Sandia National Laboratories

DEVELOPMENT AND DELIVERY OF A CUSTOM VERSAL BOARD FOR SPACE APPLICATIONS

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AMD Versal: Next Generation in Radiation Tolerant Computing

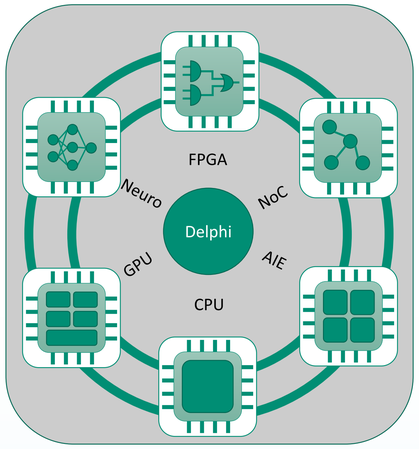
AMD Versal Adaptive Compute Acceleration Platform (ACAP)

- AMD's latest system-on-chip (SoC)
- 7nm TSMC FinFET process
- Large FPGA fabric, ARM processors (A72 & R5), and AI Engines (on AI Core variant)
- 10x LUTs, >20x flip-flops, and 15x logic cells of a Virtex5QV
- Resilient to SEL and other radiation effects

The Versal can help enable rapid advancement to the next generation of radiation tolerant computing, drastically improving the processing capability of small satellites

DELPHI: Threat-Aware Heterogenous Cognitive Computing Platform

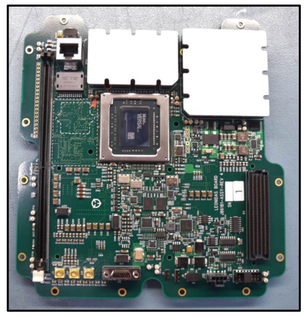
Delphi is a developing high-performance, heterogeneous, flight-ready, cognitive computing platform based around the AMD Versal.

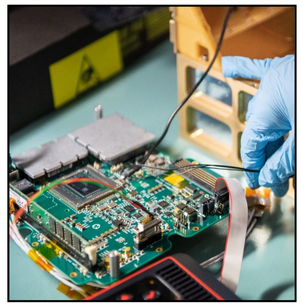


- 6U VPX form factor
- Payload C&DH (CPU)
- Sensor Control (FPGA)
- Data Preprocessing (FPGA)
- High Performance Data Processing (AIE)
- Neural Networks (AIE)
- FMC connector for additional COTS submodules to provide a flexible, scalable, and easily upgradeable architecture for off-the-shelf multi-mission data processing capabilities
- Compatible with mission communication standards (e.g. JAS, OMS/UCI)
- On-board watch dog to help mitigate single event effects

EVANDRE: Experimental Versal ANalysis, Data-processing and Remote-sensing Electronics board

EVANDRE is an experimental prototype for DELPHI developed specifically for multiple ISS missions, the first of which will be deployed this year



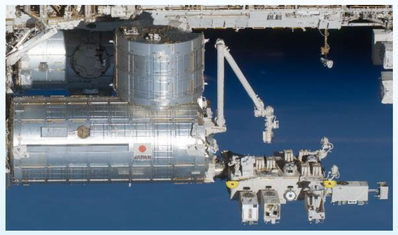


- 4U form factor board
- Integrates Versal with DDR Memory, PCIe devices, Gigabit Ethernet, USB 2.0 and 3.0, I2C, SPI, and GPIO
- FMC expansion header can enable greater mission specific optimization (Monitored by Sandian Watchdog) such as: Extra NVM, GPUs, Neuromorphic Processors, Additional Memory, Interface Adapters (i.e. SpaceFibre)

EVANDRE is set to fly on the LEONIDAS and ASTRID missions. These missions will both be launched to the ISS later this year. These payloads will be deployed on the Nanoracks External Platform (NREP)

- Hosted payloads up to 4U
- 50W Orbit Average Power (OAP)
- 24 Mbps data link (shared among NREP payloads)
- Low launch environments
- Nadir views
- Payload return
- Low-cost re-flights (4x/year)

Critical to think of NREP as a laboratory environment



LEONIDAS: Pathfinder for the ISS payload capability

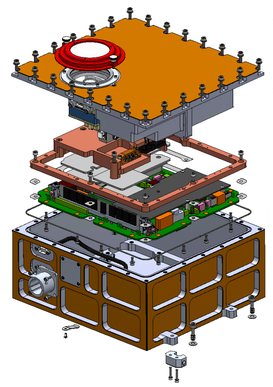
LEONIDAS is scheduled to launch August of 2023 and will be a Low-rigor payload to collect data on background, confusants, and, performance for Earth observation missions. LEONIDAS is a quick turn-around mission that was started in October 2021 and delivered to Nanoracks for launch in February 2023.

LEONIDAS contains:

- HD imager (ethernet)
- Event Based Sensor (USB 3.0)
- 8 TB NVMe drives (PCIe)
- DDR3 memory
- Pressure sensor (I2C)
- 5 temperature sensors (SPI)
- Versal Prime chip with custom Linux OS running on A72 processor, compiled through PetaLinux tool

ASTRID: Science Payload Demonstrator

ASTRID* will follow up LEONIDAS later in 2023. The ASTRID payload builds upon LEONIDAS by:



- Replacing Versal Prime chip with Versal AI Core chip
- Integrates four science payloads
  - An image integrity verification experiment
  - A Faraday cage containing mechanical transducer experiments
  - A radiation tolerant neural network experiment
  - A specialized polymer experiment

*ASTRID is sponsored by ISS National Laboratory

Future missions and work

LEONIDAS and ASTRID are pathfinder missions to prove out a new capability to provide easy, quick access to space for low-rigor research experiments. Both payloads will be returned to Sandia after flight and could be refurbished and flown for future missions. DELPHI is moving forward with a full 6U VPX board based off of the EVANDRE prototype.

U.S. DEPARTMENT OF ENERGY
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