Radiation-Tolerant Crew Laptop
Overview

Nicholas Johnston, Abeer Ahmed, Marco Rueda-Guzman, Bryce Gill, Kyra Ely

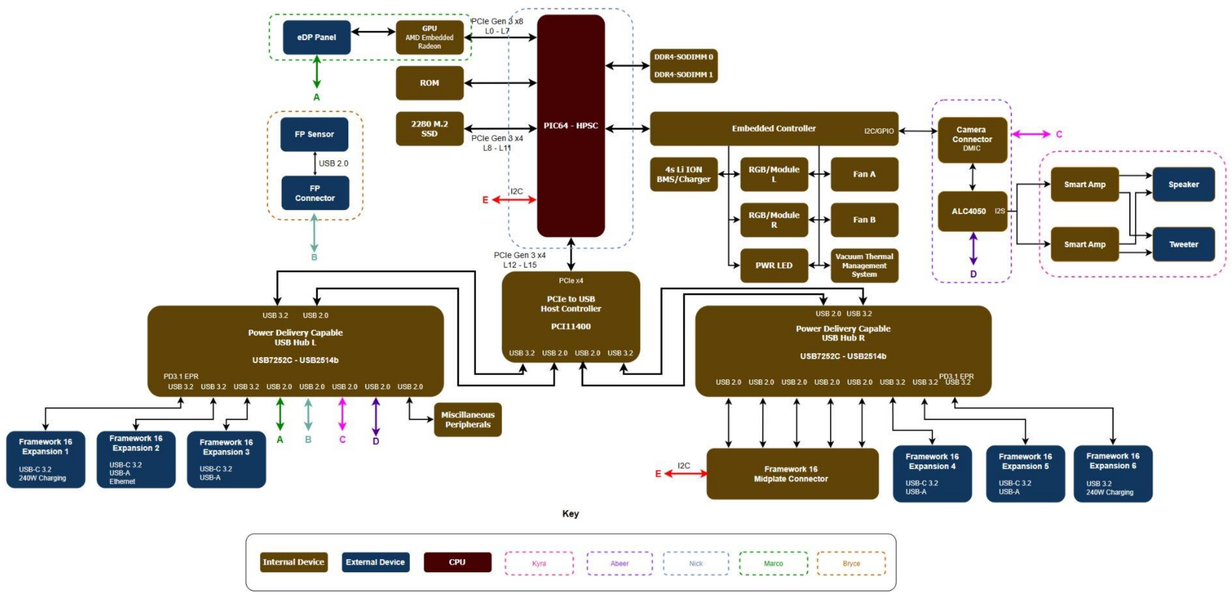
NASA Sponsor: Justin R. Bautista Faculty Advisor: Jeff Stevens

Background

Spaceflight computers need to operate reliably in an environment where radiation can cause errors and damage electronic components. While existing systems like the RAD750 have been used successfully, they have limited processing capabilities. NASA's High-Performance Spaceflight Computing (HPSC) processor is designed to provide significantly more computing power while maintaining radiation tolerance and improving energy efficiency. The goal of this project is to integrate the Microchip PIC64-HPSC processor into a Framework 16 laptop, building on previous work and the existing RadDAWG Bridge design.

The project involves designing the connections between the HPSC and the laptop's major subsystems, including memory, power delivery, graphics, audio input and output, camera, and the Framework 16 keyboard, touchpad, and fingerprint sensor. Each subsystem must be compatible with the processor and the laptop's existing interfaces. This semester, the team is researching components, reviewing existing designs, and developing functional block diagrams and schematics in Altium Designer. The end goal is to create a documented motherboard design that can be used as a starting point for future hardware development and testing.

Laptop Top Level Block Diagram



Project Schedule

Phase 1	System Architecture and Subsystem Definition	Fall 2026
Phase 2	Component Selection and Interfect Planning	Fall 2026
Phase 3	Initial Schematic Development	Fall 2026
Phase 4	Schematic Expansion and System Integration	Spring 2027
Phase 5	Schematic Verification and Design Review	Spring 2027
Phase 6	Final Documentation Generation and Release	Spring 2027

Accomplishments

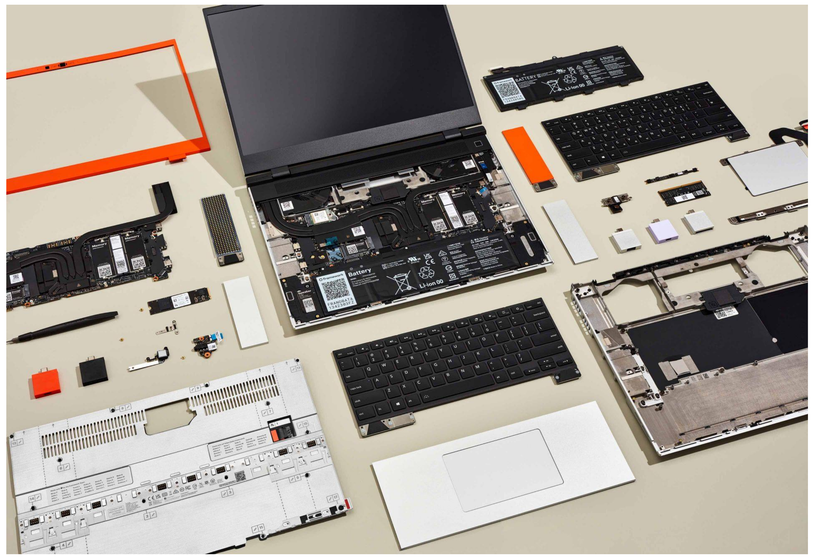
- Established the overall motherboard architecture for integrating the PIC64-HPSC processor into the Framework 16 laptop.
- Reviewed existing designs and reference schematics to guide subsystem development.
- Developed functional block diagrams and defined key subsystem interfaces.
- Researched and evaluated components for the different subsystems.
- Began developing subsystem schematics in Altium Designer.

Design Solution

The project will use the Framework 16 laptop as its foundation, integrating Microchip's radiation-tolerant PIC64-HPSC processor as the main computing unit. The existing RadDAWG Bridge from a previous team will provide PCIe-to-USB connections, allowing the laptop to retain support for its modular expansion devices. The design also includes memory and power delivery needed to support the processor and its connected components, however, these subsections will be addressed by future teams.

The remaining design decisions focus on maintaining compatibility with the Framework 16 while meeting the needs of each subsystem. The audio output design uses an ALC4050 codec and two TAS5825M amplifiers to provide four differential outputs for the laptop's two wide-band speakers and two tweeters. High-pass filters will be included on the tweeter outputs to support the speaker configuration. For graphics, an embedded AMD Radeon GPU is proposed to provide video output through the Framework 16 display's four-lane eDP connection, with a 60 Hz refresh rate as the target. The team is also developing connections for the camera, microphone, keyboard, touchpad, and fingerprint sensor based on the laptop's existing interfaces. These choices are being evaluated using component datasheets and Framework reference schematics. Altium's Electrical Rules Check will help identify pin compatibility and connectivity issues, although questions such as final GPU selection, driver support, speaker impedance, and power requirements still need to be resolved.

Power Delivery Block Diagram



Microchip HPSC V.S. RAD750

Processor:	Microchip PIC64-HPSC 1000-RH	BAE Systems RAD750 Enhanced
Year Introduced:	2024 (Announced)	2001
Architecture:	64-bit RISC-V	32-bit PowerPC 750
CPU Cores:	8 Cores	1 Core
Clock Speed:	Up to 1 GHz	200 MHz
Performance (DMIPS):	26,000 DMIPS	400 DMIPS
Total Ionizing Dose:	100 krad (Si)	1000 krad (Si)

Sources: Microchip, PIC64-HPSC Series (DS00005391D); BAE Systems, RAD750 Component Datasheet (CS-16-F78); NASA, Extreme Environment Technologies (2007)

Design Philosophy

Next semester, the team will continue developing and refining the motherboard schematics in Altium, focusing on completing subsystem designs, resolving remaining component and interface questions, and checking compatibility between the different systems. Work will also include defining the PCB layout requirements and preparing the design for review and future implementation. Some areas, including further power, memory, and system integration work, will remain open for future senior design groups to develop. These groups can build on the schematics and documentation completed by the current team as they continue toward a fully integrated laptop design.

Team



From left to right:

Marco Rueda-Guzman: Graphics Subsection

Nicholas Johnston: HPSC Processor Subsection

Kyra Ely: Audio Output Subsection

Abeer Ahmed: Camera Integration and Audio Input Subsection

Bryce Gill: Framework 16 Midplate/Input Modules + FP Sensor

Acknowledgements

We would like to thank our NASA sponsor, Mr. Justin Bautista, and the faculty at Texas State University, especially Dr. Mark Welker and Mr. Jeffrey Stevens, for providing us with this opportunity and supporting us throughout the project. We also appreciate the teachers and mentors who have contributed to our academic growth. Finally, we would like to acknowledge the technical writers and product engineers whose clear, detailed datasheets have been valuable resources throughout our research and design process.

Questions, comments and concerns regarding our project may be directed to Kyra Ely

Email: zey5@txstate.edu