GEMINI OBSERVATORY

Exploring the Universe, Sharing its Wonders

Legacy OCS and Operations Concepts

SCI-OCS3-OCD-02

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Version History

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Version	**Author(s)**	**Description of Version**	**Date Completed**
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1 Purpose and Scope

The purpose of this document is to provide the top-level view of the Observatory Control System (OCS) and operational concepts and terms as they exist in 2019. This provides background and a comparison to concepts for future systems such as the OCS Upgrades Program.

2 Applicable Documents

Acronym and Term List

3 Background Information

3.1 History of Needed Capability

Gemini Observatory is a general-purpose observatory that must meet the 8-meter optical-infrared observation needs of a diverse international partnership. In order to make the most of this expensive and still rare resource the observatory was designed to be operated mostly in “queue” mode in which observations are matched to the current conditions. This means that both the hardware and software must be designed with flexibility and ease-of-use in mind. The OCS provides the high-level user interface to the observatory, hiding the complex details of the underlying systems from the scientists and operators. It provides a common user interface for easier and more efficient operations. For example, observers don’t have to learn and remember different interfaces for different instruments, all the facility instruments are controlled with a single interface and they behave in a similar way.

3.2 Organizational Infrastructure

This section describes the current (2019) physical and technological environments in which the OCS is embedded.

- Telescopes - two 8.1-m telescopes
    - Physical locations
        - Gemini South: 75 km east of La Serena, Chile at 2722 m in the foothills of the Andes mountains.
        - Gemini North: 70 km west of Hilo, HI at 4213 m on the summit of Maunakea.
    - Site monitoring capabilities - some shared with other facilities
        - Gemini South: cloud cameras, precipitation sensors, MASS/DIMM, weather tower, top-ring camera, dust monitor, all-sky camera
        - Gemini North: cloud cameras, precipitation sensors, weather tower, MASS/DIMM, PWV sensor
    - EPICS real-time control systems running on either real-time Linux or VxWorks.
- Instruments
    - 4 Facility instruments + Adaptive Optics at each site
    - Most, if not all, mounted facility instruments used on any given queue night
    - Multiple visitor instruments every semester
    - A facility instrument delivered every ~5 years
- Base facilities
    - Gemini South: La Serena, Chile
    - Gemini North: Hilo, HI
    - Most observing is now done from the base facility control rooms. Summit observing is still required for some visitor instruments and GeMS laser operations (Gemini South).
- In-house IT infrastructure
    - Summits and base facilities have data centers with NetApp storage systems and servers including VMware virtual machine systems.
    - Summit servers contain copies of the DSS images and the UCAC4 and PPMXL star catalogs.
    - Hilo is connected to Gemini North via a fiber-optic cable to Maunakea.

    - Internet connections between La Serena and Cerro Pachon are via a new fiber-optic cable shared with LSST and a microwave connection from Telconor.
    - External internet connectivity - commercial Internet and Internet2
- Current use of cloud/external services
    - The Gemini Observatory Archive runs in Amazon Web Services (AWS)
    - We access catalogs and services from JPL, ESO, IPAC, and CDS (Harvard and Strasbourg)

3.3 Stakeholders

The main stakeholders in the system and their interest in and use of the OCS are:

- Gemini directorate and oversight committees
    - The observing system must enable the capabilities to achieve the organizational goals
    - The user interfaces must promote the use of Gemini and enhance its image, and at least not be a problem and discourage use.
- Gemini science operations staff
    - Must have tools to do efficient standard day/night operations, including nightly queue planning
    - Must have tools for running the proposal evaluation process and for semester planning.
    - Must have tools for monitoring performance and making reports.
    - Instrument teams must have tools for instrument commissioning, monitoring, and engineering
    - Must have tools for executing observations, logging, and data quality assessment
    - Must have tools for program/user support
    - Must be able to easily access and maintain documentation
- Gemini software engineering staff
    - Must be able to develop and maintain the system with reasonable efficiency
    - It must be possible to recruit new staff with the skills needed to work on the system with a minimum of training (e.g. having to learn a new programming language)
    - The operations team must have tools and documentation for troubleshooting and maintaining the systems.
- Gemini engineering staff
    - Daytime staff use the OCS for daytime checks and instrument and telescope engineering
- NGO staff
    - Must have tools for running the NTAC processes
    - Must have tools to fulfill their support roles and monitor their participants' programs
- NTAC and ITAC members
    - Must have tools for evaluating and ranking proposals
    - Must have access to the ITAC or equivalent software for allocating time and filling the queue.
    - Must have tools to provide feedback to proposers
- Community users
    - Must have tools for submitting proposals
    - Must have tools for preparing, monitoring, and managing the observations
    - Must have tools/capabilities for remote eavesdropping
    - Visiting instrument teams must have access to an API that allows visiting instruments to interact with the telescope systems.
    - Visiting observers must have tools for executing observations (similar to Gemini staff)

4 Existing Systems and Operations

4.1 General Concepts

The following are basic definitions of terms and concepts. These are derived from the legacy system but have been updated for the proposed system.

4.1.1 International Partnership and Levels of Participation

Gemini is an international partnership composed of a variety of participants, each with a share of the available observing time. Different types of participants have access to different facilities and opportunities. The types of participants are:

- Full participants have access to both sites and all instruments and proposal avenues. They maintain National Gemini Offices (NGOs) that help with user support.
- Hosts (CL and HI) only have access to the site that they host, e.g. Chile only has access to Gemini South, but they otherwise have access to all instruments and proposal routes. Hosts maintain NGOs.
- Limited-term collaborators have access to a subset of facilities and modes (for example, no joint proposals) based on their individual agreements.
- Exchange partners trade time on their facilities for time on Gemini.

The number of participants and their shares will change with time. The international agreement binding the full participants is renegotiated about every 5 years. Limited-term collaborators and exchange partners can change at any time.

4.1.2 Variety of Ways to Obtain Observing Time

Time for experiments on Gemini is allocated using a variety of processes and on different timescales. The current avenues are given in the table below.

Proposal Process	**Frequency**	**Fraction of Time**	**Duration of Project**
Queue/Classical	Every 6 months	~70%	6 - 12 months
Large and Long Programs	Every year	20%	Up to 6 semesters
Fast Turnaround	Every month	10%	3 months
Director's time and Poor Weather	Any time	<5%	Weeks to months
Demo Science and System Verification	Special cases		Weeks to months

New proposal routes and observing mode can change with time. Large and long programs and Fast Turnaround were implemented in the last 8 years. The number of participants that contribute to Large and Long Programs can change with time. New proposal routes may be developed as part of AEON.

4.1.3 Proposal

A proposal is the basic organizational unit for a request to use the observatory to conduct an experiment. A proposal has the following characteristics:

- It has a specific science goal being done by a specific team. Prior to submission access to the proposal information is limited to proposal team members and GPP administrators. After submission access is limited to appropriate NGO and Gemini staff.
- It has a unique Gemini **proposal id**. Gemini participants may add their own identifications.
- The **principal investigator** (PI) is the user responsible for the proposal and is the default contact.
- **Co-investigators** are the team members who are not the PI.
- A proposal includes the scientific rationale for the experiment, a technical analysis of the feasibility, the team, the list of targets, the instrument configurations that are needed, and the time requested from the participants. Other information may be required to aid in the assessment by a Time Allocation Committee (TAC)
- Proposals are not made public. They can be accessed by Gemini and NGO staff who are responsible for proposal handling and the TAC processes and by TAC and ITAC members. Statistics about time requests for different instruments and modes may be included in public reports as long as the individual proposal cannot be identified.

4.1.4 Program

A program is the basic organizational unit for an experiment or project that has been granted time to use the observatory. A program has the following characteristics:

- It has a specific science goal being done by a specific team. Access to the program information is limited to team members and appropriate staff.
- It has a unique Gemini **program id**.
- The **principal investigator** (PI) is the user responsible for the program and is the default contact.
- **Co-investigators** are the team members who are not the PI.
- A program has a specific amount of **allocated time** to carry out observations using the telescopes during a limited period of time. Different participants in the observatory can allocate time to a single, joint, program.
- It has a **scientific ranking** that determines the importance or priority of that program with respect to other programs. Historically programs have had one scientific ranking (band). In general a program could be allocated different amounts of time with different rankings.
- The following information about a program can be made public:
    - Title
    - PI name
    - Time allocated
    - Ranking(s)
    - Proposal abstract
    - Instruments used
    - Headers of images taken unless permission is granted to hide the headers during the proprietary period
    - Data files and observing logs become public after a **proprietary period**, usually a few months, that depends on the type of program

4.1.5 Observation

An observation is a part of a program that defines a set of actions to be done by the telescope system in order to obtain data at a region of the sky with one instrument. An observation has a unique **observation id** that is based on the program id. The telescope may make position offsets near the **base position** of the observation that is used for slewing the telescope. For observations of non-sidereal targets the position of the telescope will change slowly with time. An observation has a priority that indicates its importance within the program. The total time needed to execute the observation can be calculated from the sequence steps plus overhead information. An observation consists of the following components:

- Targets
- Observation priority
- Conditions constraints
- Timing constraints
- Sequence steps that give an instrument/telescope/GCAL configuration at each step. This includes acquisition steps as well as GCAL calibrations (arcs and flats). Each step in a sequence has an “observation class” that determines whether that step is charged to the program, the partner, or daytime (no charge).

4.1.5.1 Targets

Targets are the celestial objects of interest to, or subjects of, the observations. ToO targets are placeholders when the target information is not available at the time of the proposal. Non-ToO targets include the main science object, guide stars, acquisition or other reference objects. A **base position** must be defined for the initial telescope position. If an instrument can observe more than one target simultaneously, then a common base position must be defined. Target information includes:

- Coordinates on the sky in a defined system as a function of time (including proper motions or non-sidereal rates, all the information needed to point the telescope)
- Brightnesses in defined bandpasses
- Structural information (e.g. size, brightness profiles)
- Spectral energy distribution (SED)
- Type (e.g. base, WFS, blind-offset, user, etc)

Targets in a program are approved by the proposal evaluation process and only these targets can be observed. Changes to targets must be approved by the appropriate Head of Science Operations.

4.1.5.2 Observation Priority

An observation can have a priority of High, Medium, or Low that indicates the relative importance within the program. If there are several observations in a program in the same part of the sky, then the QCs use the priority to help them decide which to schedule first.

4.1.5.3 Conditions Constraints

Conditions constraints are the sky conditions under which the observation may be executed. These currently include image quality, sky brightness, cloud cover, and water vapor specified as percentile bins (e.g. IQ50%, IQ70%, IQ85%, IQAny) that indicate the likelihood of occurrence. The correspondence to site-specific physical conditions is given in a set of online tables. An observation may be executed in the conditions that are at least as good as the constraints, but not worse.

Conditions are approved by the evaluation process. Conditions constraints may be relaxed at any time but making them more restrictive (better conditions) requires approval by the appropriate Head of Science Operations (HSO).

4.1.5.4 Timing Constraints

Timing constraints are the periods of time during which an observation must be executed. The current timing windows are absolute intervals of time specified in UTC. An observation can have multiple timing windows in order to catch periodic or episodic events.

4.1.5.5 Sequence

A sequence is the list of steps that will be carried out by the telescope system. Each step defines a configuration of the telescope and instrument and some action (usually take an exposure). In the legacy system the acquisition steps are defined in a separate observations, or sequences, because of limitations in the OT search capability.

4.1.6 Observation Workflow

The science teams prepare observations starting with provided templates and libraries and then submit them to their contact scientists for checking and final submission to the queue for scheduling. The status of an observation within the workflow is tracked with the “Phase 2 Status” field. The workflow is shown in Figure 1 and the details of the various steps are given below.

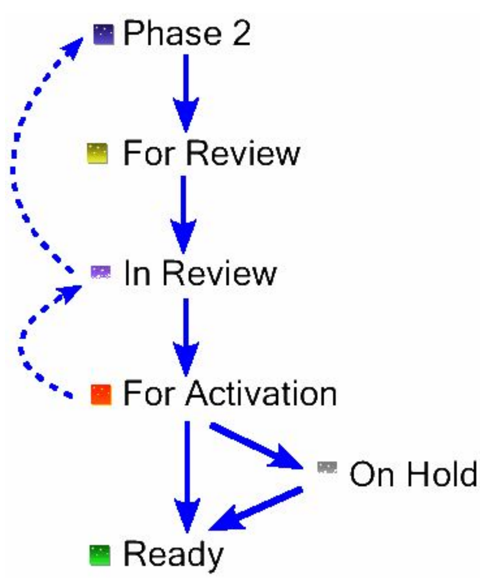

Figure 1. Observation workflow and Phase 2 Status states for the legacy OCS.

1. Skeletons and other newly created observations have status **Phase 2** indicating that the detailed definition of the observation is in progress.
2. Observations are set to **For Review** to indicate that they are ready for checking by the Principal Support staff who provides Phase II support. This sends an email notification to the support scientists.

3. Observations are set to **In Review** to indicate that the Principal Support staff are actively reviewing them. If any problems are found then may be set back to **Phase 2** for further work by the PI.
4. Observations are set to **For Activation** to indicate that they are ready for final verification by the Additional Support staff, if the Principal Support is not a Gemini staff member. If any problems are found then they may be marked back to **For Review** or Phase 2 for further work by the Principal Support staff or the PI.
5. **On Hold** observations have been checked and can be executed but are waiting on something. They are usually active templates for Target of Opportunity triggers.
6. Observations marked **Ready** may be scheduled by the QC and executed by the observer.

Users with PI privileges can only set an observation from **Phase 2** to **For Review** or, if the observation has ToO status, from **On Hold** to **Ready.** NGO staff can set the status up to **For Activation**. Gemini staff can change the status to any state.

4.1.7 Time Allocation

The fundamental currency of the observatory is available time. The participants expect to be able to allocate their share of the available telescope time for their highly ranked experiments. The ITAC process is used to merge the ranked lists of programs from each participant so that each receives their share of time in the different bands. Conditions and RA/Dec bins are filled during the process so that the resulting queue has a good chance of being completed if weather loss is not above average.

4.1.8 Program, Partner, and Daytime Time Charging

The time used on the telescopes is tracked so that the observatory knows when an experiment has used up its allocated time and is complete. While the time available to a participant is no longer adjusted based on the executed time, time accounting is still needed to monitor performance using metrics such as completion rates.

The time charged to an experiment is split into three categories: "program", "partner", and "daytime." Program time is used to execute the nighttime science observations (between nautical twilights) plus any calibrations over the baseline set, and is charged to the participants that provided the time for the project. Partner time is used for a default set of "baseline" calibrations, and is charged to the originating participant or project class (e.g. LLP, FT). Daytime is used for calibrations that are executed outside of nautical twilight, and they are not charged to any participant or project class. This arrangement was designed to ensure that every program has a minimum set of calibrations for use by future investigators who download the data from the science archive once they have become publicly available. The sum of the program and partner times, or execution time, is the total time needed to carry out a project and this is the time that needs to be allocated during the queue filling process. In the legacy system the science teams only see the "program" value.

4.2 Current Software Components

The current OCS includes the following software components:

1. Phase I Tool (PIT)

2. Phase I backend servers
3. Integration Time Calculators (ITCs)
4. ITAC software
5. Observing Tool (OT)
6. Queue Visualization Tool (QVis)
7. Observing DataBase (ODB) and underlying services including
    a. Automated Guide Star (AGS) service
    b. smartGCAL
    c. URL triggering API
    d. JPL Horizons ephemerides download
    e. Reports generation - public and internal
    f. Daily backups
8. Queue Planning Tool (QPT)
9. Observing Log (Obslog)
10. Instrument Configuration Tracking Database (ICTD)
11. Laser Target Tracking System (LTTS)
12. Sequence Executor (Seqexec)
13. Data Handling System (DHS)
14. Gemini Instrument Application Interface (GIAPI)
15. Telescope Control Console (TCC) and Telescope Status Display (TSD)

Additional software used as part of the process but not managed by the high-level software group includes:

- Nightlog - supported by the science staff
- Plan for the Week - supported by ITS
- Fault Reporting System (FRS) - supported by ITS
- Gemini Engineering Archive (GEA) - supported by the software group
- Acquisition tools (gacq, pygacq) - supported by science staff and SUSD
- FITS servers and science archive - supported by SUSD
- Data reduction and analysis tools (Gemini IRAF/Python, DRAGONS, QAP) - supported by SUSD
- Gemini MOS Mask Preparation Software (GMMPS) - supported by the science staff
- Fast-turnaround (FT) software system - supported by ITS
- Gemini blogs (QC and SOS notes) - supported by ITS
- Opswiki (including the Transition wiki) - supported by ITS
- Internal web pages (Drupal and classic html) - supported by ITS
- Public web pages (Drupal) - supported by ITS
- QLT3 - supported by the science staff
- Other scistaff scripts (e.g. obslog handling, data checking, weather alarms, mask management aids, OT XML parsing for search, etc) - supported by the science staff

The OCS also interacts with the real-time software of the instruments and telescope systems. This is mostly via the seqexec and the TCC.

4.3 Legacy Workflow

A full workflow diagram of the legacy OCS is given in Figure 2. A brief description of the workflow for the biannual semester proposal process and the tools used at each step are given below. Figures 3-5 present the tools and interfaces at each step in more detail.

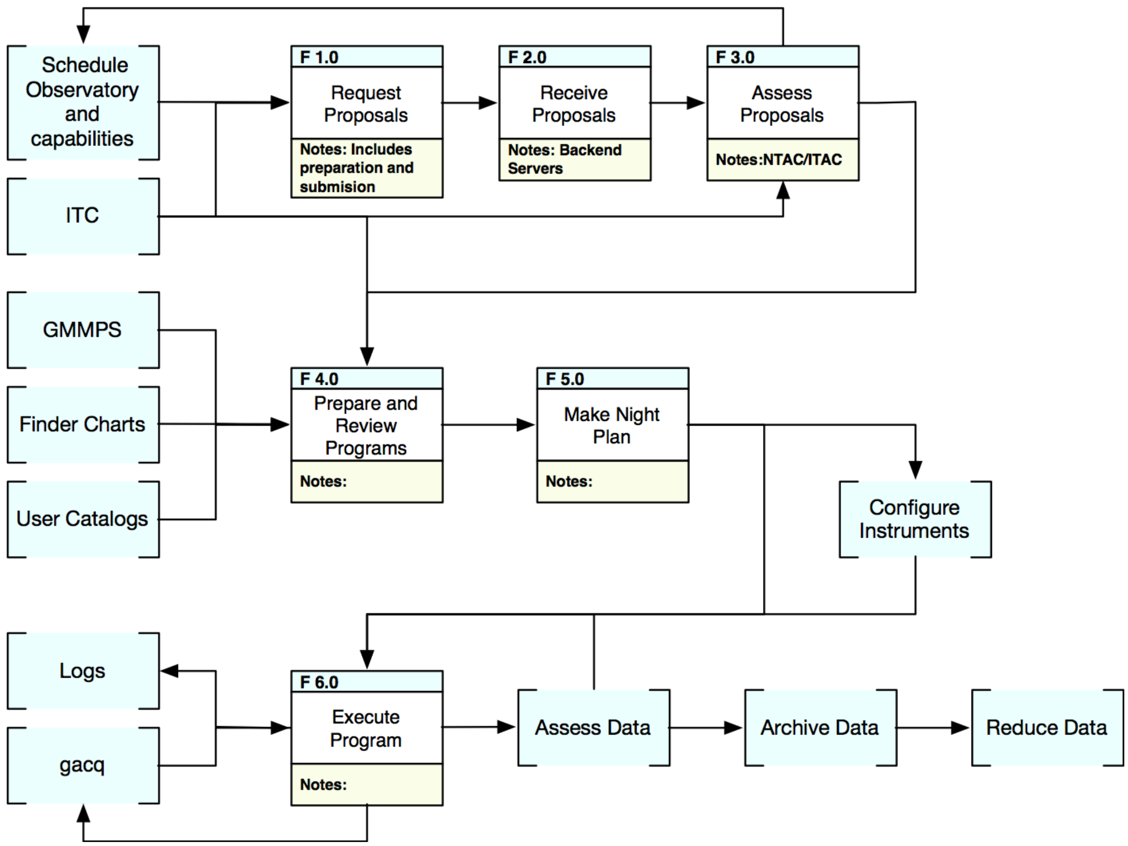

Figure 2. Full functional workflow diagram of the legacy Observatory Control System.

F1. Request proposals

a. The observatory recommends the engineering and science time fractions for the upcoming semester. The Science and Technology Advisory Committee (STAC) is asked for comments. The recommendations are then reviewed, updated if necessary, and finally approved by the Gemini Board.
b. Using the Board-approved science time fractions, the Operations Working Group (Gemini staff and NGO heads) agree on the instruments and time to be offered and major schedule constraints such as engineering shutdowns and instrument availability. A call for proposals is issued (Figure 3).
c. Astronomers use the instrument web pages to discover what instrument capabilities are available that may meet their science requirements.
d. Astronomers then use the ITCs and instrument sensitivity page to determine which of the possible instrument options are feasible for their experiments. This usually involves experimentation with conditions. They will end up calculating exposure times needed to achieve the required signal-to-noise (S/N) for representative targets given instrument configurations and conditions constraints. Representative results have to be saved as PDF files for inclusion with the proposal document.
e. Astronomers write the “essay sections”, including the science and technical justifications, using provided LaTeX or Word document templates that define the required sections. The result is saved as a PDF file that must include the example ITC PDFs. The result is the attachment PDF.
f. Astronomers use the PIT to format the full proposal and submit it. They have to provide title/abstract, team members, observations (target, configuration, conditions, time),

proposal type, time requests, etc. The PDF attachment is linked to it and during submission the proposal files are sent to the proposal servers.

g. The PIT makes use of the following services:
    i. Simbad/NED/Horizons target lookup
    ii. AGS server for guide star searches
    iii. Gemini Observatory Archive for duplication checks
h. The PIT uses a 'Phase 1' model for programs and observations.

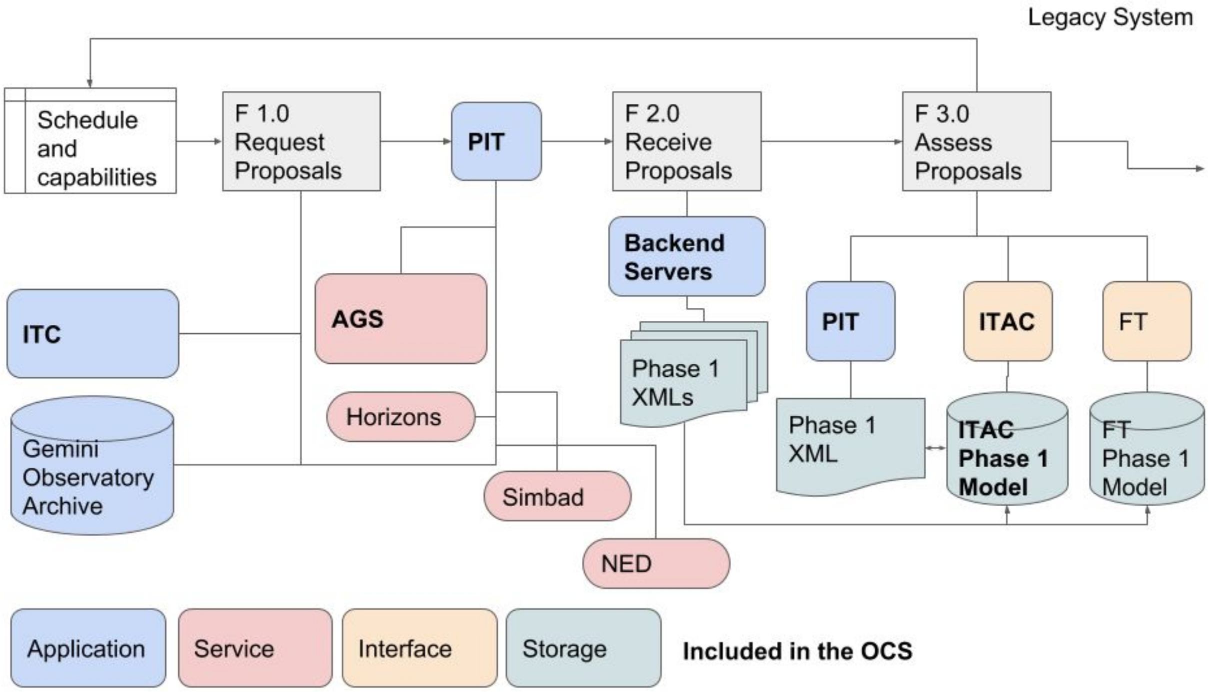

Figure 3. Functional workflow diagram of the legacy system for the semester proposal request and assessment steps (Phase 1). Pieces that are considered part of the OCS are indicated with a bold font. Lines that cross do not signify a connection. However, lines that join with a T do have a connection or common path.

F2. Receive proposals

a. A proposal submissions consists of an XML file containing the information entered in the PIT and the PDF attachment. These are received by "backend" web servers (cgi scripts). There is one configuration for each participant or proposal type (e.g. fast turnaround or director's time). The files are numbered and stored in a directory based on the semester. Upon successfully receiving a proposal the backend server sends a notification back to the PIT and includes the reference number. The PIT displays that the proposal has been received, the reference number, and a contact email as confirmation to the PI. At the moment no emails are sent to the PI confirming the submission.
b. Once a proposal is received the PIT prevents further editing unless a new copy is opened. Submitted proposals cannot be overwritten. If a PI notices a mistake they have to submit again and they will receive a new proposal reference id.
c. The backend service also includes a p1monitor that reformats the proposal file names, creates the proposal summary PDF (PIT plus attachment information), and can send an email announcement to one email address per backend. There is one email exploder (Google group) per backend. Members of the exploders include the relevant NGO and Gemini staff who need to be advised when a proposal has arrived.

F3. Assess proposals

a. Until the 2019B semester round NGOs would access the proposals either using the web interfaces to the backends or with the announcement emails sent by the p1monitor.
b. NGOs can use the PDF summaries generated by the p1monitor or generate their own using the PIT or the p1pdfmaker command-line utility.
c. Each partner then runs their own national TAC (NTAC) processes. A 'joint proposal database' is used to track technical assessments of joint proposals (proposals requesting time from more than one participant).
d. At the end of the NTAC processes each NGO returns a 'package' (tar file) of XML files and attachment PDFs of ranked proposals that should be considered for scheduling. These are ingested into the ITAC software database.
e. Starting with 2019B the ITAC staff use a web-based system based on the Fast Turnaround application so that there is less transferring of XML or tar files.
f. The ITAC software is used to generate the final queues by filling condition/RA/Dec bins. Many iterations are run as participants modify rankings or edit programs so that they will fit. Often programs have to be exported to Phase 1 XMLs and imported into the PIT before they can be edited.
g. The ITAC software uses a related but different Phase 1 model for representing programs.

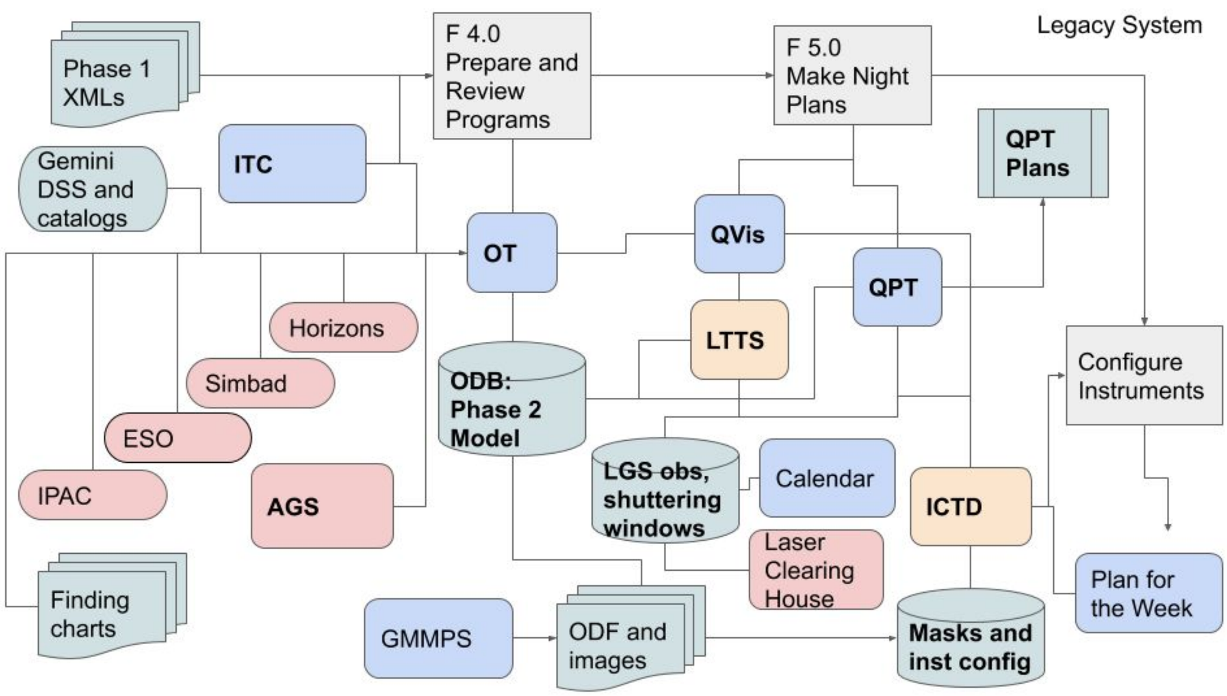

Figure 4. Functional workflow diagram of the legacy system for the program preparation (Phase 2) and nightly queue planning steps.

F4. Prepare and review programs

a. After the Gemini director approves the final list of program from the ITAC and the NGO and staff contacts have been assigned, the programs are exported to XML files by the ITAC software and then ingested into the appropriate observing database (ODB) at each site (Figure 4). Initial programs contain PI information, the Phase I files (XMLs and PDFs) the list of targets that passed ITAC, and template observations created based on the mode requested and filled in with the information provided in the PIT.

b. Successful PIs then receive an email with the time that they have been allocated, the program id (e.g G(N/S)-YYYYS-Q/C-NNN), and a program key password that they will need to authenticate with the ODB using their OT.
c. Non-ToO program PIs start the Phase 2 process, This is the process that is the most confusing and time-consuming for users. They start by making target-independent updates to the template observations. Then they apply the targets to the templates to the targets to create the full observations that will actually be executed. They next make target-specific changes to each observation (e.g. length of the sequence, set PA, check auto-selected guide star or manually select one). They must also check that the configurations of the associated calibration observations match the science observations. Example libraries can be downloaded with common cases.
    i. When the PI feels that they have completed preparing the observations they set them to an observation status of "For Review" in the OT and sync the program with the ODB.
    ii. The PI will often create finding charts and then upload them as part of the program with the OT. The finding charts are transferred to the internal Gemini web server.
    iii. An iterative review process then proceeds with two levels of contact scientist checks until the observations are deemed ready for execution and a Gemini staff contact scientist sets their observation status to "Prepared/Ready".
d. For ToO programs, the PI or the contact scientist usually create or copy a set of "ToO template" observations, full observations w/o defined targets), that will be used for the ToO triggers. After any checks these observation templates are given an observation status of "On Hold" so that the PI can use them for triggering.
e. PIs get help from the Gemini web pages and tutorials, submitting a helpdesk ticket, or, more commonly, emailing or calling their principal contact scientist.
f. If PIs need to change targets, significantly change the instrument configuration, or use better than approved conditions they must email the appropriate Head of Science Operations (HSO) with the request.
g. Finding charts have to be created by the PI and then uploaded to the program with the OT. However, the finding charts are not associated with observations. They are put in a folder that observatory staff can access via a web browser. Observers have to hunt to find the correct chart for a target.
h. PIs of MOS programs create their MOS mask designs using the Gemini MOS Mask Preparation Software (GMMPS). The images used and the FITS files that define the positions of the slits are also uploaded and made part of the program using the OT. Again, these are not associated with particular observations, so PIs must make sure that each mask name that they type into an observation is correct and corresponds to a mask file attachment.
i. The ODB copies the FITS images and tables for mask designs to the appropriate directories where SOSs review the designs and ingest the information into the local Instrument Configuration Tracking Database (ICTD). This is used for requesting that masks be cut and then tracking and managing the locations of the masks.
j. Programs in the ODB are stored using a "Phase II" model different from that used by the PIT or the ITAC software.
k. The ODBs are not relational databases. The programs are java objects that are loaded into physical RAM on the ODB servers.
l. The ODBs have the following internal services
    i. JPL Horizons service (non-sidereal target name lookup and ephemeris download)

    ii. Datamanager (communication with the FITS servers and archive)
    iii. Automatic Guide Star service (AGS)
    iv. Reports generation service
    v. Obslog service
    vi. smartGCAL service
    vii. URL triggering service
    viii. ITC
m. The OT and ODB also interface with the following Gemini tools and services
    i. TCC
    ii. Seqexec
    iii. Guide star catalog servers
    iv. DSS image servers
    v. FITS servers and the Gemini Observatory Archive
n. The OT and ODBs make use of the following external services
    i. Simbad
    ii. JPL Horizons
    iii. DSS image server at ESO
    iv. 2MASS image server at IPAC

F5. Make night plan

a. Core Queue Coordinators (QCs) at each site keep track of the overall progress of the queue and make suggestions about priorities. They often make use of the Queue Visualization (QVis) tool and the OT Browser (search tool) in the OT.
b. QCs at each site make the daily queue plans using the Queue Planning Tool (QPT). The QPT queries the Instrument Configuration Tracking Database (ICTD) to set the list of available components (e.g slits, filters, gratings) and MOS masks. Using this list the QPT presents the available “Ready” observations for a selected set of conditions. The QC then places observations on a timeline for the night. Usually plans have to be made for several weather “variants” (sets of conditions). The final plan is then “published” to the Gemini internal web site as a static HTML page.
c. The QCs must look ahead several days and anticipate what observations will be the most important to execute with the available instruments in the expected conditions and lunar phase. They then use the ICTD to request changes to instrument components, e.g. GMOS gratings and masks, so that the highest science-ranked observations are available. The ICTD change requests are added to the Plan for the Week application that is used to manage the daily telescope activities.
d. Daytime SOSs do a wide variety of activities including checking and processing data, managing the MOS mask cutting and tracking process using the ICTD, and running daily instrument checks using the OT to confirm that the instruments are ready for the night.
e. The QPT has interfaces to the following system:
    i. ODB
    ii. LTTS
    iii. ICTD
    iv. Internal web server
    v. Plan directory at the Cerro Pachon summit
f. The ICTD interfaces with
    i. Directories for importing mask files and exporting cutting instructions
    ii. Instrument lookup tables
    iii. Plan for the Week
g. The LTTS interfaces with

i. A Google calendar of laser runs - the information is entered manually from other telescope schedules
ii. The US Space Command's Laser Clearing House (LCH, via email)

h. The QPT stores observations using a "mini-model" that is a subset of the full Phase II model used by the ODB.

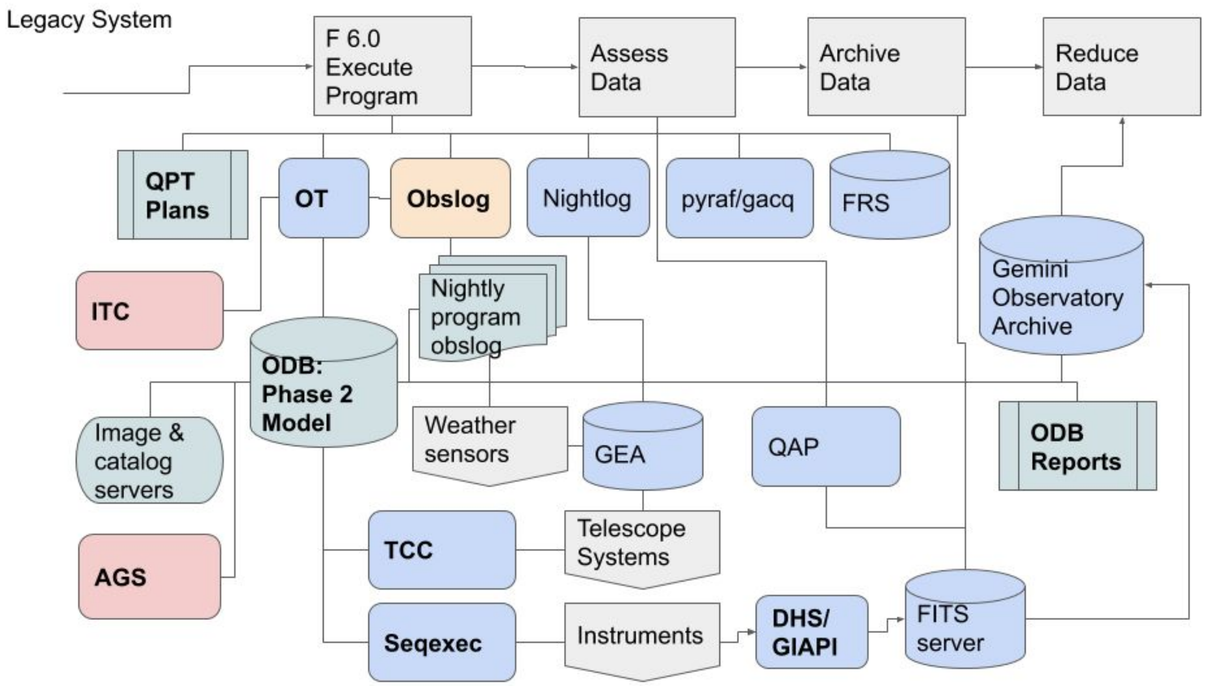

Figure 5. Functional workflow diagram of the legacy system for the program execution, assessment, and archiving steps.

F6. Execute program (observation)

a. The observer may be an SOS or a Gemini or visiting astronomer. They determine the current conditions and then select the observation to do from the variant in the published plan that matches the conditions and the queue priorities listed in the top of the plan and/or variant. They use the OT to add the observation to the "Session Queue" that can be seen by both the sequence executor (seqexec) and the Telescope Control Console (TCC) (Figure 5).
b. The telescope operator, an SOS, loads the observation into the TCC, slews the telescope to the target, and sets up the guiding.
c. The observer loads the observation "sequence" into the seqexec and uses it to configure the instrument and execute the sequence or list of steps that make up the observation.
   i. The observer uses an IRAF script called 'gacq' to do target acquisitions if needed.
   ii. Observers monitor the data using quicklook tools (e.g. QLT3), IRAF, special instrument pipelines (e.g. GPI), and the results of the Quality Assessment Pipeline (QAP) for direct images. The observer will then set the QA state for each dataset in the OT to either 'Pass', 'Usable', or 'Fail'. The OT passes this information to the local FITS server that updates the FITS headers of the images.
   iii. Comments to the PIs about datasets or events that affect the observation are written into the obslog using either the OT or the e-obslog web form.

    iv. If the conditions change so that they no longer meet the requirements of the program, then the observation will usually be stopped and the observer will select a new observation from the variant of the plan corresponding to the new conditions.

d. The FITS files that are generated by the instruments via the data handling system (DHS) or the Gemini Instruments Application Interface (GIAPI) are transferred to the Gemini Observatory Archive (GOA) via the FITS servers.
e. The night staff also keeps a record of the night's activities in the nightlog. This is entered and then emailed in the morning using a web form.
f. Night time calibrations such as flats and arcs are included in the templates and automatically configured. Infrared photometric standards and telluric-correction stars, selected by the PIs, are observed close in time to the science. Optical photometric standards and sky flats are typically observed in evening or morning twilight. The common calibrations must be copied from a set of library programs into the calibration program for the night before they are executed.
g. Daytime calibration observations are run during twilights and in the morning after on-sky observations are complete. The observer must keep track of the calibrations that are needed and then load them into the seqexec in the morning. In the case of F2 the DaySOS runs a script every Friday to generate a set of weekly calibrations. Common calibrations such as GMOS biases and long GPI weekend calibrations are again copied from the calibration library into the daily calibration program. The seqexec will then execute the "calibration queue" unattended.
h. In the morning after observing has finished (around 8 or 9am) the ODB generates a set of reports as text files and web pages (internal and public) that are used to track the progress of the queue.
i. The e-obslog entries for each program observed that night are also generated and transferred to the GOA.
j. The DaySOS will check calibrations and Band 1 and other high-priority data. If there are questions, the contact scientist is asked to check the data by setting a flag on the dataset(s) in the OT. The QC will then update the time accounting and reset or create new observations that have to be repeated. If there is uncertainty and datasets are flagged as "Check" then the contact scientist looks at the data and communicates with the PI as needed. During GSAOI runs multi-hour sets of dome flats are run manually during the day since the seqexec does not have control of the halogen dome lamps.

Proposal are also submitted and accepted outside of the biannual semester process described above. Fast Turnaround (FT) proposals are submitted every month. These proposals are received by the FT proposal backend and are then evaluated using the FT proposal system managed by the ITS group. Director's Discretionary Time (DD) and Poor Weather (PW) proposals can be submitted at any time. These are reviewed by the Chief Scientist and Head of Science Operations, respectively. System Verification (SV) and Demo Science (DS) proposals are requested at special times and are reviewed by instrument teams or special TACs. In all cases the accepted proposals are converted into Phase 2 programs using the command line 'skeleton' script that is equivalent to the ITAC software export process. The rest of the observation preparation, planning, and execution is the same as that for the semester programs.

5 References