Real-Time Edge Data Sensing and Fusion on a RISC-V computing node

Introduction

This project investigates the potential of the Milk-V Duo S, a small and affordable single-board computer that supports both RISC-V and ARM architectures. Aimed at evaluating its use in educational and embedded systems contexts, the project focuses on setting up the platform, developing and testing software, and interacting with system-level components. The work was divided into four main stages, following a progressive approach to explore and validate different aspects of the device's functionality and development process.

Project Objectives

- Boot the Linux operating system on the Milk-V Duo S and assess the ease of installation.
- Develop applications using Linux system calls, similar to those studied in the Operating Systems and Computer Networks courses.
- Evaluate the Milk-V Duo S platform objectively (regarding available hardware functionalities) and subjectively (regarding the difficulty of developing such applications).

Project Stages and Results

1. Initialization of the Linux System

- Set up the Milk-V Duo S with a Linux system using the RISC-V option.
- Fixed startup problems caused by a damaged memory card.
- Connected to the board remotely using a computer.
- Adjusted the memory settings to use the full card capacity.
- Prepared the programming environment.
- Tested everything by running a basic program on the board.

2. App Development using Linux System Calls

- Created simple programs that interact directly with the system, such as reading files or running tasks in parallel.
- Prepared the programs to run on the board.
- Solved small setup and file transfer issues.
- Ran all the programs successfully on the board.
- Confirmed the board can handle practical programming tasks similar to what is taught in university courses.

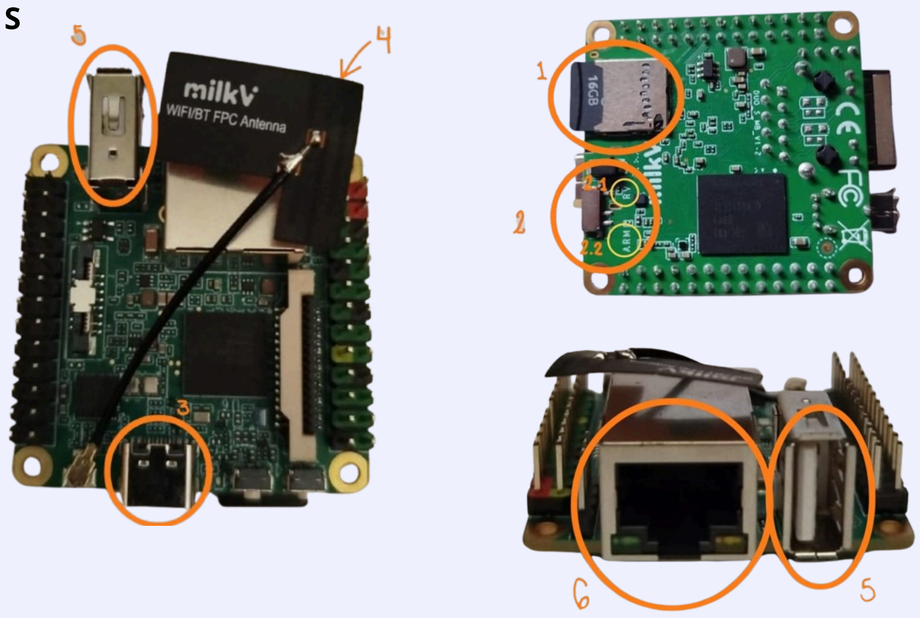
3. Intenet Connection and Communication with Sockets

- Connected the board to the internet using a mobile hotspot.
- Set up wireless access to ensure a stable connection.
- Built a program that downloads a file from a public server.
- Successfully transferred the file using internet communication.
- Proved that the board works well in networked environments.

4. Kernel Module Installation

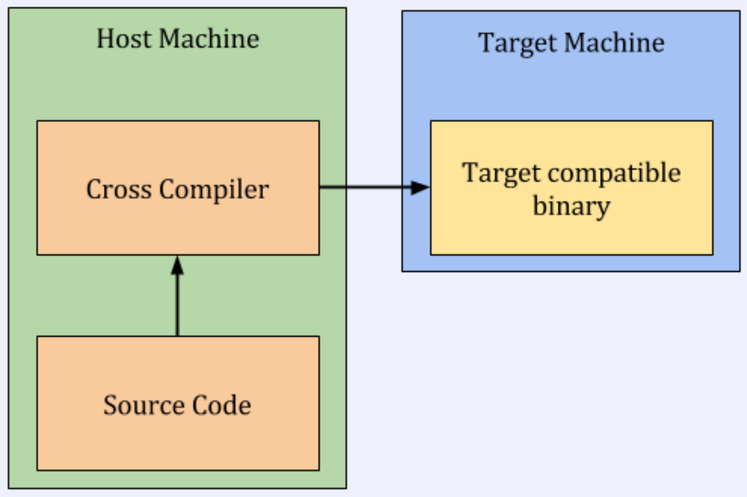
- Faced some issues with different software versions and missing files.
- Made the necessary adjustments to match the system requirements.
- Installed a simple example successfully.
- Showed that the board supports more advanced, low-level experimentation.
- Successfully compiled and installed the MINIX module on the Milk-V Duo S.

Milk-V Duo S

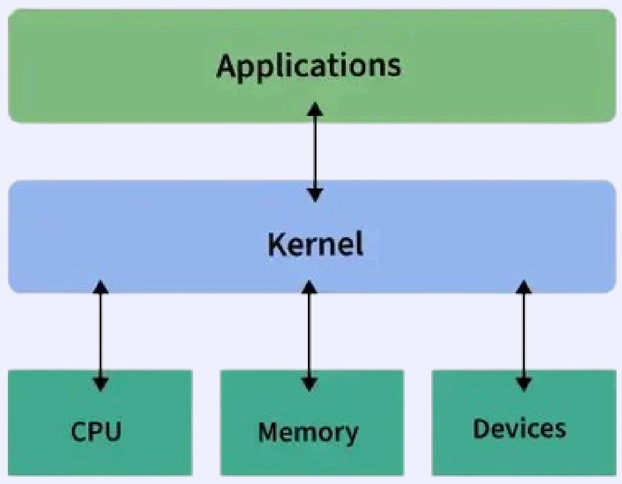


1 MicroSD card slot
2 Architecture selection switch
3 USB port type-C
4 WiFi/BT antenna
5 USB port type-A
6 Ethernet port

Cross Compile



Kernel



Conclusions

- The Milk-V Duo S proved to be a capable and flexible platform for embedded Linux development, suitable for both academic and experimental use.
- We gained experience in system configuration, application development, networking, and kernel-level programming on a RISC-V architecture.

References

- Milk-V, Community & Forum
- Milk-V, Documentação Geral & Tutorial
- Joaquim Monteiro's Master Thesis on micro-kernel API

Project Coordinator/Advisor: Prof. Pedro Souto
Course: Projeto Integrador - L.EIC 24/25

Members: Luís Martim Ferreira - up202208429
Luís Ganço - up202004196
Diogo Leandro - up202005304
Angy Pita - up202007253