E1.02 Radiation-Tolerant Crew Laptop

Cameron Callahan(Project Manager), Aaron Dahl, Noah Steres, John Camp

Texas State University - Radcat Sentinels

Team

Figure 1: Left to Right: John Camp, Cameron Callahan, Aaron Dahl, Noah Steres

Purpose and Importance

This project serves as a comprehensive validation suite for a RISC-V based main board being designed for a deep-space laptop. Leveraging NASA and Microchip's High-Performance Spaceflight Computing (HPSC) processor, this project demonstrates the feasibility of a resilient, energy-efficient laptop capable of withstanding space radiation.

Radiation Challenges:

- **Single Event Effects:** Can disrupt electronic components when high-energy particles strike a device. These effects can cause bit shifts, altering the state of a circuit (eg., changing a '0' to a '1'), which may lead to software errors or system crashes.
- **Total Ionizing Dose:** Causes undesirable charge collection at silicon and insulator interfaces, leading to performance issues and potential failure over time. TID can permanently damage in affected components.

Board Features

- Wired and Wireless Network Connectivity
- Storage and Memory Capabilities
- Integrated Audio and Video Capabilities
- Comprehensive USB Hub and Connectivity Options
- Automotive Grade Components for Increased Radiation Tolerance

Subsystems

WIFI	Cameron Callahan	USB	John Camp
LCD Display	Cameron Callahan	Audio	Noah Steres
Boot	Aaron Dahl	PCIe	Noah Steres
Camera	John Camp		

Laptop Main board Implementation

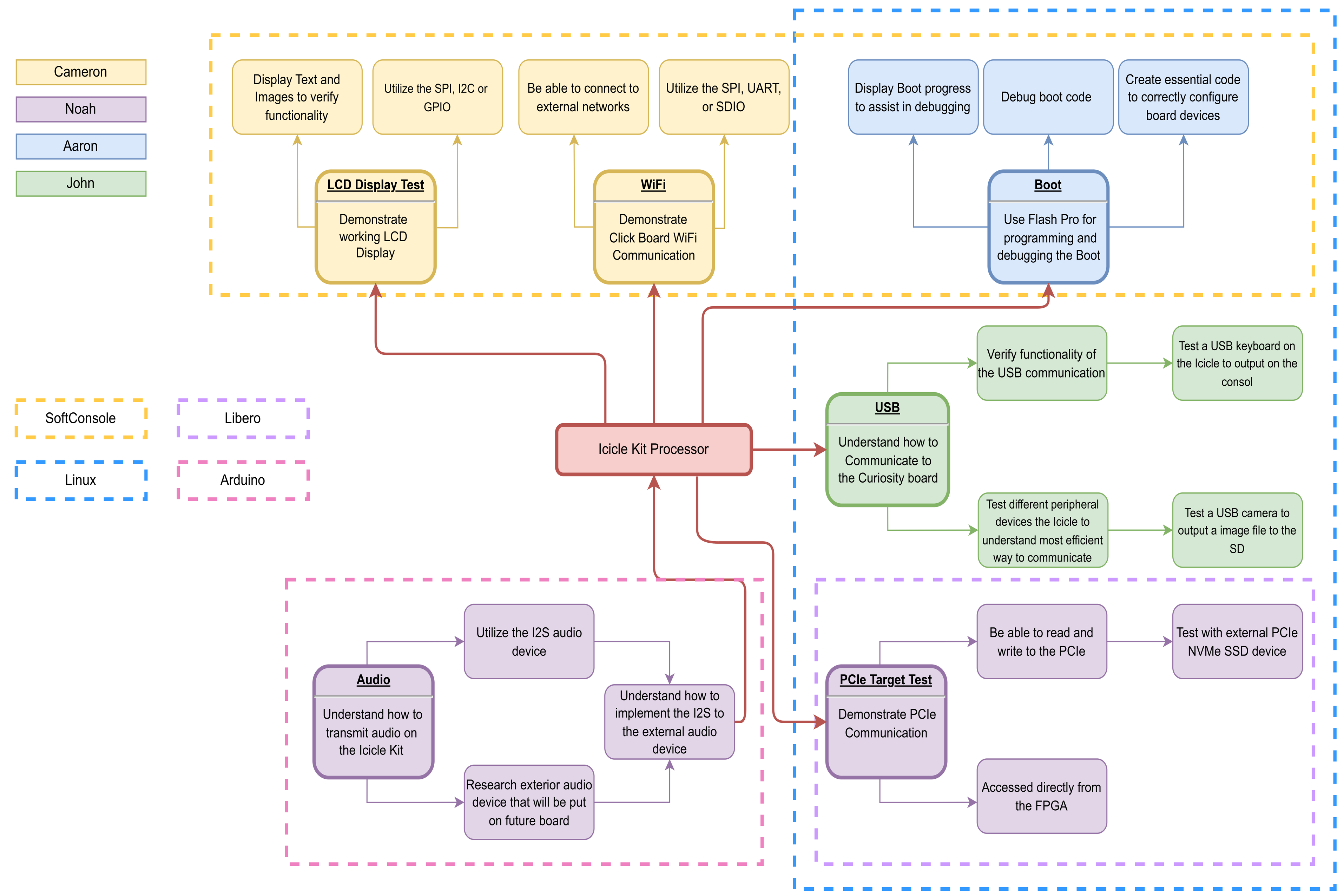


Figure 2: Top-level block diagram of the laptop main board.

Accomplishments

- Successfully booted Linux on Icicle kit, allowing us to navigate through and edit the device tree and file system of the board.
- Successfully used SoftConsole to edit and run baremetal applications for the Icicle Kit.
- Identified and altered baremetal code examples used to validate the components of each subsection.
- Identified and altered the HSS boot loader code for the Icicle kit allowing for a more detailed boot process and a more reliable debugging process.
- Identified a method of switching between boot modes allowing the board to boot as expected for each mode used.

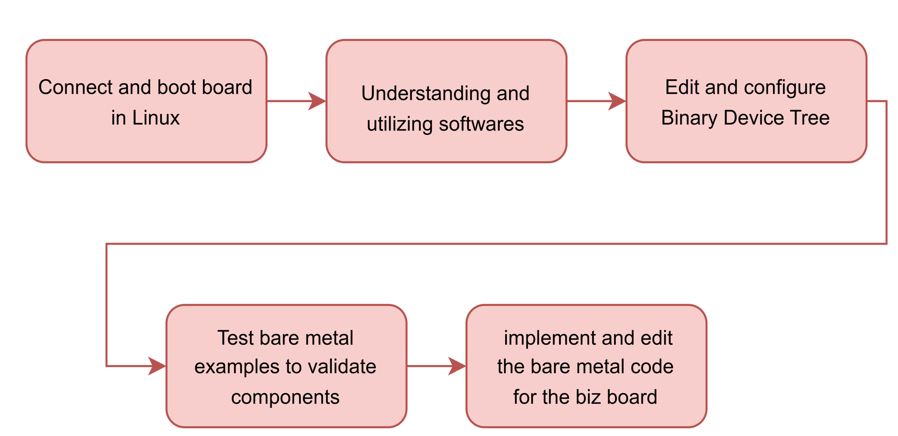


Figure 3: Design Objectives.

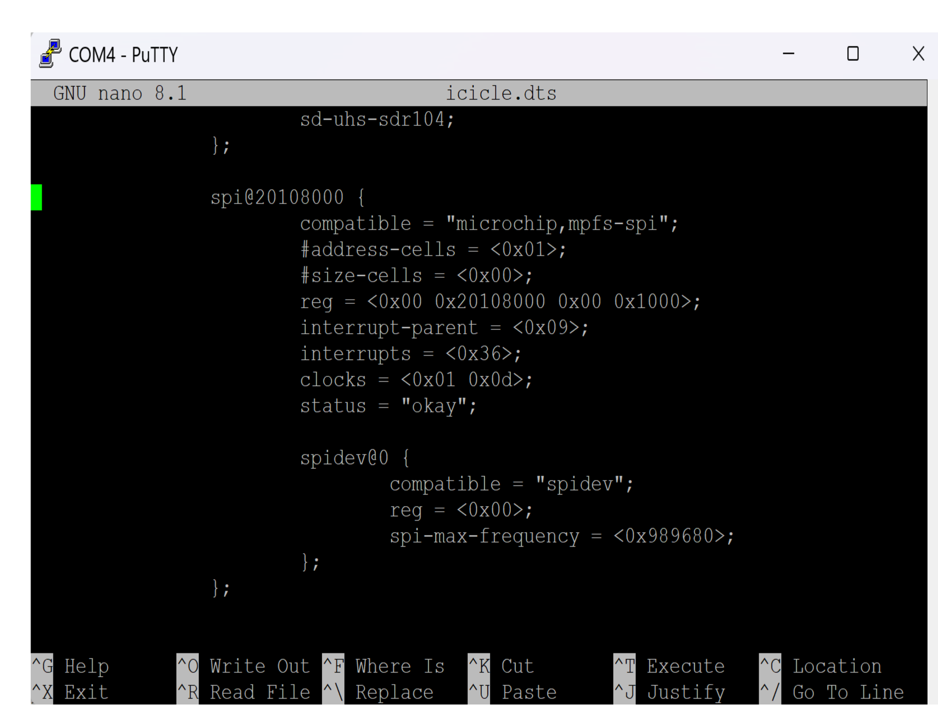
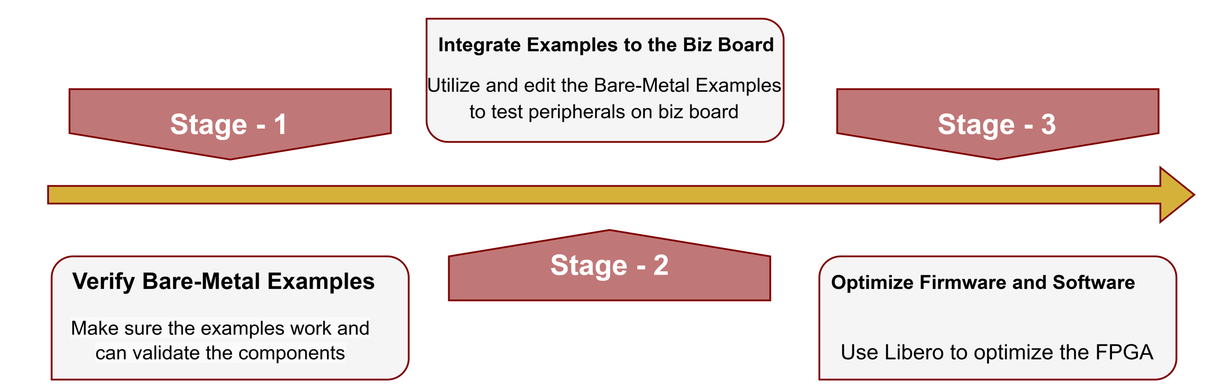


Figure 4: Device Tree.

Path Forward

Next Steps and Development Goals:

- Verify functionality of all baremetal examples and ensure that they allow for full validation of each component needed to be tested.
- Integrate all baremetal examples needed for the main board in order to accommodate for any changes made from Icicle to main board
- Optimizing firmware and software to improve functionality and efficiency
- Finish the design for the current D2 Effectively Grounded team main board being designed.
- Test the hardware and software on the board to ensure full functionality of the essential components on the board.



A Platform for Continuous Innovation:

The Radiation-Tolerant Crew Laptop project provides a path toward a HPSC processor based crew laptop suitable for deep space missions. Our project will work as a proof of concept, so future teams can build off our design and work toward an HPSC based laptop.

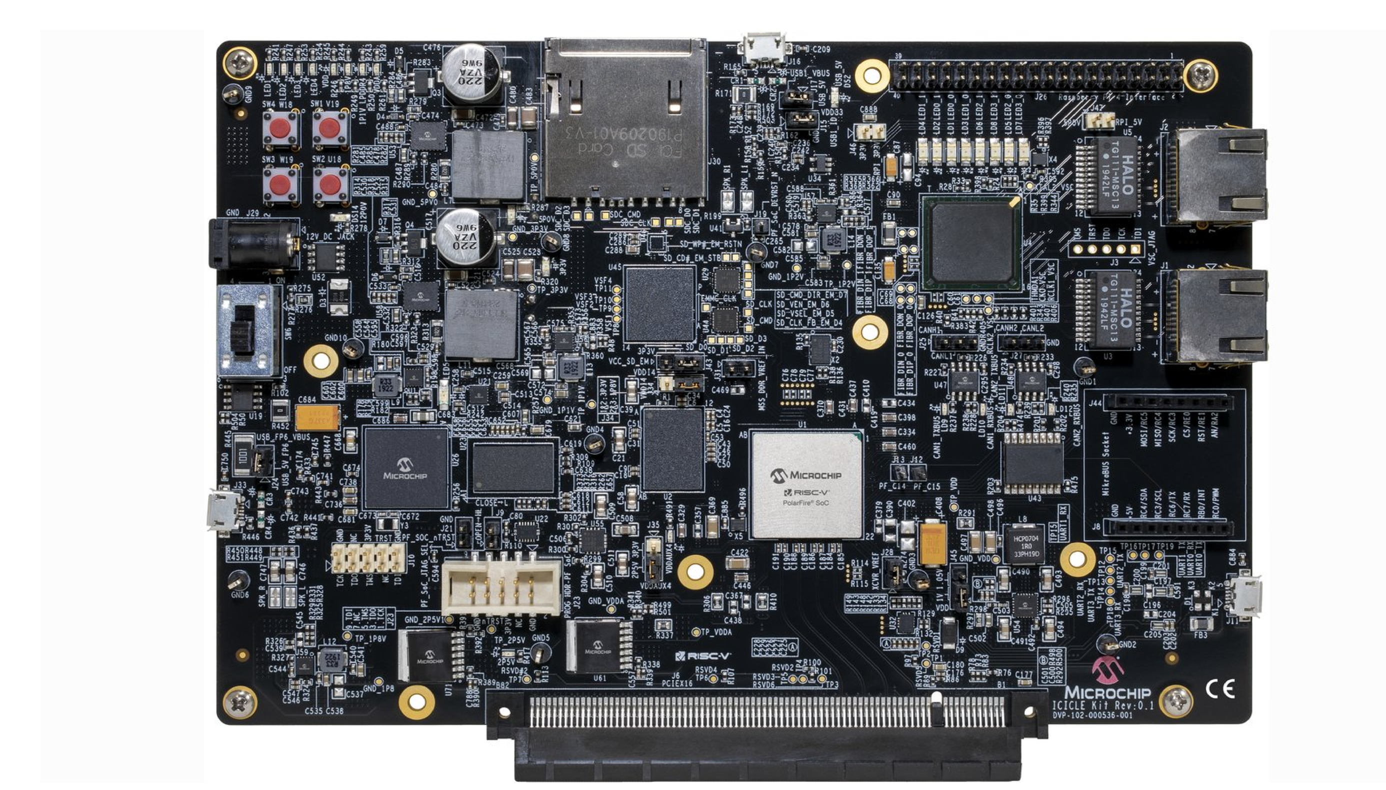


Figure 5: Icicle Kit Development Board (Courtesy of Microchip)

Acknowledgments

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