Sierra Stars Observatory Network: An Accessible Global Network

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ABSTRACT

The Sierra Stars Observatory Network (SSON) is a unique partnership among professional observatories that provides its users with affordable high-quality calibrated image data. SSON comprises observatories in the Northern and Southern Hemisphere and is in the process of expanding to a truly global network capable of covering the entire sky 24 hours a day in the near future.

The goal of SSON is to serve the needs of science-based projects and programs. Colleges, universities, institutions, and individuals use SSON for their education and research projects. The mission of SSON is to promote and expand the use of its facilities among the thousands of colleges and schools worldwide that do not have access to professional-quality automated observatory systems to use for astronomy education and research. With appropriate leadership and guidance educators can use SSON to help teach astronomy and do meaningful scientific projects. The relatively small cost of using SSON for this type of work makes it affordable and accessible for educators to start using immediately. Remote observatory services like SSON need to evolve to better support education and research initiatives of colleges, institutions and individual investigators. To meet these needs, SSON is developing a sophisticated interactive scheduling system to integrate among the nodes of the observatory network. This will enable more dynamic observations, including immediate priority interrupts, acquiring moving objects using ephemeris data, and more.

Keywords: SSON, observatory network, astronomy education, distance learning

1. INTRODUCTION

Remote robotic and automated observatory technology is well established and common going into the second decade of the 21st century. Installations of these systems by both professional and amateur astronomers is growing rapidly worldwide and linking these systems into networks opens up new opportunities for astronomy education and research. Several programs for building and establishing global telescope networks are currently in development. The organization of these networks varies from using standardized homogeneous instrumentation throughout the network with tightly controlled, top-down management to *ad hoc*, loosely-managed networks of heterogeneous observatories working on temporary special projects.

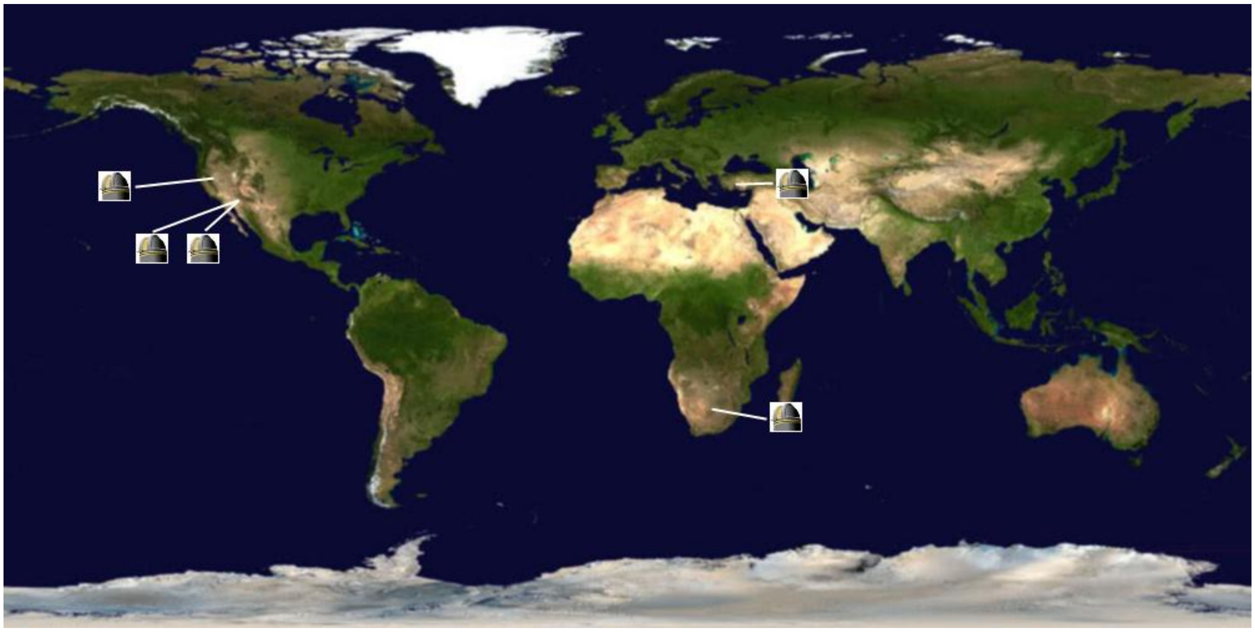


Figure 1. SSON Observatory Partner Site Locations as of March 2011.

1.1 What is SSON?

Sierra Stars Observatory Network (SSON) is a growing, fee-based network of professional observatory partners working together to provide its customers with high-quality astronomical imaging data. Users schedule images to be taken by telescopes within the network and SSON delivers calibrated astronomical data. SSON guarantees that each user will receive data that is acceptable based on reasonable expectations for each observatory site. If data are corrupted by weather or equipment failure, SSON users are reimbursed by credits to their SSON account.

SSON has a unique method of charging its customers for the use of its facilities. Users pay ***only*** for the actual time the camera shutter is open taking in photons on the CCD chips of the cameras. There are no additional or hidden costs. This makes budgeting and accounting easy. The cost for hourly imaging shutter time varies among the observatories within SSON. To make the system equitable, fair, and comprehensible the cost in credits for each telescope is roughly computed by what exposure times are required for each system to achieve a roughly comparable signal-to-noise-ratio (SNR). Other considerations for individual observatories are, however, figured in such as especially consistent seeing conditions, overhead costs, and what the independent observatory operators require. Ultimately it is the SSON users who determine which observatories are most often used based on the cost and the quality of data received.

1.2 Origin of SSON

One of the authors (Rich Williams) founded SSON early in 2007 starting with a single observatory called the Sierra Stars Observatory (SSO) located in Markleeville, California. The observatory houses a 0.61-meter OMI f/10 Classical Cassegrain telescope with a Linux-based observatory control system (Talon) capable of automated/robotic operation. In addition to controlling the telescope operation, the Talon suite of software includes programs to control the CCD camera, filter wheel, dome, and to create and run optimized observing schedules. Steve Ohmert, a principle partner of SSON, developed the programming extensions to Talon to fit the needs of SSON and designed and built a more robust control system for the observatory dome.

During the extensive testing of the SSO system to ensure it was robust and able to consistently run dense automated observing sessions regularly, Kathy Fox-Williams developed the web applications and database applications for the SSON enterprise system. SSO, the first node in SSON, began serving users in the summer of 2007.

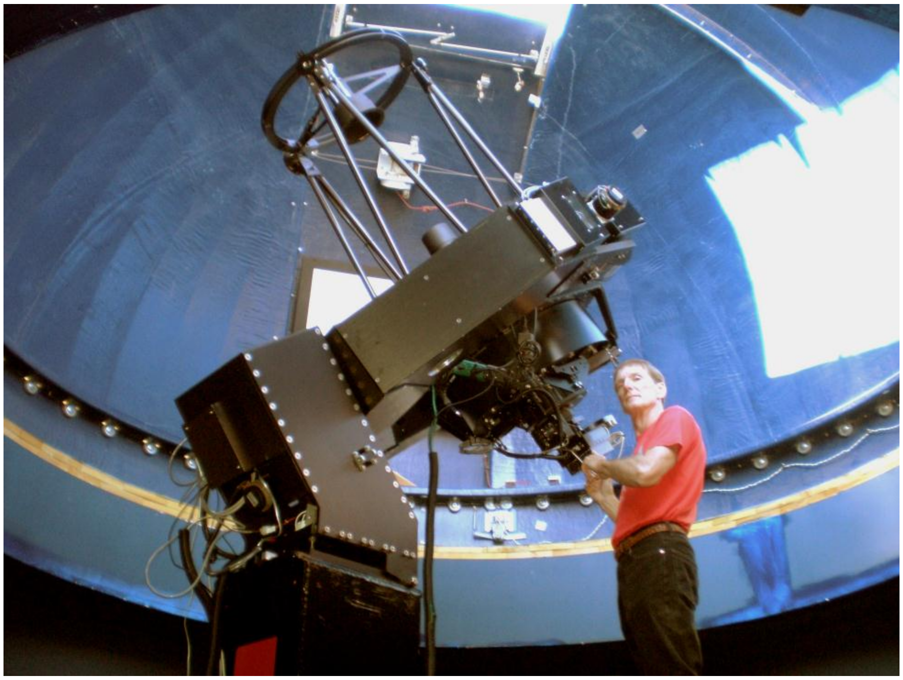


Figure 2. Rich Williams in SSO Observatory Markleeville, CA.

1.3 From One to Many Partnership Nodes

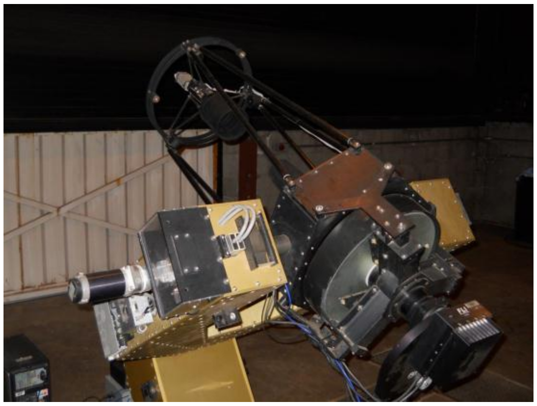
Rich Williams was one of the founders of Torus Technologies (now Optical Mechanics, Inc.) and was the company that developed and manufactured the SSO telescope. One of the earliest adaptors of using automated remote telescopes for education and research was Dr. Robert Mutel. After experimenting with automated robotic telescope technology using a small telescope on top of the physics building on the University of Iowa campus in Iowa City, Dr. Mutel was awarded an NSF grant to develop a robotic telescope system for developing a curriculum for astronomy education. Together with the help of students at the university Dr. Mutel designed and built a 0.5-meter Cassegrain telescope on an altazimuth mount and named the Iowa Robotic Observatory (IRO). Elwood Downey was contracted to develop the Linux-based control software called OCAAS, which was adapted by OMI and later renamed Talon. The telescope was located at the Winer Observatory in Sonoita, Arizona and operated remotely by students at the University of Iowa under the guidance of Dr. Mutel.

Some design issues of the IRO telescope were problematic and Dr. Mutel contracted with Torus Technologies to build a new robotic telescope to replace it. The design was a 14.5-inch (37cm) f/14 Classical Cassegrain with an equatorial fork mount. The new telescope was named Rigel and proved to be an excellent robotic design.

Dr. Mutel was interested in Rich's plans for developing a network of similarly capable telescopes and he set up a partnership agreement between the University of Iowa and SSON. Because the SSO and Rigel telescopes used the same observatory control software it was relatively easy to integrate the two systems into a network configuration. Rigel began operations within SSON in the spring of 2008 and continues serving SSON users today.

The SSON partnership/networking model proved very successful. As SSON established a track record for delivering high-quality imaging data and the number of users increased Rich contacted key people responsible for managing other professional observatories around the world to present his ideas for establishing partnerships between their organization and SSON. Ed Beshore, one of the authors of this paper, and other staff members of the University of Arizona's Mt. Lemmon Sky Center appreciated the potential of partnering with SSON. A partnership agreement between the university and SSON was signed in December 2010, bringing the Mt. Lemmon Sky Center's newly installed RCOS 32-inch (0.81-meter) f/7 Schulman telescope into SSON.

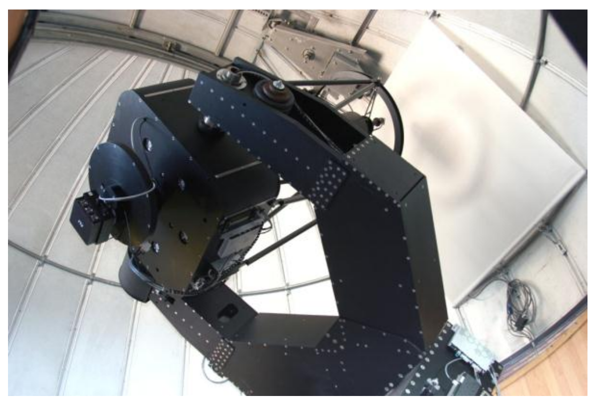
In March, 2011 SSON announced two additional professional observatory partners. The University College Dublin Watcher telescope located at the Boyden Observatory in South Africa and the Institute of Tubitak TUG telescope in Turkey are undergoing integration testing within SSON and plan to start operation within SSON in the spring of 2011. The Watcher Telescope is a 16-inch (0.4-meter) f/14.5 Classical Cassegrain system. The TUG Telescope is a 24-inch (0.61-meter) f/10 OMI Classical Cassegrain system.



Rigel Telescope – Sonoita, Arizona

Watcher Telescope – South Africa

Mt. Lemmon Sky Center Telescope – Tucson, Arizona



TUG Telescope – Turkey

Figure 3. Expanding Global Network of SSON Telescopes.

2. SSON PARTNERSHIP MODEL

SSON developed a partnership model that is mutually beneficial to both the individual partners and its users. SSON seeks out organizations with observatory systems comprised of professional-quality 0.4-meter to 1.0-meter and greater diameter telescopes and CCD imaging systems. The sites must have an established infrastructure with the capability to accept observing requests and to transfer image data from nightly observing runs within a short time after the completion of the observing run. Finally, potential partners must have some unused time or excess capacity to run SSON jobs.

Potential SSON partners typically have observatories located at excellent remote sites with dark skies, good seeing, and are strategically located to enhance the global coverage of the network. The observatory facility should have the capability to accept observing requests and process the requests in some form of automated schedule queuing mechanism. The observatories must have sufficiently large high-quality telescopes with CCD cameras capable of taking relatively high quantum efficiency raw image data and calibration frames. Partner sites must have high speed Internet service of some type to transfer image data files during or shortly after the completion of nightly observing runs. Finally the potential observatory partner must have some amount of unused available time during some or most of the observing runs throughout the year. Systems that are completely scheduled through the year with unavailable blocks of time obviously are not candidates for becoming SSON partners.

2.1 What Are the Benefits of an SSON Partnership?

Assuming an organization has all the requisite equipment, infrastructure and some freely available observing time to become an SSON partner why would they decide to do so? There are a couple of compelling reasons.

Member observatories can realize a significant recurring revenue stream. Many observatories rely on grants and other forms of donations to fund their operations. Current economic conditions and competition for funding have conspired to make grants and donations a more unreliable source of support. SSON offers a generous revenue sharing plan where the partners receive 67 percent of the monies paid by SSON users for observing time. Partners only need to obtain and deliver the scheduled images in the same manner they normally would at their facility. In return, SSON handles all operations, including customer contact, collection, and marketing.

Partner sites may choose to exchange some or all of the time from their sales for time on other SSON partner observatories. This opens up opportunities for running projects and programs that require greater temporal or sky coverage than would be possible from a single site.

Finally there is the benefit gained from participating in cooperative projects among SSON partners and publicity of being part of a professional global network of observatories. For example, the network of telescopes can work together to monitor objects continually over entire 24-hour periods.

2.2 How Does the Network Operate?

The individual observatories within SSON operate in a heterogeneous manner. Each observatory operates according to their own unique programs and requirements. SSON technical staff works with the each observatory site to create a “middleware” solution to integrate them into the SSON system. From the end user’s perspective the method for scheduling jobs on any of the telescopes within the network works the same.

Here is a high-level description of how the observatory network process works:

1. SSON sends schedule requests in an appropriate format to each facility at specified location and time.
2. Each facility incorporates SSON schedule requests into the local observation scheduling queue.
3. Observatory control, scheduling software, and local operations are all handled by partner’s system.
4. Immediately following the end of each observatory’s scheduled run FITS and calibration files for SSON job schedules uploaded to SSON FTP server.
5. SSON processes FITS files to transfer them to the appropriate SSON users FTP directory.
6. SSON handles all company operations (customer service, credit management, database management, and so on).

3. WHO USES SSON?

The targeted market of users for SSON are organizations and individuals that want to plan, schedule, and receive high-quality astronomical imaging data for research and education projects and program. The demographics of the SSON users include:

- Professors, teachers, and students use SSON telescopes for astronomy education and research.
- Citizen scientists, serious amateur astronomers and general public interested in “doing” astronomy.
- Astro-imagers interested in esthetic/artistic imaging.

- Organizations like the British Astronomical Association (BAA), American Association of Variable Star Observers (AAVSO), International Astronomical Search Collaboration (IASC), who conduct coordinated campaigns for astronomical research.

Colleges and universities use SSON for course work and research projects. SSON offers a very affordable way for students to access professional observatory facilities and to receive high-quality fully calibrated imaging data. In effect each institution has access to professional observatories located at pristine remote dark-sky sites with infrastructures costing hundreds of thousands of dollars or more for very low hourly rates. This capability enables even very small schools with very limited budgets to afford to use SSON for their education and research programs.

A surprisingly large percentage of SSON users are what we refer to as citizen scientists. They are non-professional astronomers doing sophisticated astronomical science work. Their interests cover many fields including variable star observations, minor planet discovery and follow-up work, transient phenomena and so on.

Not all SSON users are strictly into doing astronomy science work. Some users use high quality imaging data to create stunning images of astronomical objects for their esthetic and artistic appeal. Of course many of these same images are valuable science data in their own right as well.

Professional astronomy organizations are a major focus for SSON. The British Astronomical Association (BAA) uses SSON for their Robotic Telescope Project (RTP). BAA members participating in the RTP use SSON to observe deep sky objects, variable stars, variable nebula, nova, supernova, and asteroids. Even though the American Association of Variable Star Observers (AAVSO) has their own network of telescopes available for free to their users, many AAVSO members are regular SSON users. SSON offers them more flexibility and options according to their feedback on using SSON.

SSON is an integral part of the International Astronomical Search Collaboration (IASC), which works with hundreds of students in dozens of schools around the world in several 6-week campaigns to discover and follow up NEO and main belt minor planets. In 2011 the Pan-STARSS PS1 Board approved the PS1 Asteroid Search Campaign with IASC. Subsets of the current data from PS1 are sent to IASC, analyzed by students overseen by professional astronomer mentors to search for NEOS and main belt asteroids. IASC uses SSON for follow-up work on discovery candidates for this project and for discovery candidates by other telescopes within IASC. In the process of performing follow-up work with SSON students sometimes discover new asteroid in the data as well.

4. HOW DO USERS WORK WITHIN SSON?

SSON users schedule images to be taken and delivered to their personal SSON accounts using the web application interfaces on the SSON web site (www.sierrastars.com). No local client software or any specific operating system is required to use SSON or to download completed calibrated data. The general method of operation for SSON users is as follows:

- Users set observation schedule requests using an online form on the SSON web site.
- The scheduling form enables users to select which telescope to use, what filters to use, and what exposure times to set, number of sets to run, time delay between series, and so on.
- Users can select objects from among many catalogs for both stationary and moving objects (NGC, AAVSO, Minor Planet Center database, and so on)
- In addition users can set specific RA and DEC coordinates, LST start times, and UTD date to run.
- Schedules are queued and optimized to run as close to transit as possible.
- Calibrated FITS files are processed immediately after observing runs and files are transferred to each users SSON FTP directory.

4.1 Extended SSON Management Tools

SSON offers the capability to extend an individual account to a master account capable of managing and overseeing Affiliate accounts, which are essentially sub-accounts under the primary SSON account. This SSON Affiliate Management system enables organizations and individuals to allocate and manage credits from a SSON account to other registered SSON users. This is a very effective and convenient tool for universities, colleges, and others to control and manage the distribution of SSON credits among constituents within their group.

5. DEVELOPMENT PLANS FOR THE NEAR FUTURE

SSON plans to pursue additional observatory partners to create a true 24/7 global observatory network, which will give SSON users complete coverage of the sky. In addition to enlarging our network SSON plans to achieve the following goals in the coming months and years:

- Make affordable high-quality image data accessible to as many schools and colleges as possible. Many schools/colleges have limited budgets and/or no astronomy facilities.
- Assist in the development of astronomy curricula and lab tools for education and research needs.
- Expand the scheduling capabilities within SSON including "real time" schedule updates, enable interrupt of schedules for critical transient events, and more.
- Foster relationships/partnerships with other observatories and organizations to enhance the opportunities for all SSON users.

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