Radiation -Tolerant Crew Laptop

Hunter McCrea, Jesog (Brian) Lee, Samuel Drell, Stuart Plaugher
Texas State University – RadDAWGs

Problem & Motivation

NASA is seeking a powerful, energy-efficient laptop capable of operating in the extreme conditions of cislunar travel for the upcoming Artemis missions. In this environment, digital electronics are exposed to ionizing radiation, which can permanently damage mission-critical components such as the processor.

Radiation Effects on Electronics

- **Single Event Effects (SEE):** High-energy particles can flip bits or disrupt circuits, leading to software errors or system crashes.
- **Total Ionizing Dose:** Long-term radiation buildup degrades device performance and can permanently damage components.
- **Displacement Damage Dose (DDD):** Radiation displaces atoms in the silicon lattice, creating defects that reduce reliability and may cause premature failure.

Design Solution

Solution

- The High Performance Spaceflight Computing (HPSC) RISC-V processor, developed by MicroChip, is being introduced as a radiation-tolerant solution.
- The Framework 16 opensource computer architecture allows us to develop a method for integrating the radiation tolerant processor into the Framework 16's modular ecosystem.

Challenges

- The HPSC cannot be directly integrated into the Framework 16 laptop. The HPSC natively supports PCIe, but the Framework 16 utilizes a USB ecosystem.

Expected Outcome

- Design a PCIe-to-USB controller that will allow NASA to deploy a modular, high-performance, and radiation-tolerant crew laptop suitable for space missions on the Lunar Gateway.

Subsystems

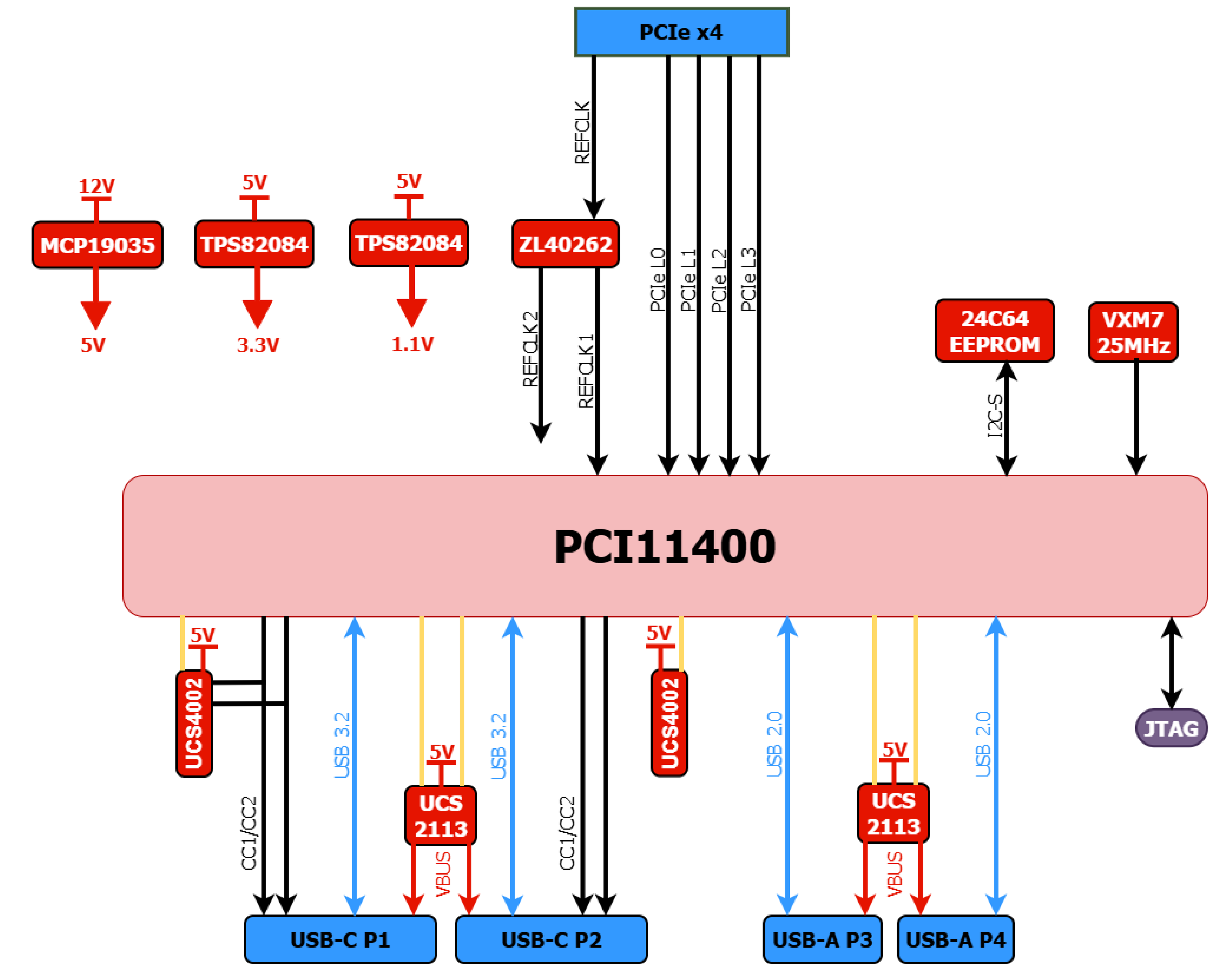
Hunter McCrea
- Processor Integration

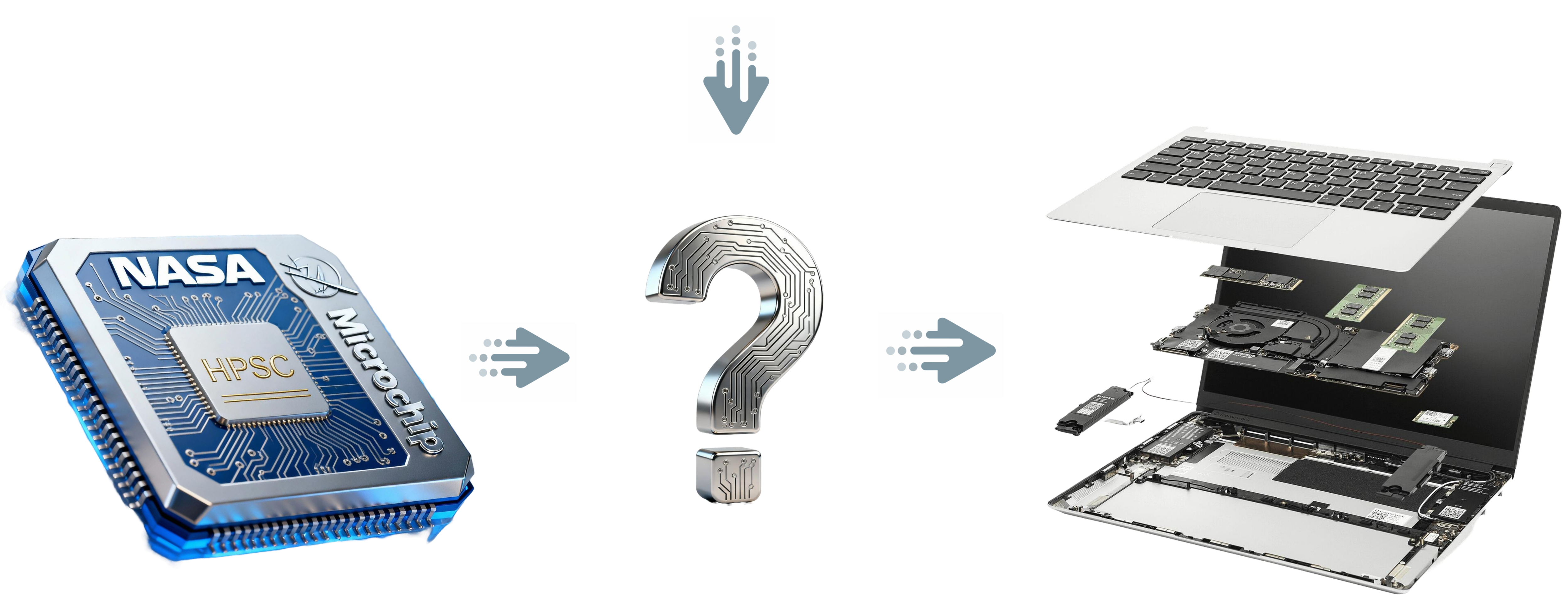
Jesog (Brian) Lee
- Peripheral Component Integration Express

Samuel Drell
- USB Functionality

Stuart Plaugher
- Power Integration

High-Level Design Perspective





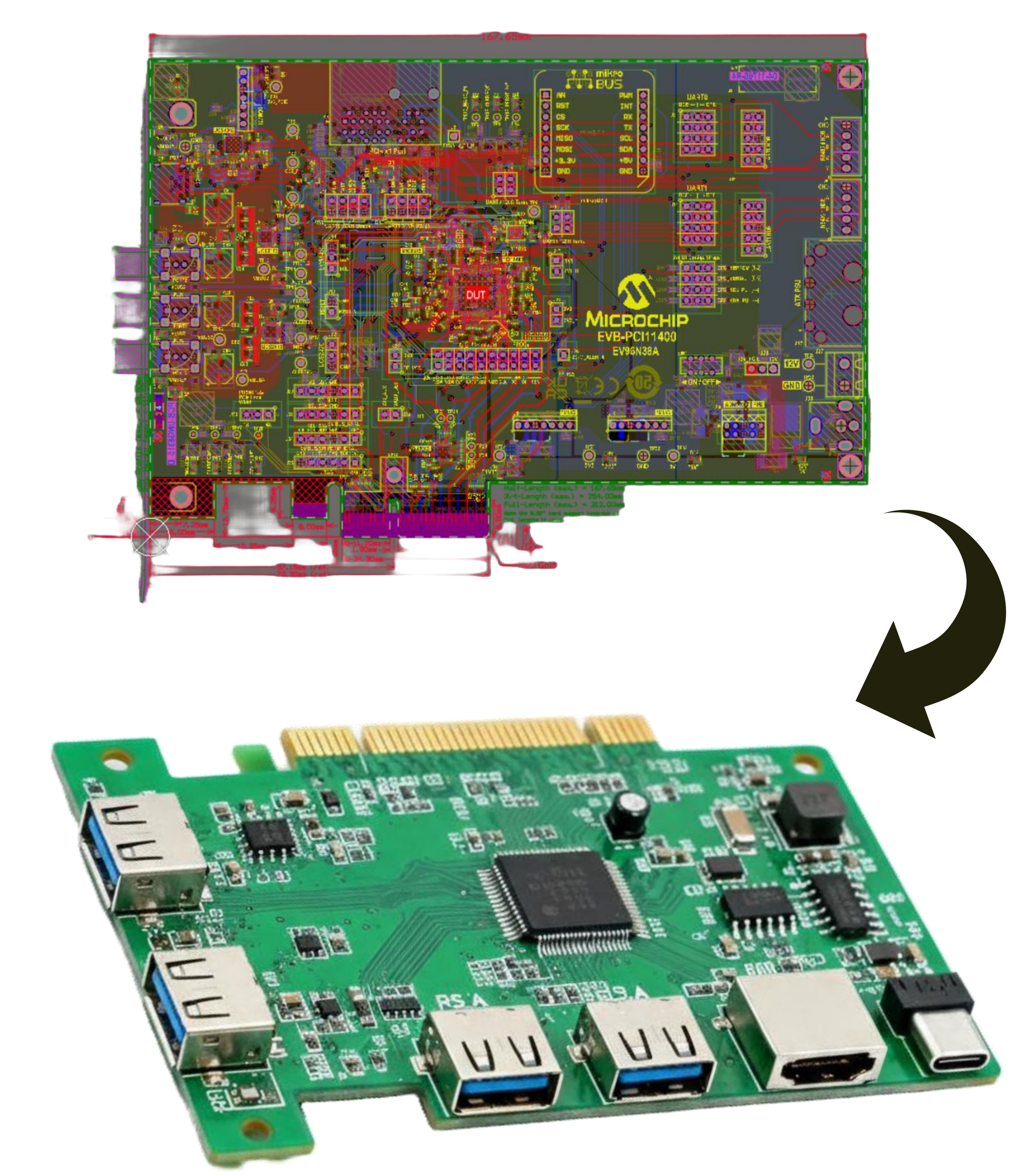
For any questions or comments please email hbm31@txstate.edu

Results

- Created comprehensive, well-organized multipage schematics to streamline and support an efficient board layout process.
- Performed detailed schematic reviews to validate critical circuit connections, ensure functionality, and confirm proper integration across all schematic sheets.
- Applied industry-standard design methodologies to achieve accurate, error-free schematic designs.
- Designed and validated the circuit schematic in Altium and initiated the board layout process.
- Tested the functionality of MicroChips development board, the EVB-PCI11400, with a Linux machine, verifying that Human Interface Devices (HIDs) perform as expected.

Future Work

- Modify existing design to support integration of the High-Performance Spaceflight Computing.
- Finalize printed circuit board layout of the controller in Altium.
- Manufacture board through external fabrication service.
- Develop a test methodology to characterize and analyze the controller's functionality.



Acknowledgements

First, we would like to extend our gratitude towards the amazing faculty at Texas State who make opportunities like this possible: Dr. Mark Welker, Dr. Rich Compeau, and Mr. Jeffery Stevens. We would also like to thank Mr. Bautista, and Mr. Stevens for their guidance and support while working on this project. We would also like to thank Jim at Microchip for rapidly providing all of the necessary documentation to complete this project.