Debugging an Embedded System

(The case for RP2040 and Picoprobe)

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Overview

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2. Approaches to Debugging
3. Why use Hardware Debuggers?
4. Picoprobe

Introduction

What is an Embedded System?

An embedded system is a computerized system that is purpose-built for its application.
– **Elecia White, Making Embedded Systems**

What is an Embedded System?

A combination of computer hardware and software, and perhaps additional mechanical or other parts, designed to perform a dedicated function.
– **V. Gadre, Netaji University of Technology,New Delhi**

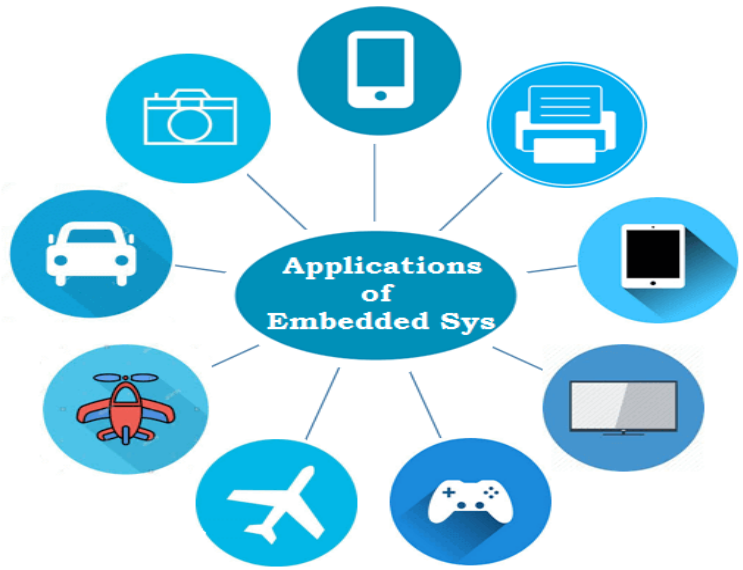
An embedded system

A computing system found in another system whose primary purpose is not computing.

Application areas

Application areas

- Robotics
- Telecommunication
- Sports
- Medicine
- Safety critical systems



Debugging

Debugging

The procedures through which engineers find and fix bugs(incorrect behaviour) in software(systems).

From Code to Binary

Embedded toolchain

In a compiler toolchain for a language like C/C++, there is :

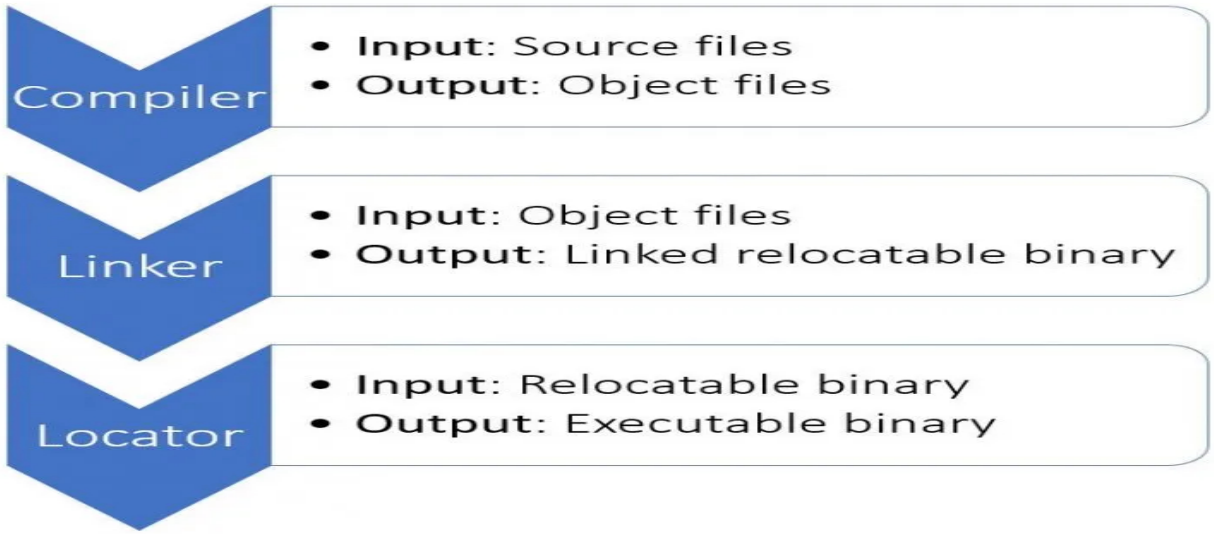
- **Compiler**: Takes source code in files and generates corresponding assembly code in files.
- **Assembler**: Takes assembly and produces machine code with no absolute addresses.
- **Linker**: Takes machine code and links them against libraries and references from all files included in the project to produce a single binary file.

Most times, invoking the compiler will call the subsequent steps in order.

Embedded Programming Concepts

Cross-compiling

Compiling code for an architecture different from the host CPU's architecture.
Example: arm-none-eabi-gcc



"Flashing"

Copying the resulting machine code in the right format(**.hex, .bin, .elf**) into non-volatile memory of the MCU.

Approaches to Debugging

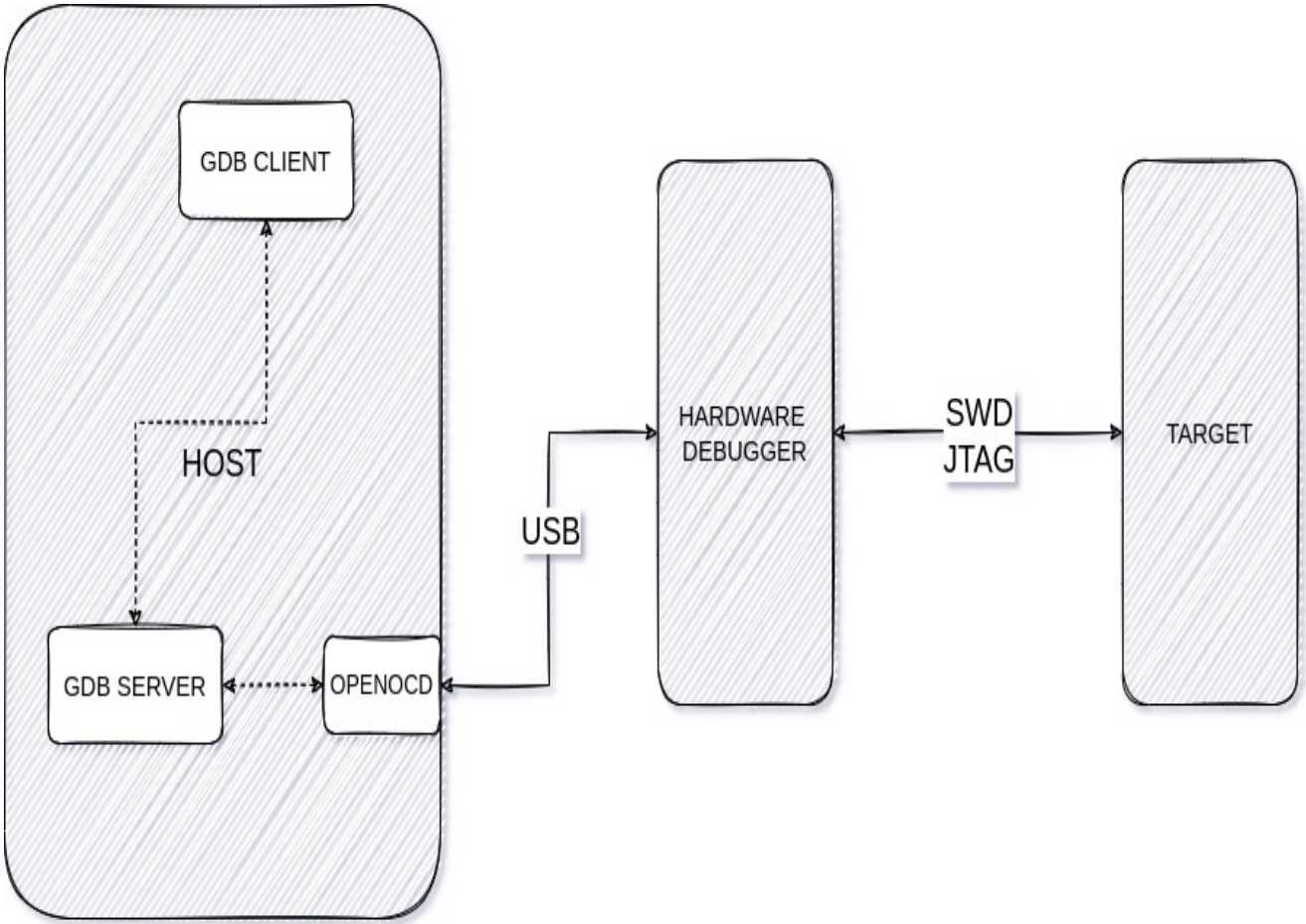
Approaches

- Logging over a serial port(printf debugging)
- Using a debugger
- Using a Logic Analyzer
- Oscilloscope, multimeter

Why use Hardware Debuggers?

- Ability to set breakpoints
- Step into, step out, step over, continue execution
- Inspect memory content (see values in variables during execution)
- Watch expressions
- printf debugging changes the timing(WS2812B might not work)

Hardware Debuggers



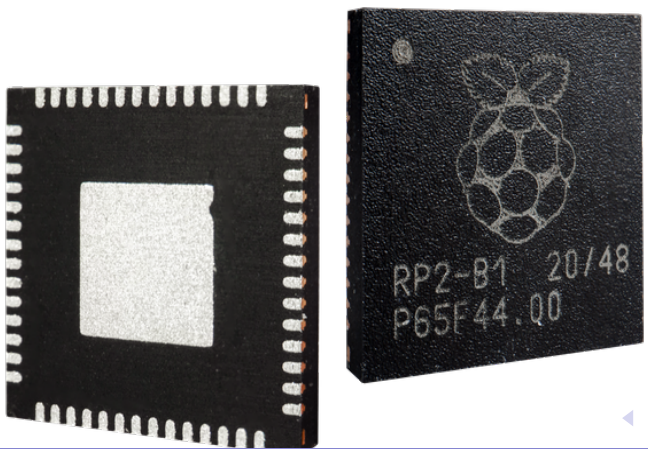
Hardware Debuggers – Examples

Examples

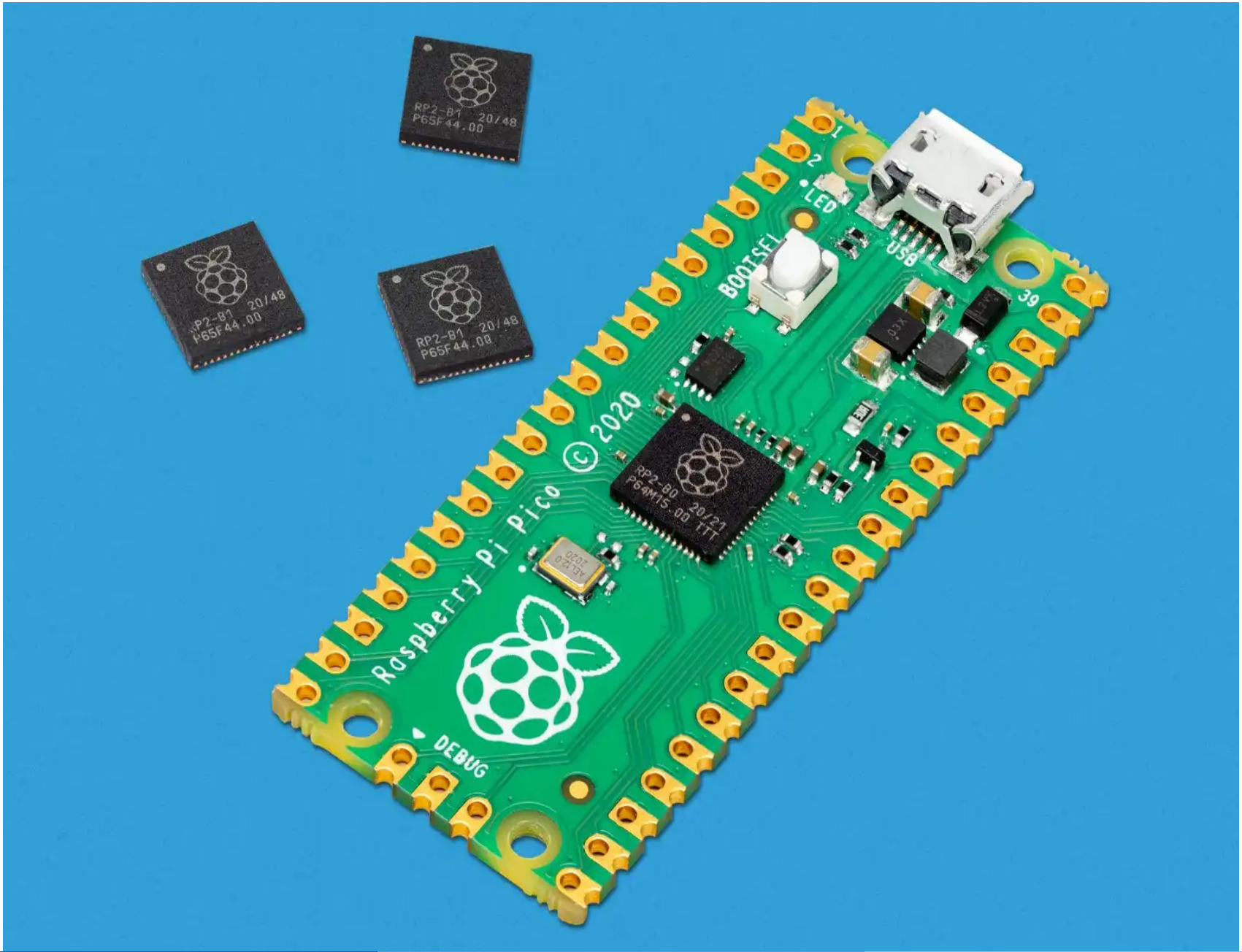
- JLink Edu Mini($42.32)
- ST Link($20.00)
- Raspberry Pi(openocd)
- Raspberry Pi Pico(picoprobe)($4.23)

RP2040

- Dual Cortex M0+ processor cores, up to 133 MHz
- 264 kB of embedded SRAM in 6 banks
- 30 multifunction GPIO
- 6 dedicated IO for SPI Flash (supporting XIP)
- Dedicated hardware for commonly used peripherals
- Programmable IO for extended peripheral support
- 4 channel ADC with internal temperature sensor, 0.5 MSa/s, 12-bit conversion
- USB 1.1 Host/Device



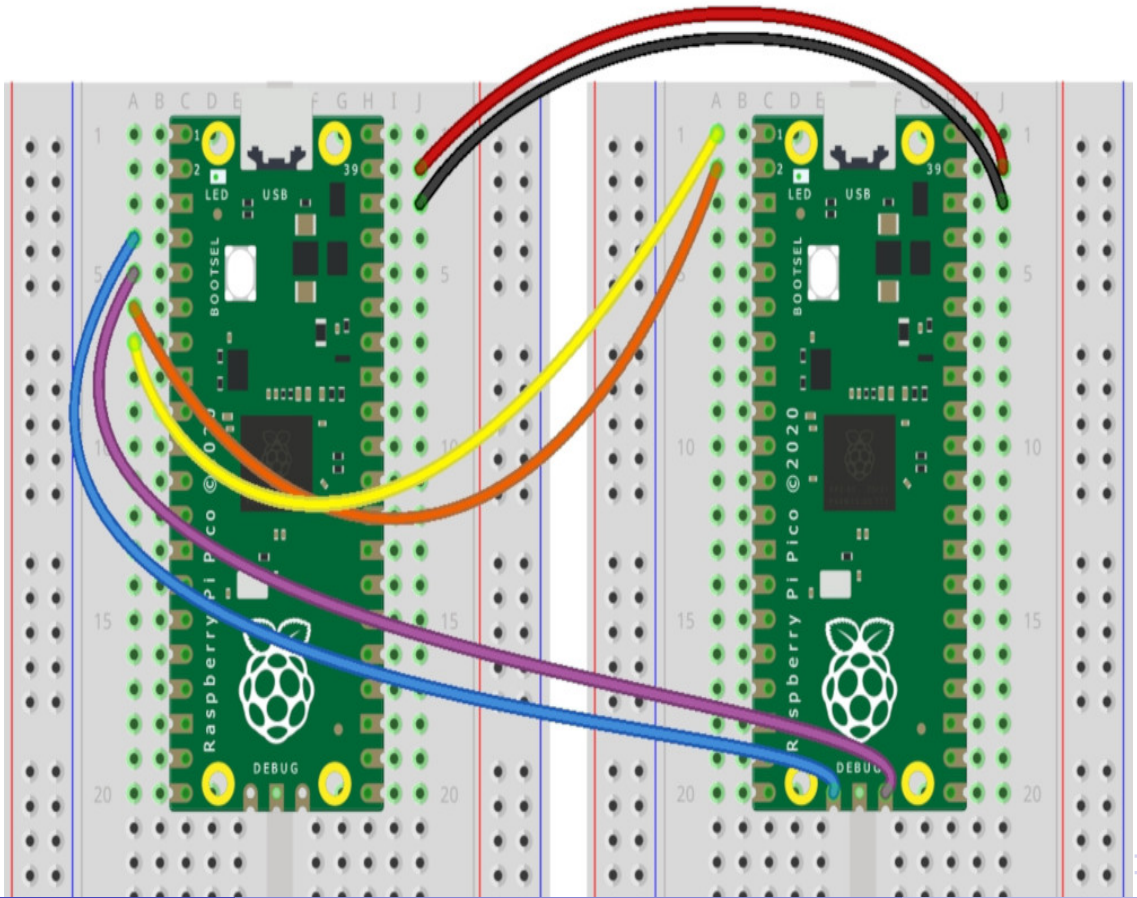
Raspberry Pi Pico



Picoprobe

What is Picoprobe?

"Picoprobe allows a Pico / RP2040 to be used as USB to SWD and UART bridge. This means it can be used as a debugger and serial console for another Pico." – Raspberry Pi LTD.



Thank you