

Rubin SSSC Follow-up Observations Coordination Website

Software Requirements

Revision: 1.1

Introduction

Purpose

The goal of the Observation Follow-up Coordination Website is to serve as a single point of reference for current, past and future follow-up observations of new and unusual objects discovered by Vera C. Rubin Observatory's (hereafter Rubin) LSST. It is intended to perform similar tasks to the PTF/[ZTF Marshal](#), IAWN, the International Asteroid Warning Network [campaign sites](#) or LCO's NEOexchange Target and Observation Manager (TOM) system but for a more general variety of solar system science cases and taking advantage of increased automation and use of APIs to scale to the larger volume of targets expected from Rubin.

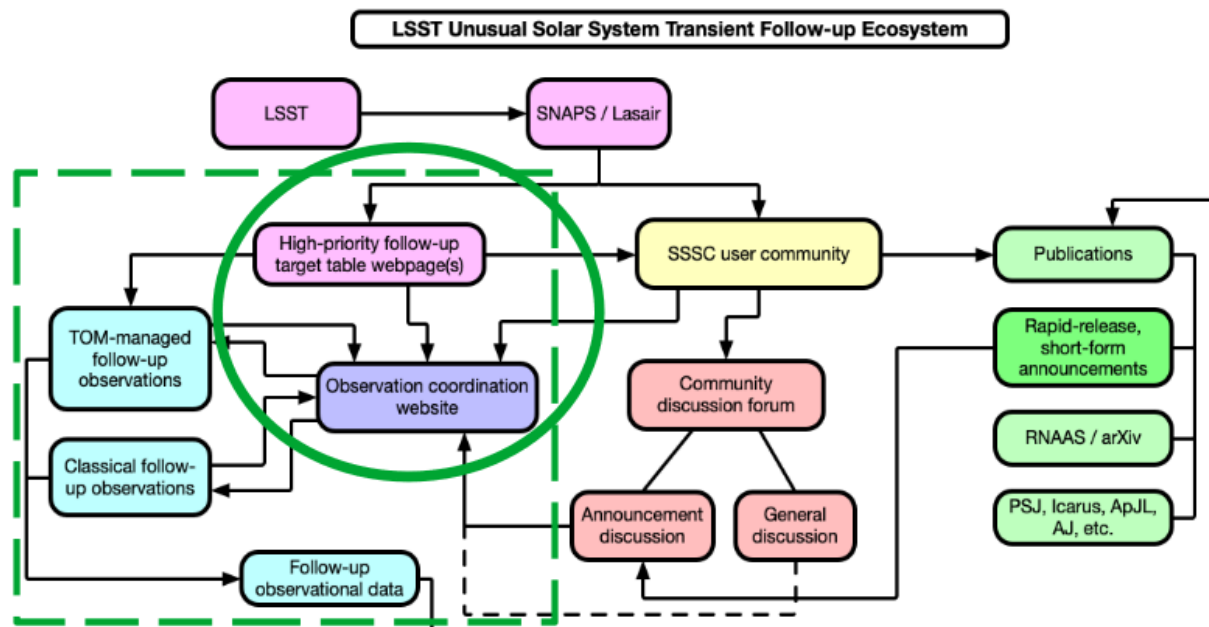


Diagram representing the LSST Solar System Follow-up Ecosystem as currently envisaged. The scope of the software discussed in this document is contained in the solid green ellipse while the resulting observations and metadata about the observations are contained within the larger green dashed rectangle (Figure originally produced by [Henry Hsieh](#), modified by Tim Lister)

The diagram above shows where the present Follow-up Coordination Website (green circle) fits in within the overall Solar System Transient Follow-up Ecosystem. Its function is to act as an

interface between the SSSC user community and allow visualization and triaging of new interesting objects delivered from the brokers or uploaded by users and for scheduling and tracking the progress of follow-up observations on a range of follow-up resources.

Intended Audience

The primary audience consists of the community of solar system astronomers who are engaged in follow-up of new unusual discoveries from the Vera C. Rubin Observatory's LSST.

Intended Use

The goal of the Observation Follow-up Coordination Website is to serve as a single point of reference for follow-up observations of newly discovered interesting objects and phenomena discovered by Rubin. It should be able to provide a searchable and filtered list of objects undergoing follow-up and the status of the observations, reducing duplication of observations and waste of scarce follow-up resources.

In Scope:

- Rapid follow-up coordination of a newly discovered interesting object
- Rapid follow-up coordination of newly discovered phenomena on a known object
- Coordination of long-term monitoring of transient phenomena (e.g., activity)
- Follow-up coordination of potentially hazardous objects to quickly minimize orbit uncertainty

Out of Scope:

- Coordination of observations related to science goals that can be achieved using Rubin Data Releases (e.g., colors of typical main-belt asteroids)

Overall Description of Requirements

User Needs

The SSSC Follow-up System needs to be accessible to all relevant users, regardless of whether they have time on any follow-up resources. New objects should be ingestible from the brokers and from user-provided data. The SSSC Follow-up System needs to be able to support all varieties of solar system objects and support optical and near-infrared imaging and spectroscopy observations. Potential users should be able to readily see the status of the Rubin Observatory and the most popular follow-up facilities. At a minimum, metadata about the status of follow-up observations should be reported back to the Follow-up System. The default system

is for the general user, with additional features available to registered users and registered observers.

A **general user** will have the ability to view target information (including follow-up status), observatory statuses, and observation results. A **registered user** will have the ability to add objects to the system, specify what type of observations are needed, and trigger observation requests to automated follow-up facilities. A **registered observer** will have the ability to receive observation requests, trigger observations on automated follow-up facilities, and (optionally) report updated follow-up status and/or results back to the system.

Assumptions and Dependencies

- There is a programmatic API way to send the results of community-defined filters stored and executed on a broker to the Follow-up System
- There is an externally provided queryable endpoint or authentication system that can determine if the user is valid
- There is a programmatic way of returning the current observatory status and planned and executed observations for Rubin and the most likely follow-up observatories
- There is a programmatic way of submitting observation requests to the most likely follow-up observatories
- There will be a programmatic interface to the Solar System Research Announcements (SSRA) service
- The proposal team is committed to ten plus years of service for continued operations

Functional Requirements

Functional requirements define what a system is supposed to do. If functional requirements are not met, the system won't meet the expectations.

- The system must support the ability to ingest new objects from community-defined filters executed on the Rubin brokers and from MPECs for new discoveries
- The system must support the ability for users to manually add targets
- New objects must only be creatable by authenticated users for traceability purposes
- The system must report the availability and observing status of the Rubin Observatory. The availability is the longer-term but coarse-grained status on a ~nightly granularity as to whether the facility is operational, closed for weather, down between date X and Y for maintenance etc. The observing status is finer-grained and would include the fields that have been observed, potentially with basic metadata such as m5 depth achieved, and those that the scheduler is planning to observe in the current night.
- The system should report the availability and observing status of important follow-up assets for Rubin follow-up to include SOAR, Gemini, DECam and ESO, Keck, Magellan, LDT.

- The system must support filtering and display of objects based on object type, magnitude, follow-up status
- The system must support filtering and display of objects based on desired observation type (e.g., deep imaging, colors, lightcurve, spectroscopy...)
- The system must support the ability of a user to request an observation of an object to a specific facility and proposal/observer.
- The system must support the planning, submittal and the retrieval and display of the outcome status for the following observation types:
 - Optical imaging
 - Optical spectroscopy
 - NIR (defined to be $\lambda < 2.5\mu\text{m/K}$ band) imaging
 - NIR spectroscopy
- The system should support the retrieval and display of the observation status for the following observation types:
 - Adaptive optics (AO) observations
 - Ground-based mid-IR (4-20 μm) observations
 - HST/JWST observations (+Swift? XXX)
 - Planetary radar observations
- The system must have the ability to store information about awarded telescope time proposals and allow the association of multiple users with multiple proposals. The association system must allow the designation of different roles at the minimum to include Principal Investigator and Co-Investigator and an assignable amount of telescope time that the user can use to schedule observations.

Non-Functional Requirements

Ensure that the system will work the way the user would expect, e.g. Performance requirements, Safety requirements, Security requirements, Usability requirements, Scalability requirements.

- There should be an easy way for non-robotic telescope facilities to quickly and easily communicate observation status back to the Follow-up Coordination System. This could e.g. take the form of a provided piece of code that can be run at the facility which communicates with the Follow-up Coordination Website through an API call.
- Minimal observation resources may be available either directly or via a link to an external site (e.g., finder charts, elevation charts)
- The system should be able to create a target list for a given time-frame and observatory based on observation requests
- The system should support the ingestion of photometric and spectroscopic data
- The system may support the query and ingestion of archival photometric data from other surveys
 - Potential surveys: SDSS, Pan-STARRS, ATLAS, ZTF
 - MPC archive has a lot for each object, but may be too much?

External Interface Requirements

Outline how the system will interact with other components.

- The system must interface with the SNAPS, Lasair and Fink brokers as a minimum
- The system must communicate with the SSRA system to issue alerts (and ingest targets?)
- The system must be able to retrieve Rubin planned observations schedule and planned observed fields
- The system should be able to interface with robotic/automated follow-up facilities using API

Potential Future Upgrades

*Describe features that **may** be implemented in the future, but not for the initial release.*

- Follow-up coordination for NEO Surveyor objects
- Searches of catalogs to identify optimal observation windows, especially for slow-moving targets, that avoid over-running known field stars