基于RISC-V的IDEs的调研

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01 IDE简介

- IDE：集成开发环境（Integrated Development Environment）
- 辅助编写源代码文本、并编译打包成可用的程序的一种开发工具

通常包含：

- 编程语言编辑器
- 自动构建工具
- 调试器

有些包含：

- 编译器/解释器
- 版本控制系统
- 类别浏览器、对象查看器、对象结构图

参考资料：
[1] https://zh.wikipedia.org/wiki/%E9%9B%86%E6%88%90%E5%BC%80%E5%8F%91%E7%8E%AF%E5%A2%83

02 GNU MCU Eclipse

简介

GNU ARM → GNU MCU Eclipse!

The GNU MCU/ARM Eclipse project is currently under migration to the Eclipse Foundation as Eclipse Embedded CDT (C/C++ Development Tools).

Starting with Eclipse plug-ins v4.x, the project was enhanced with support for RISC-V devices, thus the new **MCU** name, more appropriate for a multi-platform project. For more details, see the RISC-V Corner and xPack GNU RISC-V Embedded GCC page.

GNU MCU Eclipse is an open source project that includes a family of Eclipse plug-ins and tools for multi-platform embedded ARM and RISC-V development, based on GNU toolchains. This project is hosted on GitHub. The former project was hosted on GitHub and SourceForge.

参考资料：

[1] https://gnu-mcu-eclipse.github.io/

02 GNU MCU Eclipse

特点介绍

附带的工具：

- GNU MCU Eclipse Windows Build Tools
- xPack GNU Arm Embedded GCC
- xPack GNU RISC-V Embedded GCC： 由 SiFive 维护的裸机版 RICS-V GCC
- xPack OpenOCD：调试器
- xPack QEMU Arm： 为 Cortex-M 提供模拟仿真支持

多模板：

/// Generic templates

- Cortex-M template (CMSIS)

/// ST Micro templates

- STM32F0xx template
- STM32F1xx template
- STM32F2xx template
- STM32F3xx template
- STM32F4xx template (CMSIS-CORE)

/// Freescale templates

- Kinetis KLxx templates
- Processor Expert template

参考资料：
[1] https://gnu-mcu-eclipse.github.io/
[2] https://xpack.github.io/qemu-arm/
[3] https://gnu-mcu-eclipse.github.io/templates/

02 GNU MCU Eclipse

基于RISC-V

所需环境/工具：

- GNU MCU Eclipse IDE for C/C++ Developers
- GNU MCU Eclipse plug-ins
- GNU MCU Eclipse Windows Build Tools
- xPack GNU RISC-V Embedded GCC
- xPack OpenOCD

xPack GNU RISC-V Embedded GCC

- riscv64-unknown-elf-gcc
- 没有 riscv64- 或 riscv32- 前缀
- 用 -march 和 -mabi 参数传递给 GCC

支持的处理器：

- SiFive Freedom E310, RV32IMAC, a 32-bit embedded processor
- SiFive E31 Coreplex, RV32IMAC, a Verilog synthesised 32-bit embedded processor
- SiFive E51 Coreplex, RV64IMAC, a Verilog synthesised 64-bit embedded processor

支持的开发板：

- SiFive HiFive1, an Arduino-compatible development kit featuring the Freedom E310
- Xilinx/Digilent Artix-7 35T Arty FPGA Evaluation Kit, a board capable of running the synthesised E31/E51 devices

参考资料：

[1] https://gnu-mcu-eclipse.github.io/
[2] https://xpack.github.io/riscv-none-embed-gcc/

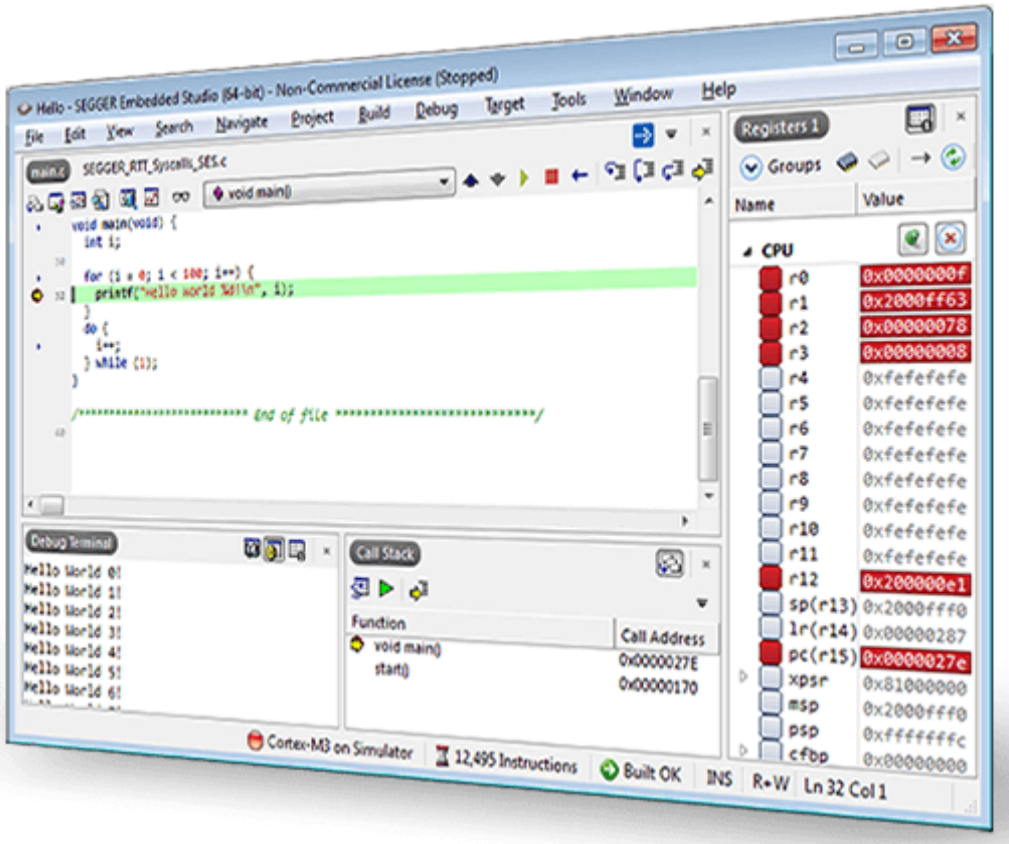
03 Embedded Studio

简介

Contents [show]

Embedded Studio is a complete all-in-one solution for managing, building, testing, and deploying your embedded applications: From the project generator which gets you easily started with common microcontrollers, to the powerful project manager, and source code editor, the included C/C++ compiler, and the integrated debugger with advanced debug information windows, and direct J-Link integration, right through to version control features for automatic deployment of your applications. Embedded Studio is the best solution for embedded C programming.

Its Visual Studio-like style offers the embedded world of engineering the same intuitive usage that PC developers are familiar with.



参考资料：
[1] https://www.segger.com/products/development-tools/embedded-studio/

03 Embedded Studio

特点介绍

- Clang/LLVM, and GCC C/C++ Compilers included
- Highly optimized run-time library for best performance and smallest code size
- Feature-packed debugger with seamless J-Link integration
- Support for 3rd party debug probes via GDB protocol
- Powerful Project Manager, even for huge projects
- Package-based project generator for all common microcontrollers
- Multi-Threaded build minimizes build times
- Cross-Platform: Runs on Windows, macOS, and Linux

参考资料：
[1] https://www.segger.com/products/development-tools/embedded-studio/

03 Embedded Studio

J-Link

- All popular debuggers and IDEs are supported
- Cross platform support (Windows, Linux, Mac)
- Ultrafast download speed into RAM and flash memory
- Unlimited breakpoints in flash memory —— Unlimited Flash Breakpoints
- Unique Real-Time Transfer technology (RTT)
- Multiple CPUs supported—8051, PIC32, RX, ARM7/9/11, Cortex-M/R/A, RISC-V

Unlimited Flash Breakpoints

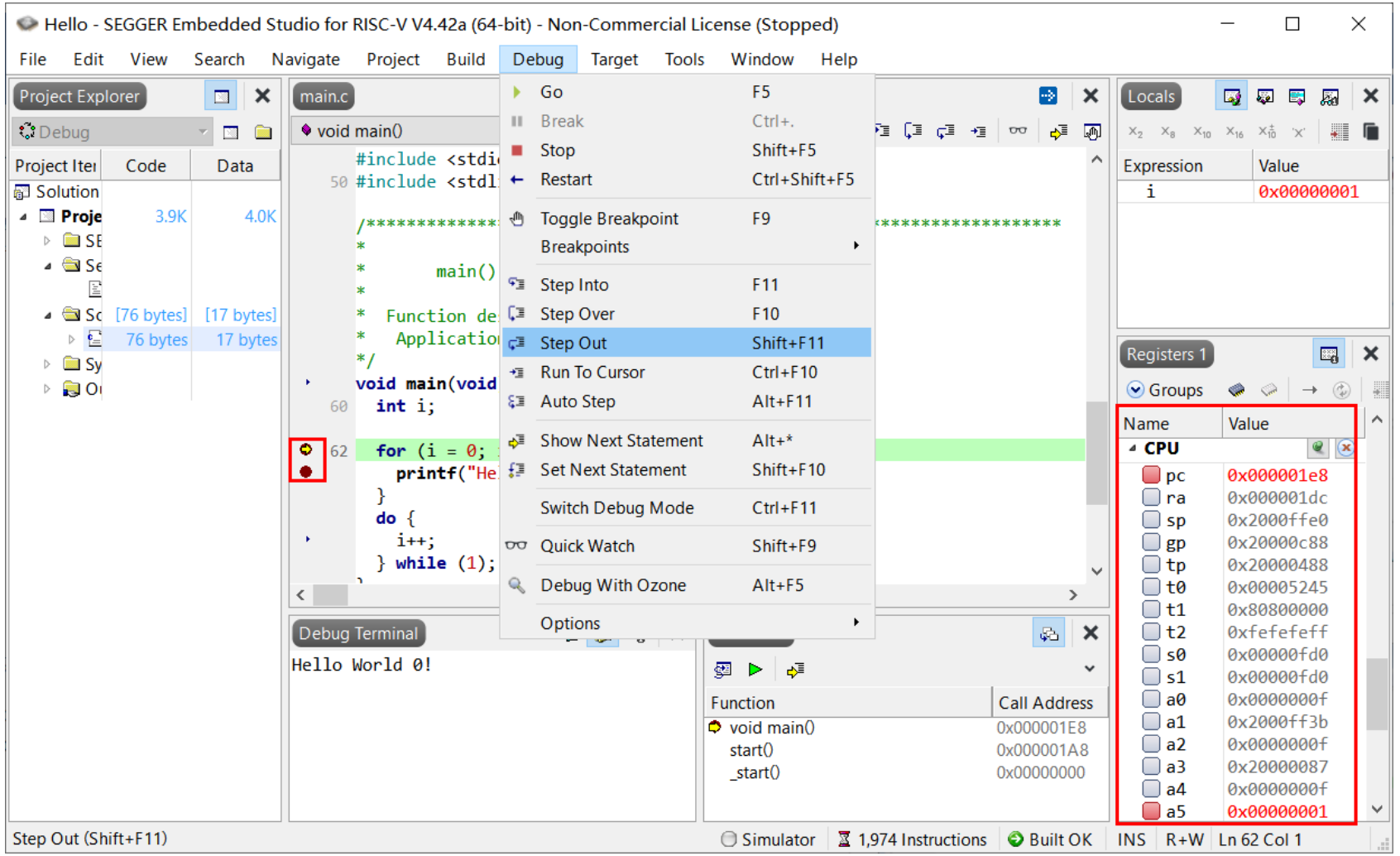
- CPU 调试单元支持的硬件断点数量有限
- 允许在Flash内存中调试时设置无限数量的断点
- CPU耗尽了硬件断点，J-Link 会自动使用Flash断点

Real-Time Transfer technology (RTT)

- 与目标应用程序的双向通信
- 高传输速度，不影响实时行为
- 使用调试通道进行通信，可用于多个“虚拟”终端
- 不需要额外的硬件或目标引脚

参考资料：
[1] https://www.segger.com/products/debug-probes/j-link/
[2] https://www.segger.com/products/debug-probes/j-link/technology/flash-breakpoints/
[3] https://www.segger.com/products/debug-probes/j-link/technology/about-real-time-transfer/

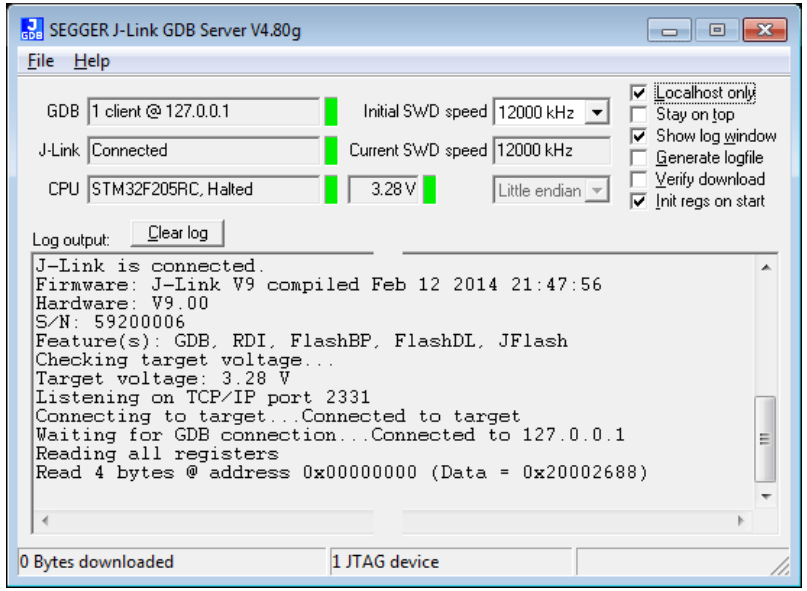
03 Embedded Studio

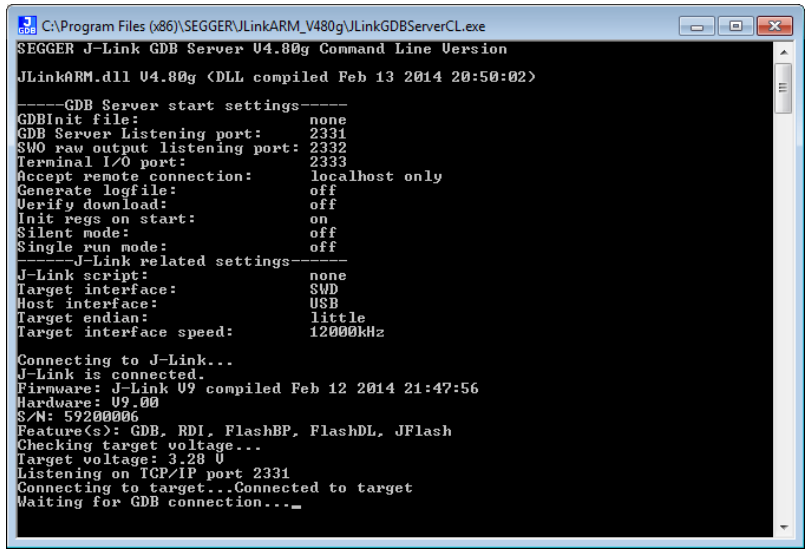


03 Embedded Studio

GDB

- GNU Project Debugger (GDB)
- 在GNU公共许可证 (GPL) 的条款下发布
- 通过 TCP/IP 连接到模拟器
- 可以连接到每个可用 GDB 服务器软件的模拟器
- 支持一组标准的命令，如打开elf/bin文件、读取/写入内存等
- 支持监视器命令，这些命令被传递到 GDB服务器并由 GDB 解释
- 允许实现J-Link特定的命令，如读取/写入CP15寄存器，通过J-Link支持flash下载，使用无限闪存断点技术，支持半托管等



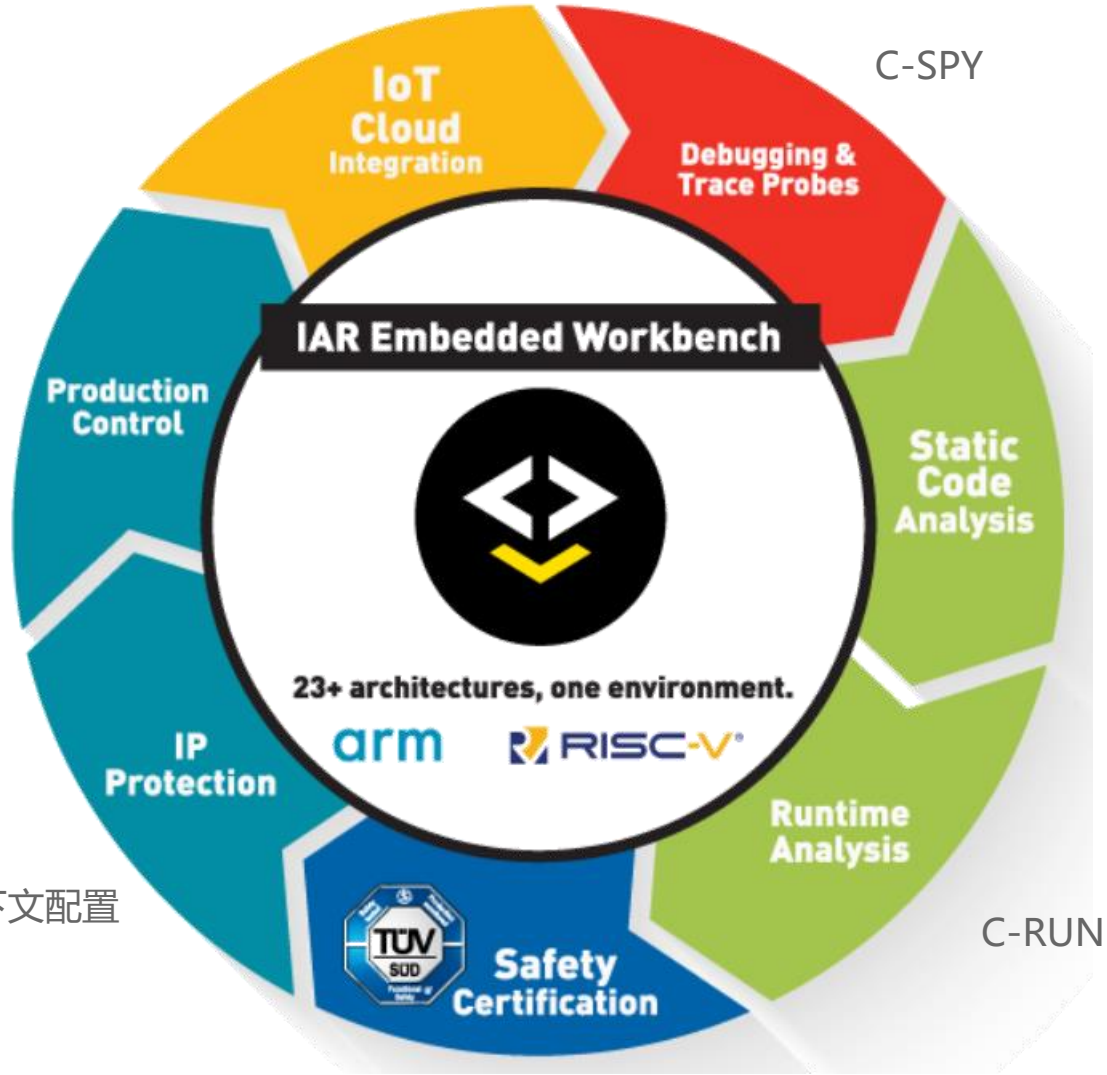


参考资料：

[1] https://www.segger.com/products/debug-probes/j-link/tools/j-link-gdb-server/about-j-link-gdb-server/

04 IAR Embedded Workbench

概述



C-SPY

C-STAT

C-Trust

安全上下文配置

C-RUN

参考资料：

[1] https://www.iar.com/iar-embedded-workbench/#!?architecture=RISC-V
[2] https://www.iar.com/security-from-inception/c-trust/
[3] https://www.iar.com/iar-embedded-workbench/add-ons-and-integrations/analysis-tools-for-arm-and-rx/

04 IAR Embedded Workbench

基于 RISC-V 的特点工具

C-STAT included

IAR Embedded Workbench for RISC-V includes C-STAT, the static analysis tool in IAR Embedded Workbench that ensures code compliance with branch specific standards and best programming practices. C-STAT also improves code quality and generates reports needed for certification.

C-SPY

IAR Embedded Workbench for RISC-V also includes C-SPY, the debugging tool in IAR Embedded Workbench that enables developers to analyze and track the exact root of a specific bug to fix issues at an early stage.

C-SPY is a state-of-the-art debugger that gives full control of the application in real time with full debugging capabilities even without access to the hardware using the C-SPY simulator. Native debug probe support through I-jet enables high-speed in-circuit debugging.

The debugger also includes a command line utility. In addition, a plugin SDK is available for easy integration of emulator interfaces, RTOSs, TCP/IP and network stacks, etc.

参考资料：
[1] https://www.iar.com/iar-embedded-workbench/#!?architecture=RISC-V&currentTab=overview

04 IAR Embedded Workbench

IAR Embedded Workbench for RISC-V version 1.20.1

- Support for the base instruction set RV32E
- Support for the standard extension for Atomic operations (A).
- Support for interrupt vectors
- Stack protection
- Optimized floating-point libraries for devices without an FPU
- Interrupt and exception catching
- Data breakpoints
- Asynchronous multicore debugging
- C-SPY SDK

Device support

- Andes —— D25F
- CloudBear —— BM-310

Stack protection

- 将在堆栈变量和返回地址之间放置一个检测值
- 在函数返回到该地址之前检测到函数返回地址的损坏
- 编译器将使用启发式来确定一个函数是否需要堆栈保护
- 如果任何已定义的局部变量具有数组类型或包含数组类型成员的结构类型，则该函数将需要堆栈保护

参考资料：
[1] https://netstorage.iar.com/SuppDB/Public/UPDINFO/014214/riscv/doc/infocenter/readme.ENU.html

04 IAR Embedded Workbench

IAR Embedded Workbench for RISC-V version 1.21.1

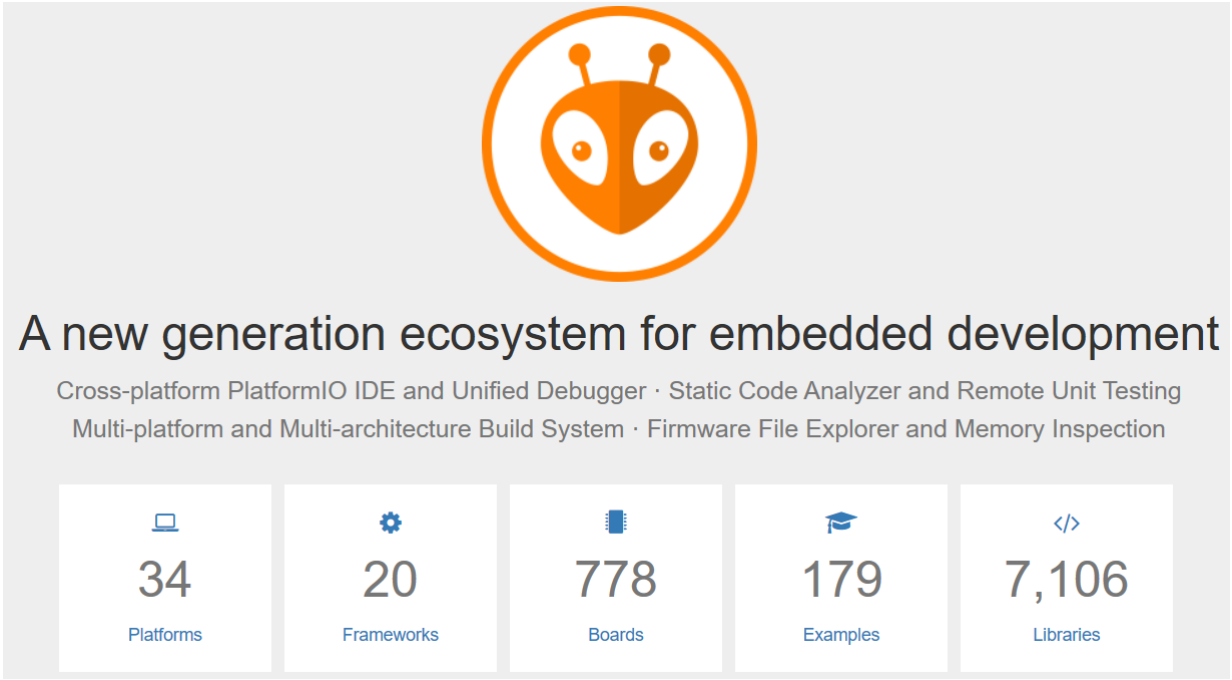
- **Nexus IEEE-ISTO 5001™ compatible trace**
  The Embedded Workbench for RISC-V now support the I-jet Trace probes and a first implementation of trace based on the Nexus Protocol. Trace adapters for the Arty A7-100T FPGA development platform can be used to enable capture of external 4-bit trace via the Pmod connectors. Trace viewers including time-line visualization and search capabilities are enabled in the Embedded Workbench IDE.

参考资料：
[1] http://supp.iar.com/FilesPublic/UPDINFO/014506/riscv/doc/infocenter/readme.ENU.html

05 PlatformIO

概述

- PlatformIO 是一个用于嵌入式开发的新一代生态系统
- 为嵌入式 C/C++ 开发新一代工具集
- 跨平台的代码生成器和库管理器
- 可以在Windows、Mac和Linux等最流行平台上运行的工具链、调试器、框架
- 独立于所运行的平台，可以轻松转移与共享
- 可在服务器上运行
- 可与各种桌面IDE或文本编辑器结合使用，例如PlatformIO IDE for Atom, Eclipse, NetBeans, Vim, Visual Studio, PlatformIO IDE for VSCode 等等



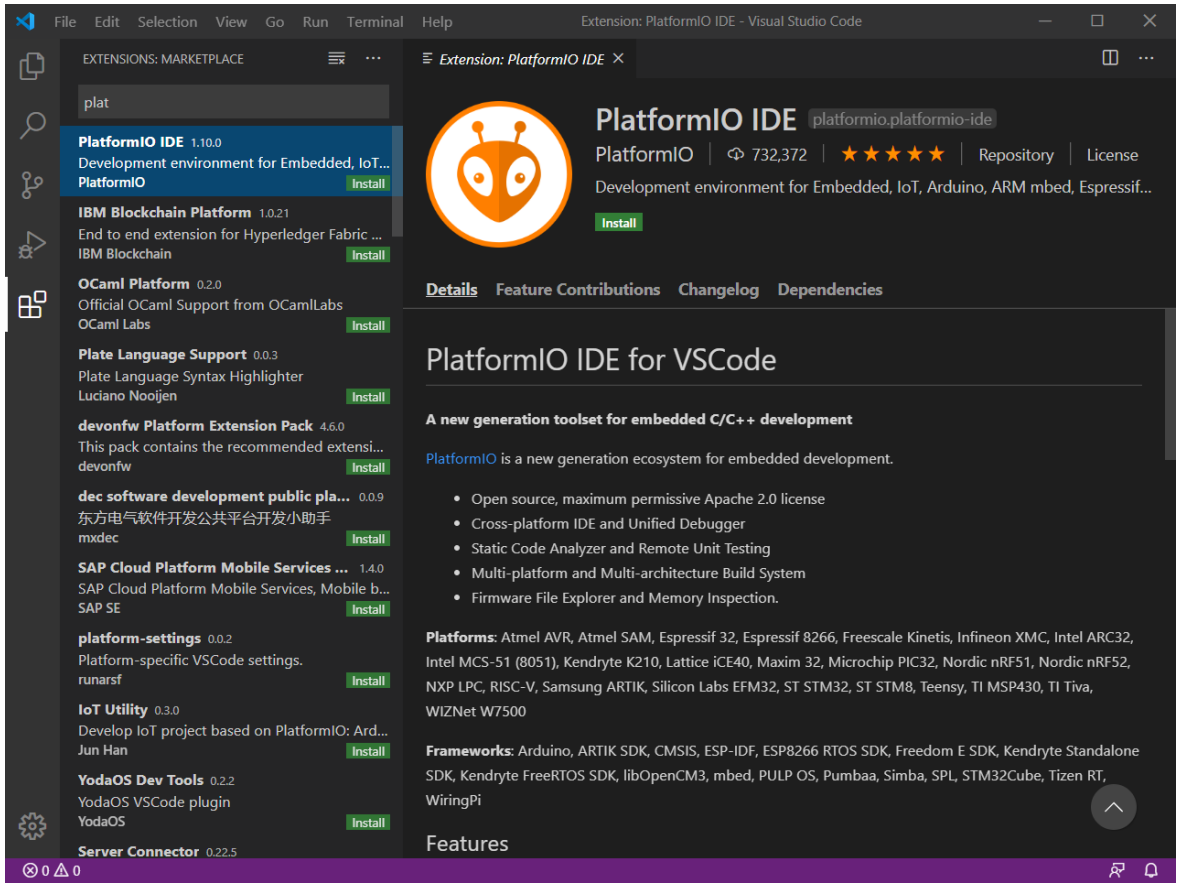
参考资料：
[1] https://platformio.org/
[2] https://docs.platformio.org/en/latest/what-is-platformio.html

05 PlatformIO

特点介绍

PlatformIO IDE for VSCode

- Open source, maximum permissive Apache 2.0 license
- Unified Debugger —— PIO Unified Debugger
- Static Code Analyzer —— PIO Check
- Remote Unit Testing —— PIO Remote、PIO Unit Testing
- Compiler —— GCC、Clang/LLVM
- Firmware File Explorer, Version Control and Memory Inspection



参考资料：
[1] https://platformio.org/
[2] https://docs.platformio.org/en/latest/plus/unit-testing.html
[3] https://docs.platformio.org/en/latest/plus/debugging.html

06 总结归纳

GNU MCU Eclipse （开源）

- 模拟器（不支持RISC-V）
- 提供处理器模板（不支持RISC-V）
- 仅支持GCC
- 支持的RISC-V处理器、开发板很少

Embedded Studio

- J-Link集成调试器，无限断点，RTT
- GDB远程第三方调试技术
- 断点变量->断点寄存器
- 同时支持GCC与LLVM

IAR Embedded Workbench

- 安全性：C-Trust、堆栈保护
- I-jet实现基于Nexus协议的跟踪
- 查看器的时间线可视化与搜索功能

PlatformIO （开源）

- 单元测试、远程技术
- 版本控制系统
- 广泛支持多种IDE平台
- 广泛支持各种处理器框架与开发板
- 同时支持GCC与LLVM

IDE开发基本方向：

- 程序语言编辑器
- 自动构建工具
- 编译器/编译工具链 —— GCC、LLVM
- 调试器 —— 断点（寄存器）、第三方调试、跟踪探测、RTT
- 静态分析器
- 项目资源管理器

其他：

- 多处理器、开发板支持
- 提供处理器开发模板
- 安全性 —— 知识产权保护、堆栈保护
- 模拟器 —— 查看模拟变量、寄存器情况
- 查看器 —— 时间线可视化、搜索
- 远程功能
- 版本控制系统

06 总结归纳

附录

1、GNU MCU Eclipse 基于 RISC-V 相关工具包：

- GNU MCU Eclipse IDE for C/C++ Developers 开源链接：https://github.com/gnu-mcu-eclipse/org.eclipse.epp.packages
- GNU MCU Eclipse plug-ins 开源链接：https://github.com/gnu-mcu-eclipse/eclipse-plugins
- GNU MCU Eclipse Windows Build Tools 开源链接：https://github.com/gnu-mcu-eclipse/windows-build-tools
- GNU MCU Eclipse RISC-V Embedded GCC 开源链接：https://github.com/ilg-archived/riscv-none-gcc
- xPack OpenOCD 开源链接：https://github.com/xpack-dev-tools/openocd-xpack

2、PlatformIO 开源链接：https://github.com/platformio

谢 谢

欢迎交流合作

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