Space Geodesy Satellite Laser Ranging Computer Design
(Abstract 3093)

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Abstract

The new Space Geodesy Satellite Ranging (SGSLR) computer architecture and software will allow full automation to be realized after the lessons learned during development of the NGSLR prototype [1]. A more streamlined approach will be shown using industry standard I/O devices, more powerful off the shelf computers and an open source operating system with a real-time application interface. SGSLR will utilize most of the NGSLR software. This new approach will consolidate systems, provide a broader expanse of hardware solutions and reduce computer related costs and maintenance.

Introduction

The SGSLR computer design is derived from the knowledge gained from the Next Generation Satellite Laser Ranging (NGSLR) system and other NASA legacy systems. Much of the NGSLR functionality will remain the same but the redesigned computer system will take advantage of the latest computer advances and standard interfaces. The new design uses Linux as the base operating system with the Real-Time Application Interface (RTAI) applied for the hard real-time functions.

Upgrade Computer Hardware

SGSLR utilizes the latest multi-core CPU's on a standard PCI/PCIe bus in rack mount, desktop or laptop computer systems. Some computers such as the Interface Control Computer (ICC) and the Pseudo-OPerator (POP) will be consolidated from the NGSLR design to the SGSLR design maintaining the same functionality; other computers may be consolidated in the future as we gain experience with the new configuration. The consolidation of computer systems allows for reduced cost and expands options for future upgrades to SGSLR.

Operating Systems

The Linux and Microsoft Windows™ operating systems will be utilized on SGSLR. The Linux operating system will be installed with the Real-Time Application Interface (RTAI) on the computers requiring hard real-time constraints (ICC/POP and Device Access Manager (DAM)). The computers not requiring hard real-time will simply use the Linux operating system(RAT and ANA). The Microsoft Windows™ operating system will be used on the CAMera (CAM) computer. The Windows operating system enables the use of packages that are not currently supported under Linux.

Computer Interfaces

SGSLR communication interfaces will be industry standard. SGSLR will utilize the Curtiss-Wright ScramNet™ fiber optic token ring network for a new shared memory implementation. The Microsemi (formerly Symmetricom) XLi GPS receiver will be employed and interfaced with their standard BC635 PCI card. Other equipment and devices will communicate using a PCI Digital input/output interface such as the United Electronic Industries Digital IO Board, part # PD2-DIO-128I. All other communications between components will be through RS232/RS485, TCP/IP sockets, NFS or USB.

SGSLR Subsystem and Computer Connectivity

The ICC/POP computer makes many of the operational decisions based on the weather, priority tracking schedule and system readiness. It also controls the following subsystems: Tracking (telescope/mount), Laser, Receiver, Laser Safety and Ranging Control Electronics.

The DAM computer controls many components on the Optical Bench, hosts the Ratsnest interface to the Remote Access Terminal (RAT), interfaces to the meteorological instruments and monitors health & safety to establish system readiness.

The RAT computer primarily facilitates operator interaction with the system. In addition the RAT computer may be used to enable software simulators that allow for testing of components and subsystems prior to them being integrated into the system.

The ANAlysis (ANA) computer performs post processing analysis and transfers data to the central facility.

The CAMera (CAM) computer hosts both the sky and star cameras, and is also used to configure the laser for operational modes such as tracking, alignment or calibration.

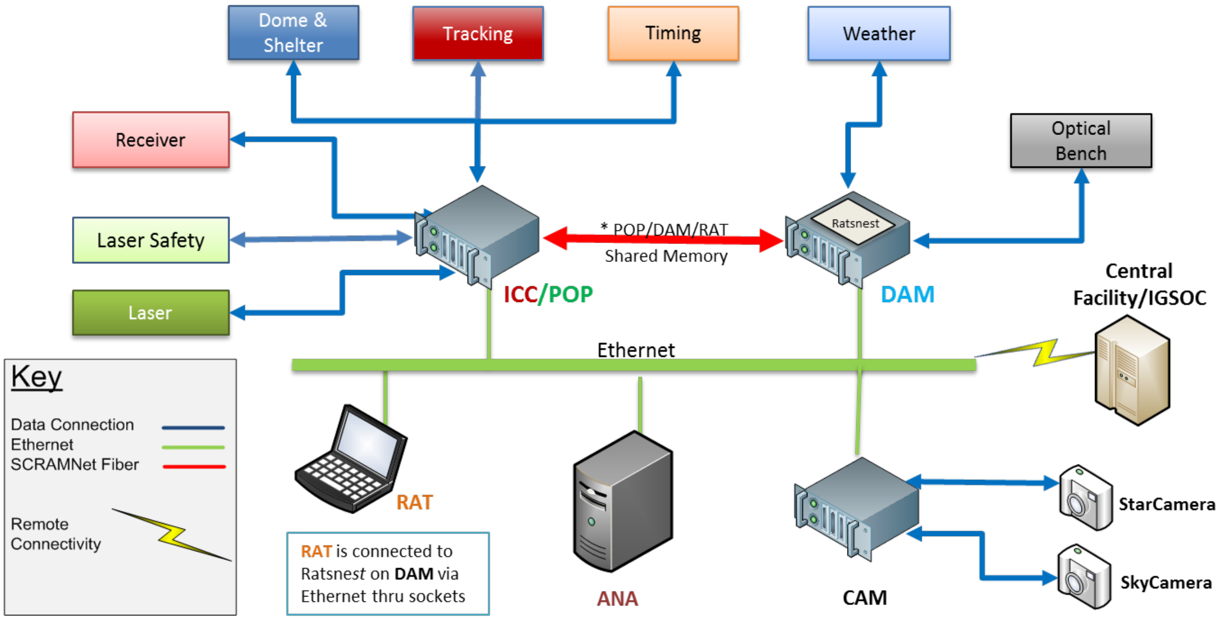

Figure 1 - SGSLR System Block Diagram.

NGSLR/SGSLR Software Architecture

In Figure 2, Green boxes indicate changes from NGSLR to SGSLR:

1) Complete automated satellite search and acquisition, beam divergence control, cloud coverage decisions and closed loop tracking;

2) Update messaging system with additional sensors for monitoring voltage, temperature and current of a number of components;

3) Integrate new shared memory, add automated dome shutter, interface to hardware sensors and UPS's.

Pink boxes indicate software changes from external developers that require changes to existing software:

a) Standard interfaces eliminate the need for custom device drivers;

b) Real-time Linux is POSIX compliant.

Blue boxes will have little or no changes.

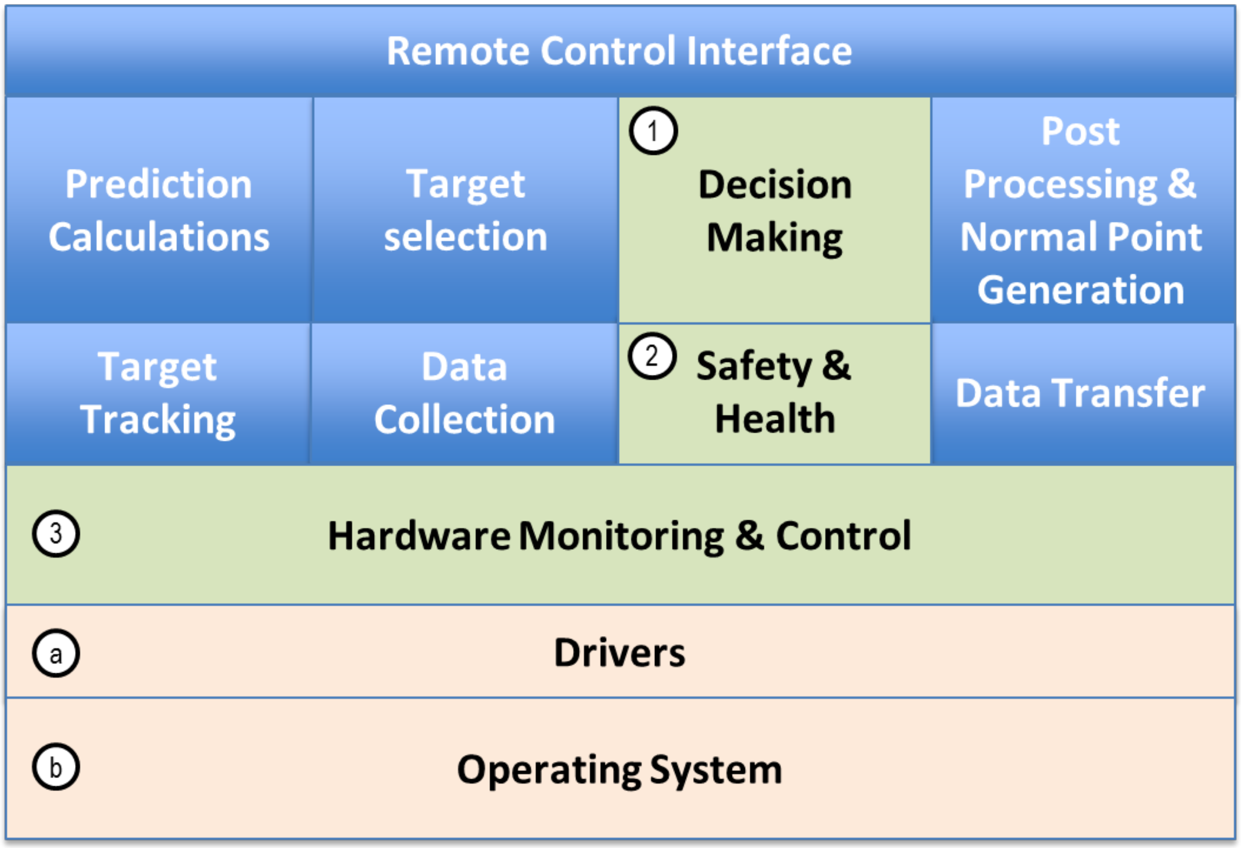

Figure2 – NGSLR/SGSLR System Architecture.

Automation Demonstrated by NGSLR Prototype

The NGSLR system automatically downloads satellite predictions and an operational schedule. The software automatically follows the operational schedule, changing configuration between satellite tracking, ground calibration, and star calibration based on the target indicated in the schedule.

Ground calibrations are completely automated. This process includes pointing to the target, setting ND filters to obtain correct return rates from the ground target, determining when a minimum number of observations have been collected and calculating the system delay.

The Risley prisms are controlled by the software to point the transmit optics ahead of the receive optics.

The pulse repetition frequency (PRF) is changed by software to prevent collisions between outgoing and incoming laser pulses.

Laser safety implemented by deploying beam blocks triggered by the Laser Hazard Reduction System (LHRS), a radar based system for aircraft detection, and pressure pads on the stairway and dome area for personnel safety.

The real-time software uses a signal detection algorithm to determine signal and noise counts in near real-time. This information is utilized by a spiral search routine as well as other routines for making tracking decisions. The system automatically processes satellite and calibration data. The system sends status messages and transfers tracking summary files to the Integrated Geodetic Science Operations Center (IGSOC). Normal points are generated and transferred hourly to the central facility which for SGSLR will be the IGSOC.

Automation to be Completed with SGSLR

Automated satellite search and acquisition have been utilized in the past but do not always perform adequately due to latency in the signal detection. The delay in signal detection sometimes results in passes ending before the satellite is acquired. Improvements in computing speed and signal strength may eliminate many of these problems.

Automated dome shutter control decisions are already being made but no interface to the hardware exists to control the shutter at NGSLR.

Completion of beam divergence implementation based upon satellite orbit will occur for SGSLR.

Although cloud coverage automated decision processes are in place to change targets when clouds interfere with the primary target, they have not been adequately tested to determine whether they are making the best decisions.

Closed loop tracking will be completed with updated receiver electronics.

Automated laser setup and monitoring will also be completed.

In Conclusion

Upgraded off the shelf computer hardware, open source real-time operating systems and standard device interfaces will reduce costs and improve our ability to build a more modular system [2]. The use of a POSIX operating system as was done with NGSLR allows for most of the software from NGSLR to be reused at SGLSR. In addition, with the overall improvements to the system we should be able realize full automation [3] and build a robust operational software package.

References

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