frared photodetector (QWIP) imager; a 60.5 megapixel BuckEye EO camera; and a fast (e.g. 200+ scanlines/s) and wide swath-width (e.g., 1,920+ pixels) CCD/InGaAs imager-based visible/near infrared reflectance (VNIR) and short-wave infrared (SWIR) imaging spectrometer. MAICSS records continuous precision georeferenced and time-tagged multisensor throughputs to mass storage devices at a high aggregate rate, typically 60 MB/s for its LWIR/EO payload.

MAICSS is a complete stand-alone imaging server instrument with an easy-to-use software package for either autonomous data collection or interactive airborne operation. Advanced multisensor data acquisition and onboard processing software features have been implemented for MAICSS. With the onboard processing for real time image development, correction, histogram-equalization, compression, georeference, and data organization, fast aerial imaging applications, including the real time LWIR image mosaic for Google Earth, have been realized for NASA's LWIR QWIP instrument.

MAICSS is a significant improvement and miniaturization of current multisensor technologies. Structurally, it has a complete modular and solid-state design. Without rotating hard drives and other moving parts, it is operational at high altitudes and survivable in high-vibration environments. It is assembled from a suite of miniaturized, precision-machined, standardized, and stackable interchangeable embedded instrument modules. These stackable modules can be bolted together with the interconnection wires inside for the maximal simplicity and portability. Multiple modules are electronically interconnected as stacked. Alternatively, these dedicated modules can be flexibly distributed to fit the space constraints of a flying vehicle. As a flexibly configurable system, MAICSS can be tailored to interface a variety of multisensor packages. For example, with a 1,024×1,024 pixel LWIR and a 8,984×6,732 pixel EO payload, the complete MAICSS volume is approximately 7×9×11 in. (≈18×23×28 cm), with a weight of 25 lb (≈11.4 kg).

*This work was done by Xiuhong Sun of Flight Landata for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-15817-1*

# Radiation-Tolerant, SpaceWire-Compatible Switching Fabric

**Potential applications include next-generation computer interconnects, production of motion pictures, intra-hospital networks, and inventory management.**

*Goddard Space Flight Center, Greenbelt, Maryland*

Current and future near-Earth and deep space exploration programs and space defense programs require the development of robust intra-spacecraft serial data transfer electronics that must be reconfigurable, fault-tolerant, and have the ability to operate effectively for long periods of time in harsh environmental conditions. Existing data transfer systems based on state-of-the-art serial data transfer protocols or passive backplanes are slow, power-hungry, and poorly reconfigurable. They provide limited expandability and poor tolerance to radiation effects and total ionizing dose (TID) in particular, which presents harmful threats to modern submicron electronics.

This novel approach is based on a standard library of differential cells tolerant to TID, and patented, multi-level serial interface architecture that ensures the reliable operation of serial interconnects without application of a data-strobe or other encoding techniques. This proprietary, high-speed differential interface presents a low-power solution fully compatible with the SpaceWire (SW) protocol. It replaces a dual data-strobe link with two identical independent data channels, thus improving the system's tolerance to harsh environments through additional double redundancy. Each chan-nel incorporates an automatic line integrity control circuitry that delivers error signals in case of broken or shorted lines.

The complete 4×4 SW switching fabric chip (with dimensions 6,618×5,658 mm$^2$), incorporating the switching fabric core synthesized in a standard radiation-tolerant by-process 180-nm CMOS (complementary metal oxide semiconductor) library and four proprietary interfaces, has been fully designed in a BiCMOS technology from Jazz Semiconductor and prepared for fabrication. All critical blocks of the switching fabric have been verified through fabrication of several test chips and demonstrated the radiation tolerance up to TID = 1 MRad. All main blocks of the fabric have been developed as IP (intellectual property) macro-blocks ready to be integrated into other systems in order to minimize the design time, efforts, and risk.

The complete architecture of a 4×4 switching fabric with selectable SW or ML interfaces has been developed based on the Core code supplied by NASA. The architecture of a custom SW/ML routing port has been developed and evaluated. Based on the detailed investigations, the SiGel20 BiCMOS technology has been selected for the implementation of the proposed SF. A complete library of CML (Chemical Markup Language) cells with full anti-TID and anti-SEE protection by architecture (SPBA) has been developed and simulated. The designed SPBA library has been fully characterized to make it suitable for automatic synthesis procedures. Special techniques required for the adaptation of the new differential library to existing single-ended synthesis software tools have been developed and verified.

A complex test chip based on the SPBA library has been fabricated and tested. The measurement results gathered in accordance with the developed test plan demonstrated the efficiency of the selected approach for the implementation of high-duty logic functions and SerDes systems in particular. The provided SF Core has been fully synthesized and simulated in the SPBA library. In an attempt to minimize the power consumption, the SF Core was re-synthesized in the foundry-provided standard CMOS library. This approach, in combination with a CML-based implementation of routing ports, proved to be optimal.

*This work was done by Vladimir Katzman of ADSANTEC for Goddard Space Flight Center. Further information is contained in a TSP (see page 1).*
GSC-15818-1