XI. Mission Operations

Space Segment
SAFIR operations are based on nominally having one ground contact occurring per day, during normal business days. The onboard solid-state recorders are sized accordingly to allow data to be dumped after a weekend, and the on-board memory is sufficient to allow the weekend command loads to be uplinked on a Friday. Command loads will be generated from the ground and uplinked to the spacecraft for daily execution from an on-board buffer.

The baseline science mission assumes the concurrent use of any two instruments. This limitation is assumed due to potential thermal restrictions, although a more detailed analysis will occur to determine if more instruments can be used concurrently as part of a campaign mode. The total data volume for any two instruments is 70 Gb per day. If all instruments were to be operated concurrently, then the maximum data rate could be as high as 844 Gb per day. The DSN will be used for communications.

The DSN will provide tracking data in addition to data communication link. One tracking pass will be scheduled each day to support orbit determination. For the JWST, tracking passes are required every 19 of 21 days. SAFIR, which will be in an orbit similar to JWST, is expected to have similar requirements. Higher tracking requirements may be required around orbital adjust maneuvers. The exact frequency of the orbital adjust maneuvers will be determined based on the type of orbit selected around L2.

Communication
For communications, SAFIR will use a 0.5 m high-gain antenna with a 5W power amplifier (Figure XI-1). The downlink is at Ka-Band, with a transmission rate of 30 Mbps. For nominal, all recorded data will be downlinked within one eight-hour pass from the onboard solid-state recorders (SSR). The SSRs are sized sufficiently large to allow data to record for several days before needing to be downlinked. For campaign modes where additional instruments may be operated, the onboard storage capability and the communication link are sized sufficiently to provide additional capability.

For the ground segment, two 12m Ka-band stations will support the downlink. The uplink will occur over X-band at a rate of 2 kbps. The telecom system will have full redundancy and have heritage from JWST. A low-gain omni antenna will also be available for launch and early orbit operations and contingency scenarios. Although the baseline design uses the DSN as the primary communication ground station, trades will be conducted with other satellites projects to see if it is more cost effective to share time on a dedicated station.

Ground Segment
Despite differences between individual spacecraft and missions, current and planned on-orbit observatories such as JWST, HST, Spitzer, and Chandra tend to share common characteristics in many of their high-level goals and methodologies. Some of these methodologies are also common to ground observatories and other facilities which schedule large numbers of activities supporting many users. Although the exact mission planning concept has still to be determined, the processes described below are consistent with the SAFIR mission.

The science proposal preparation phase begins 1-1.5 years prior to execution and is baselined as that being designed for JWST. Astronomers throughout the science community will create proposals to use SAFIR, specifying their observations and related constraints using web-based tools providing access to SAFIR databases. The databases will contain information on how to use SAFIR

instruments, how to optimally execute observations, and how to estimate the amount of SAFIR time required to acquire science and related ancillary data.

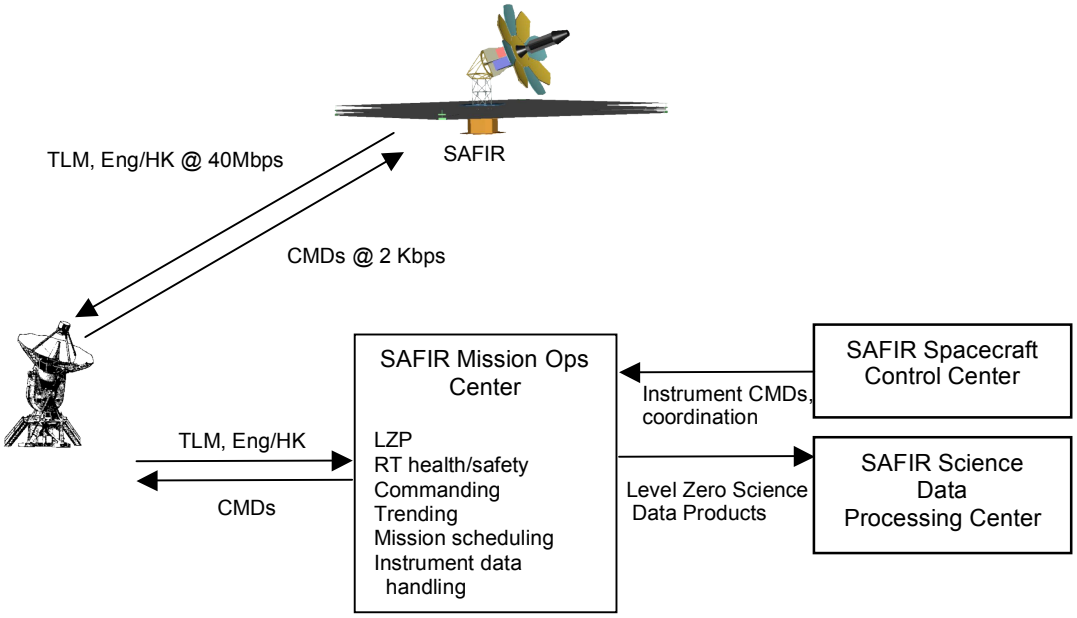

Figure XI-1: SAFIR Data Flow

One year prior to execution, the SAFIR Science Committee will review the proposals. The committee will be composed of experienced peer astronomers. Those proposals that are accepted will be included in the next 1-year cycle, and assigned a priority based upon their scientific merit, degree of difficulty, and other factors. Shortly after selection, the astronomers will use an automated expert system to expand their proposal to a format consistent with the planning and scheduling system.

Approximately 3 months prior to execution, the scheduling system will assign each observation to a planned period, while at 3 weeks the system will assign the observations to a specific day. The scheduling system will also select appropriate guide stars, insert required calibrations, and schedule any related engineering activities such as star tracker updates or science downlink requests. Finally an automated system will execute a quality check to ensure compliance with mission constraints.

The Flight Operations Team (FOT) will operate the spacecraft during nominal business hours of eight hours per day, five days a week. All spacecraft contacts will be automated, with the FOT having the capability to manually conduct a pass if necessary. Recorded data will be temporarily stored at the DSN, with the files then electronically transferred to the science center. By 2020, data distribution to the science team is expected to be completely electronic, although physical media distribution could also be used if desired. As the spacecraft and science operations are so intertwined, the science center and the spacecraft control center will be co-located, similar to the philosophy for JWST, HST, Spitzer, and Chandra.