Gemini Scheduler

Work Package Implementation Stage Plan

Version 2.0 - 2022 April 14

1 Introduction

This document provides a plan for the implementation stage of the Gemini Scheduler as described in the Gemini Scheduler Software Design. This document presents the team organization for the implementation stage, identifies the core products that will be built during this stage, the schedule, key milestones, and identifies required resources for completion.

2 Team Organization

The work package team is organized as indicated in Figure 1.

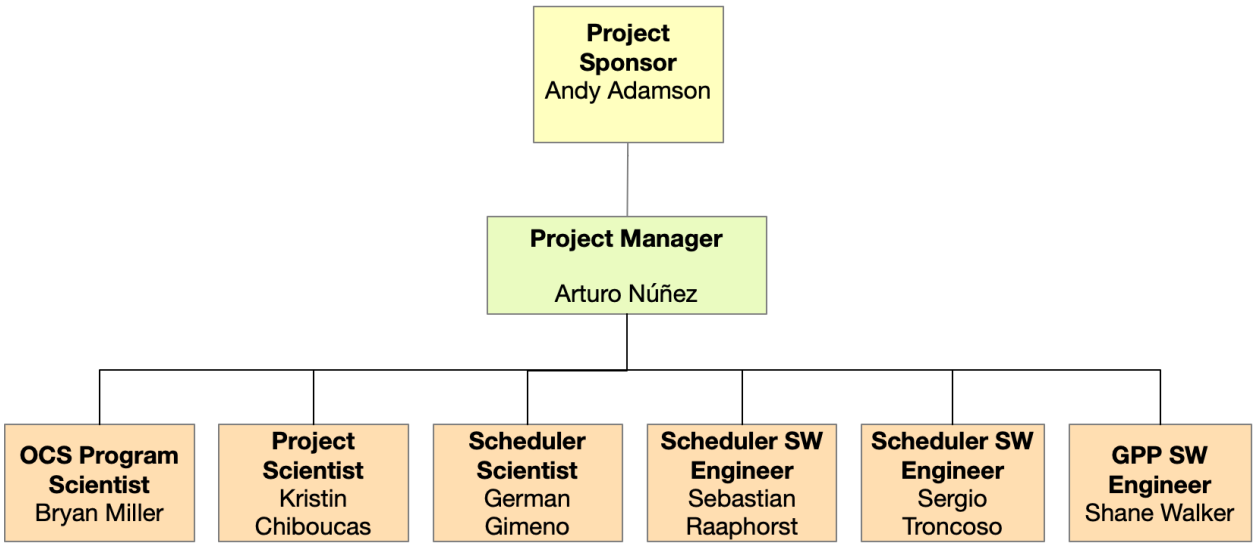

Figure 1: Internal organization of key project staff

Project Sponsor: The Project Sponsor is responsible for supporting the Project Manager and ensuring that the Project Manager performs the assigned tasks. The Project Sponsor manages the escalation process outside of the purview of the Project Manager. The Sponsor is ultimately accountable for the project's success and is the key decision maker.

Project Manager: Reports to the Project Sponsor. The Project Manager is accountable for the management of the project. Within the tolerances agreed upon with the Project Sponsor, the Project Manager has the authority to make decisions on all aspects of the project. Decisions outside the tolerances must be approved by the Sponsor.

OCS Program Scientist: Responsible for the overall scientific direction of and compatibility between the OCS Upgrades Program projects (e.g. Scheduler, GPP, Proposal Evaluation) and for algorithm development.

Project Scientist: Reports to the Project Manager. Responsible for the scientific direction pertaining to the project, science requirements, and verifying functionality.

Scheduler Scientist: Provide advice to the Project Scientist on project goals and operational aspects related to the project. Assist in defining testing procedures for the Scheduler and with the execution of these tests.

Scheduler SW Engineers: Reports to the Project Manager. Responsible for the project software technical work.

GPP SW Engineer: Provides technical advice to the project related to the integration of the Scheduler with the Gemini Program Platform.

3 Project Products

The Scheduler work package is organized as a collection of services and end user applications that will form the core products that this project will deliver. The following table provides a list of these products.

Services *The following services are required to meet requirements. This work package will provide all of these.*	
Scheduler	This is the heart of the system. The Scheduler is a service that automatically generates plans to observe groups of science programs, aiming to meet the observatory's program completion goals. The Scheduler is used in three modes: Operations, Validation and Simulation - these modes are described in detail in the Scheduler Software Design Document.
Simulation and Verification Observing Database	For simulation and verification purposes, the Scheduler relies on access to an instance of the observing database. The definition of how that database is set up is part of the scope of this work package. The database itself is provided by the Gemini Program Platform.

Simulated Calibration Service	Similar to the observing database, the calibration service is provided by the Gemini Program Platform. The definition of access and any required work to serve the simulation and verification purposes of the Scheduler is part of the scope of this work package.
Interface to Laser Target Tracking System Database	A modification to the existing LTTS APIs will be added to allow the scheduler to obtain the required information, as specified in the Software Design Document.
Simulated Environmental Monitor Service	This service provides environmental information for the verification and simulation modes of the Scheduler. For operations, the Scheduler relies on the Environmental Service provided by GPP.
Simulated Resource Service	Resource is a service provided by GPP that provides past and present availability of masks and instrument features along with the telescope and staff-engineering schedule. The Scheduler work package adds the required work for the simulation and verification modes of the Scheduler.

End User Applications *The following are the key end user tools that this work package will provide or update.*	
Schedule	This is the Queue Coordinator interface to the Scheduler used to plan engineering tasks and run simulations. This is a tool provided by this work package.
Observe	Observe is provided by the Gemini Program Platform project. The Scheduler will extend it to add a view to the Scheduler information.

4 Implementation Approach

The Scheduler will be built using Agile software methodologies that Gemini has used successfully in previous software projects. In order to manage the complexity of the work package, we are separating the implementation in two stages, described in the following sections.

4.1 Implementation Stage for Initial Science Verification

The implementation stage for system verification aims to build the foundation work for the Scheduler, focusing on the verification and operations modes. It includes

- Initial release of the Scheduler service, with support of the operations and verification modes.
- API implementation for the Gemini Program Platform (specifically, Observing Database, Calibration Service, Environment Service and Resource) and the Scheduler API itself.
- Integration of the Scheduler service with the Gemini Program's platform Observing Database Service, Calibration Service, Environmental Service and Resource Service. This includes the use of the APIs to access these services.
- Integration of the Scheduler Service with Observe. This includes the minimum work required to allow Observe get the next observation available in the plan.

Completion of this stage allows the system to be used for basic science verification. More advanced capabilities, tools and other integrations are left for the next stage.

The stage has a duration of 9 months.

4.2 Implementation Stage for Regular Operations and integration with Gemini Program Platform

This stage builds upon the products produced in the previous stage by adding:

- Integration of the Scheduler service with the Laser Target Tracking System
- Adding support for the Scheduler's simulation mode
- Implementation of the Schedule Application.
- Refinements to the integration and usability of Observe to benefit from the Scheduler - this includes ability to respond to changing plans, visibility of the current plan, etc.

At the completion of this stage, the system is ready to use for regular science operations. This stage has a duration of 13 months.

5 Overall Work Package Schedule

The following table summarizes the overall schedule of the work package, highlighting the Implementation stages described in section 4:

Project Stage	Begin	End
Concept Definition	October 2018	October 2019
Trade Studies and Scheduler Design	November 2019	May 2022
Implementation for Science Verification	May 2022	March 2023
Implementation for Regular Operations and Integration with GPP	April 2023	March 2024

6 Implementation for Science Verification Stage - Detailed Stage Plan

6.1 Stage Plan Description

As noted in Section 4, the implementation stage for science verification is focused on building an end-to-end system that can be integrated with the Gemini Program Platform, with the goal to do basic science verification. This system will be developed to a point that a usable initial release of the Scheduler service can be delivered.

In order to accomplish this, the development effort is focused on the operational and validation modes of the Scheduler, aiming to build the minimum set of features that will allow us to test the Scheduler in an operational environment. This minimum set of features include:

- A Scheduler service, with support of the operations and validation modes. Ability to generate an observing plan in near real time for night time operations.
- API implementation for the Gemini Program Platform services (specifically, Observing Database, Calibration Service, Environment Service and Resource) and the Scheduler API itself. This will include necessary mockup services that are needed for Scheduler verification.
- Integration of the Scheduler service with the Gemini Program's platform Observing Database, Calibration Service, Environmental Service and Resource. This includes the use of the APIs to access these services.

- Integration of the Scheduler Service with Observe. This includes the minimum work required to allow Observe get the next observation in the plan produced by the Scheduler.

The following specific features and components are NOT part of this stage:

- Implementation of the Scheduler Simulation Mode
- Integration with the Laser Target Tracking System
- Implementation of the Schedule Application
- Observe features required to get more than the next observation to execute (for instance, ability to offer a full view of the entire night plan directly in Observe are outside the scope of this stage).

6.2 Plan Organization

The plan is organized in three WBS items:

- Scheduler Service for Operations and Validation Software Development
- Interface Implementation
- Software Integration for Science Verification

In the next tables we provide a WBS dictionary for each one of these items.

WBS 1 - Scheduler Service for Operations and Verification Software Development *This WBS d*escribes the activities required to build the Scheduler service. We will use an iterative development process, aiming for 5 major releases, with a cadence of approximately 6 weeks each. The initial roadmap for these is described below. The content of each release is subject to modification based on the findings at each one. Every release includes the implementation and testing of the features noted. In the plan we added 25% of contingency to account for issues that might show up during development. This comes from experience during the previous work package stages.	
Release 1 Scheduler Skeleton	The goal of this release is to produce the first end-to-end version of the Scheduler service, including all its major components (Collector, Selector, Optimizer and Storage as described in the Software Design Document). A functional Scheduler is produced at the end of this iteration, with mockup services acting as data providers for the Scheduler.

Release 2 Validation Mode 1	In this release we provide all the infrastructure required to simulate GPP and other services to create a plan. The GraphQL scheduler service is added and the APIs are made available. With this release, basic testing of performance requirements can begin.
Release 3 Validation Mode 2	The Scheduler service now supports the validation mode and testing and refinements to the score metric begin.
Release 4 Operations Mode 1	With this release, we begin connecting the system to GPP. As GPP services might not be ready yet, at the very minimum the APIs will be finalized and the services not available will be stubbed. At the end of this stage, we can start testing with all the AND/OR groups features.
Release 5 Operations Mode 2	Final release completing the operations mode for system verification.

WBS 2 - Interfaces *This WBS manages the effort required to implement the major software interfaces required by the Scheduler.*	
GraphQL Environment Setup	This work produces a module to access GraphQL APIs and to provide GraphQL endpoints for the Scheduler. This is a prerequisite for the other interface work.
Observing Database API	The implementation of the APIs required by the Scheduler to access information from the Observing Database - including observation details and associated calibrations.
Calibration API	An API to access the Calibration Service to identify the necessary calibrations required for science.

Environmental API	This API provides the Scheduler with the necessary environmental information to determine a plan. The API provides notifications when conditions change that require a new plan.
Resource API	This API provides the Scheduler the necessary information about telescope and instrument resources that are needed to determine an observing plan.
Scheduler API	This implements the API that the Scheduler offers to other services (like Observe) to get information related to the plans produced, including the next observation to execute.

WBS 3 - Integration *This WBS is focused on integrating the Scheduler with external services. We distinguish two categories*.	
GPP Integration	This integration connects the Scheduler with the real GPP services that provide the information needed to compute an observing plan. The services required for this stage are the Observing Database, the Calibration Service, the Environmental Service and the Resource Service. Note that some of these might still be preliminary and simulation might be used for some of them.
Observe Integration	Initial integration with Observe is executed here. Observe will be able to obtain the next observation to execute after completion of this work. Further integration is done in the next project stage.

6.3 Plan Prerequisites

This plan assumes a successful completion of the Design Stage.

6.4 Planning Assumptions

For this plan, we assume the availability of the software and science personnel required for the completion of this stage. The integration part requires availability of the software components provided by the Gemini Program Platform.

6.5 Monitoring and Control

The work package is monitored via monthly highlight reports to the project sponsor, as part of the Gemma TDA Project.

6.6 Schedule

The Implementation schedule is shown in the following Gantt chart (in Calendar Years):

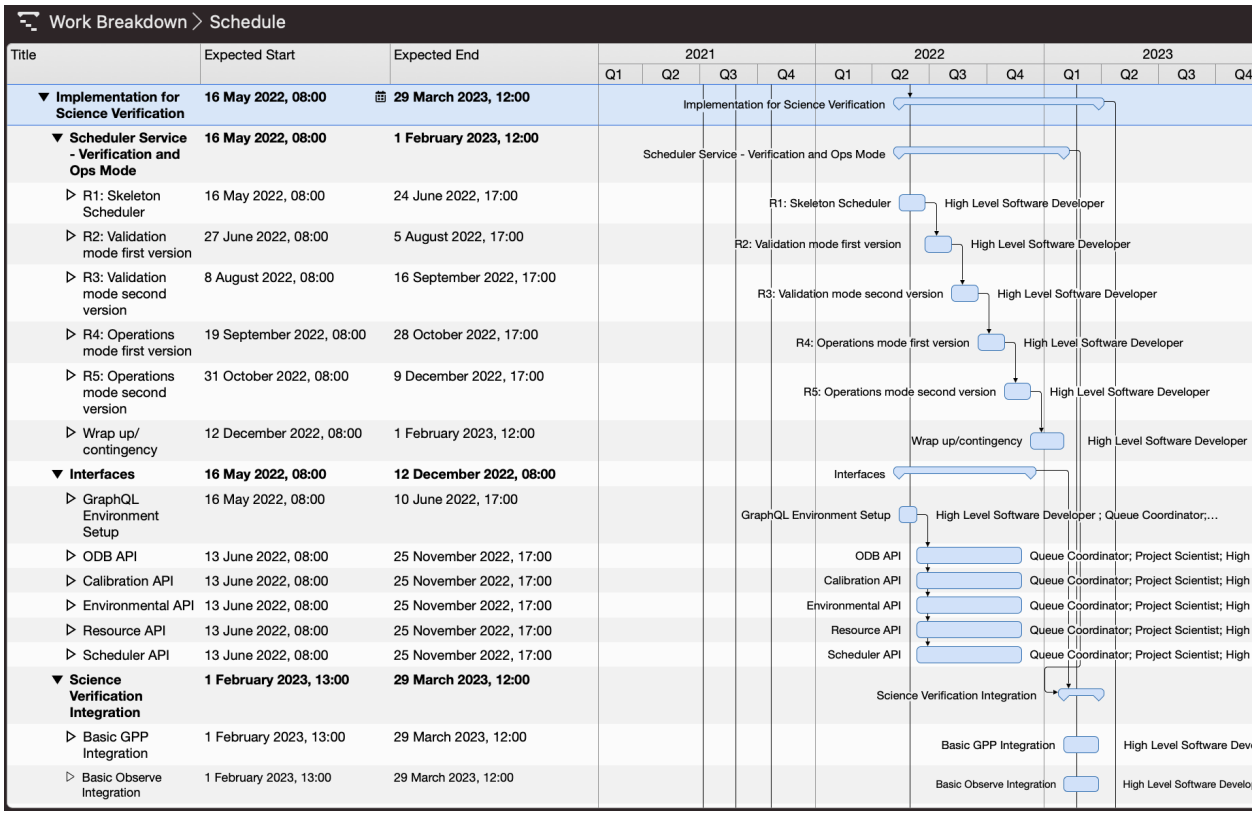

Figure 2: Scheduler Implementation for Science Verification Schedule

6.7 Milestones

A description of the main work package milestones is presented in the following table.

ID	Milestone	Expected Completion
SCH-C-01	Stage Kick Off	May 16, 2022
SCH-C-02	Scheduler Release 1 - Scheduler Skeleton	June 24, 2022
SCH-C-03	Scheduler Release 2: Validation Mode First Release	August 5, 2022
SCH-C-04	Scheduler Release 3: Validation Mode Second Release	September 16, 2022
SCH-C-05	Scheduler Release 4: Operations Mode First Release	October 28, 2022
SCH-C-06	Scheduler Release 5: Operations Mode Second Release	December 9, 2022
SCH-C-07	Integration and stage completed	March 29, 2023

6.8 Resources

The expected cost for the implementation for science verification stage is 2580 hours distributed approximately as follows:

- Software Engineering effort: 2000h (80%)
- Science effort: 580h (20%)

Project management effort is part of the GEMMA TDA Project and not accounted for in the numbers above.