Observatory Simulator and Scheduler Interface Definitions

The LSST Observatory Control System will feature the Scheduler as the main component. A prototype of this Scheduler is included in the OpSim, and this prototype will continue evolving to become the actual Scheduler. Given these plans and design choices, the Simulator architecture has to be built around the Scheduler prototype. The interface of this Scheduler prototype has to be identical to the interface of the Control System Scheduler, at least in the input/output definitions as understood at this stage of the project. Then, the Operations Simulator surrounds this Scheduler prototype with the needed Control System components and simulated environment.

First, the actual expected environment for the Scheduler has to be considered. This is, the surrounding OCS elements, the internal telemetry, and the external conditions.

Now, the Observatory Simulator has to provide the same harness by simulating the needed external conditions and the observatory telemetry, as well as the behavior during the observations.

The following sections detail the input and output interfaces for the Observatory Simulator and the Scheduler. Any of the topics or parameters that have a question mark are listed as placeholders and may be expanded or removed as requirements finalize. Parameters that have positively identified types have the types placed in brackets. Notes about the topics or parameters are contained in parentheses.

Scheduler

The Scheduler is integrated into the OCS architecture following the same message-based framework. This is all the inputs and outputs are actually publication and subscription of topics, classified in terms of commands, events and telemetry. This schema provides all the flexibility for the control aspect of the problem, as well as immediate access to relevant information from the system.

Inputs

1. Control
    1. Scheduler Configuration
        1. Proposal Parameters
        2. Scheduler Observatory Model Parameters
        3. Scheduler Astronomical Sky Parameters
        4. Scheduler Optimizer Parameters
        5. Scheduler Data Parameters
    2. Scheduler Mode
        1. Scheduler Operation Mode [int] (possible values below)
            - Disabled
            - Active Mode
            - Passive Mode
            - Engineering Mode?
            - Calibration Mode?
    1. Downtime
        1. Duration
        2. Reason
    2. Degraded
        1. Unavailable Filter (array)
        2. Reduced Filter Change Time
        3. Observatory Issues
            1. Mount Reduced Speed
            2. Mount Reduced Range
            3. Dome Reduced Speed
            4. Dome Reduced Range
            5. Rotator Reduced Speed
            6. Rotator Reduced Range
    3. Observatory Time
1. Telemetry (all topics need timestamps)
    1. Observatory Conditions
        1. Dome
            1. Altitude
            2. Azimuth
            3. Altitude Velocity

         4. Azimuth Velocity
      2. Telescope Mount
         1. Altitude
         2. Azimuth
         3. Altitude Velocity
         4. Azimuth Velocity
         5. Rotator Angle
         6. Rotator Velocity
         7. Track Sky [boolean]
      3. Camera
         1. Current Filter
         2. Mounted Filters (array)
         3. Unmounted Filter
   2. Environment Conditions
      1. Transparency (array)
      2. Seeing (at zenith, 500 nm)
      3. Sky Brightness (array)
      4. Weather Data
         1. Temperature
         2. Wind Direction
         3. Wind Speed
         4. Relative Humidity
         5. Barometric Pressure
   3. Forecast
      1. Transparency (array, per minute?)
      2. Seeing?
      3. Weather Data
         1. Temperature
         2. Wind Direction
         3. Wind Speed
         4. Relative Humidity
         5. Barometric Pressure
2. Image Quality
   1. Point Spread Function Quality
   2. Transparency Map Across Field (array)
   3. Statistics for Seeing
   4. Statistics for Sky Brightness

3. History
    1. Array of Visits (see Visit definition for content)
4. Visit
    1. Target ID
    2. RA
    3. Dec
    4. Sky Angle
    5. Filter
    6. Exposure Times (array)
    7. Raw Seeing (at first open shutter time)
    8. Date (array of visit event times)
    9. Actual Slew Time
    10. Raw Transparency (at first open shutter time)
    11. Airmass (at first open shutter time)
    12. Sky Brightness (at first open shutter time)
    13. Observatory Parameters (begin slew, at first exposure, end of visit)
        1. Mount Altitude
        2. Mount Azimuth
        3. Dome Altitude
        4. Dome Azimuth
        5. Rotator Position

Outputs

1. Targets
    1. Next Target (array?)
        1. RA
        2. Dec
        3. Sky angle
        4. Filter
        5. Exposure Times (array)
        6. Target ID
2. Scheduler Telemetry
    1. Ranking Data
        1. Target ID (primary key)
        2. Target Rank Position (secondary key, 1 is winner)
        3. Target Overall Rank

   4. Target Coadded Rank Value (across all interested proposals)
   5. Target Rank Cost
   6. Observation Night
   7. MJD
   8. Date
   9. Local Sidereal Time
   10. Field ID
   11. RA
   12. Dec
   13. Sky angle
   14. Filter
   15. Exposure Times (array)
   16. Mount ALT
   17. Mount AZ
   18. Rotator Angle
   19. Slew Time
   20. Visit Time
   21. V Filter Sky Brightness
   22. Filter Brightness
   23. Seeing
   24. Transparency
   25. Moon Profile
       1. Illumination
       2. RA
       3. Dec
       4. Altitude
       5. Azimuth
   26. Distance to Moon
   27. Sun Profile
       1. Altitude
       2. Azimuth
       3. Elongation
   28. Weather Profile
       1. Wind Speed
       2. Wind Direction
       3. Humidity

2. Interested Proposals

1. Target ID
2. Target Rank Position
3. Proposal ID
4. Target Proposal Rank Value
5. Subsequence
6. Subsequence Number
7. Pair Number

Observatory Simulator

The Observatory Simulator is responsible for generating the input streams needed by the Scheduler and handling the output streams generated by the Scheduler. It will use the same messaging architecture as the Scheduler.

Inputs

1. Targets (see Scheduler definitions)
2. Configuration
    1. Scheduler Parameters (see Scheduler definitions)
    2. ObsSim Observatory Parameters
        1. Site Parameters
        2. Kinematic Parameters
        3. Filter Parameters
    3. Environment Model Parameters
        1. Weather Parameters
        2. Astronomical Sky Parameters(?)
    4. Downtime Parameters
    5. Quality Model Parameters
    6. Simulation Kernel Parameters
3. Scheduler Telemetry (see Scheduler definitions)

Outputs

All of the outputs below are defined in the Scheduler inputs section.

1. Control
2. Visit

3. Telemetry
    1. Observatory Conditions
    2. Environment Conditions
    3. Forecast
4. Image Quality
5. History
    1. Past Observations

Sample DDS IDL files for Scheduler<->ObSim topics

scheduler_nextTarget.idl

```
struct scheduler_nextTarget {
  double ra;
  double dec;
  double skyAngle;
  char filter[32];
  double expoureTime[10];
  int numExposures;
  long targetId;
}
```

scheduler_rankingData.idl

```
struct scheduler_rankingData {
    long      targetId;
    long      targetRankPosition;
    double    targetOverallRank;
    double    targetCoaddedRankValue;
    double    targetRankCost;
    long      observationNight;
```

```
double   MJD;
double   date;
double   LST;
long     fieldId;
double   ra;
double   dec;
double   skyAngle;
char     filter[32];
double   exposureTime[10];
double   mountAzimuth;
double   mountAltitude;
double   rotatorAngle;
double   slewTime;
double   visitTime;
double   skyBrightnessV;
double   skyBrightnessFilter;
double   seeing;
double   transparency;
double   moonIllumination;
double   moonRa;
double   moonDec;
double   moonAlt;
double   moonAz;
double   moonDistance;
double   sunAlt;
double   sunAz;
double   sunElongation;
double   weatherWindSpeed;
double   weatherWindDirection;
double   weatherHumidity;
```

```
}
```

scheduler_interestedProposal.idl

```
struct scheduler_interestedProposal {
   long    targetId;
   long    targetRankPosition;
   long    proposalId;
   double  targetProposalRankValue;
   char    subSequence[32];
   long    subSequenceNumber;
   long    pairNumber;
}
```