional Requirements

1. There shall be a mechanism to check that the time of proposal submission is within the boundaries of the specified *Solicitation* dates. For DDT proposals there are no boundaries. For semester *Solicitations* this is typically within one month leading up to the deadline; that is, users have about one month to create, edit, and then submit the proposal. There shall be a configurable grace period.

2. There shall be a user interface to aid a TTA Group member to vet the SCIENCE CATEGORY of all proposals submitted for a semester *Solicitation*. The user interface shall show:

   (a) PROPOSAL ID

   (b) TITLE

   (c) ABSTRACT

   The user shall be able to filter by the SCIENCE CATEGORY. There shall be a way to select a different SCIENCE CATEGORY before saving. There shall be a mechanism to save the SCIENCE CATEGORY for all proposals. The history of the SCIENCE CATEGORY shall be maintained; that is, there shall be a way to view the original SCIENCE CATEGORY.

3.3.3 Non-Functional Requirements

3.4 Review Configuration

All proposals submitted for either a "semester" or "DDT" *Solicitation* are evaluated by an NRAO review process. Proposals submitted for a semester *Solicitation* will be reviewed by a panel-based, dual-anonymous review process. (See §A for an alternate review process that may be adopted by ALMA.) Science reviews are performed on each *Proposal*, whereas feasibility reviews (either technical or data management) are performed on each *Allocation Request*. Proposals submitted for a DDT *Solicitation* are reviewed by a local observatory site committee, typically organized by the scheduler.

Proposals submitted for a "special" *Solicitation* are not evaluated by the NRAO review process. These consist of External TAC proposals, which are reviewed by the external institution, and Sponsored proposals, which are reviewed by the sponsoring institution. In most cases a technical review will be performed to assess the feasibility of the proposed observations, but such reviews are handled outside of the TTA Tools and are therefore out-of-scope.

3.4.1 Stakeholder Use Cases

1. Science Review Panel (SRP) Configuration

   Prior to the beginning of the review process a TTA Group member will configure the science review panels (SRPs) The starting configuration should be defaulted to a previous cycle's values. This configuration, however, is not automatic and requires manual approval from a TTA Group member. Each SRP consists of a SCIENCE CATEGORY, SRP members, and an SRP chair. (A chair pro tem may be assigned at a later time.) There shall be two or more reviewers, consisting of SRP members and SRP chairs, assigned to each *Proposal*. A reviewer can only be on one SRP.

2. Feasibility Review Configuration

   Prior to the beginning of the review process a TTA Group member will configure the system. To manage assignments the software shall support a mechanism to specify feasibility review groups (FRGs) that act as an alias to allow more than one feasibility reviewers to be assigned to an *Allocation Request*. Feasibility reviews consist of both technical and data management reviews. The structure of data management reviews is similar to technical reviews, except that they will most likely only be performed on a small sub-set of *Allocation Request*. This determination will likely depend on reasonable logical combinations of TOTAL REQUESTED TIME, ESTIMATED PROCESSING, and ESTIMATED DATA VOLUME. It is very likely that these criteria will evolve over time, so reasonable effort shall be made to provide flexibility in the software.

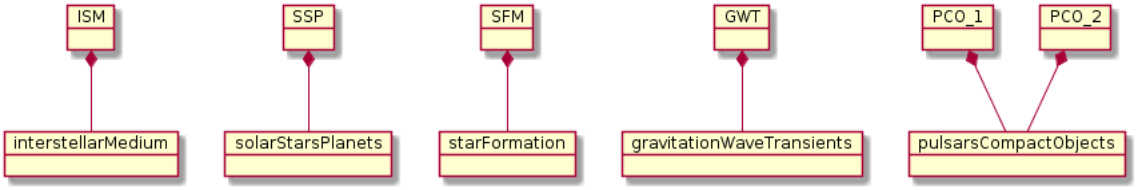

Figure 8: Example of the mapping between science review panels and SCIENCE CATEGORIES. Here we assume there are many proposals with a SCIENCE CATEGORY of "Pulsars and Compact Objects", and therefore we divide these proposals between two SRPs: PCO_1 and PCO_2.

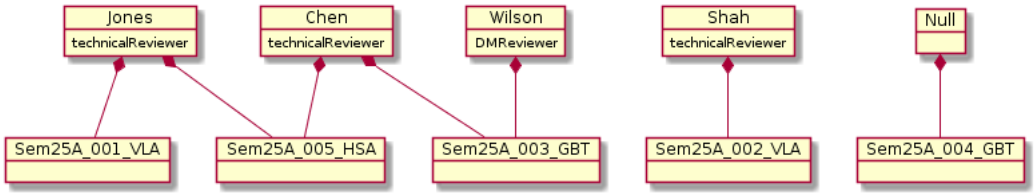

Figure 9: Example of the mapping between feasibility reviewers and *Allocation Requests*. Here we show how one feasibility reviewer (Jones) is mapped to two different *Allocation Requests*, and how one HSA *Allocation Request* (Sem25A_005_HSA) is mapped to two feasibility reviewers (Jones and Chen). In principle a FRG could be created as a alias that includes Jones and Chen that is used to assign them to all *Allocation Requests* that include the HSA as a *Facility*. For the *Allocation Request* Sem25A_004_GBT there are no feasibility reviews.

3.4.2 Functional Requirements

1. Only TTA Group members shall be able to view and modify the science and feasibility review configurations.
2. There shall be a many-to-one mapping between SRPs and SCIENCE CATEGORIES. In the case where multiple SRPs are connected to the same SCIENCE CATEGORY, we implicitly assume that a given proposal is only reviewed by one SRP; that is, the proposals are divided between the SRPs. See Figure 8 for an example where two PCO SRPs split the proposals that have the "Pulsars and Compact Objects" SCIENCE CATEGORY.
3. The TTA tools shall assign science reviewers to proposals.
4. A science reviewer can only be on one SRP.
5. There shall be a zero-to-many mapping between feasibility reviewer and *Allocation Request*. See Figure 9 for an example where an HSA *Allocation Request* is reviewed by two different technical reviewers and where one technical reviewer is mapped to two *Allocation Requests*. In some cases there shall be no feasibility reviewers assigned to an *Allocation Request*.
6. The TTA tools shall assign feasibility reviewers to *Allocation Requests*.
7. A feasibility reviewer can be on one more feasibility groups.
8. It shall be possible to execute a configuration file. For example, for testing purposes a TTA Group member will want to automatically configure the system using a previous configuration file.

3.4.3 Non-Functional Requirements

1. Changes to the number of reviewers, panels, or science categories shall not require a software update.

3.5 Review Process

A proposal review consists of COMMENTS FOR THE PI, INTERNAL COMMENTS, and a scientific merit metric. Each proposal has at most one proposal review, and most proposals will have exactly one. Both COMMENTS FOR THE PI and INTERNAL COMMENTS have scientific, technical, and data management components. The scientific evaluation of each proposal is associated with the overall proposal and consists of the scientific merit metric, and both internal and PI focused scientific comments. The technical and data management comments are referred to as Feasibility reviews and when performed are associated with the *Allocation Requests* for the proposal. The TTA Tools are required to support different review processes, but the output of each process is the same, a proposal review for each submitted proposal.

Depending on the proposal *Solicitation* there are currently two processes the TTA Tools must support: a Panel Proposal Review or an Observatory Site Review. These review processes may change in the future. For example, we may move to a distributed review process, as described in §A. The scientific merit metric depends on the process. For example, the metric is a NORMALIZED LINEAR-RANK SCORE for the Panel Proposal Review process, and a BINARY SCORE for the Observatory Site Review. **The description for the Observatory Site Review is an internal software view, but the user view will be more streamlined and will consist of a single interface for the review process, the Allocation Disposition, and the Allocation Approval.**

Proposals that were submitted under a "special" *Solicitation* do not go through the NRAO review process but in some cases still need to be in the system. External TAC proposals are not submitted using the TTA Tools, but *Allocation Requests* and *Allocation Dispositions* are created since *Scheduling Blocks* need to be generated for approved *Projects*. Feasibility reviews are performed by Observatory staff in most cases, but these are handled outside of the TTA Tools and are therefore out-of-scope. Sponsored proposals are either "public" or "closed". Sponsored public proposals are submitted using the TTA Tools but are externally reviewed. Feasibility reviews are performed by Observatory staff in most cases, but these are handled outside of the TTA Tools and are therefore out-of-scope. Sponsored closed proposals are not visible within the TTA Tools.

3.5.1 Panel Proposal Review (PPR)

Figure 10 is an activity diagram for the Panel Proposal Review (PPR) process. The PPR starts with an Individual Science Review performed at the same time as the Feasibility Reviews which consists of technical and data management reviews. The output of these reviews are used as input to the Consensus Proposal Review meeting which then produces the proposal review: COMMENTS FOR THE PI, INTERNAL COMMENTS, and a NORMALIZED LINEAR-RANK SCORE.

Individual Science Review (ISR)

Figure 11 is an activity diagram for the Individual Scientific Review (ISR) process. The first step in the ISR is to identify conflicts of interest. There is a CONFLICT STATE that indicates the conlfict status of each reviewer/proposal. The software automatically identifies conflicts and then the SRP member can declare additional conflicts of interest. Once it has been determined that the reviewer is not conflicted, the SPR chair can assign the reviewer to the proposal. There is a REVIEW TYPE for each reviewer/proposal that determines the type of review that is assigned (e.g., primary reviewer). Then SRP members will enter reviews which consist of an INDIVIDUAL SCORE and COMMENTS FOR THE SRP. There is a REVIEW STATE that indicates the state of the review (e.g., completed). The TTA Tools shall provide a user interface for the SRP chair and a TTA Group member to monitor the review process and to complete all reviews. The INDIVIDUAL SCORES are normalized by reviewer to produce a NORMALIZED SCORE which is used in the next step.

Stakeholder Use Cases

1. SRP Member: conflicts

   The first action of an SRP member, prior to viewing any proposal, is to identify potential conflicts of interest. Where possible conflicts shall be automatically identified based on information known to the system. A CONFLICT REASON should be included when a conflict has been identified. The SRP member shall be

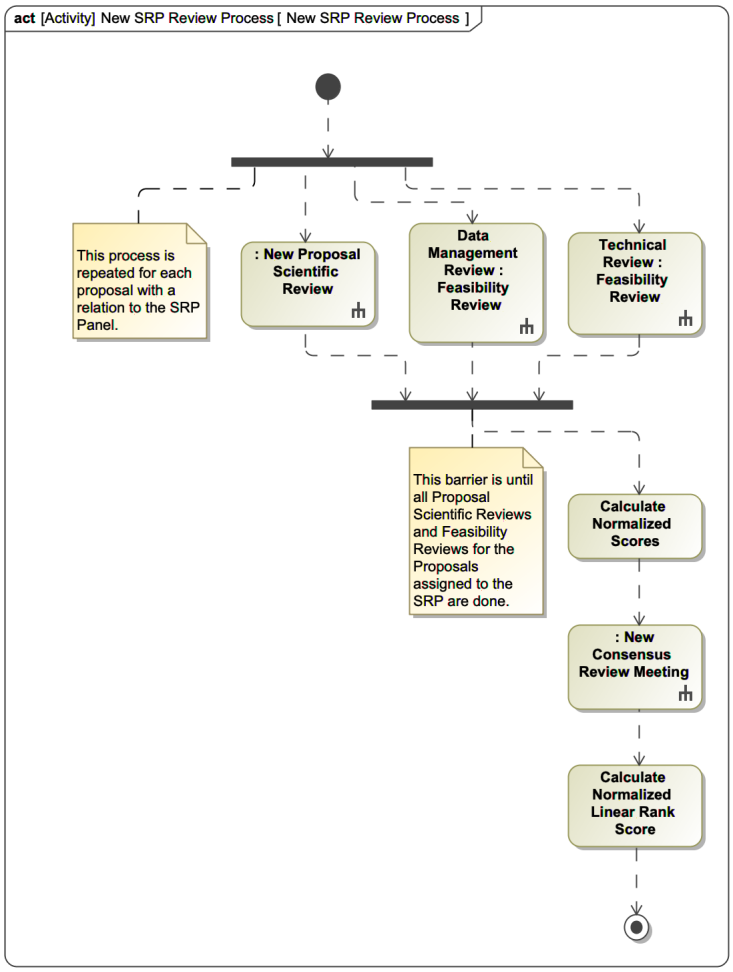

Figure 10: Activity diagram for the Panel Proposal Review. An Individual Scientific Review (ISR) is performed together with the two Feasibility Reviews (technical and data management). The output from the ISR is an INDIVIDUAL SCORE and COMMENTS FOR THE SRP. Once these reviews have been completed the INDIVIDUAL SCORES are normalized and a Consensus Review meeting is held to produce the proposal review: COMMENTS FOR THE PI, INTERNAL COMMENTS, and a NORMALIZED LINEAR-RANK SCORE.

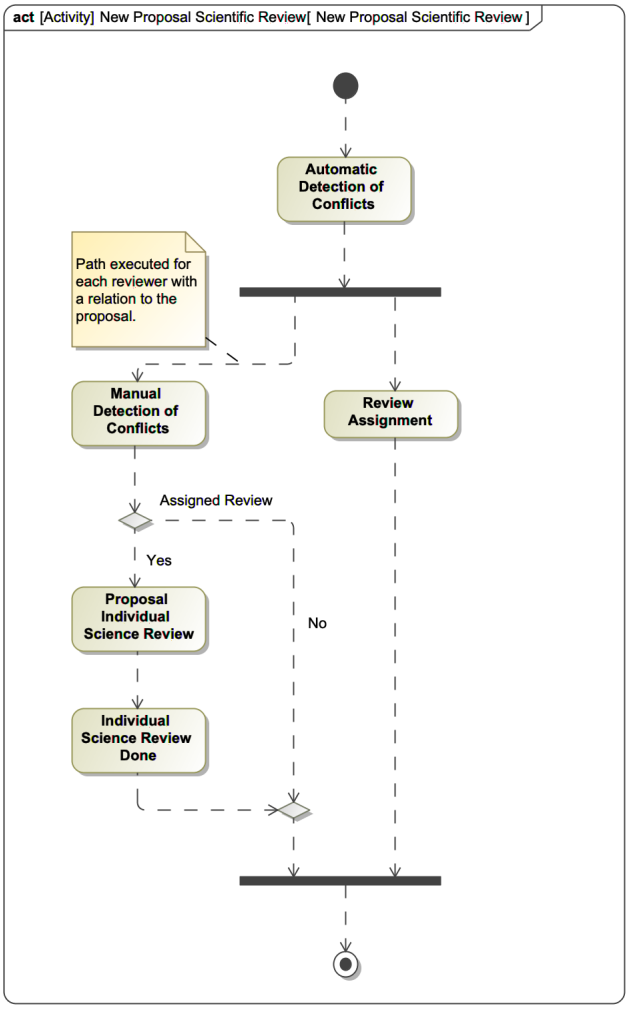

Figure 11: Activity diagram for the Individual Science Review. Conflicts are first identified automatically and then manually by the SRP member. Once all conflicts have been identified the SRP chair will assign reviewers to proposals. Lastly, the reviewer will enter their reviews.

provided with the PROPOSAL ID, the TITLE, and the ABSTRACT. The review process is dual-anonymous so no author information shall be listed. The workflow and guidelines[1], however, shall not change.

Once the conflict status has been updated and there are no conflicts of interest, the SRP member shall have access to the proposal. Reviewers may either view each proposal online, or create and download PDF files for convenience. For proposals that are RE-SUBMISSIONS or reference RELATED PROPOSALS from other *Solicitations*, the reviewer shall be able to access previous reviews (i.e., the disposition letter). Care must be taken of any conflicts of interest; that is, if the reviewer had a conflict on the previous proposal they shall not be able to view the review.

2. SRP Chair: assigning reviewers

   The SRP chair shall be able to montor the CONFLICT STATE of all reviewers/proposals in their panel. Once it has been determined that there is no conflict of interest, the SRP chair shall be able to assign reviewers to proposals either directly using a user interface or by file import. The SRP chair shall be able to monitor the REVIEW TYPE and REVIEW STATE.

3. SRP member: entering reviews

   For each proposal the SRP member enters an INDIVIDUAL SCORE and COMMENTS FOR THE SRP. The INDIVIDUAL SCORE is a numeric evaluation of the proposal. The COMMENTS FOR THE SRP are rough working notes for the SRP Consensus Review meeting (see below) and are used to form the consensus comments. Scores and comments shall be saved for each review as they are entered, and the REVIEW STATE updated. At this stage the reviews are only visible to the SRP member who entered the review. The reviewer may elect to complete reviews individually or to complete all reviews currently in the REVIEW STATE Saved with a single button click. Once completed, a review may no longer be edited by the reviewer.

4. TTA Group Member

   TTA Group members shall be able to monitor the progress of the individual scientific review via the user interface. A TTA Group member shall have administrative privileges to modify the following: CONFLICT STATE, REVIEW TYPE, INDIVIDUAL SCORE, and the review comments. A TTA Group member shall also be able to either "complete" or "close" the reviews for a given reviewer.

Functional Requirements

1. SRP members shall be provided with the PROPOSAL ID, the TITLE, and the ABSTRACT.
2. There shall be the concept of CONFLICT STATE for each reviewer/proposal. The CONFLICT STATE consists of Unknown, Available, or Conflict. The default is Unknown.
3. The system shall automatically generate a conflict designation for a given reviewer for any proposal that:
   (a) The reviewer is an author of the proposal.
4. There shall be a mechanism for the reviewer to manually declare their conflict status; that is, set the CONFLICT STATE to either Available or Conflict. If the CONFLICT STATE is set to Conflict, a reason must be specified, the CONFLICT REASON, with variable length text.
5. Once the CONFLICT STATE has been set to Available or Conflict, either automatically by the software or manually by the SRP member, it cannot be changed (except by a TTA Group member).
6. No reviewer shall be able to view or review a proposal for which they have an identified conflict.
7. When the conflict status has been determined for all reviewers/proposals in a given SRP, a notification shall be sent to the SRP chair and a TTA group member. Included shall be the semester, the SRP name, and a list of proposals with fewer than a specified number of assigned reviewers (e.g., proposals have fewer than 3 reviewers).

[1] See https://science.nrao.edu/observing/proposal-types/coi for the NRAO conflict of interest guidelines.

8. When a TTA Group member updates the CONFLICT STATE a notification shall be sent to the SRP chair and TTA Group member. Included shall be the PROPOSAL ID, the reviewer name, and the reason for the conflict (or the change in conflict status).

9. To facilitate the review process, in addition to the online display of proposals, they shall be made available to SRP members and the TTA Group as:

   (a) Individual PDF files of each *Proposal*.

   (b) A tar file containing all of the individual *Proposal* PDF files.

   (c) A single PDF file containing all of the *Proposals* for the SRP.

10. The generation of the PDF shall have the following options:

    (a) Full proposal.

    (b) *Proposal Information* content only.

    (c) Exclude FIELDS in the *Allocation Requests*.

11. There shall be the concept of REVIEW TYPE for each reviewer/proposal. The SRP chair shall assign a REVIEW TYPE for each reviewer/proposal where the CONFLICT STATE is Available. The REVIEW TYPE consists of None, Primary, Secondary, or Tertiary. The default review type is None. A reviewer shall be able to enter a review for REVIEW TYPES Primary, Secondary, or Tertiary.

12. It shall be possible for a reviewer to enter review results either directly through the review user interface or via a file import. In either case values shall be validated upon entry:

    (a) The INDIVIDUAL SCORE for each proposal shall be validated to be within range (currently defined on the open interval between 0 and 10, in one tenth point increments).

    (b) COMMENTS FOR THE SRP are variable length strings.

13. SRP members and the chair shall not be able to view other panel members reviews until all reviews are complete.

14. There shall be a concept of REVIEW STATE for each reviewer/proposal. The REVIEW STATE shall consist of Not Saved, Saved, Complete, or Closed.

15. The SRP chair shall be able to monitor the status of the individual scientific review process. Specifically to view the CONFLICT STATE, REVIEW TYPE, and REVIEW STATE. The SRP chair shall be able to modify the REVIEW TYPE at any time during the ISR.

16. A TTA Group member shall be able to monitor the status of the individual scientific review process. Specifically to view the CONFLICT STATE, REVIEW TYPE, and REVIEW STATE. A TTA Group member shall be able to modify the CONFLICT STATE and REVIEW TYPE at any time during the ISR.

17. It shall be possible for a TTA Group member to complete all of the reviews for a given reviewer; that is, set the REVIEW STATE to Complete. This assumes a valid score has been entered; otherwise the REVIEW STATE will be set to Closed and not further considered.

18. It shall be possible for a TTA Group member to close out all of the reviews of a given reviewer; that is, set the REVIEW STATE to Closed. A review that has been closed is no longer considered; that is, the score is not used in the normalization process and the text is not shown.

19. Once all reviews for a given reviewer are complete the NORMALIZED SCORE shall be generated which yields a mean of 5 and a standard deviation of 2.

20. When all reviewers in a given SRP have completed their individual reviews a notification shall be sent to the SRP chair and the TTA group.

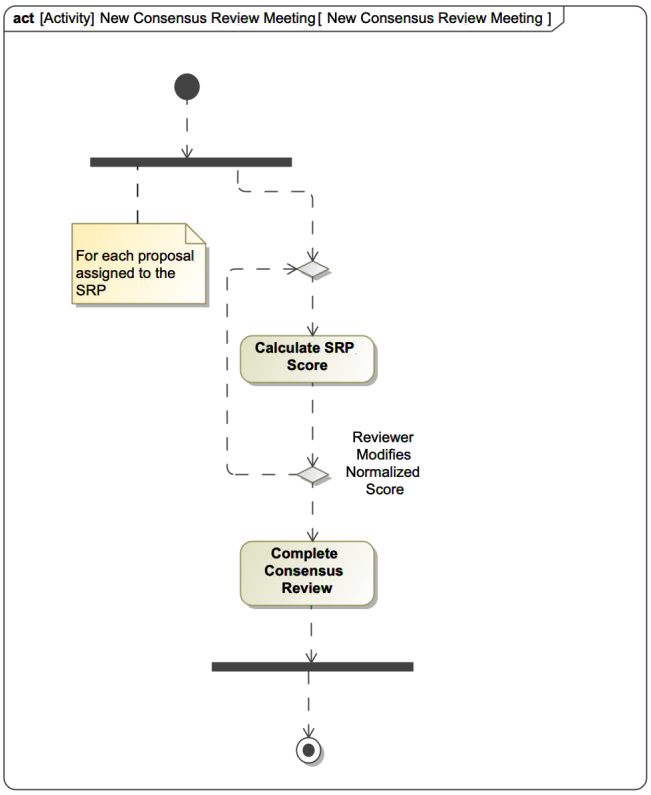

Figure 12: Activity diagram for the Consensus Review meeting. During the Consensus Review meeting the panel discusses the proposal and may adjust the NORMALIZED SCORES. The SRP SCORE, equal to the mean of the NORMALIZED SCORES, is calculated. The SRP also draft the COMMENTS FOR THE PI and INTERNAL COMMENTS. When done the SRP chair then completes the review.

21. A TTA Group member shall be able to simulate individual reviews for testing purposes.

Non-Functional Requirements

1. The individual scientific review shall be a dual-anonymous review process, where all information about the author list is suppressed.

Consensus Review Meeting

Figure 12 is an activity diagram for the Consensus Review meeting. For the Panel Proposal Review process the panel is expected to discuss the scientific merit of each proposal based on the ISR. The Feasibility reviews are also included as input during the Consensus Review meeting. The outcome of the Consensus Review meeting are COMMENTS FOR THE PI, INTERNAL COMMENTS, and an SRP SCORE. The NORMALIZE LINEAR-RANK SCORE is then calculated using the SRP SCORES for each panel.

Stakeholder Use Cases

1. The Consensus Review Meeting

   Once all required individual reviews have been completed (including any required technical or data management reviews) and the scores are normalized, the SRP consensus review information shall be available; this provides the basis for discussion during the SRP review meeting The NORMALIZED SCORES for each proposal shall be visible, including the mean and standard deviation. By default the SRP SCORE is equal to the mean value of the NORMALIZED SCORES for each proposal. During the meeting, the SRP SCORE may be modified in two ways.

- The SRP chair (or a TTA Group member) may directly modify the SRP SCORE by entering a new value.
- SRP members may modify their NORMALIZED SCORE and have this reflected in the SRP SCORE.

The SRP drafts the COMMENTS FOR THE PI and INTERNAL COMMENTS, only visible to TAC members. All non-conflicted SRP members shall be able to view and edit both fields.

Similar to the individual reviews there shall be a state model for each proposal under review that denotes the current state of the consensus review. Only the SRP chair shall be able to complete the consensus review, triggering the generation of the NORMALIZED LINEAR-RANK SCORE.

2. TTA Group Member

   TTA Group members shall be able to monitor the progress of the consensus scientific review via the user interface. A TTA Group member shall have administrative privileges to modify all scores and consensus comments. A TTA Group member shall be able to complete the consensus comments for each SRP.

Functional Requirements

1. Only the SRP chair (and TTA Group members) is allowed to modify the SRP SCORE. Note it is permissible that other committee members must press the reload button to see the updated score.
2. The NORMALIZED LINEAR-RANK SCORE shall be automatically computed by the system as $10R/n$ where R is the ordinal rank of the proposal based on the SRP SCORE (in ascending order) and n is the number of proposals reviewed by the Science Review Panel.
3. When the consensus reviews for a given SRP are completed a notification shall be sent to the TTA group.
4. History of the changes made during the consensus review need to be tracked.
5. A TTA Group member shall be able to simulate consensus reviews for testing purposes.

Non-Functional Requirements

1. The individual scientific review shall be a dual-anonymous review process, where all information about the author list is suppressed.

Feasibility Review

Feasibility reviews are assessments of the feasibility of the technical aspects of each *Allocation Request* or the feasibility of the proposers to carry out the data management plan. Such reviews are often performed by observatory staff. Technical and data management reviews have a similar structure but are different types of feasibility reviews. As with scientific reviews they consist of COMMENTS FOR THE PI and INTERNAL COMMENTS.

Stakeholder Use Cases

1. TTA Group Member: assigning reviewers.

   A TTA Group member will assign zero or more reviewers to each feasibility justification to evaluate the technical feasibility. This will also be done separately for the data management; that is the reviewers need not be the same.

2. Entering Reviews

   The first action of a technical reviewer is to login to the TTA Tools to access the proposals to review. The user interface shall provide a mechanism(s) to enter all of the information necessary for the technical review. Conflicts are relaxed for technical reviews with the exception that technical reviews shall not be assigned to a reviewer who is an author on the proposal. In the rare case that a reviewer feels uncomfortable reviewing a proposal they will communicate outside the TTA Tools to a TTA Group member to reassign the review.

   For each feasibility justification the reviewer enters COMMENTS FOR THE PI and INTERNAL COMMENTS. The COMMENTS FOR THE PI will be visible to the PI but also to SRP and TAC members. The INTERNAL will only be visible to the TAC.

Functional Requirements

1. There shall be a mechanism to assign feasibility reviewers to each feasibility justification. As a convenience feasibility review groups (FRGs), defined during the review configuration, may be used as an alias to map more than one reviewer to an *Allocation Request*.
2. The software shall prevent the assignment of a feasibility reviewer to a proposal for which they are an author.
3. Proposal author information (name, affiliation, etc.) shall not be visible to any SRP member at this time in the review process.
4. To facilitate the review process, in addition to the online display of proposals they shall be made available for Feasibility reviewers and the TTA Group as:
   (a) Individual PDF files of each *Proposal*.
   (b) A tar file containing all of the individual *Proposal* PDF files.
   (c) A single PDF file containing all of the *Proposals* for the Feasibility reviewer.
5. The generation of the PDF shall have the following options:
   (a) Full proposal.
   (b) Only the associated *Allocation Request*.
   (c) Only the ALLOCATION ID, PI, TITLE, and TECHNICAL JUSTIFICATION.
6. It shall be possible for a reviewer to enter review results either directly through the review user interface or via a file import. In either case values shall be validated upon entry:
   (a) COMMENTS FOR THE PI are variable length strings.
   (b) INTERNAL COMMENTS are variable length strings.
7. When the feasibility reviews have been completed a notification shall be sent to the TTA group.
8. A TTA group member shall be able to monitor the status of the individual technical review process. Specifically to view the REVIEW STATE.
9. A TTA Group member shall be able to simulate feasibility reviews for testing purposes.

Non-Functional Requirements

3.5.2 Observatory Site Review (OSR)

The Observatory Site Review (OSR) is a less formal review process whereby primarily Observatory staff will provide information for the scientific, technical, and data management components of the proposal review. As with the PPR, for each component there will be COMMENTS FOR THE PI, INTERNAL COMMENTS, and a scientific merit metric. For the OSR the scientific merit metric is a BINARY SCORE; that is, an up or down decision on whether to recommend allocating telescope time.

Stakeholder Use Cases

1. DDT Proposals

   A TTA Group member will be assigned the task of coordinating the review of DDT proposals. An observatory site committee will be formed outside the TTA Tools to perform the review. Similar to the panel-based review there are three review components: science, technical, and data management. And for each component there are COMMENTS FOR THE PI and INTERNAL COMMENTS. A BINARY SCORE is also assigned which corresponds to a recommendation to allocate time or not. Only a TTA Group member shall be able to enter all review information.

Functional Requirements

1. It shall be possible for a TTA Group member to enter review results either directly through the review user interface or via a file import. In either case values shall be validated upon entry:
   (a) COMMENTS FOR THE PI are variable length strings.
   (b) INTERNAL COMMENTS are variable length strings.
   (c) BINARY SCORE is zero or one.
2. When the reviews have been completed a notification shall be sent to the TTA group.
3. A TTA Group member shall be able to simulate reviews for testing purposes.

Non-Functional Requirements

3.6 Allocation Disposition

The reviews discussed in §3.5 provide an assessment of the scientific justification and feasibility of the proposal. The next step is to use this information, together with any resource or scheduling constraints, to allocate telescope time; that is, create an *Allocation Disposition* for each *Allocation Request*. An *Allocation Disposition* consists of scheduling priorities, approved time, disposition comments, disposition constraints, and proprietary periods. There can be zero or more types of disposition comments for each *Allocation Disposition*. Currently, these consists of TAC, Super TAC, OSC, and External. Similar to review comments each type of disposition comments is composed of COMMENTS FOR THE PI and INTERNAL COMMENTS.

Typically a committee is formed to make a recommendation that must be approved by the Director (see §3.7). For a semester *Solicitation* a Time Allocation Committee (TAC) is formed, whereas for a DDT *Solicitation* an Observatory Site Committee (OSC) is formed. For special solicitation an External Committee will recommend the *Allocation Disposition*.

3.6.1 Time Allocation Committee (TAC) Meeting

A Time Allocation Committee (TAC) is formed to recommend scheduling priorities, approved time, etc. that comprise the *Allocation Disposition* for proposals submitted as part of a semester *Solicitation*. The TAC may consist of both external and internal scientists.

Stakeholder Use Cases

1. TAC Meeting Preparation

   To aid the TAC, preliminary scheduling priorities shall be generated by telescope specific methods based primarily on the the NORMALIZED LINEAR-RANK SCORE. Two documents will be prepared by the TTA Group: a Facility Report and a Proposal Summary. The Facility Report provides a narrative about the scheduling issues for each *Facility* and includes an LST (or GST) pressure plot. The Proposal Summary is a list of relevant information for each proposal that provides context for the TAC meeting discussion.

2. TAC Meeting

   The output of the TAC meeting is that for each *Observation Specification* the TAC recommends a scheduling priority, approved time, proprietary period, and any constraints. The TAC also provides the input for "TAC" disposition comments. TAC members shall have access to all information, regardless of conflicts. This includes all proposals, a report for each telescope, and a compact summary of relevant proposal and review information.

3. HSA/GMVA Allocation Request

   Since the HSA and GMVA are arrays that consist of stations from different observatories, the recommendation from the NRAO TAC is used as input to a "super" TAC. That is, HSA and GMVA proposals are assessed by multiple TACs and the results are discussed at a Super TAC meeting. A TTA Group member will then update the *Allocation Disposition*, including entering any Super TAC disposition comments.

4. RSRO Allocation Request

   A RSRO *Allocation Request* undergoes the "normal" review process; that is, a RSRO proposal will have a scientific and feasibility review, and go through the TAC meeting. There is, however, an additional step that occurs after the TAC meeting to assess the team and any specific resource issues related to the new *Capabilities*. This additional step will be considered a "Super" TAC.

Functional Requirements

1. A TAC member shall be able to view or download all proposals. There shall be a way to filter by *Facility* (e.g., download only files with an *Allocation Request* that contains the VLA), and *Proposal Class* (e.g., Large proposals).
2. A TAC member shall be able to view or download the Facility Report for each *Facility* which includes an LST (or GST) pressure plot.
3. A TAC member shall be able to view or download the Proposal Summary which consists of the following information for each proposal: PROPOSAL ID, NORMALIZED LINEAR-RANK SCORE, SRP NAME, TELESCOPES, PRINCIPAL INVESTIGATOR, CO-INVESTIGATORS, TITLE, ABSTRACT, PRELIMINARY PRIORITIES, COMMENTS FOR THE PI, and INTERNAL COMMENTS. There shall be a way to organize these by *Facility* and *Proposal Class*.
4. A TTA Group member shall be able to create and modify the *Allocation Disposition* before, during, and after the TAC meeting.
5. A TTA Group member shall be able to enter TAC disposition comments, which consist of COMMENTS FOR THE PI and INTERNAL COMMENTS, using the UI or by file import.
6. A TTA Group member shall be able to enter Super TAC disposition comments, which consist of COMMENTS FOR THE PI and INTERNAL COMMENTS, using the UI or by file import.
7. For testing purposes there shall be a mechanism to automatically generate *Allocation Dispositions* for each *Allocation Request*.

Non-Functional Requirements

3.6.2 Observatory Site Committee (OSC) Meeting

An Observatory Site Committee (OSC) is formed to recommend scheduling priorities, approved time, etc. that comprise the *Allocation Disposition* for proposals submitted to the DDT *Solicitation*. Unlike the TAC, the OSC typically consists of Observatory staff, but external members are not excluded. A TTA Group member provides any necessary coordination for the OSC meeting.

Stakeholder Use Cases

1. DDT Allocation Request

   The *Allocation Requests* from a DDT proposal are evaluated by the Observatory Site Committee (OSC). The OSC will use as input the Observatory Site review, together with any resource/scheduling constraints, to recommend scheduling priorities, approved time, etc. that comprise the *Allocation Disposition*.

Functional Requirements

1. A TTA Group member shall be able to create and modify the *Allocation Disposition*.
2. A TTA Group member shall be able to enter OSC disposition comments, which consist of COMMENTS FOR THE PI and INTERNAL COMMENTS, using the UI or by file import.
3. For testing purposes there shall be a mechanism to automatically generate *Allocation Dispositions* for each *Allocation Request*.

Non-Functional Requirements

3.6.3 External Committee

Proposals submitted under a "special" *Solicitation* include external TAC proposals and Sponsored proposals. These proposals are not evaluated by the NRAO review process, but since they may be observed by AUI/NA *Facilities* an *Allocation Disposition* must be created.

Stakeholder Use Cases

1. External TAC

   Proposals submitted to external facilities (e.g, HST) that request time on AUI/NA *Facilities* are evaluated outside of the TTA Tools. Any scientific evaluation is run by the external observatory. Technical reviews may be performed by Observatory staff for the component of the proposal related to AUI/NA, but these are done outside the TTA Tools.

2. Sponsored

   Sponsored proposals are often submitted to the AUI/NA TTA Tools, especially if they are public, but do not undergo a proposal review. As with External TAC proposals, Sponsored proposals may require a technical review to be performed by the Observatory, but these could be done outside the TTA Tools.

Functional Requirements

1. A TTA Group member shall be able to create and modify the *Allocation Disposition*.
2. A TTA Group member shall be able to enter External disposition comments, which consist of COMMENTS FOR THE PI and INTERNAL COMMENTS, using the UI or by file import.
3. For testing purposes there shall be a mechanism to automatically generate *Allocation Dispositions* for each *Allocation Request*.

Non-Functional Requirements

3.7 Allocation Approval

As a general rule committees make recommendations, whereas Directors (or their delegate) allocate telescope time. For semester *Solicitations* there is a formal process called the Director's Review, whereas for DDT *Solicitations* the Director's Delegate decides.

3.7.1 Director's Review

Stakeholder Use Cases

1. Director's Review Report

   A TTA Group member is responsible for producing a Director's Review report which is based on all proposals, the NORMALIZED LINEAR-RANK SCORE, and the *Allocation Dispositions*. The TTA Tools shall generate various metrics (tables and plots), and csv-formatted spreadsheets that will be included with the report. A TTA Group member must be able to alter any *Allocation Disposition*.

2. HSA/GMVA Proposals

   Approval of HSA and GMVA proposals may be delayed since the results from the Super TAC may not be available before the Director's Review.

Functional Requirements

1. For each *Facility* a csv-formatted file by shall be generated that lists: ALLOCATION REQUEST ID, PRINCIPAL INVESTIGATOR, NORMALIZED LINEAR-RANK SCORE, REQUESTED TIME, and APPROVED TIME (broken down by semester) for each SCHEDULING PRIORITY (A, B, C [filler], F [fixed], and N [rejected]).
2. For each *Facility* the following statistics shall be generated: the number of proposals submitted, approved (priority A, B, F), filler (C), rejected (N), and oversubscription (submitted/approved); and by proposal hours: the requested time, the available time, the approved time (priority A, B, F), filler time (C), rejected time (N), and the pressure (requested hours/available hours).
3. There shall be a mechanism for a TTA Group member to approve each *Allocation Disposition* based on results from the Director's Review.
4. For testing purposes there shall be a mechanism to automatically approve each *Allocation Disposition*. A TTA Group member shall be able to either approve all dispositions or to randomly approve dispositions.

Non-Functional Requirements

3.7.2 Director's Delegate

Stakeholder Use Cases

1. DDT Proposal

   DDT proposals receive an observatory site review. In principle the Director approves the science program, but in practice delegates this responsibility to the *Facility* head.

Functional Requirements

1. There shall be a mechanism for the Director's Delegate to approve each *Allocation Disposition*.

Non-Functional Requirements

3.8 Process Closeout

Here we describe the final steps of the TTA process where disposition letters are sent to the PI and the science program is made public depending on the *Solicitation*. Table 3 is a matrix of the different processes for each *Solicitation*.

3.8.1 Stakeholder Use Cases

1. Semester Solicitation

   For a semester *Solicitation* a TTA Group member needs to produce a TAC report which summarizes the results of the TAC recommendations (after any adjustments made by the Director). The TTA Tools shall produce metric statistics (tables and plots) that are required in the TAC report. A TTA Group member will also write an ENews article that quotes a subset of the statistics in the TAC report.

   The TTA Tools shall generate a template disposition letter for each proposal that can be reviewed and modified by a TTA Group member. There shall be a user interface that allow a TTA Group member to send the dispositions.

2. DDT Proposal

   The TTA Tools shall generate a template disposition for the given DDT proposal that can be modified and sent by a TTA Group member.

3.8.2 Functional Requirements

1. There shall be a mechanism to generate a template disposition, either for a specified proposal or for all proposals within a semester *Solicitation*. A TTA Group member shall be able to edit the disposition text. A TTA group member shall also be able to send the dispositions either in bulk (e.g., semester *Solicitations*) or one at a time (e.g., DDT *Solicitations*).

2. There shall be a mechanism for a TTA Group member to make the approved *Allocation Dispositions* public in the archive. Either for a given proposal or for all proposals within a semester *Solicitation*.

3.8.3 Non-Functional Requirements

Table 3: Proposal Process Matrix

Process	**Semester**	**DDT**	**External TAC**	**Sponsored**
Configuration	Panel	N/A	N/A	N/A
Review	Panel	Observatory Site	N/A	N/A
Disposition	TAC	OSC	External	External
Approval	DR	Delegate	External	External
Closeout	TAC Report/Letter	Letter	Letter	Letter

3.9 Project Creation

For now we focus on the creation of observing *Projects*, possible future extensions could include other types of projects (archive or processing for example). Each AUI/NA *Facility* has a unique project model and it is beyond the scope of the TTA Tools project to redefine or modify those models.

3.9.1 Stakeholder Use Cases

1. General Case

   A TTA Group member or a Telescope Operational staff member shall be able to trigger the generation of *Projects* for each facility on a single proposal, subset, or *Solicitation* basis. Safeguards should be in place to prevent the same proposal-facility *Project* from being generated more than once. It shall be possible to identify the *Projects* generated from a proposal. The requirements below define both initial and final requirements. The initial requirements are the minimum level necessary for the TTA Tools to be operational, the final state is the target *Capabilities* for *Project* completion.

2. VLA

   The system shall generate and store *Project* models suitable for use by the VLA online system.

   (a) Initial. The goal is to reproduce the current capabilities of the proposal *Project* migration and extend it in easily implemented ways. The generated *Projects* should include at minimum: Authors, FIELD SOURCES, Hours Allocation, Configuration, and Priority.

   (b) Science Ready. The system shall generate *Projects* with executable scheduling blocks suitable for execution without additional intervention.

3. GBT

   The system shall export observing session specifications suitable for import to the GBT Dynamic Scheduling System (DSS).

4. VLBA/HSA/GMVA

   The system shall produce a summary of the *Projects* to be created (including the PROJECT CODE) and the awarded time.

3.9.2 Functional Requirements

1. The system shall allow the creation of observing *Projects* for each *Allocation Request* with a positive disposition in a format appropriate for each *Facility*.

   (a) It shall be possible to extend the set of supported *Facilities*; for example, the ngVLA or a processing center.

2. Batch generation of observing *Projects* for a *Facility* shall be supported, generating all observing *Projects* from a *Solicitation*, a subset, or single projects.

   (a) The system shall maintain the linkage between a *Project* and proposal.

   (b) The system shall prevent more than one *Project* being created for any *Allocation request*.

3. For SRDP telescopes the generated *Projects* shall be executable without further intervention from the user. This implies that all observational and processing details must be derived from the proposal.

4. All generated *Projects* must conform to the *Allocation Disposition*.

3.9.3 Non-Functional Requirements

1. The user shall not be required to enter information more than once in order to observe. Thus all FIELD SOURCE and resource information must be transferred from the proposal to the *Project*.

2. The *Project* creation mechanism shall be fault tolerant, individual proposals that cause errors in the *Project* creation shall not prevent subsequent *Projects* from being created. The list of failing *Projects* shall be easily discovered and corrective action taken.

A Distributed Review Model

Here we explore a distributed review model as a possible future direction. (**N.B., these are not requirements.**) The objective is to determine what changes would be required in the system to accommodate this type of review model and determine if it is possible to accommodate with minor modifications. This is done as a hedge against future possible changes in policy making this suite of tools obsolete.

As a reference implementation we take the ALMA implementation of a distributed review. Other implementations could be chosen, but are likely to have similar requirements. In the ALMA model the proposal capture happens as described above except for the identification of exactly one author as the designated reviewer for the proposal.

Once the proposal deadline has passed, the reviewer for each proposal is cross-matched with 10 other proposals to review based on the category and keywords for the proposals. Conflicts are identified and cross matching completed again.

The designated reviewer completes a scientific review on each of the assigned proposals and enters their score and a comment through a user interface. All assigned reviews are submitted together, although the scores may be persisted prior to submission. No review panel stage is implemented, the normalized scores are ranked and serve as the input to the Time Allocation Process.

While the actual implementation of this review process would require a nearly complete re-implementation of the *Proposal Review Subsystem* to accommodate it outside of the review subsystem scope only two additional pieces of information are required: the designated reviewer and a more granular set of keywords than provided by the SCIENCE CATEGORY.

The SCIENCE CATEGORY is customized at the beginning of each cycle. If a distributed review process has been selected for a particular cycle a more granular set of SCIENCE CATEGORIES could be specified (effectively serving as keywords), the only additional requirement is the ability to specify that users shall be able to select more than one SCIENCE CATEGORY.

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