Gemini Program Platform

Project Plan

Version 2.2 - Last updated: 2020 July 8

1 Introduction

This document provides a plan to build the Gemini Program Platform (GPP) as described in the GPP Software Conceptual Design and further expanded in the Inception Design Document. This document introduces the team organization, identifies the core products that will form the system, describes the project stages, schedule, key milestones, and identifies required resources for completion.

This version of the document is updated in preparation for completing the Inception Design stage. As such, we also document here the stage plan for the next project stage, the Initial Construction Stage.

2 Team Organization

The project team is organized as indicated in Figure 1.

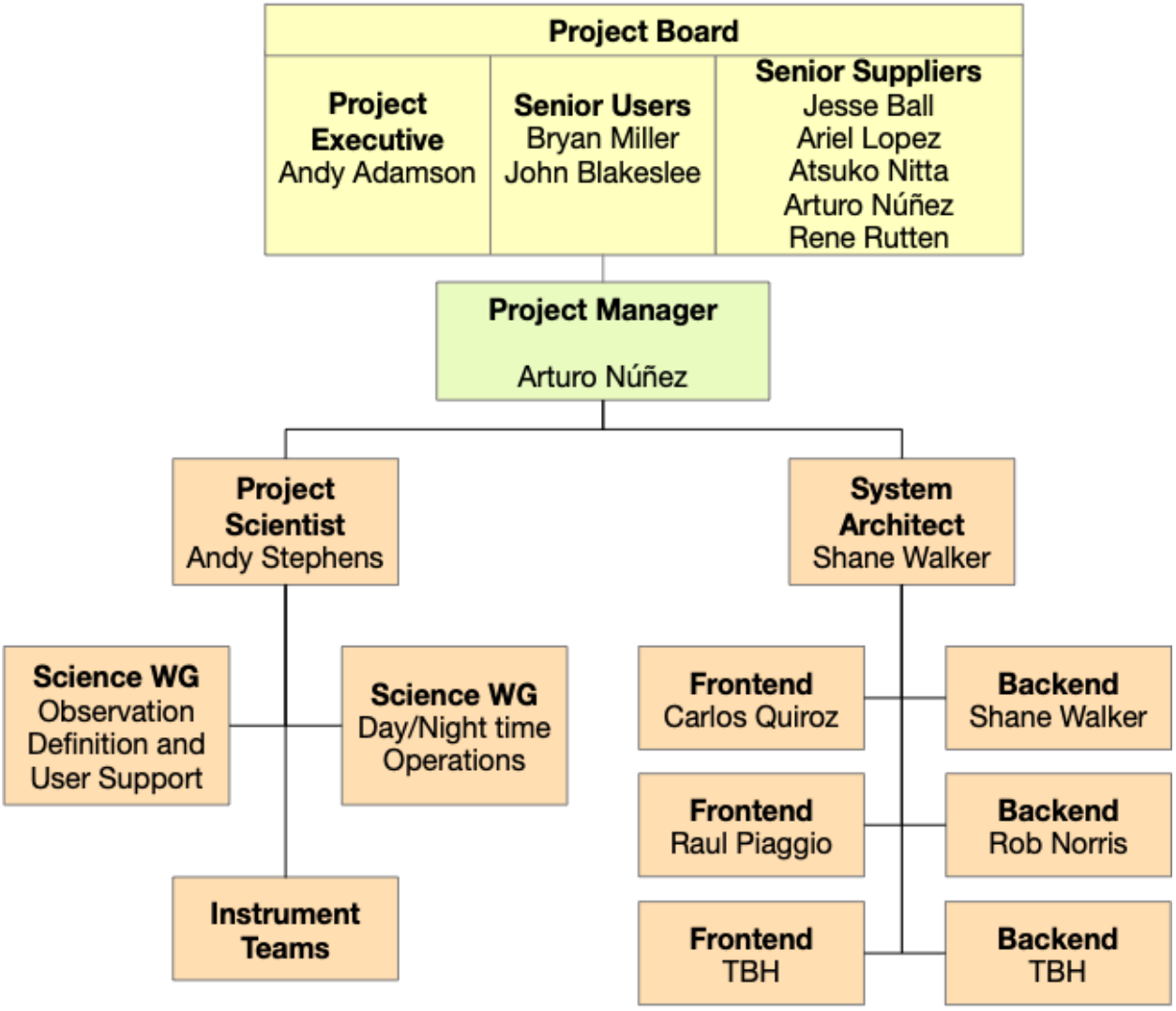

Figure 1: Internal organization of key project staff

Project Board: The Project Board is accountable to Gemini for the success of the project, and has the authority to direct the project within the remit set by Gemini as described in the project mandate. The Project Board is also responsible for the communications between the project management team and stakeholders external to the team. The Project Board is formed of a Project Executive, a Senior User and Senior Suppliers.

Project Executive: The Project Executive is responsible for supporting the Project Manager and ensuring that the Project Manager performs the assigned tasks. The Project Executive manages the escalation process outside of the purview of the Project Manager. The Project Executive works with the Project Board (Senior Users and Senior Suppliers) to make decisions outside of the Project Manager's tolerances. The Executive is ultimately accountable for the project's success and is the key decision maker.

Senior User: The Senior User is responsible for specifying the needs of those who will use the project products, for user liaison with the project management team, and for monitoring that the solution will meet those needs.

Senior Suppliers: The Senior Suppliers represent the interests of those designing, developing, facilitating, procuring and implementing the project's products. This role is accountable for the quality of the products delivered by the suppliers and is responsible for the technical integrity of the project.

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

Project Scientist: Reports to the Project Manager. Responsible for the scientific direction pertaining to the project. It is supported by science working groups (shown in Figure 2) that give advice on both observation definition and user support, and day and night time operations.

Systems Architect: Reports to the Project Manager. Responsible for the project technical direction pertaining to the project. Software engineering effort is provided by front end (user interface) and back end (middleware and database) specialists.

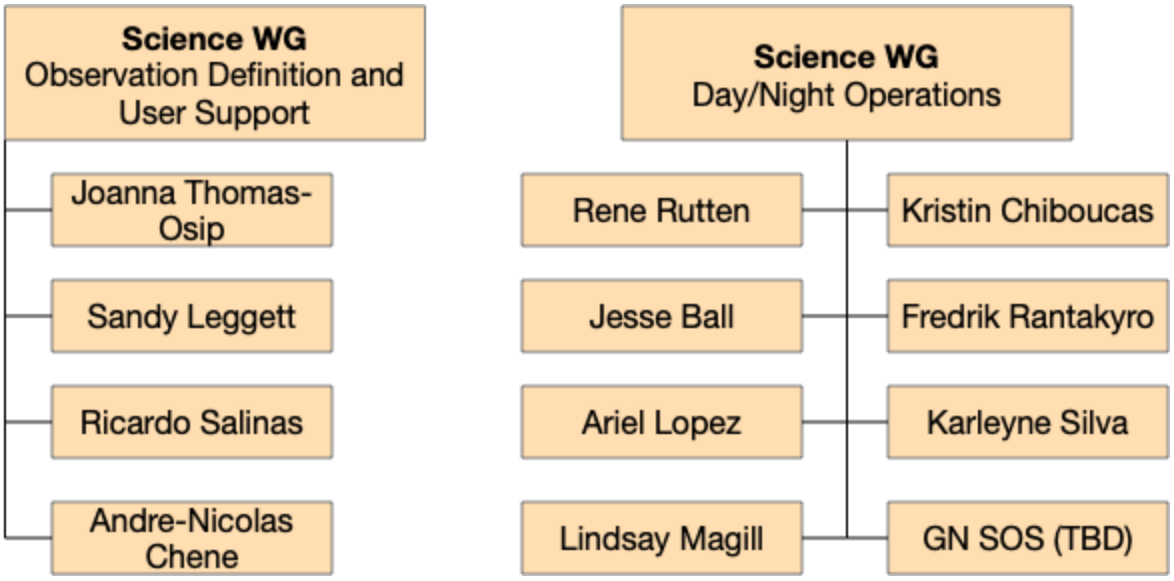

Figure 2: Science Working Groups supporting GPP

3 Project Products

The GPP is organized as a collection of services and end user applications that will form the core products that this project will deliver. Specifically, the Product Breakdown Structure (PBS) for GPP is listed below with an indication of our basis for estimating the effort required to build them:

Core End User Applications *The following are the key end user tools that GPP will provide.*	
Explore	Explore is a new web-based application that will be used to propose for time and prepare science programs. This is the largest application within GPP. It will be built using technologies similar to those used by the new web-based sequence executor.
Observe	Observe is targeted to night time operators and is envisioned as an extension to the web-based Sequence Executor with additional interfaces to incorporate user interactions with the Scheduler.
Chronicle	This is a new web-based system to provide a view of events happening at night, allow operators to comment, mark weather and

	fault loss, update time accounting in general, and make data quality assessments. It will aim to replace the existing Night Log/Obslog systems.
Auxiliary End User Applications *These applications either already exist in the current system and they will be adapted to obtain data from the new database, are relatively simple so the anticipated effort for them is smaller than for the Core End User Applications, or can be done after the core end user applications are in place.*	
Dashboard	A PI-focused mini-application that provides a listing of proposals and programs to which PIs have access along with a place to view announcements from and communications with Gemini.
Browse	A staff-oriented program-query facility used to find and open science programs in Explore, Chronicle or other apps.
Weather	Provides a user interface to the conditions server and may be used to input weather information that is not automatically ingested.
Resource	The interface to the resource tracking service used by the scheduler to determine telescope, instrument, instrument component, and staff availability.
Admin	Program administrative controls such as approving special proposals and PI change requests.
Schedule	Queue Coordinator interface to the scheduler used to plan engineering tasks and run simulations.
Reports	GPP will offer reporting capabilities using standard SQL statements against a read-only replica of the observing database. The effort here will focus on setting up this replica database, and defining the required endpoints for reports to be built. The intent is that actual reports can be written not only by software staff but also end users according to their needs.

Laser Target Tracking System	LTTS software will continue as is, with small adjustments to interact with the new observing database.
Queue Visualization	Queue Visualization will continue as is, with small adjustments to interact with the new observing database.
Manual Planning Tool	The Manual Planning tool will be the existing QPT updated to read information from the new observing database.
Services *The applications listed above require the following infrastructure services to meet their primary functions. GPP will provide all of these.*	
Observing Database	The Observing Database service includes all work on the science program model and its mapping to relational database tables. This service will be under constant development for the duration of the GPP project.
Scheduler	The scheduler will take advantage of an existing constraint solver like Gurobi. The majority of the work here will be writing the weighting function that will be optimized, providing visibility into its decisions, and user access to its configuration. This is being developed as part of the GEMMA TDA project.
Single Sign On Service	Single Sign On provides authentication services required to use the GPP applications and APIs.
Target Database	Much of the target database has been prototyped successfully. The remaining work is to make it a standalone service with a GraphQL API.
Automated Guide Star Service	The Automated Guide Star Service will be a rewrite of the existing AGS, incorporating lessons learned and providing probe range and science area models that can be shared directly with the Program Tool.
Integration Time Calculator	The Integration Time Calculator service work involves creating a small wrapper around the existing ITC such that it is accessible to other applications and services via GraphQL.
Resource Service	The Resource Service replaces the existing ICTD, adding visibility into past and present availability of masks and instrument features along with the telescope and staff-engineering schedule.

Calibration Service	The Calibration Service is entirely new and will determine which calibrations are required (and which are already present) for a given dataset.
Environmental Monitor	The Environmental Monitor tracks existing automated sources and manually-provided conditions information in a database such that it is available for the Scheduler.
Instrument Service	The Instrument Service will be an update to the existing new Seqexec backend such that it works with the remainder of the GPP.
Control Systems Bridge Service	The control systems bridge simply exposes low-level telescope and instrument status to the remainder of the GPP.

4 Project Stages

GPP will be built using Agile software methodologies that Gemini has used successfully in previous software projects. The Project stages are illustrated below and discussed in the next sections.

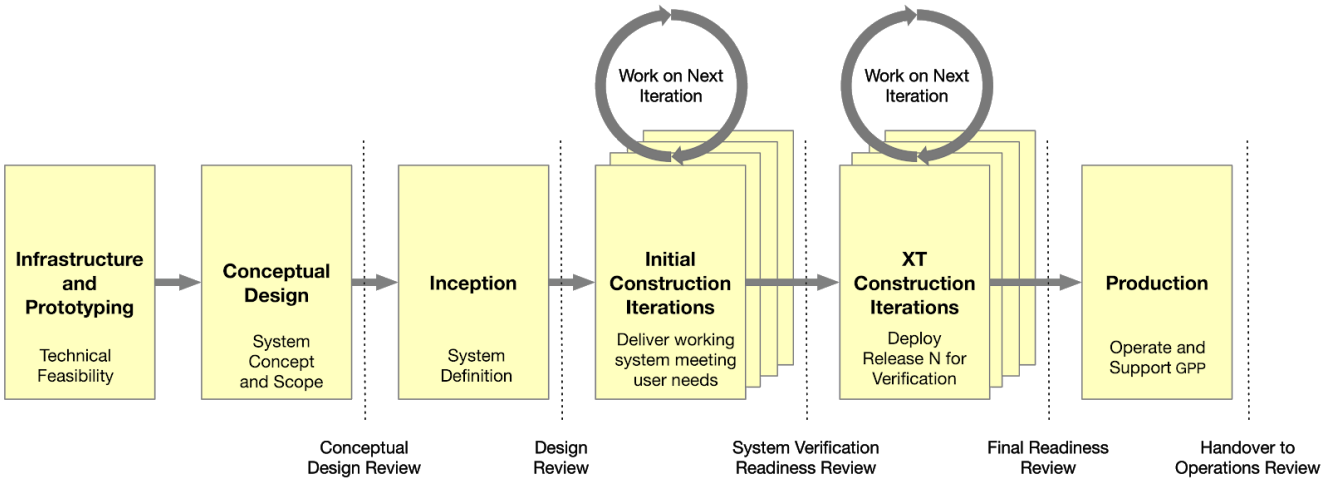

Figure 3: GPP Project Stages and Stage Reviews

4.1 Infrastructure and Prototyping

This stage was completed by the end of 2018. The core software infrastructure that supports the Program Platform was prototyped during this stage, based on lessons learned from the first

generation of the system. These components are required irrespective of what tools or operational model we choose to implement. In particular, this infrastructure provided:

- A sequence model - a representation of science sequences. Includes a new sequence model (with F2 as a working example), its corresponding program model, a new observing database, authentication, backups, automatic deployment infrastructure and mechanisms to import content from the existing database into the new one.
- Instrument model - a way of representing Gemini instruments and their properties in a relational database.
- Target Model - a representation of targets, and their characteristics. This provides a unified way of handling targets in the GPP, and it is the foundation block for services that use targets like the Automated Guide Star service.

4.2 Conceptual Design Stage

This stage was completed in October 2019. The goals of this stage were:

- Agree upon and baseline the GPP high-level scope
- Review and agree upon an Operational Concept Document for GPP.
- Review and agree upon a proposed software concept for GPP.
- Review and agree upon a proposed verification process concept to ensure the system can be built with required verification prior to its final release.

To achieve these goals, this stage produced an Operational Concept Document (OCD) for the GPP describing the overarching goals of the system focusing on addressing key shortcoming in the existing software. The OCD introduces a software concept to address them, including a proposal for system verification during construction.

An initial GPP architecture was described, identifying the core software products that will be built. A plan was presented to assess the project feasibility and required funding.

4.3 Inception Stage

The inception stage starts after the concept of operations is baselined and GPP scope is approved. The goals of this stage are:

- Obtain initial product feature set and high level requirements for the system
- Continue to refine the system and product architecture
- Update project plan for construction

- Prepare project teams for construction

The focus during this stage is on the core end-user products (Explore, Observe, and Chronicle) and their underlying support services, and to identify core features with sufficient detail to plan the initial milestones and allocate staff resources for the next phase.

The plan for construction is updated, identifying top level milestones that will be used to guide the software development work. This stage ends with a design review to ensure the goals are met and the software is sufficiently defined to begin the construction stage.

4.4 Initial Construction Stage

This stage covers the initial implementation of the software products that form the new system, to the point that a usable initial release may be delivered to external PIs for verification. This is an iterative process of implementation and refinement with the end goal of producing an end-to-end system for at least a single observing mode of a single instrument (we have decided to begin with GMOS Long Slit). It will be capable of creating a proposal, refining its phase 2 details, and executing the resulting observations.

We anticipate beginning with the core program model, along with services like integration time calculation and automatic guide star search in order to enable progress on Explore. Early milestones will focus on providing the basic software functionality to enable support of automated GMOS long slit sequences. We will then turn to the corresponding APIs and software infrastructure that enable progress on other tools, like Observe.

The stage ends with a system verification readiness review that will confirm the system is sufficiently defined to allow PIs to use it for verification.

In the following sections, we list the products that will be incrementally built during this stage. A collection of supporting applications will be left to the next stage since they are not critical to achieving our goal of providing an initial release to external PIs.

4.4.1 Core End User Applications

During initial Construction, our goal is to provide the first release of the Core End User Applications to support the goals defined in this stage:

- Explore
- Observe
- Chronicle

These systems are briefly described in section 3, and expanded in great detail in the GPP Inception Design Documentation.

Explore is the system that will be most feature-complete and will drive most of the development during the stage. Observe and Chronicle will be developed to a minimum set of features that will allow these systems to be used for system verification during the XT stage.

Details of these products are discussed in section 3. They will be implemented by a team of high-level software engineers with web development and user interface design experience in collaboration with science experts including astronomers and telescope operators.

This stage will include the development of the majority of features in Explore described in the inception design document. However, the following features will **not** be included (the figure in parenthesis indicates the figure in the inception design document where the feature is shown and described):

- Advanced Configuration Panel/Offset Generator (Fig 3.4)
- Sequence Reordering and step edition (Fig 3.5)
- Non sidereal target support (Fig 3.6)
- Target Import/Export (Fig 3.6)
- Program Section/Change Requests (Fig 3.13)
- Status/Announcements/Communications (Fig 4.1)

The rest of functionality described in the Inception Design document for Explore will be developed during this stage.

In Observe we anticipate updating the existing web based sequence executor to be able to read sequences from the new observing database, use the new GMOS sequence definition, add support for sequence events, sequence synchronization and to support acquisitions. This will allow us to use Observe to run sequences with GMOS at night for system verification using the new system. Additional user interface support for the scheduler will be added in the next stage.

For Chronicle, we will provide a minimum version of this tool that will support:

- Adding comments (Fig 6.2)
- Editing dataset conditions, QA state, and comment (Fig. 6.3)
- Adding weather loss (Fig 6.4)
- Integration with the fault reporting system (Fig 6.4)
- Viewing all the events during a night or in a program (Fig 6.13).

The figures in parenthesis indicate where these features are introduced in the inception design document.

4.4.2 Gemini Program Platform Services

The Gemini Program Platform Services enable the user interface applications. During this stage, the following services are implemented sufficiently to support the core end user application functionality described in the previous section:

- Authentication Service (Single Sign-On SSO)
- Automated Guide Star Service
- Calibration Service
- Control System Bridge
- Environmental Monitor Service
- Instrument Service
- Integration Time Calculators
- Observing Database
- Resource Service
- Scheduler
- Target Database

These services will be built in parallel with the required applications that will consume them. Further details of these services are described in Section 3.

At a lower level, a number of business-logic libraries will be needed to support the services and applications in general. For example these include a software model for Gemini science programs, a model for proposals, catalog search, target math and scheduling calculations. These will be developed during this stage and widely shared across many services and applications.

Finally underlying everything are general purpose components like our GraphQL service API library. A system of the size and complexity of GPP requires making basic infrastructure decisions about logging, profiling, and user session management (for example) and working through these details will take time during this stage as well.

4.5 XT Stage

The readiness review from the Initial Construction stage will confirm that we have produced a minimally functional version of Explore, Observe, and Chronicle, with adequate documentation and training materials for at least a single observing mode and instrument. In other words, the XT Stage begins when we have sufficient support to offer our applications to external PIs for verification in practice, obtaining real science data at night.

The XT stage will then proceed in an iterative process much like the initial construction stage. Here we incorporate improvements that have been identified through usage of the system along with adding new observing modes and instruments. At this stage, we expect to start

using the system via the “XT” mode introduced in the GPP Operational Concept Document and expanded in the Inception Design Document.

Testers consisting of Gemini staff, NGO staff, and community users will be recruited during the inception and initial construction phases and will be involved as soon as there are new features and interfaces to evaluate. Initially the testers may help generate test observations or translate observations from programs in the legacy system. XT time will likely need to be oversubscribed in order to provide a sufficient body of observations to test all modes and evaluate scheduler performance; and the amount of on-sky time required for XT will likely increase through this stage.

The stage ends with a final readiness review, to approve the use of the system for regular operations.

4.5.1 Auxiliary Applications

In addition to perfecting the major applications and services begun in the Initial Construction Stage, during the XT Stage we will produce the following auxiliary applications:

- Reports
- Laser Target Tracking System (LTTS)
- Queue Visualization
- Manual Planning Tool

We believe these products can be scheduled for later in the process, as they are either less complex or built based on existing products and not required for an initial public offering.

4.6 Production Stage

This stage is when the GPP will become fully operational. Tasks will include final testing and verification of requirements, completion of maintenance and user documentation, and training. At this stage, we expect to retire the “XT” mode and turn off the old system from operations. The process to do this will be detailed later in the project, and will complete with a Handover to Operations review. That will mark the end of the project.

5 Project Schedule

The following table summarizes the overall project schedule:

Project Stage	Begin	End
Infrastructure and Prototyping	January 2018	December 2018

Conceptual Design	January 2019	October 17, 2019
Inception Stage	Oct 18, 2019	June 26, 2020
Initial Construction Stage	July 1, 2020	May, 2022
XT Stage	May, 2022	June, 2023
Production Stage	June, 2023	November, 2023

6 Project Resources

We estimate about 22.4 FTE over 6 years (2018-2023) to complete this project, distributed as follows:

15.5 FTE High Level Software Engineers
2.9 FTE Project Scientist
0.6 FTE SOS
2.2 FTE Scientist/Astronomers
1.2 FTE Project Management

A breakdown of this effort per project stage is as follows:

Project Stage	Effort	% of total effort	Stage Duration
Infrastructure and Prototyping	1.5 FTE	7%	1 year
Conceptual Design	2.1 FTE	10%	10 months
Inception Stage	0.9 FTE	4%	9 months
Initial Construction Stage	11.4 FTE	51%	2 years
XT Stage	5.6 FTE	25%	1 year
Production Stage	0.8 FTE	4%	5 months

Non-labor budget is for travel to support project reviews, technical team meetings and training. We estimate these to be in the order of $90K, distributed as follows:

FY2020: 30K - Design Review plus technical visits during construction and technical training
FY2021: 12K - Technical visits during construction plus technical training.

FY2022: 28K - Technical visits during construction, technical training and stage review.
FY2023: 20K - Training and final release travel support.

Note: Gemini's Fiscal Years (FY) are from October 1 to September 30. FY2020 = October 1, 2019 to September 30, 2020.

7 Construction Stage Plan

7.1 Plan Description

The Gemini Program Platform identifies a number of end user products, and corresponding supporting services. The construction stage is focused on building an end-to-end system for at least a single observing mode for a single instrument. We have selected GMOS Long Slit to begin. This system will be developed to a point that a usable initial release can be delivered to external PIs for verification during the next stage, XT. The system will be capable of creating a proposal, refining its phase 2 details, and executing the resulting observations.

In order to accomplish this, the development effort is focused on the Core end user tools, services, libraries and infrastructure described in section 4.4.

7.2 Plan Organization

The plan is organized in four WBS items:

- WBS 4.1 Software Development
- WBS 4.2 Process Definition
- WBS 4.3 Stage Review
- WBS 4.4 Stage Management

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

WBS 4.1 - Software Development *This WBS d*escribes the activities required to build the stage products, which are discussed in detail in section 4.4.	
WBS 4.1.1 GPP Bootstrapping	The goal of this WBS item is creating the necessary software infrastructure, development frameworks and libraries that are required to build the system. During this stage, work on libraries and

	infrastructure components for both backend and front end are developed, software development processes for deployment, logging and tracing are set up, to a sufficient level such as application development can begin.
WBS 4.1.2 End User Tools	This item contains the work to build the Core End User Applications - Explore, Observe and Chronicle
WBS 4.1.2.1 Explore	Explore is the biggest system that is developed during this stage. In this WBS item we include the effort to build 8 to 10 interim releases of explore, with a cadence of approximately 2 months each. The first release starts upon completion of the bootstrapping work described above. This first release will be focused on building the first “Explore” application, with a focus on target Information features. The second release will add additional program information and basic instrument details. We expect the third release to provide sufficient support for sequence information and associated APIs, such as work on Observe can begin. Every release includes planning and refinement for the next release, so details on each one are subject to change based on progress, risks, and schedule.
WBS 4.1.2.2 Observe	This item contains the necessary work to build Observe to sufficient detail to be able to run a GMOS Long Slit observation defined in Explore. We are aiming to complete this WBS item as early as possible to allow end to end testing early in the development cycle. We anticipate this work can begin after the completion of the third interim release of Explore.
WBS 4.1.2.3 Chronicle	This item focused on building Chronicle at a minimum level such such as it is usable for XT verification. This item starts upon completion of Observe, due to software resource limitations.
WBS 4.1.3 Science consulting and testing	This item contains the effort from the science team for consulting and testing during construction. This effort is available during the whole software development process, providing input to the software development team and assisting with testing of interim releases.

WBS 4.2 - Process Definition *This WBS manages the effort required to define processes and plans necessary to support GPP during the XT stage*.	
WBS 4.2.1 XT Time Allocation Process	This WBS item covers the required work to define the process that Gemini will use to initiate XT verification stage by May 2022. As we aim to offer the system for real science, definition of the process to invite users, time allocation, approvals from stakeholders, etc need to be in place by May 2021 so the required night-time requests is factored in the plans for the semesters 2022A and 2022B.
WBS 4.2.2 Transition to operations plan	This item produces the plan to transition from the old OCS to the new system. Although some details are already sketched, with the completion and approval of the XT time allocation process, we expect to refine this plan in preparation for the next stage.

WBS 4.3 - Stage Review *This WBS is focused on preparing the necessary documentation and associated material for the XT verification readiness review that we plan to have prior to launching the system for XT*.	
WBS 4.3.1 Preparation	Once Explore, Chronicle, Observe, and the underlying services supporting these tools have reached enough maturity, we will prepare a readiness review to ensure XT can begin.
WBS 4.3.1 Review	This WBS item accounts for the effort required to carry out the readiness review for XT itself.

WBS 4.4 - Stage Management

This WBS accounts for project management and science leadership required to complete the construction stage.	
WBS 4.4.1 Science Leadership	This WBS item accounts for the scientific leadership required to complete this stage, provided by both the project scientist and the senior user.
WBS 4.4.2 Project Management	This WBS item accounts for the project management effort required during this stage.

7.3 Plan Prerequisites

This plan assumes a successful completion of the Inception Design Stage, which includes a baselined Inception Design Document.

7.4 Planning Assumptions

For this plan, we assume the availability of the software and science personnel required for the completion of this stage, as detailed in section 7.8.

7.5 Monitoring and Control

The project will continue being monitored via monthly highlight reports to the project executive.

7.6 Schedule

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

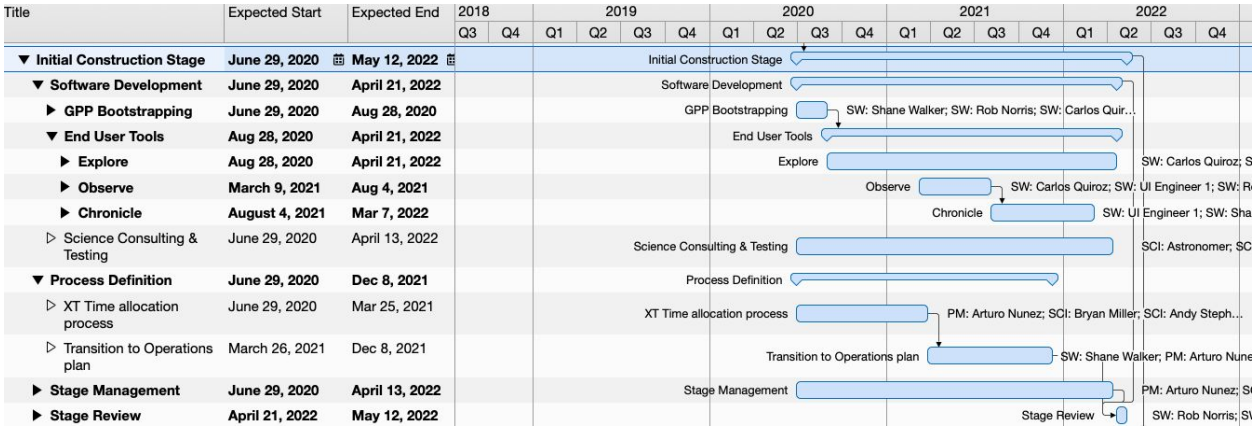

Figure 4: GPP Construction Schedule

7.7 Milestones

The following diagram depicts the main milestones we will be tracking during construction:

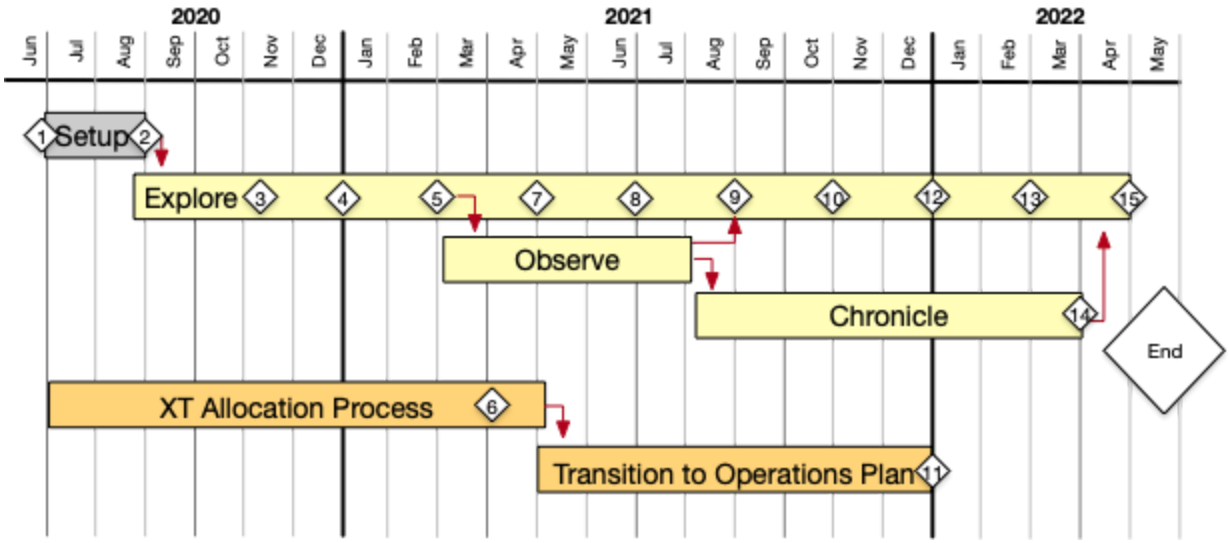

Figure 5: GPP Construction key milestones

A description of each milestone is presented in the following table. Numbers in diamonds in Figure 5 correspond to each milestone ID number in the table. Highlighted in **bold** are the milestones that are tracked as part of the FY2021 Gemini Program Operations Plan (GPP-C-03 and GPP-C-05):

ID	Milestone	Expected Completion

GPP-C-01	Stage kick off	June 29, 2020
GPP-C-02	GPP Bootstrapping completed	August 28, 2020
GPP-C-03	**Explore first milestone released - Target Info**	**November 3, 2020**
GPP-C-04	Explore second milestone release - Program info	Jan 14, 2021
GPP-C-05	**Explore 3rd interim milestone release. GPP model support ready for Observe**	**March 9, 2021**
GPP-C-06	XT time allocation process defined	March 25, 2021
GPP-C-07	Explore 4th interim milestone release	May 6, 2021
GPP-C-08	Explore 5th interim milestone release	July 1, 2021
GPP-C-09	Explore 6th interim milestone release. First Observe and Explore integration test	August 26, 2021
GPP-C-10	Explore 7th interim milestone release	Oct 27, 2021
GPP-C-11	Transition to operations plan completed	December 8, 2021
GPP-C-12	Explore 8th interim milestone release	Jan 5, 2022
GPP-C-13	Explore 9th interim milestone release	March 2, 2022
GPP-C-14	Basic Chronicle released	March 7, 2022
GPP-C-15	Explore for XT ready	April 21, 2022
GPP-C-16	END: XT Readiness review	May 9, 2022
GPP-C-17	END: Initial Construction stage completed	May 16, 2022

7.8 Resources

The expected cost for the initial construction stage is 19,606 hours or 11.4 FTE from July 2020 to May 2022, distributed approximately as follows:

- Software Engineering effort: 15,500h (79%)
- Science and SOS effort: 3,100h (16%)

- Project Management Effort: 1000h (5%)

In addition, we estimate about $40K ($12K in FY2021, $28K in FY2021) for travel required for cross site technical visits and a stage review.

8 Risk Management

Program risks are managed using the Gemini PMO risk management processes, and reported on a monthly basis to the project executive. A snapshot of the project risk registry can be found here, and the working version is maintained in a Google sheet.

9 Appendix - Questions and Answers

The following table contains all the questions received by the review committee and the corresponding responses. Initials of review committee members are indicated in the second column:

- BG: Bob Goodrich
- IJ: Inger Jorgensen
- AB: Alan Bridger
- JC: Joy Chavez
- JW: Jonelle Walsh

Section	Who	Question	Answer
2	BG	It would have been good to mention the software engineers in Section 6 doing the actual work. Even then, this seems a little top heavy. In section 7.8, by percentage of hours, it sounds more reasonable.	Agree. Section 2 of the project plan has been updated to show this.
3	IJ	Will there be a separate review of this critical service? (Scheduler)	Yes - this is scheduled for Q2FY2021
3	AB	I'm not sure this is the right document for this comment, but: Which service deals with roles or groups that control permissions and authorizations?	One of the first services we will need to develop is the Single Sign On service (not pictured in the context diagram). It will authenticate with ORCiD for external users and AD for internal users, and provide a secure token that can be verified and used by any other GPP service. It will provide a mechanism to grant and revoke user roles and permissions.
4.1	BG	It's interesting that prototyping was done before conceptual design. My guess is that that is not strictly true. Water under the bridge, in any case.	Noted. We probably should have called that "feasibility stage" instead of prototyping.
4.4.1	JC	Of this document? Or the Inception Design Document? (Section 3)	Of this document. Section 3 present a summary of all the services we plan to use in GPP

4.4.1	JW	Why were these features chosen to be excluded from development at this stage? Are they considered more complex tasks? Are they considered lower in priority compared to the rest of the Explore features?	They are considered lower priority for this stage (as they aren't needed to fulfill the stage goal).
4.4.2	BG	Will databases be prefilled with existing data to provide a more realistic environment?	Yes, existing programs will be translated and imported into the new database. The observations they contain will appear as manually configured.
4.4.2	JC	Of this document? (Section 3)	Of this document. Section 3 present a summary of all the services we plan to use in GPP
4.5	BG	How much time on sky will be allotted to XT proposals? Will time be allocated outside the normal TAC process (to commission the software)? What if no proposers want to use the new system? GMOS long-slit is probably a fairly narrow slice of all proposals.	We anticipate about ~5% of telescope time used for XT. Part of our plan in the next stage is to define incentives for people to use the new system such as it is attractive for users to try the new system using a "shared risk mode" - this definition will be completed before May 2021 and it's the scope of WBS 4.2.1. For the initial mode (GMOS-LS) we expect to test the phase 1 process there, and therefore we aim to treat it using a separate TAC process. For modes that are added later during the XT stage, one approach could be to supplement time awards to active programs.
4.5.1	BG	I'm unclear whether this means after the XT stage or late in the XT stage. Why would you need LTTS for GMOS long-slit observations? Will developing these products during XT slow down getting to the Production Stage?	This means after the Initial Construction stage (i.e, after May 2022) - at that point everything needed for GMOS long-slit is in place and testing is ongoing. We expect at that point to initiate construction of the "rest" of the system, which includes these auxiliary applications with GPP.
4.6	BG	"Fully operational" means all instruments, all observing modes? Five months (less than a semester) seems short for this.	Correct. The work to build all modes is during the XT stage (May 2022-June 2023). The production stage is to transition the system from development to operations, complete training and documentation.

6	BG	Is this 22.4 FTE years, or an average of 22.4 FTEs over 5 years? This started in 2018; how much resources are needed to completion? Is there a breakdown by stage?	Yes, this is 22.4 FTE to complete the whole project. A breakdown of FTE/stage is here: * Feasibility/Infrastructure: 1.5FTE * Conceptual Design: 2.1 FTE * Inception Design: 0.9 FTE * Initial Construction: 11.4 FTE * XT Construction: 5.6 FTE * Production Stage: 0.8FTE
6	IJ	I'd like to second Bob's comments. Can we have a breakdown of effort by quarter. I think you mean 22.4FTE in total over the 5 years. Having the breakdown will make it clearer where the high intensity effort is located in time. Also, what are the conflicts for resources with GEMMA TDA? The Scheduler comes from GEMMA TDA.	Correct. Scheduler specific effort is not accounted for in this, as it's part of GEMMA TDA. The project treats the scheduler as a black box (using an agreed API). There is a separate software engineer dedicated to the scheduler work to avoid resource conflicts.
6	AB	Are these all co-located or distributed? And if distributed how do you plan to handle the collaborative aspects of the work?	Work is distributed - we use the following tools to enable this collaboration: a) All source code is open source and managed in GitHub b) Slack is used for daily coordination and collaboration among the different teams and time zones. c) Zoom is used for virtual "face to face" meetings and reviews. d) JIRA or Clubhouse (tbd) will be used for software task tracking (to be defined during project bootstrapping)
6	IJ	How much of this travel is strictly needed? What happens if we cannot travel say the rest of FY2020 (very likely) and all of FY2021 (quite possible) due to COVID-19?	Contingency plans include moving physical meetings to virtual meetings blocking calendars to avoid other distractions. For training, the industry is also adapting to Covid-19 so we expect that if travel is restricted, we'll have ways to attend training remotely.
7.1	JW	When do the remaining instruments/modes get built?	The remaining modes are built during the XT Stage (May 2022-June 2023)
7.2	BG	Who is the science team? They are not listed in the team organization figure. Does the team include all manner of observers (not just GMOS, but AO, TOO, Solar System, etc.)?	The core team has representatives from various groups such as QCs and SOSs. As we implement the different instruments will involve the instrument teams. Also, more staff and external users will be requested for testing. Section 2 of the project plan was updated to show the science team.

7.2	BG	What is the application deadline for 2022A? May 2022 sounds too late to initiate the XT verification stage, even for 2022B proposals.	We aim to have all this sorted out by May 2021 (one year before XT is ready in May 2022). We might begin offering existing PIs in 2022A the option to do their science twice for instance. These details are what we intend to get sorted out before May 2021 so we can present it to the board in preparation for the FY2022 plans.
7.2	AB	I was looking for a description of the agile development process - sprint/planning cadence etc. Is it developed as part of this item?	Correct - it will be refined during the bootstrapping process. In previous projects we have used a 2 week sprint/planning size. We are considering adopting a Kanban approach for task management and use planning meetings every two weeks to adjust priorities and check progress. The stage has identified 8 major milestones during construction that will be used to guide development and help the project stay on track.
7.6	IJ	Please make it clear the Gantt chart uses calendar years, not fiscal years (while the rest of Gemini's planning is now on fiscal years). Please state somewhere for external readers, what months the fiscal years correspond to.	Done. Updated section 6 to introduce FY and noted the gantt chart is in calendar years.
7.7	IJ	Can we highlight the 2 milestones we decided to put in the FY2021 POP?	Yes. Section 7.7 was improved to better illustrate milestones and we have highlighted the FY2021 POP ones.
7.8	IJ	11.4FTE, 1 FTE=1720h of work	Yes - that's a typo - thanks for catching that error.