

Nuclei Development Tool Guide

Release 2024.06

Nuclei

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INTRODUCTION

This user guide mainly talked about how to use Nuclei Development Tools, including Nuclei Studio IDE, Nuclei RISC-V Toolchain, Nuclei OpenOCD, Nuclei QEMU and Nuclei Model.

Nuclei Studio IDE is built on Eclipse Embedded CDT plugins, mainly optimized for Nuclei RISC-V Processor to improve user experience in IDE.

Nuclei RISC-V Toolchain is built on RISC-V GNU and LLVM toolchain(gcc/llvm/binutils/gdb/newlib) and also include Nuclei C Runtime Library, it provide good support for Nuclei RISC-V Processor.

Nuclei OpenOCD is built on RISC-V OpenOCD, adding nuspi flash support, cjtag support, customized csr support, nuclei openocd flashloader support.

Nuclei QEMU is built on QEMU project, adding Nuclei N/NX/UX RISC-V processor support, which works with Nuclei SDK and Nuclei Linux SDK.

Nuclei Model uses spike as the RISC-V ISA simulator and adds support for Nuclei 's N/NX/UX RISC-V processors, it supports near cycle-level simulation and SystemC TLM 2.0 Nuclei EvalSoC modeling.

Note: To get a pdf version of this documentation, please click Nuclei Development Tool User Guide

If you have issues in this user guide, please send us an pull request in https://github.com/Nuclei-Software/ nuclei-tool-guide repo to help us improve it.

If you have issues in our Nuclei Tools, please send us an issue in this repo or related tool repo to help us improve it.

- Nuclei Studio: https://github.com/Nuclei-Software/nuclei-studio
- Nuclei RISC-V Toolchain: https://github.com/riscv-mcu/riscv-gnu-toolchain
- Nuclei OpenOCD: https://github.com/riscv-mcu/riscv-openocd
- Nuclei Qemu: https://github.com/riscv-mcu/qemu
- Nuclei DLink: https://github.com/nuclei-Software/nuclei-dlink

NUCLEI STUDIO IDE

2.1 Nuclei Studio IDE 简介

Note:

- Nuclei Studio 出视频教程啦,相关内容在芯来科技视频号中持续更新中,您可以在微信中搜索芯来 科技视频号并关注,以便获取到我们最新的更新内容。
- 在使用 Nuclei Studio, Nuclei Tools 过程中, 如查有问题, 可以查阅 https://github.com/Nuclei-Software/ nuclei-studio内容, 也可以向我们提交相关 Issue。

一款高效易用的集成开发环境(Integrated Development Environment, IDE)对于任何 MCU 都显得非常重要,软件开发人员需要借助 IDE 进行实际的项目开发与调试。ARM 的商业 IDE 软件 Keil,在中国大陆很多嵌入式软件工程师均对其非常熟悉。但是商业 IDE 软件(譬如 Keil)存在着授权以及收费的问题,各大 MCU 厂商也会推出自己的免费 IDE 供用户使用,譬如瑞萨的 e2studio 和 NXP 的 LPCXpresso 等,这些 IDE 均是基于开源的 Eclipse 框架, Eclipse 几乎成了开源免费 MCU IDE 的主流选择。

Nuclei Studio IDE 正是芯来公司,基于 Eclipse IDE 开发的一款针对芯来 RISC-V 处理器 IP 核产品的 集成开发环境工具。

Eclipse 平台采用开放式源代码模式运作,并提供公共许可证(提供免费源代码)以及全球发布权利。 Eclipse 本身只是一个框架平台,除了 Eclipse 平台的运行时内核之外,其所有功能均位于不同的插件中。 开发人员既可通过 Eclipse 项目的不同插件来扩展平台功能,也可利用其他开发人员提供的插件。一个插 件可以插入另一个插件,从而实现最大程度的集成。

由于 Eclipse IDE 已经在社区被大量使用,一些常见的使用方法在 Eclipse IDE 里面,如果没有和硬件 或者 CPU 绑定,一般情况下是可以借鉴其他人写的关于 Eclipse IDE 的使用教程,这里推荐几个常用的 教程网站:

- https://help.eclipse.org/latest/index.jsp
- https://eclipse-embed-cdt.github.io/
- https://mcuoneclipse.com/

Eclipse IDE 平台具备以下几方面的优势。

• 社区规模大

Eclipse 自 2001 年推出以来,已形成大规模社区,这为设计人员提供了许多资源,包括图书、教程和网站等,以帮助他们利用 Eclipse 平台与工具提高工作效率。Eclipse 平台和相关项目、插件等都 能直接从 eclipse.org 网站下载获得。

• 持续改进

Eclipse 的开放式源代码平台帮助开发人员持续充分发挥大规模资源的优势。Eclipse 在以下多个项目上不断改进。

- 平台项目——侧重于 Eclipse 本身。
- CDT 项目——侧重于 C/C++ 开发工具。

- PDE 项目——侧重于插件开发环境。

• 源码开源

设计人员始终能获得源代码,总能修正工具的错误,它能帮助设计人员节省时间,自主控制开发工 作。

兼容性

Eclipse 平台采用 Java 语言编写,可在 Windows 与 Linux 等多种开发工作站上使用。开放式源代码 工具支持多种语言、多种平台以及多种厂商环境。

• 可扩展性

Eclipse 采用开放式、可扩展架构,它能够与 ClearCase、SlickEdit、Rational Rose 以及其他统一建模 语言(UML)套件等第三方扩展协同工作。此外,它还能与各种图形用户接口(GUI)编辑器协同 工作,并支持各种插件。

Nuclei Studio IDE 充分利用上述 Eclipse IDE 优势,结合社区成熟的 Eclipse embedded CDT, Linux Tools 等插件,并研发自有插件满足 RISC-V 嵌入式开发的日常需求:

- 工程创建,管理,编译和调试
- 支持多种调试方案,例如 OpenOCD, JLink, Nuclei DLink, Nuclei Qemu 等
- 支持扩展调试方案,方便扩展支持更多调试器
- 支持多种编译器,包括 gcc, clang, zcc
- 提供快捷的工程常用设置工具 Nuclei Settings
- 支持基于 Nuclei ETrace 软硬件方案的 Onchip Trace
- 支持基于 gprof、gcov 的大幅增强 profiling 和 code coverage 方案
- 支持 Nuclei PacKage(NPK) 软件包方案,可以便捷的扩展支持软件开发包和 Nuclei Studio 解耦,实现 软件包导入 -> Project Wizard 的便捷方案,这种方案已经得到广泛的应用,例如芯来科技自有的 Nuclei SDK.
- 更快捷的工程和工作空间的打开方式
- 更好用的 Launchbar 功能

2.2 Nuclei Studio 更新说明

2.2.1 2024.06 版更新说明

本版本是一次比较重大的版本升级,2024.06 版本升级了 CDT 版本到 Eclipse CDT 2024-06,升级了芯 来科技的工具版本至 2024.06,优化了部分原有功能,新增了调试及代码性能分析等功能,以及解决了 2024.02 版中存在的缺陷。

升级 Eclipse CDT 版本

在 Nuclei Studio 2024.06 版本中基础的 CDT 版本,升级到了 11.6.0,并基于 Eclipse CDT 2024-06 版本开 发此版本。

升级 RISC-V Toolchain、OpenOCD、QEMU 版本

在 Nuclei Studio 2024.06 版本中集成了 Nuclei RISC-V Toolchain 2024.06 版,具体信息可以查看: https://github.com/riscv-mcu/riscv-gnu-toolchain/releases/tag/nuclei-2024.06。

在 Nuclei Studio 2024.06 版本中集成了 OpenOCD 2024.06 版,具体信息可以查看: https://github.com/riscv-mcu/riscv-openocd/releases/tag/nuclei-2024.06。

在 Nuclei Studio 2024.06 版本中集成了 Nuclei Qemu 2024.06 版,具体信息可以查看: https://github. com/riscv-mcu/qemu/releases/tag/nuclei-2024.06。

新增对 U600 和 UX1000 的支持

配合 U600 和 UX1000 核的发布,同步增加了对 U600 和 UX1000 核配套支持。

优化 NPK 软件包管理

优化 Nuclei Package Management 中对 NPK 包依赖的管理,使其更易使用;优化了部分 NPK 包安装的提示信息及日志,提高 NPK 包管理的使用体验。具体参见NPK 软件包管理 (page 73)。

Note: 注意:本次版本升级,变更了 NPK 包管理的配置,在 2024.02 版及之前版本中安装的 NPK 包在 2024.06 版 NucleiStudio 无法识别,用户需重新下载安装 NPK 包。

增加和优化部分编译选项

在 Properties 和 Nuclei Settings 页面内, 在 Optimization Level 中新增 -Oz 选项; 在 GNU RISC-V Cross C++ Linker 的 Libraries 页新增对 group libraries 的支持, 参见工程编译链接 C 库找不到符号报错 (page 250)。

优化调式模式切换

NucleiStudio 支持多种调试模式,如 OpenOCD、Jlink、Dlink、Custom 等,同时还有 Qemu 等仿真器,为 了方便用户在多工程多种模式之间切换,优化了调式模式的切换,具体内容参见调试模式管理 (page 134)

优化和完善 DLink Debug 调试

Nuclei DLink 是芯来科技基于 RV Link,并在 RV Link 的基础上做了许多功能增加后,所研发的 RISC-V 调试器,使之更适应于 Nuclei Studio 的应用场景。具体内容可以查看使用 DLink 调试运行项目 (page 170)。

集成 Terapines ZCC Lite 编译器

Terapines ZCC 是兆松科技研发的高性能 RISC-V 编译器。Nuclei Studio 2024.06 版中对 Terapines ZCC 进行支持,用户可以在 Nuclei Studio 中直接使用。具体参见Nuclei Studio 中编译 Hello World 项目 (page 133)。

新增 LST View 工具

LST View 是一个 lst 文件查看器,可以方便用户查看 lst 格式的文件,并实现 *.lst 文件与源代码的联动, 具体请参见LST View (page 184)。

优化和完善 Gprof 功能

Gprof 是一个强大的性能分析工具,可以帮助开发者理解 C/C++ 程序的运行情况,通过 Gprof 可以获取 到程序中各个函数的调用信息、调用次数、执行时间等,对优化程序、提升程序运行效率具有重要的意 义。具体请参见Code Coverage 和 Profiling 功能 (page 187)。

优化和完善 Gcov 功能

Gcov 是一个测试 C/C++ 代码覆盖率的工具,伴随 GCC 发布,配合 GCC 共同实现对 C/C++ 文件的语句 覆盖、功能函数覆盖和分支覆盖测试。具体请参见Code Coverage 和 Profiling 功能 (page 187)。

新增 Call Graph 功能

Call Graph 是分析函数调用关系图的工具,结合 Gprof 使用,便于开发者快速了解程序执行的过程及调用 关系。具体请参见Code Coverage 和 Profiling 功能 (page 187)。

新增 Nuclei Near Cycle Model 支持

Nuclei Near Cycle Model,它是由芯来科技自主研发的仿真测试和性能分析工具,可以帮助研发人员在项目初期进行一些必要的仿真测试和程序性能分析,具体请参见使用 Nuclei Near Cycle Model 仿真性能分析 (page 229)。

2.2.2 2024.02.dev 版更新说明

本版本是开发版本 (您下载到的链接内容随时可能会变更),本版本解决了 Nuclei Studio 2023.10 版中存 在的缺陷,并优化了部分原有功能如 ETrace 特性,新增了一些功能如对 N100 的支持、Dlink 的支持等, 更好为满足客户评估和更新使用。

升级 Eclipse CDT 版本

在 Nuclei Studio 2024.02.dev 版本中基础的 Eclipse CDT 版本,升级到了 Eclipse CDT 2023.12 版。

新增对 N100 的支持

配合 N100 核的发布,同步增加了对 N100 的配套支持。

新增批量转换 Gcc13 工程工具

在 2023.10 版 Nuclei Studio 中,升级 GCC 13 后,当有大量工程需要转换时,单个转换效率低,为方便开发者,提供了一个批量转换 GCC 13 工具。具体内容参见批量将工程转换成支持 gcc 13 的工程 (page 178)。

优化和完善 Trace 功能

Nuclei Studio 中 Trace 功能升级,实现了在 OpenOCD 模式下对单核应用、SMP 多核应用、AMP 多核应用的支持,具体内容参见*Trace* 功能的使用 (page 208);在 Dlink 模式下,仅对单核应用支持。Trace 功能需要有对应 CPU IP 的支持,如需体验此功能,请与我们联系。

优化和完善 RVProf 功能

RVProf 是芯来科技基于 CPU cycle model 开发的性能分析工具,具体内容参见第*RVProf* 功能的使用 (page 221)。此功能需要有相应的 NPK 软件包支持,如需体验此功能,请与我们联系。

新增对 DLlink Debug 的支持

Dlink 是芯来自主研发的调试解决方案,在本次版本中得到支持。此功能需要有相应的 Dlink 调试器的支持,如需体验此功能,请与我们联系。

2.2.3 2023.10 版更新说明

本版本是一次比较重大的版本升级,集成了 Nuclei 2023.10 版本的 Toolchain, QEMU, OpenOCD, 且 Eclipse CDT 版本进行了升级, GCC 版本也做了重大迭代,升级到了 GCC 13, NPK 部分也做了大量的新功能的 增加以支持 GCC 或者 CLANG 的工程创建,并且增加很多新的 Configuration 字段类型,方便在 Project Wizard 中更灵活的进行工程配置。

升级 Eclipse CDT 版本

在 Nuclei Studio 2023.10 版本中基础的 Eclipse CDT 版本,升级到了 Eclipse CDT 2023.06 版; Eclipse CDT 2023-06 版本是 Eclipse 基金会 2023 年第二个季度同步版本,有 64 个参与项目,于 2023 年 6 月 14 日发 布。

参考地址: Eclipse IDE for C/C++ Developers1

升级后打开之前版本创建的 workspace, 会弹出不兼容的警告, 使用时可能会有异常, 建议更换新的 workspace 目录。

\delta Older Workspace Version	×					
The '/C:/L' 'NucleiStudio_workspace202212/' workspace was written with an older version. Continue and update workspace which ma make it incompatible with older versions?	y					
Do not warn again about workspace versions Continue Change Workspace						

¹ https://www.eclipse.org/downloads/packages/release/2023-06/r/eclipse-ide-cc-developers

升级 build-tools 版本

在 Nuclei Studio 2023.10 版将 toolchain 中的 build-tools 更新到 4.4 版本,并额外增加了 bash.exe、cp.exe、mv.exe、tar.exe 工具。



支持 GCC 13 和 Clang 17

在 Nuclei Studio 2023.10 版本中实现了对 GCC 13 的支持,相对于之前的 gcc10 版本 GCC 13 在对 RISC-V 指令扩展的支持更加完备,且在我们维护的版本中,支持完整的 RVV Intrinsic API v0.12 版本。同时 Nuclei Studio 2023.10 版本中也实现了对 Clang 17 的支持(参考地址: https://releases.llvm.org/17.0.1/docs/ RISCVUsage.html)。当然,如果有用户依然想使用 GCC 10 时行项目开发,我们也保留了相关的配置,但 是工具链并没有集成到 IDE 中,用户需要自行下载并放置在 gcc10 目录中,参见里面的 README.txt,并 且我们也提供了老版本采用 gcc10 的 Nuclei Studio 创建的工程升级到 gcc13 工具链上,具体使用可以参 考导入回版本 Nuclei Studio 创建的工程 (page 176)。Nuclei RISC-V Toolchain 2023.10 更详细的说明,请参 阅: https://github.com/riscv-mcu/riscv-gnu-toolchain/releases/tag/nuclei-2023.10

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> Validation WikiText	Listing generator:	objdump					
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RISC-V 指令扩展使用变更

因 gcc 和 clang 的变更,在扩展的使用上,有了较大的变化。原来的 bpkv 扩展与新的规则对应关系如下,更详细的说明,请参阅https://doc.nucleisys.com/nuclei_sdk/develop/buildsystem.html#arch-ext

- b->_zba_zbb_zbc_zbs
- p -> rv64: _xxldsp, rv32: _xxldspn3x for n300, _xxldspn1x for n900
- k->_zk_zks
- v -> rv32f/d: _zve32f, rv64f: _zve64f, rv64fd: v

以 N307FD + B + V + Nuclei DSP with N1 extension 为例,创建一个使用扩展的应用,在创建工程的引导中,需要 Nuclei ARCH Extensions 中填入对的扩展字段,如需要使用 bpv 扩展,根据以上规则,需要填入_zba_zbb_zbc_zbs_zve32f_xxldspn1x。

& Creating Nuclei RISC-V C/C++	- project — 🗆 🔿
Create Nuclei project	
Please select the relevant config	uration item
Project name:	test
Project Filter by:	no filter v Filters:
Project Example:	Coremark Benchmark @app-nsdk_coremark
Toolchain:	RISC-V GCC/Newlib (riscv64-unknown-elf-gcc)
Download/Run Mode:	ILM download mode, program will be download into ilm/ram and run directly in ilm/ram v
Select NMSIS Library:	No NMSIS Library used
Nuclei RISC-V Core:	N307FD Core(ARCH=rv32imafdc, ABI=ilp32d)
Nuclei ARCH Extensions:	_zba_zbb_zbc_zbs_zve32f_xxldspn1x
Nuclei Cache Extensions:	□ICache □CCM
Nuclei SMP Count:	0
Boot HartID:	0
Heap Size:	
Stack Size Per CPU:	
Enable Semihosting:	
Standard C Library:	newlib nano with printf float
Select Benchmark Options:	Options for Nuclei 300 Series
?	< <u>B</u> ack <u>N</u> ext > <u>F</u> inish Cancel

生成的工程中,可以看到在工程的 Nuclei Settings。

& NucleiStudio_workspace - test/test.nuproject - NucleiSt	tudio IDE											
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> 🛐 Includes	project name:	test	Configuration:	Debug	~	Save settings (ctrl	+s)	outline.				
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	Runtime Info											
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同样的查看工程的属性,在 C/C++ Build->Settings->Target Processor 中也是有关于 RISC-V 指令扩展的配置项。



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同时在 QEMU 的配置中也会有相对应的 RISC-V 指令扩展的配置项。

NPK 包的使用变更

为了支持 GCC 13 和 Clang 17, Nuclei SDK 包升级到了 0.5.0 版本,使用 SDK 包创建工程时,用户可以根据需要,选择创建一个 GCC 13 或者 Clang 17 的工程。因为版本变动较大,0.5.0 之前的 sdk 可能有部分 功能在 Nuclei Studio 2023.10 版中使用异常,所我们提供了工具帮助您快速进行工程迁移和升级,请自行 备份老版本的工程,具体可能参考导入旧版本 Nuclei Studio 创建的工程 (page 176)。

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另外 Nuclei Studio 2023.10 中会对 npk 在线组件包做适配版本的校验(上传阶段需要填写测在什么版

本的 Nuclei Studio 上测试使用),不同的组件包所适配的 Nuclei Studio 版本号会在 Package Management 页面展示,在下载安装的时候如果版本不匹配,会给与提示,但是导入离线包不会有任何提示,请自行甄别是否被所使用的 Nuclei Studio IDE 版本所支持,具体如下。

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升级 OpenOCD

OpenOCD 版本升级至 2023.10 版, 增加了一些额外的调试特性, 例如查看 cpu 信息, etrace 实验性的 支持。关于 OpenOCD 变更更详细的说明, 请参阅: https://github.com/riscv-mcu/riscv-openocd/releases/tag/ nuclei-2023.10

升级 QEMU

在 Nuclei Studio 2023.10 中集成 Nuclei QEMU 2023.10 版本,而 Nuclei QEMU 2023.10 基于 QEMU 8.0 进行二次开发(参考地址: https://wiki.qemu.org/ChangeLog/8.0)。本版本的 QEMU 和 2022.10 版本使用方面有比较大的变化,不再支持 gd32vf103_rvstar 这块开发板,转而只支持 Nuclei EvalSoC,可以配置 Nuclei SDK/Nuclei Linux SDK 无缝使用。且支持的 machine 由 nuclei_n/nuclei_u 转而统一变为 nuclei_evalsoc。关于详细 Nuclei QEMU 更详细的说明,请参阅: https://github.com/riscv-mcu/qemu/releases/tag/nuclei-2023.10

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	QEMU 8.0所在的目录		

新增了 elf 文件查看器

在 Nuclei Studio 2023.10 新增 elf 文件编辑器,方便用户查看编译后产生.elf、.o文件。

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新增 Code Coverage 和 Profiling 功能

在 Nuclei Studio 2023.10 新增了对 Code Coverage 和 Profiling 功能的支持,具体参考 Code Coverage 和 Profiling 功能 (page 187)。

新增 trace 功能

在 Nuclei Studio 2023.10 实验性新增了 trace 功能,因使用此功能需要带有 Nuclei Trace IP 的 CPU,如需体验此功能,请与我们联系。

Nuclei Settings 功能优化

为了应对更个性化的配置,我们修改了 Nuclei Settings 部分功能。

Nuclei Studio 2023.10 去掉了原来的 B/P/K/V 的单选框,换成 Other Extensions 输入框,用户可以根据 自己的需求自定义填写。而关于 B/P/K/V 的使用,可以参考*RISC-V* 指令扩展使用变更 (page 11)。

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Nuclei Studio 2023.10 去掉了原来的 Select C Runtime Library 单选框,在项目中如果需要使用,可能 过项目配置传入的 --specs= 选项,或者 Libraries 选项,来实现。

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Nuclei Settings 增强了其通用性,使它不仅仅能对 Nuclei 的工程进行快速修改,也新增以对通用 riscv 和 arm 创建的 static 和 shared 的 library 工程的支持。下面为 shared 对应示图。

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新增指定工作空间快速打开

类似双击项目下的*.nuproject 文件可快速打开 Nuclei Studio 并导入该项目,现在 Nuclei Studio 会在 使用过的工作空间目录下创建 work.nuworkspace 文件,双击该文件可以直接打开 Nuclei Studio,但 该功能暂时只支持 windows 版本。这个功能需要解压 IDE 后,在 windows 上执行 install.bat 来设置 文件关联。

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2.2.4 2022.12 版更新说明

Nuclei Studio 自 2021.09 版后,将 IDE 与 SDK 完全分离,将采用全新的 Nuclei Package(NPK) 的包管理的 方式进行模板工程的管理和使用,方便用户进行不同 SDK 的导入并且在 IDE 上创建示例工程并使用,针 对 Nuclei SDK 和 HBird SDK 以及我们公司的 SoC IP 产品提供的 SDK,均可以打包成 Zip 包的方式以通 过 Nuclei Package Management 方式进行导入使用。

2.3 Nuclei Studio 下载与安装

2.3.1 Nuclei Studio IDE 下载

为了方便用户快速上手使用,本文档推荐使用预先整理好的 Nuclei Studio IDE 软件压缩包。芯来公司已 经将该软件压缩包上传至公司网站,具体地址为https://www.nucleisys.com/download.php。

用户可以在芯来科技公司网站的"下载中心",根据用户开发环境,下载对应 Windows 或 Linux 的 Nuclei Studio 压缩包(注意:芯来科技公司网站的下载中心,其内容会不断更新,用户请自行选择使用最 新版本或继续使用当前版本)。

目前已在 Win 10 64 位系统, Ubuntu 18.04/20.04 和 Redhat7.6 64 位版本上验证测试, 推荐使用以上版本的系统。



2.3.2 Nuclei Studio IDE 安装

当完成 Nuclei Studio IDE 压缩软件包下载,解压后包含若干文件,分别介绍如下。

- Nuclei Studio 软件包
 - 该软件包中包含了 Nuclei Studio IDE 的软件。注意:具体版本以及文件名可能会不断更新。
- HBird_Driver.exe (2021.02 版本起不再提供)
 - 仅 Windows 版提供,此文件为芯来蜂鸟调试器的 USB 驱动安装文件。
 - 当在 Windows 环境下,使用该调试器时,需要安装此驱动使该 USB 设备能够被系统识别。
 - 由于 2021.02 版本中更新的 openocd 引入了免驱功能。
- SerialDebugging_Tool (2021.02 版本起不再提供)
 - 仅 Windows 版提供,此文件为"串口调试助手"软件。此软件可以用于后续软件示例调试时 通过串口打印信息。

```
Data (D:) > NucleiStudio IDE 202102-win64 >
```

名称	修改日期	类型	大小
NucleiStudio	2021/2/2 10:44	文件夹	

2.3.3 Nuclei Studio IDE 启动

启动 Nuclei Studio 的要点如下 (windows 和 linux 均按照如下操作):

直接双击 Nuclei Studio IDE 文件包中 Nuclei Studio 文件夹下面的可执行文件,即可启动 Nuclei Studio。

名称	修改日期	类型	大小
configuration	2023/10/18 14:43	文件夹	
📕 dropins	2023/10/18 14:31	文件夹	
📙 features	2023/10/18 14:38	文件夹	
📕 p2	2023/10/18 14:43	文件夹	
📕 Packages	2023/10/18 14:47	文件夹	
📕 plugins	2023/10/18 14:38	文件夹	
📕 readme	2023/10/18 1 4 :31	文件夹	
📕 toolchain	2023/10/18 14:32	文件夹	
.eclipseproduct click here	2023/10/18 14:31	ECLIPSEPRODUC	1 KB
artifacts.xml	2023/10/18 14:38	XML文件	353 KB
📧 eclipsec.exe	2023/10/18 1 4 :31	应用程序	233 KB
🗟 install.bat	2023/10/18 14:39	Windows 批处理	1 KB
o notice.html	2023/10/18 14:31	Chrome HTML D	10 KB
\delta NucleiStudio.exe	2023/10/18 14:32	应用程序	521 KB
🔄 NucleiStudio.ini	2023/10/18 14:32	配置设置	1 KB
NucleiStudio_Studio_User_Guide.pdf	2023/10/18 14:39	WPS PDF 文档	15,179 KB
Ver.2023-10.txt	2023/10/18 14:39	文本文档	1 KB

第一次启动 Nuclei Studio 后,将会弹出对话框要求设置 Workspace 目录路径,该目录将用于存放后续创建的项目工程文件。

🚯 NucleiStudio IDE Launcher	×
Select a directory as workspace	
NucleiStudio IDE uses the workspace directory to store its preferences and development artifacts.	
Workspace: C:\Users\24954\NucleiStudio_workspace > Browse	
Use this as the default and do not ask again	
Launch Cancel	

设置好 Workspace 目录之后,单击"Launch"按钮,将会启动 Nuclei Studio。第一次启动后的 Nuclei Studio。

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കി	NucleiStudio	Welcome to the NucleiStudio for C/C++ Developers				Workbench	Î
	E	Tutorial: Import an existing project A guided walk-through how to import an existing project		Overview Get an overview of the features			
	•	Review IDE configuration settings Review the IDE's most fiercely contested preferences	1	Tutorials Go through tutorials			
	0	Create a new C project Create a new Eclipse project for C source code	2	Samples Try out the samples			
	0	Create a new C++ project Create a new Eclipse project for C++ source code		What's New Find out what is new			
	•	Import a project with a working Makefile Open the New Item wizard					
	♦	Checkout projects from Git Checkout Eclipse projects hosted in a Git repository					
	*	Import existing projects Import existing Eclipse projects from the filesystem or archive					
	4	Launch the Eclipse Marketplace Enhance your IDE with additional plugins and install your Marketplace favorites					
	D	Open an existing file Open a file from the filesystem			Always show Wel	come at start u	P
							- 0

Note: 2021.02 版本 Nuclei Studio 默认关闭了 Launch Bar,请参照 10.10.1 开启 Nuclei Studio 中的 Launch Bar 功能,方便快速编译调试和下载。

2.4 Nuclei Studio NPK 介绍

在芯来 RISC-V 嵌入式软件开发里面引入组件 (Package) 的理念,主要是借鉴于 npm 包管理,开发出方便开发者开发,使用,分发设计好的软件组件,可以大大加快软件的迭代速度。

组件包主要由以下文件组成:

- 组件描述文件 (基于 YAML 语言): npk.yml
- 组件相关代码以及说明文档

组件包会以 zip 包形式存在,组件包在导入使用时,需要被 IDE 或者其他工具进行包完整性以及可用性检查,才予以导入。

Note:

- 我们提供了一个开源的 NPK 软件包检查工具,参见 https://github.com/Nuclei-Software/npk-checker
- 最好的 NPK 软件包参考项目可以参见 Nuclei SDK 以及其他线上的软件包 (搜索 npk.yml 文件) https://www.rvmcu.com/nucleistudio-npk.html
- 组件包后期会提供签名机制,在发布前先签名,然后导入软件包会验证签名,确保导入的开发包是 合法身份发布,不导入不可信的开发包。

2.4.1 组件描述文件 (npk.yml)

组件主要分为以下几大类型,分别是:

- csp: Core Support Package, 例如 NMSIS
- ssp: SoC Support Package, 例如 gd32vf103 的 SoC 的支持包
- bsp: Board Support Package,例如 rvstar 开发板板级支持的代码包
- osp: RTOS Support Package, 例如各类 RTOS 支持包
- app: Application Package, 例如各类上层应用
- mwp: Middleware Package, 各类第三方中间件, 例如语音识别, 算法库之类的
- sdk: Software Development Kit, 一组预设定好的软件开发包, 一般情况下里面会包含了 CSP, SSP, BSP, APP 类型的包, OSP 和 MWP 类型的包可选加入
- bdp: Bundle Package, 一组 package, 目前仅对 app 有效

以下是比较特殊的类型,主要用于工具包和模版包

- tool: Tool Package, 各类工具组件包, 可放入其他需要引用或参考的文件
- **tpp:** Template Package, 模板类型, 可以用于创建 csp/ssp/bsp/osp/app/mwp/sdk 的模板工程, 该类型比 较特殊, 描述文件名称为 **npk_template.yml**

描述文件通用定义

组件描述文件示例以及详细说明参见如下:

bsp 类型 package: bsp-xxxx # osp 类型 package: osp-xxxx # app 类型 package: app-xxxx # mwp 类型 package: mwp-xxxx # sdk 类型 package: sdk-xxxx # tpp 类型 package: tpp-xxxx # tool 类型 package: tool-xxxx description: 简要描述软件包的功能 # <MUST> 一句话描述清楚包的主要特性与功能, English_ →only, 20 字符以内 details: 详细描述软件包的功能 # <MUST> 描述清楚包的主要特性与功能, English only # <OPTIONAL> 可选,如不填,默认为空,建议采用 **version:** 1.2.3 SEMVER2.0 版本号管理,只能数字打头, 例如 1.2.3 # <MUST> 针对 sdk 类型的 package 必须包含一个 version tag # <MUST> 包类型, 可选类型有 csp, ssp, bsp, _ type: ssp →osp, app, mwp, sdk, tpp, tool # <MUST> OS 类型,例如 win32、win64、lin64、 os: win64 lin32, 但目前组件包上传页面只支持 win64 和 lin64, 该字段只存在 tool 类型 package # <OPTIONAL> 包分类,按照上面的包类型进行二次分类, category: 主要是针对 package 进行分类 # <MUST> 包关键字,主要用于索引与搜索 keywords: - soc - risc-v - nuclei # <OPTIONAL> 对应包代码所用的许可证,可选列表。 **license:** Apache-2.0 →GPL, GPLv2, MIT, Apache License v2, BSP 等 # <MUST> 组件包的拥有者,便于后期进行权限查找匹 owner: nuclei 配 # 后期在整合到网站以后,用户在发布新的开发包的时候, 需要先注册一个唯一的 owner 名称 # 然后申请一个 package name, 确保 name 可用的情 况下才可以发布新的该 name 的包,同时限制单用户发布的包个数。 # <OPTIONAL> 组件包的代码贡献者列表 contributors: - author_name, author_email # <OPTIONAL> 组件包的主页, 如果有的话, 必须是链接 homepage: *## Package Information* # <MUST> Only for bsp/ssp type, optional.. packinfo: →for other types 用于描述 SoC 层面的一些信息 core_vendor: Nuclei # <MUST> only for ssp, 处理器内核的供应商英文名 称,如果是基于芯来的处理器内核,这里填写 Nuclei # <MUST> For ssp/bsp, <OPTIONAL> for others vendor: Nuclei # For ssp, SoC 或者芯片的供应商英文名称,填写对应 的厂商的名称,例如 GigaDevice # For bsp, 表示板子的提供商英文名称 # For others, OPTIONAL, 表示该 package 提供商 # <MUST> 这里 name 和 package name 作用不一样, **name:** demosoc → 用来显示具体的包名称 # For ssp, 表示本组件包中 Soc 的具体英文名称, 可 以是一个系列名称,例如 GD32VF103 # For bsp, 板子的名称 # For others, 表示该 package 显示名称, 中英文均 可,不写的话,默认使用根字段 name # <OPTIONAL>, 不填的话,这里为空,不做展示 doc: # <OPTIONAL>, Package 对应的网站 website: # <OPTIONAL> only for bsp, 表示板子的电路图 sch: # <OPTIONAL>, package datasheet 本地地址或者是 datasheet: 网址 usermanual: # <OPTIONAL>, Package User Manual (continues on next page)

(continued from previous page) # <OPTIONAL>, 额外的一些资料,列表形式 (URI +_ extra: $\rightarrow DESCRIPTION)$ # <OPTIONAL>, file path or web link - uri: # <MUST> when uri is defined, description. description: \hookrightarrow for file *## Package Dependency* # <OPTIONAL> 列出依赖的组件包列表 owner/ dependencies: *→name:version* # 1. 针对 sdk *# <MUST> when defined* - **name:** csp-nsdk_nmsis 类型的包,内部有一个隐形的依赖,依赖有且仅有一个 bsp 类型的包, owner: nuclei # <OPTIONAL> if not defined, it will use the owner definiton. →above. 用于依赖特定所有者的 package, owner/name:version, 最终查找的包按照这样来找的 version: # <OPTIONAL> when defined empty, use default as version number # →并且会自动查找当前路径下所有的 npk.yml 文件,并作为 sdk 包中一部分 # 2. 除了 sdk 类型的包之外的其他的包,如果不是放在 sdk 包下面的目录,则依赖于 sdk,则需要显式加上 dependency # 3. bsp 类型的 package 肯定会依赖一个 ssp 类型 的 package # 4. 依赖包也可以带上版本号,支持版本号条件比对,如 果不带版本号,则优先选择不带版本号的包,其次最新的包 # 参考 https://docs.platformio.org/en/ →latest/librarymanager/config.html#version # https://docs.npmjs.com/about-semantic-↔versioning # 1.2.3 - an exact version number. Use_ ⇔only this exact version # ^1.2.3 - any compatible version (exact_ ↔version for 1.x.x versions # ~1.2.3 - any version with the same major_ →and minor versions, and an equal or greater patch version # >1.2.3 - any version greater than 1.2.3. →>=, <, and <= are also possible # >0.1.0, !=0.2.0, <0.3.0 - any version \rightarrow greater than 0.1.0, not equal to 0.2.0 and less than 0.3.0 # 例如 version: master, version: 1.2.3, _ →version: >0.1.0 # 依赖关系处理规则 # 1. sdk, app 类型的包可以依赖多个 ssp、bsp 类型 的包,但是最终只会根据 project wizard 选择具体使用到 package # 2. app/bsp/ssp/csp/osp/mwp 类型的包可以依赖 sdk,如果依赖了 sdk 类型的包,则表述该包隶属于 sdk 下 # 3. bsp 类型的包只能依赖一个 ssp/csp 类型的包, ssp 类型的包只能依赖一个 csp 类型的包 # 4. sdk 类型的包可以依赖多个 app/bsp/ssp/csp/ →OSP/mwp 类型,但是这种依赖只是建立从属关系,表示该 sdk 包含了这些包 # 5. 一个 sdk 类型的包不可以依赖另一个 sdk 包, 但 是 app/bsp/ssp/csp/osp/mwp 却可以依赖多个 sdk 类型的包 ## Package Configurations # <OPTIONAL> 关于包配置的一些选项,用于 Project_ configuration: →Wizard 创建以及内部参数设置 # 其中 sdk 类型暂不支持 configuration 参数定义 # configuration 定义的配置可以互相覆盖 # 覆盖规则为 app > mwp > osp > bsp > ssp >. (continues on next page)

⇔csp # <OPTIONAL> 一个配置选项, 类型为 choice nuclei_core: # <MUST> 如果这个配置定义了,针对 choice 类型,默 default: n307fd 认值选择必须是 choices 里面列举的 type: choice # <MUST> 配置类型, 可选有 choice, list, _ ←checkbox, multicheckbox, text global: true # <OPTIONAL> 可选为 true 或者 false, 默认为 true description: Nuclei RISC-V Core # <MUST> 该配置项的描述, 20 字以内 # <MUST> 当配置项 type == choice 时 choices: # <MUST> item 中必须包含 name 和 description - **name:** n201 # <OPTIONAL> 仅用于表示 RISC-V CORE 中的 ARCH arch: rv32iac 信息,不建议随意使用 # <OPTIONAL> 仅用于表示 RISC-V CORE 中的 ABI abi: ilp32 信息,不建议随意使用 # <OPTIONAL> 仅用于表示 RISC-V CORE 中的 TUNE tune: 信息,不建议随意使用 # <OPTIONAL> 用于自定义 key-value 数据的访问,例 info: 如 \${nuclei_core.info.key1} 返回的是 value1 # <MUST> key in pair with value, 字符串类型, - name: key1 不包含任意空格 value: value1 # <MUST> value in pair with key, 字符串类型 - **name:** key2 # <MUST> **value:** value2 $\# \langle MUST \rangle$ description: N201 Core(ARCH=rv32iac, ABI=ilp32) # <MUST> 描述这个 item 具 体含义 # 除了 name, description 之外, 可能会定义其他 items, 名称不定 # 例如在这里就定义了 arch 和 abi # 另一个 item - **name:** n201e **arch:** rv32eac abi: ilp32e description: N201E Core(ARCH=rv32eac, ABI=ilp32e) # <OPTIONAL> 一个配置选项, 当前这个为 extra_flags: text 类型 # <MUST>, 仅接受英文字符串 value: # <MUST> 该配置项的描述, 30 字以内 description: Extra compiler flags # <OPTIONAL> 一个配置选项, 当前这个为 dsp_present: *checkbox* 类型 # <MUST>, 默认为 0, 可选 0 或者 1 default: 0 # <MUST>, 配置类型, 当前为 checkbox type: checkbox global: true # <OPTIONAL> 可选为 true 或者 false, 默 认为 true # <MUST> 该配置项的描述, 30 字以内 description: P-Extension(DSP) Present # <OPTIONAL> 一个配置选项,当前这个为 libraries: multicheckbox 类型 # <MUST> 默认值,为 choices 里面的组合 default: [dsp, nn] # <MUST>, 配置类型, 当前为 **type:** multicheckbox multicheckbox global: true # <OPTIONAL> 可选为 true 或者 false, 默 认为 true description: Libraries Used # <MUST> 该配置项的描述, 30 字以内 # <MUST> 当配置项 type = choices: →multicheckbox 时 # <MUST> item 中必须包含 name 和 - **name:** dsp description # <MUST> 描述这个 item 具体含义 **description:** DSP Library # 除了 name, description 之外, 可能会定 义其他 items, 名称不定 - name: nn description: NN Library

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- name: ai
      description: AI Library
## Source Code Management
                                       # <MUST> 这个为必选项
codemanage:
 installdir: demosoc
                                       # <MUST> 希望代码安装的目录名称, 仅限英文, 满
足 C 语言命名格式
                                       # 针对 sdk 类型的 package, 会被安装到<sdk_
→installdir>, 如果 installdir 未定义, 默认为 SDK, 如果没有任何 sdk 类型的 package 被引用,
sdk_installdir 也被默认设置为 SDK
                                       # 针对 csp 类型的 package, 会被安装到<sdk_
⇔installdir>/<csp_installdir> 目录下, TBD
                                       # 针对 ssp 类型的 package, 会被安装到<sdk_
⇔installdir>/SoC/<ssp_installdir>/Common 下面
                                       # 针对 bsp 类型的 package, 会被安装到<sdk_
→installdir>/SoC/<ssp_installdir>/Board/<bsp_installdir> 下面,如果不依赖于任何 ssp 类
型,则安装到<sdk_installdir>/BSP/<bsp_installdir>
                                       # 针对 osp 类型的 package, 会被安装到<sdk_
→installdir>/OS/<osp_installdir> 下面
                                       # 针对 app 类型的 package, 会被安装到 <app_
→installdir>/目录下, 如果 installdir 未定义, 默认为 application
                                       # 针对 mwp 类型的 package, 会被安装到<sdk_
↔installdir>/Components/<mwp_installdir> 目录下
                                       # <MUST> 待拷贝的文件或者文件夹,支持 glob_
 copyfiles:
→pattern 匹配,这里是指所有的目录或者文件
   - path: ["Source/", "Include/", "demosoc.svd"]     # <MUST> 待拷贝的文件或者文件
夹的路径列表,支持 glob pattern 匹配
   - path: ["DSP_Source", "DSP_Include"]
     condition: $( ${dsp_present} == 1 )
                                                    # <OPTIONAL> 这里的 if 是一
个固定的标识符,如果出现则表示要做判定,判定的方式如下
                                                    # 如 dsp_present 是在
configuration 里面定义的, 根据 wizard 或者其他 package 选定而定
 incdirs:
                                                    # <OPTIONAL> 需要加入头文件
目录列表
                                                    # <OPTIONAL> 需要加入头文件
   - path: ["Include/"]
的目录
                                                    # <OPTIONAL> 可选的 lib 库
 libdirs:
所在目录
     - path:
 ldlibs:
                                                    # <OPTIONAL> 可选的需要链接
的库
     - libs:
## Set Configuration for other packages
                                                    # <OPTIONAL> 这个用于设置其
setconfig:
他 Package 的选项
# 以下选项是覆盖关系,规则 app > mwp > osp > bsp > ssp > csp
 - config: nmsislibarch
                                                    # <OPTIONAL> 直接设置
   value : ${nuclei_core.arch}p
Configuration 里面的选项
  condition: $( ${dsp_present} == 1 )
                                                   # <OPTIONAL> 根据这里 dsp_
→present 来判断是否设置 nmsislibarch 值
 - config: nmsislibarch
   value: ${nuclei_core.arch}
   condition: $( ${dsp_present} == 0 )
```

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## Build Configuration
                                          # <OPTIONAL> 编译选项的配置
buildconfig:
                                          # 目前编译选项会将 package 中定义的所有的拼
接在一起或者覆盖
                                          # 以下选项是覆盖方式, app > mwp > osp >_
→bsp > ssp > csp
                                          # type 是一个特殊字段,用于标识特定的编译器,_
→目前支持 gcc
                                          # cross_prefix, prebuild_steps,_
→postbuild_steps, description
                                          # 其余选项是拼接的
                                          # <OPTIONAL> 目前只有 gcc, 预留其他接口
 - type: gcc
   description: Nuclei GNU Toolchain
                                          # <MUST> For ssp
     cross_prefix: riscv-nuclei-elf-
提供的工具性也合
                                          # <OPTIONAL> 如果不写或者留空,就自动按照系
统里面提供的工具链来定
                                          # <OPTIONAL> 通用的编译选项,将会添加到
   common_flags:
cflags, asmflags, cxxflags 上
      - flags: -g -fno-common -ffunction-sections -fdata-sections
     - flags: -march=${nuclei_core.arch} -mabi=${nuclei_core.abi} -mcmodel=medany
   ldflags:
                                          # <OPTIONAL> 链接选项列表, 留空表示没有任何
选项
     - flags: -nostartfiles --specs=nosys.specs
     - flags: --specs=nano.specs
       condition: $(${newlib} != "normal")
     - flags: -u _printf_float
       condition: $(${newlib} != "nano_with_printfloat")
      - flags: -u _isatty -u _write -u _sbrk -u _read -u _close -u _fstat -u _lseek
                                          # <MUST> 链接脚本的定义,必须在 bsp/ssp 中
   linkscript:
定义
     - script: "Source/GCC/gcc_demosoc_${.download}.ld"
         condition: $(check pattern)
                                          # <OPTIONAL> 进行条件判断
                                          # <OPTIONAL> C 编译选项,留空表示没有任何选
   cflags:
项
     - flags: -03
                                          # <OPTIONAL> ASM 编译选项, 留空表示没有任何
   asmflags:
洗项
     - flags: -02
                                          # <OPTIONAL> CXX 编译选项, 留空表示没有任何
   cxxflags:
选项
     - flags: -01
   common_defines:
                                          # <OPTIONAL> 通用的宏定义
     - defines: __RISCV_FEATURE_DSP=1
       condition: $(${dsp_present} == 1)
     - defines: DOWNLOAD_MODE_STRING=\"flashxip\"
                                          # <OPTIONAL> C 的宏定义
   cdefines:
     - defines: __RISCV_FEATURE_DSP=1
       condition: $(${dsp_present} == 1)
      - defines: DOWNLOAD_MODE_STRING=\"flashxip\"
   asmdefines:
                                          # <OPTIONAL> ASM 的宏定义
      - defines: ___RISCV_FEATURE_DSP=1
       condition: $(${dsp_present} == 1)
     - defines: DOWNLOAD_MODE_STRING=\"flashxip\"
   cxxdefines:
                                          # <OPTIONAL> CXX 的宏定义
      - defines: ___RISCV_FEATURE_DSP=1
       condition: $(${dsp_present} == 1)
     - defines: DOWNLOAD_MODE_STRING=\"flashxip\"
                                          # <OPTIONAL> 编译前执行的命令
   prebuild_steps:
     command:
                                          # <OPTIONAL> 执行的命令行
     description:
                                          # <OPTIONAL> 执行的命令的描述
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(continued from previous page) # <OPTIONAL> 编译完成后执行的命令 postbuild_steps: # <OPTIONAL> 执行的命令行 command: # <OPTIONAL> 执行的命令的描述 description: ## Debug Configuration debugconfig: # <MUST> For bsp type, optional for app/ *⇔ssp* type # 目前 Debug 选项会将 package 中定义的所有的拼接在一起或者覆盖 # type 是一个特殊的字段,用于描述特定的调试器,目前支持 openocd, gemu # 以下字段是覆盖关系: app > mwp > osp > bsp > ssp > csp # description, svd # configs 字段下面的 key, value 是合并关系,如果对应的 key 存在就覆盖,覆盖规则同上,如果不存在 就合并 - **type:** openocd # <MUST> 选择的工具 description: Nuclei OpenOCD # <MUST> For bsp type svd: gd32vf103.svd # <OPTIONAL> 可选的 SVD 文件 configs: - key: config # openocd 配置文件 value: "openocd_gd32vf103.cfg" - type: qemu description: Nuclei QEMU svd: configs: - key: nuclei_core # Nuclei RISC-V Core value: \${nuclei_core} condition: # condition set nuclei_core key - key: download_mode # Download mode value: \${download_mode} - key: riscv_arch # RISCV ARCH value: \${nuclei_core.arch} - key: riscv_abi # RISCV ABI value: \${nuclei_core.abi} - key: machine # QEMU Machine value: gd32vf103v_rvstar ##Extended variable ## Only works on tool 类型 ## 每个包存在一个包路径,引用为 npk 名称-版本号,例如\${tool-cmlink-1.0.0}, ## 其他变量的引用为 npk 名称-版本号-变量名,例如 \${tool-cmlink-1.0.0-proxy} # 扩展变量 environment: # 变量名, - **key:** proxy # 实际引用结果为 npk 文件父路径 +value, 例如 value: bin/cmlink_gdbserver.exe C:\Users\jj\nuclei-pack-npk\NPKs\XinShengTech\Tool_Package\tool-cmlink\1.0.0\ \hookrightarrow cmlink\bin\cmlink_gdbserver.exe description: proxy location system: true # 默认为 fasle, 当 system 为 true 时,该变量引用时直接使用变量名,例如\$ \hookrightarrow {proxy} ## Template File Management ## Only works on tpp 类型,该类型比较特殊,描述文件为 npk_template.yml,是基于 npk.yml 做的 扩展 templatemanage: installdir: \${soc} files: build.mk.ftl: build.mk Common/npk.yml.ftl: Common/npk.yml Common/demosoc.svd.ftl: Common/\${soc}.svd Common/Source/demosoc_common.c: Common/Source/\${soc}_common.c

Common/Source/system_demosoc.c.ftl: Common/Source/system_\${soc}.c Common/Source/Drivers/demosoc_uart.c.ftl: Common/Source/Drivers/\${soc}_uart.c Common/Source/GCC/intexc_demosoc.S.ftl: Common/Source/GCC/intexc_\${soc}.S Common/Source/GCC/startup_demosoc.S.ftl: Common/Source/GCC/startup_\${soc}.S Common/Source/Stubs: Common/Source/Stubs Common/Include/demosoc.h.ftl: Common/Include/\${soc}.h Common/Include/demosoc_uart.h.ftl: Common/Include/\${soc}_uart.h Common/Include/nuclei_sdk_soc.h.ftl: Common/Include/nuclei_sdk_soc.h Common/Include/system_demosoc.h.ftl: Common/Include/system_\${soc}.h Board/nuclei_fpga_eval/openocd_demosoc.cfg: Board/\${board}/openocd_\${soc}.cfg Board/nuclei_fpga_eval/npk.yml.ftl: Board/\${board}/npk.yml Board/nuclei_fpga_eval/Source/GCC/gcc_demosoc_ilm.ld.ftl.ftl: Board/\${board}/ →Source/GCC/gcc_\${soc}_ilm.ld Board/nuclei_fpga_eval/Source/GCC/gcc_demosoc_flash.ld.ftl: Board/\${board}/ →Source/GCC/gcc_\${soc}_flash.ld Board/nuclei_fpga_eval/Source/GCC/gcc_demosoc_flashxip.ld.ftl: Board/\${board}/ →Source/GCC/gcc_\${soc}_flashxip.ld Board/nuclei_fpga_eval/Include/board_nuclei_fpga_eval.h.ftl: Board/\${board}/ →Include/board_\${board}.h Board/nuclei_fpga_eval/Include/nuclei_sdk_hal.h.ftl: Board/\${board}/Include/ →nuclei_sdk_hal.h

内容约定

为了保证 npk.yml 文件的可读性与简约性,对 npk.yml 文件的存储制定如下约定:

- · 各字段的存储顺序请保持与模板一致,数据与 DICT 按读入时顺序保存
- 各字段建议适当加上注释,尤其是那种需要解释的地方
- MUST 类型的字段需要按照上述注释描述的规则进行检查,如果不合规请报错提示,并不予导入
- 缩进建议采用 2 个空格字符
- 针对一些 OPTIONAL 的字段可以留空或者不写该字段
- 一级字段之间增加一行空行,二级及以下字段不使用空行,第一部分基础信息一级字段间不使用空行
- 字符串建议不使用引号,除特殊语法需要
- 所有的 `description`字段建议控制在 20 字符以内, 方便排版展示, 仅限英文
- 关于 yaml 里面多行的约定如下: https://yaml-multiline.info/

包导入规则

下面定义合法的包导入规则:

如果存在导入包中存在一些依赖的包(带版本匹配),并没有被导入,则不允许导入,并提示缺乏依赖的包,请导入该包。

- 后续包管理联网了,则可以提示是否从网上下载依赖的包,或者手动导入 zip 包

- 如果删除包,并且该包被其他包依赖,则提示哪些包依赖于该包,询问是否删除,如果删除以后,则在包管理中显示缺少的包
 - 后续包管理联网了,支持点击按钮下载缺失的包,或者手动导入 zip 包
- 如果导入相同版本的包,则提示该包已经存在,是否替换
- 如果导入不同版本的包,则提示已经存在其他版本的包,是否继续导入
- 导入的包,按照定义的类型分类显示,显示包的版本,包的 name, owner, description, homepage, license

zip 包内容规范

下面定义合法的 zip 包的内容规则:

- 一个 zip 包中必须包含至少 1 个 npk 文件
- 包类型的判定:如果包内存在多个类型的 npk 文件, npk 类型判定条件如下
 - sdk > ssp > bsp > osp > mwp > csp > app
 - 如果判定出包的类型存在多个相同的 npk,则该包不合法,不允许导入,并提示
- 该类型的包不允许存在多个该类型的 npk 文件
- 如果是 sdk 类型的包,则必须包含至少一个 ssp 和依赖于该 ssp 的 bsp 文件,以及至少一个 app 类型的文件,允许存在其他类型的包
- 如果是其他类型的包,则里面包含的其他 npk,必须显式依赖于该包

包依赖关系处理

包依赖关系的处理涉及到如何能够将包拆分并形成合理的依赖关系,便于包的独立维护。这里对不同类 型的包的依赖处理进行详细的分析。

依赖通过 dependencies 字段下的依赖列表来控制,支持依赖特定 owner 的某个 name,某个 version 版本的包,查找规则为 owner/name:version,如果 owner 未定义,则默认为该 npk 文件中定义的 owner,如果 version 未定义,则优先在同组件包查找,否则取最新的包。

csp Core Support Package 依赖

csp 类型的包是处理器内核 CORE 支持的软件包,目前针对 Nuclei RISC-V 内核,我们主要推广 NMSIS 这样的开源软件支持包。

一般情况下, csp 类型的包是非常底层的包,这里不支持依赖 ssp/bsp/mwp/rtos/app 这样的类型的包。但是可以依赖 sdk 类型的包,表示该包属于依赖的 sdk 包的环境中。

ssp SoC Support Package 依赖

ssp 类型的包是 SoC 或者芯片的支持的软件包,例如 gd32vf103,demosoc 这样 SoC 的支持软件 包。

ssp软件包仅可以依赖 csp/mwp/osp 这样的软件包,如果依赖了这三种类型的软件包,则表示在工程创建的时候或者是代码引入的时候,这三类软件包需要导入代码。而如果依赖 sdk 类型的软件包,则 表示该 ssp 类型的包属于依赖的 sdk 类型的软件包的环境。

理论上用户可以创建一个 ssp 软件包,不依赖任何 csp/mwp/rtos 的软件包,也不属于 sdk 类型的 软件包。osp 类型软件包仅可以依赖一个。

bsp Board Support Package 依赖

bsp 类型的包是针对基于某款 SoC/芯片做的开发板而推出的软件支持包,例如 gd32vf103-rvstar 这款开发板的 bsp 软件包。

bsp 软件包仅可以依赖 ssp/csp/mwp/osp 这样的软件包, 如果依赖了这几种类型的软件包, 则表示在工程创建的时候或者是代码引入的时候, 这类软件包需要导入代码。而如果依赖 sdk 类型的软件包, 则表示该 ssp 类型的包属于依赖的 sdk 类型的软件包的环境。

理论上用户可以创建一个 bsp 软件包,不依赖任何软件包。osp 类型软件包仅可以依赖一个。
osp OS Support Package 依赖

osp 类型的包是指特定的 RTOS 的软件支持包,例如 freertos, ucosii 之类的。

osp 类型的包仅可以依赖 ssp/csp/mwp 类型的软件包,如果依赖了这几种类型的软件包,则表示 在工程创建的时候或者是代码引入的时候,这类软件包需要导入代码。而如果依赖 sdk 类型的软件包, 则表示该 ssp 类型的包属于依赖的 sdk 类型的软件包的环境。

mwp Middleware Support Package 依赖

mwp 类型的软件包是指中间件类型的软件包,例如某个语音算法的库,某种物联网连接库如 mqtt, coap 之类。

mwp 类型的包仅可以依赖 bsp/ssp/csp/mwp/osp 类型的软件包,但是不建议直接依赖 bsp/ssp, 在创建 middleware 的时候尽量保证其通用性,可以很好被集成到其他的软件中。

sdk Software Development Kit Package 依赖

sdk 类型的软件包是一类非常特殊的软件包,本身并不会有额外的代码引入,而是通过依赖其他类型的软件包而组织的一个特殊的包。如果是 sdk 类型的软件包,导入是会强制检查软件包目录下所有的 npk.yml 文件以查找其他的软件包并引入该 SDK 依赖中,无需 npk.yml 文件显示进行依赖,这种依赖 关系并不会直接导致创建工程时的代码的导入,更多的是软件包的集合。

一个 sdk 类型的软件包可能会依赖多个 ssp, 多个 bsp, 多个 csp, 多个 app, 多个 mwp 和多个 osp。 更详细的内容请参见 [构建 SDK 开发包](# 构建 SDK 开发包)

对于属于 sdk 类型的软件包的其他软件包里面的依赖,优先使用都属于统一 sdk 软件包内部的软件 包。例如:

- sdk-nuclei-sdk 是一个 sdk 类型的软件包, 内部包含了 csp-nsdk_nmsis, bsp-nsdk_nuclei_fpga_eval, ssp-nsdk_demosoc, ssp-nsdk_gd32vf103, osp-nsdk_freertos, osp-nsdk_ucosii 这些软件包
- 而外部也有 csp-nsdk_nmsis, osp-nsdk_freertos 这类的软件包,在工程创建阶段,在版本匹配满足的 情况下,优先使用内部的 csp-nsdk_nmsis 和 osp-nsdk_freertos,只有在版本匹配不满足要求的情况 下,才会使用
- 在工程创建完成后,用户可以手动升级特定的包到其他版本。

2.4.2 模块说明

从上述描述文件中可以看出,一个标准的 npk.yml 实际是上由几个大块组成的,而在实现应用中,我们 并不一定会完全用到,一个合规的 npk.yml 文件,只要拥有基本的信息,就是可以正常给 Nuclei Studio 使用。

Package Base Information

这一块分信息,是 NPK 的基础的信息,很多关键的信息在这部分内容中需要描述清楚。其中着重说明几个字段。

• name

必填,NPK 的名称 ID,不要有空格,符合 C语言命名规范,英文名称,是唯一名称 ID。

version

```
选填,如不填,默认为空,建议采用 SEMVER2.0 版本号管理,只能数字打头,例如 1.2.3
```

• type

必填,可选类型值有 csp, ssp, bsp, osp, app, mwp, sdk, tpp, tool

• **os**

选填,标明该 NPK 适用于什么类型的 Nuclei Studio,目前我们发行的 Nuclei Studio 有 win64 和 lin64 两个版本。OS 类型可以填 win32、win64、lin64、lin32,但目前组件包上传页面只支持 win64 和 lin64,该 字段只存在 tool 类型 package

• owner

必填,组件包的拥有者,该 ID 一般为认证开发者 ID,便于后期进行权限查找匹配。如果该 NPK 仅 作本地测试,可以随意。

Package Information

packinfo 这一块分信息,主要是对 NPK 做一些说明,包括一些文档等信息,最终在 Nuclei Studio 中 使用该 NPK 时,这部分信息,会在 New Project 的导引中显示。

Package Dependency

dependencies 描述的是 NPK 的依赖关系,为了实现 NPK 的复用性,减少 NPK 的维护成本,我们在 设计时,是允许 NPK 实现依赖关系,一个 NPK 可以依赖 0 个以上的 NPK,所以在这里 dependencies 是 以组对象出现,每个依赖对象内需要明确 NPK 的 **name owner version**

Package Configurations

Configuration 字段是个非常特殊的字段,主要用于提供一些可配置项,以满足在工程创建时的交互场景。

不同包里面的 configuration 字段的下的二级字段名称可以一样,如果使用一样的名称则具备一样的 含义,如果定义了一样的名称则按照如下的规则进行覆盖。

覆盖规则为: app > mwp > osp > bsp > ssp > csp

Configuration 对象组会包含多个对象,而每个对象有固定的结构。

• XXX(变量名)

变量名可以随意,简合 c++ 的命名规范即可。在后面部分会以 \${XXX} 或 \${XXX.XX} 的方式引用。

• default

默认值,可选项。

• type

这个变量的类型,为了支持更丰富的 UI 体验,我们在 NPK 中定义了很多的 UI 组件类型,具体请参 看后面章节。

global

标明此字段是否在工程创建时显示在引导页面中。

• tips

对该变量的说明信息,主要用于 UI 的 tips 事件。

• hints

对该变量的说明信息,如值的示例等,主要用于 UI 的 hints 事件。

• description

此变量的 NPK 中的说明描述。

• **UI** 组件信息

支持的类型有 choice, list, checkbox, multicheckbox, text 等,具体信息参见

Source Code Management

codemanage 描述的是跟模板工程有关的内容,大多的时候,我们的 NPK 会包括很多复杂的功能,需要创建某个一个具体的工程的时候,我们又只需要一些具体的文件,同时需要配置这些文件的信息。 codemanage 就是将这些信息描述出来,它包含以下关键字:

custom

默认为 false, 当为 true 时,这个 installdir 就表示直接安装的目录

srcroot

默认为.,表示当前 npk.yml 所在目录,可以是相对路径,例如../,../bsp 等;需要注意的是,设置了这个以后,对应的 copyfiles/incdirs/libdirs 的路径的根目录均受到影响,就会使用新设置的和这个路径

• installdir

希望代码安装的目录名称, 仅限英文, 满足 C 语言命名格式

- 针对 sdk 类型的 package, 会被安装到 <sdk_installdir>, 如果 installdir 未定义, 默认为 SDK, 如果没有任何 sdk 类型的 package 被引用, sdk_installdir 也被默认设置为 SDK
- 针对 csp 类型的 package, 会被安装到 <sdk_installdir>/<csp_installdir> 目录下, TBD
- 针对 ssp 类型的 package, 会被安装到 <sdk_installdir>/SoC/<ssp_installdir>/Common 下面
- 针对 bsp 类型的 package, 会被安装到 <sdk_installdir>/SoC/<ssp_installdir>/Board/
 <bsp_installdir>下面,如果不依赖于任何 ssp 类型,则安装到 <sdk_installdir>/BSP/<bsp_installdir>
- 针对 osp 类型的 package, 会被安装到 <sdk_installdir>/OS/<osp_installdir> 下面
- 针对 app 类型的 package, 会被安装到 <app_installdir>/ 目录下, 如果 installdir 未定义, 默认 为 application
- 针对 mwp 类型的 package, 会被安装到 <sdk_installdir>/Components/<mwp_installdir> 目录下

Note: 2023.05.26 新增 copyfiles/incdirs/libdirs 均支持 ../../ 这样的相对上级目录, 但是安 装或者设置路径的时候, 均设置到 <installdir> 下面

例如:path: ["../common/"] 就拷贝上一级目录的 common,并放在 <installdir>/common 下面,

如果下面有 common 这个目录,则创建 R1L_common,如果是 ../../common,则创建 R2L_common,

这种方案不考虑了,直接创建同名目录,同名文件直接覆盖,建议采用 srcroot: .. 来解决问题 对应的 incdirs/libdirs

如果遇到这种相对路径,也需要以最终安装到路径以及文件名为准

copyfiles

待拷贝的文件或者文件夹,这里是指所有的目录或者文件,支持 ../ 、* 、* .* ,给结合 srcroot 一 起使用,

• incdirs

必填,加入头文件目录列表,Nuclei Studio 会进行补全,最终的路径是相对于工程根目录的路径。

libdirs

可选,lib 库所在目录,Nuclei Studio 会进行补全,最终的路径是相对于工程根目录的路径。

• Idlibs

可选的需要链接的库, Nuclei Studio 会进行补全, 最终的路径是相对于工程根目录的路径。

Set Configuration for other packages

setconfig 用来设置 NPK 的其他选项, 遵循覆盖规则 app > mwp > osp > bsp > ssp > csp。

setconfig 是一个对象组,可以无限扩展,每个对象中有三个字段来描述一个对象。

• config

变量名,遵循 C++ 命名规范,一般变量 XXX,在其它部分以 \${ XXX } 的方式引用

该变量名不唯一,可以通过条件进行判定生效,也遵循覆盖规则 app > mwp > osp > bsp > ssp > csp, 进行自动覆盖。

• value

变量的值

• condition

变量的条件,只有条件生效时,该变量的该值才会生效

Build Configuration

设置工程的编译工具和编译选项的配置,它的关键字包含以下几个固定字段。

• type

支持的编译工具的类型,值一般为 gcc、clang、common。目前只支持 gcc、clang 两种,因为编译选项的配置有一些是相同的,为了提高代码的复用性,我们又添加 common 类型。

description

对此编译工具的说明。

toolchain_name

重要字段,编译工具名字。

• cross_prefix

重要字段,编译工具的前缀。

• unflags

在 buildconfig section 中的 common_flags/cflags/asmflags/ldflags/cxxflags 中生效,用于删掉之前已经定义的 flags。

• undefines

在 buildconfig section 中的 common_defines/cdefines/asmdefines/cxxdefines 中生效,用于删掉之前已经定义的 defines。(字符串完全匹配,则生效)

common_flags

用的编译选项,将会添加到 cflags, asmflags, cxxflags 上,留空表示没有任何选项。

Idflags

链接选项列表,留空表示没有任何选项。

linkscript

链接脚本的定义,必须在 bsp/ssp 中定义,留空表示没有任何选项。

• cflags

```
C编译选项,留空表示没有任何选项。
```

• asmflags

ASM 编译选项, 留空表示没有任何选项。

• cxxflags

CXX 编译选项, 留空表示没有任何选项。

common_defines

通用的宏定义,留空表示没有任何选项。

• cdefines

C的宏定义,留空表示没有任何选项。

• asmdefines

ASM 的宏定义, 留空表示没有任何选项。

• cxxdefines

CXX 的宏定义, 留空表示没有任何选项。

prebuild_steps

– command

编译前执行的命令,留空表示没有任何选项。

- description

编译前执行的命令的说明,留空表示没有任何选项。

postbuild_steps

- command

编译后执行的命令,留空表示没有任何选项。

description

编译后执行的命令的说明,留空表示没有任何选项。

Debug Configuration

设置工程的 Debug 类型及相关参数的配置,它的关键字包含以下几个固定字段,可以不用配,如果配置 了,在工程生成的时候,Nuclei Studio 会根据这里面的内容,生成了个 launch 文件,同时可以根据相关内 容进行工程的 Debug。

• type

Debug 类型, 目前支持 GDB Custom 、GDB SEGGER J-Link、GDB OpenOCD、GDB Nuclei QEMU、 Nuclei RVProf

• description

对支持的 Custom Jlink OpenOCD Qemu RVProf 的说明

• configs

对应的 Debug 类型的参数,所有的参数,都是以 key-value 的方式出现,因为每中 Debug 类型所需参数不同,对应的情况也不同,更详细的说明如下。

```
debugconfig:
  - type: openocd
  description: Nuclei OpenOCD
  configs:
      - key: XXXX
      value: xxxx
```

GDB Custom 的 Debug 参数

Name	Reset Value	Description
doStartGdbCL ient	true	Start locally
doStartGdbSarvar	true	Start CDR session
adbClientOtherCommands	titue	adh Client Other Commands
adhClientOtherOntions		gdb Client Other Options
gubChentOtherOptions adhMada	Commanda	gub Chefit Outer Options 主持的考刊 日前主持 Commanda Canar
gdbNode adhSamarConnectionAddress	Commands	又行的天空, 日前又行 Commands、 Gener
gdbServerConnectionAddress		gdb Server Connection Address
gdbServerExecutable		gdb Server Executable
serverCheckFlag	Started by GNU MCU Eclipse	server Check Flag
gdbServerGdbPortNumber	3333	gdb Server Gdb Port Number
gdbServerOther		Config options
DEBUG_NAME	{cross_prefix}gdb{{cross_suffix}	Executable path
ipAddress	localhost	Host name or IP address
portNumber	3333	
UPDATE_THREADLIST_ON_SUSPEND	false	Force thread list update on suspend
otherInitCommands		Initialization Commands
loadImage	true	Load executable
imageFileName		use File For Image name
imageOffset		Executable offset (hex):
useFileForImage	false	Use file for Image
useProjBinaryForImage	true	
loadSymbols	true	Load symbols
symbolsFileName		
symbolsOffset		Symbols offset (hex)
useProjBinaryForSymbols	true	Use project binany
useFileForSymbols	false	Use file for Symbols
doDebugInRam	true	Debug in RAM
otherRunCommands		Run/Restart Commands
setPcRegister	false	Set program counter at (hex)
pcRegister		
setResume	false	
setStopAt	true	Set breakpoint at
stopAt	main	•
doContinue	true	Continue
svdPath		svd file path

Table 2.1: Arguments of GDB Custom Debug

GDB SEGGER J-Link 的 Debug 参数

Description
Start the j-Link GDB server locally
Connect to running target
Executable path
Allocate console for the GDB server
do Gdb Server Init Regs
do Gdb Server Local Only
do Gdb Server Silent
do Gdb Server Verify Download
Start the j-Link GDB server locally
gdb Client Other Commands

Table 2.2: Arguments of GDB SEGGER J-Link Debug

continues on next page

		5
gdbServerConnection	usb	gdb Server Connection
gdbServerConnectionAddress		gdb Server Connection Address
gdbServerDebugInterface	itag	gdb Server Debug Interface
gdbServerDeviceEndianness	little	gdb Server Device Endianness
gdbServerDeviceName		gdb Server Device Name
gdbServerLog		gdb Server Log path
gdbServerGdbPortNumber	2331	gdb Server Gdb Port Number
gdbServerSwoPortNumber	2332	gdb Server SwoPort Number
gdbServerTelnetPortNumber	2333	gdb Server Telnet PortNumber
gdbServerOther	2555	gdb ServerO ther
DEBLIG NAME	{cross prefix}db{{cross suffix}	Executable path
gdbClientOtherOptions		adh Client Other Options
in A ddroog	looplbost	gub Chent Other Options
IPAddless portNumber		
	2331	11. C D
gabServerDeviceSpeed		gab Server Device Speed
doFirstReset	false	Initial Reset and Halt
firstResetType	1000	
firstResetSpeed	1000	
enableFlashBreakpoints	true	Enable flash breakpoints
doGdbServerAllocateSemihostingConsole	true	Allocate console for semihosting and SWO
enableSemihosting	true	Enable semihosting console routed to
enableSemihostingIoclientTelnet	true	Telnet
enableSemihostingIoclientGdbClient	false	GDB client
enableSwo	true	Enable SWO
swoEnableTargetCpuFreq	0	SWO Cpu freq
swoEnableTargetSwoFreq	0	SWO freq
swoEnableTargetPortMask	0x1	SWO Port mask
otherInitCommands		other Init Commands
itagDevice	GNU MCU J-Link	
loadImage	true	Load executable
imageFileName		
imageOffset		
useFileForImage	false	
useProiBinaryForImage	true	
loadSymbols	true	Load symbols
symbolsEileName	titue	Load symbols
symbols		
symbolsOffset	falae	
useFileForSymbols	false	
useProjBinaryForSymbols	true	
doDebugInRam	true	Debug in RAM
doSecondReset	true	Pre-run/Restart reset
secondResetType		Type (always executed at Restart)
otherRunCommands		
setPcRegister	false	Set program counter
pcRegister		Set program counter at (hex)
setStopAt	true	Set breakpoint
stopAt	main	Set breakpoint at
doContinue	true	Continue
svdPath		svd file path

Table 2.2 - continued from previous page

GDB OpenOCD 的 Debug 参数

Name	Reset Value	Description
doStartGdbServer	true	Start OpenocD locally
gdbServerExecutable		Executable path:
gdbServerGdbPortNumber	3333	GDB port
gdbServerTelnetPortNumber	4444	Telnet port
gdbServerTclPortNumber	6666	Tcl port
gdbClientOtherOptions		gdb Client Other Options
gdbServerOther		Config options
doGdbServerAllocateConsole	true	do GdbServer Allocate Console
doGdbServerAllocateTelnetConsole	false	do Gdb Server Allocate Telnet Console
gdbServerConnectionAddress		gdb Server Connection Address
doStartGdbCLient	true	do Start Gdb CLient
DEBUG_NAME	{cross_prefix}gdb{{cross_suffix}	
gdbClientOtherCommands		Commands
ipAddress	localhost	Host name or lp address
portNumber	3333	Port number
UPDATE_THREADLIST_ON_SUSPEND	false	Force thread list update on suspend
doFirstReset	false	Initial Reset and Halt
firstResetType	init	
otherInitCommands		
enableSemihosting	false	Enable semihosting console routed to
loadImage	true	Load executable
useFileForImage	false	
imageFileName		
imageOffset		
symbolsFileName		
symbolsOffset		
loadSymbols	true	Load symbols
useFileForSymbols	false	
useProjBinaryForImage	true	
useProjBinaryForSymbols	true	
useRemoteTarget	true	
doDebugInRam	true	Debug in RAM
doSecondReset	true	Pre-run/Restart reset
secondResetType	halt	Type (always executed at Restart)
otherRunCommands		
setPcRegister	false	Set program counter
pcRegister		Set program counter at (hex)
setStopAt	true	Set breakpoint
stopAt	main	Set breakpoint at
doContinue	true	Continue
svdPath		svd file path

Table 2.3:	Arguments	of GDB	OpenOCD	Debug
	<u> </u>			

GDB Nuclei QEMU 的参数

doStartGdbServer true true true StartOpenocD locally gdbServerExecutable gdbMachineBit gdbMachineBit gdbMachineBit gdbMachineBit gdbMachineBit gdbSreverBoartName gdbCoreName gdbCoreName gdbCoreName gdbServerSMPCount I Nuclei RisC-V Core: gdbServerSMPCount I Download: gdbServerOther -serial stdio -nodefaults -S More options: otherExtensions gdbServerOther -serial stdio -nodefaults -S More options: otherExtensions gdbServerOther -serial stdio -nodefaults -S More options: otherExtensions gdbServerOther I234 GDB port: isGdbServerVerbose false enableSemihosting true Enable Arm semihosting GdbServerAllocateConsole true Do not open graphic windows doGdbServerAllocateConsole true BeBUC_NAME gdcClientOtherOptions gdbClientOtherOptions gdbClientOtherOptions true total advess portNumber I234 Port number doFirsReset false Initial Reset and Halt otherIniCommands true Load symbols symbolsFileName symbolsOffset useFrileForImage false true Load executable useFrileForImage false true Commands true true Code executable useFrileForImage false true Code executable Code	Name	Reset Value	Description
gdbServerExecutable in Kachine Bir gdbMachineBir gdbServerBoardName Machine Bir gdbServerSMPCount 1 Nuclei RisC-V Core: gdbServerSMPCount 1 Nuclei SMP Count: gdbServerOther -serial stdio -nodefaults -S More options: other Extensions other Extensions gdbServerCdbPortNumber 1234 GDB port: isGdbServerCdbPortNumber 1234 GDB port: isGdbServerAllocateConsole true Enable Arm semihosting disableGraphics true Do not open graphic windows doGdbServerAllocateConsole true Allocate console for QEMU DEBUG_NAME \${cross_prefix}gdb\${cross_suffix} gdbClientOtherOptions Compands ipAddress localhost Host name or lp address portNumber 1234 Port number doFirstReset false Initial Reset and Halt otherInitCommands ipAddress Initial Reset and Halt otherInitCommands Intervent Initial Reset Initi	doStartGdbServer	true	Start OpenocD locally
gdbMachineBitMachine Bit: gdbServerRoardNameMachine Bit: gdbCoreNamegdbCoreNameNuclei RisC-V Core: Nuclei RisC-V Core: gdbServerSMPCount1gdbServerSMPCount1Nuclei SMP Count: gdbServerCothergdbServerCother-serial stdio -nodefaults -SMore options: other Extensions gdbServerCothPortNumber1234GDB port: isGdbServerVerbosefalseExtra verboseenableSemihostingtrueDo not open graphic windowsdoGdbServerAllocateConsoletrueAllocate console for QEMUDEBUG_NAME\${cross_prefix}gdb\${cross_suffix}Executable namegdbClientOtherCoptionsOther optionsgdbClientOtherCommandsIocalhostHost name or lp addressportNumber1234Port numberdoFirsResetfalseInitial Reset and HaltotherEinStreSetfalseIstale ResetuseFileForSymbolstrueLoad symbolsuseFileForSymbolstrueLoad executableuseFileForSymbolstrueLoad executableuseFileForImagefalseItrueuseFileForImagefalseItrueuseFileForImagefalseItrueuseFileForImagefalseItrueuseFileForImagefalseItrueuseFileForImagefalseItrueuseFileForImagefalseItrueuseFileForImagefalseItrueuseFileForImagefalseItrueuseFileForImagefalseItrueuseFileForImagefal	gdbServerExecutable		Executable path:
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gdbServerOther -serial stdio -nodefaults -S More options: otherExtensions otherExtensions otherExtensions otherExtensions gdbServerGdbPortNumber 1234 GDB port: isGdbServerVerbose false Extra verbose enableSernihosting true Enable Arm semihosting disableGraphics true Do not open graphic windows doGdbServerAllocateConsole true Allocate console for QEMU DEBUG_NAME \${cross_prefix}gdb\${cross_suffix} Executable name gdbClientOtherOptions { commands locate console for QEMU BeBUG_NAME } localhost Host name or lp address portNumber 1234 Port number doFirstReset false Initial Reset and Halt there in the false locad symbols symbolsFileName symbolsOffset useProjBinaryForSymbols true Load symbols false symbolsOffset useRemoteTarget true loadImage true loadImage true loadImage false limageOffset set set false Debug in RAM false set set false Set program counter at (nex Set preakpoint at docontinue true Continue Set preakpoint at doecontinue set preakpoint at doecont preakpoint	gdbDownloadName		Download:
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ipAddresslocalhostHost name or lp addressportNumber1234Port numberdoFirstResetfalseInitial Reset and HaltotherInitCommandsloadSymbolstrueLoad symbolssymbolsFileNamesymbolsOffsetuseFileForSymbolsfalseuseProjBinaryForSymbolstrueloadImagetrueloadImagetrueuseFileForImagefalseimageFileNameimageOffsetuseProjBinaryForImagetruedoDebugInRamfalseotherRunCommandsdoSecondResettruesetPcRegisterfalsesetPcRegisterfalsesetDreRupfortSet program counter at (hex)setStopAttruestopAtmainset breakpoint at (docontinueSet breakpoint at (docontinue	gdbClientOtherCommands		Commands
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priorintermdoFirsResetfalseInitial Reset and HaltotherInitCommandsLoad symbolsloadSymbolstrueLoad symbolssymbolsOffsetsymbolsOffsetuseFileForSymbolsfalseuseProjBinaryForSymbolstrueuseRemoteTargettrueloadImagetrueuseFileForImagefalseimageOffsetuseProjBinaryForImageimageOffsettrueuseFileForImagefalseimageOffsetuseProjBinaryForImagefalseDebug in RAMotherRunCommandsYruedoSecondResettruesetPcRegisterfalsesetStopAttruedoContinuetruetoopAtmaindoContinuetruecontinuetrue </td <td>portNumber</td> <td>1234</td> <td>Port number</td>	portNumber	1234	Port number
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useRemoteTargettrueloadImagetrueLoad executableuseFileForImagefalseimageFileName	useProjBinaryForSymbols	true	
loadImagetrueLoad executableuseFileForImagefalse	useRemoteTarget	true	
useFileForImagefalseimageFileName	loadImage	true	Load executable
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stopAtmainSet breakpoint atdoContinuetrueContinue	setStopAt	true	Set breakpoint
doContinue true Continue	stopAt	main	Set breakpoint at
	doContinue	true	Continue
svdPath svd file path	svdPath		svd file path

Table 2.4: Arguments of GDB Nuclei QEMU Debug

Nulcei RVProf 的参数

NY.	D 171	D. I.I.
Name	Reset Value	Description
cycleModelExecutable	\$ {cycelmodel_path}/\$	cycleModel Executable
	{cycelmodel_executable}	
cycleModelExecutableTimeOut	20	cycleModelExecutable TimeOut
cycleModelExecutableProces-	4	cycleModel Executable Processor
sorCores		Cores
cycleModelOther		cycleModel Other
docycleModelAllocateConsole	true	
docycleModelAllocateTelnet-	false	
Console		
RVProfExecutable	{rvprof_path}/\${rvprof_executable}	RVProf Executable
RVProfExecutableTimeOut	20	RVProf Executable TimeOut
RVProfOther		RVProf Other
RVProfPortNumber	5000	RVProfPort Number
doRVProfAllocateConsole	true	
doRVProfAllocateTelnetCon-	false	
sole		

Table 2.5: Arguments of Nuclei RVProf

Extended variable

environment 是应用于 tool 类型的 NPK 包中的配置,当用户想要通过 NPK 来共享一个 tools 如 cycleModel,可以使用。当定义了 **environment**, Nuclei Studio 会自动产生几个全局,这个变量可以在其他的 NPK 中以 \${xxx-1.0.0-XXX} 的方式使用。

Note:

- 每个包存在一个包路径,引用为 npk 名称-版本号,例如 \${tool-cyclemodel-1.0.0}
- 其他变量的引用为 npk 名称-版本号-变量名,例如 \$ {tool-cyclemodel-1.0. 0-cycelmodel_path},\${tool-cyclemodel-1.0.0-cycelmodel_executable}
- 当变量的 system 值为 true 时,额外新增一个不带版本号的变量,取最高版本的该变量,例如 \$ {tool-cyclemodel-cycelmodel_executable}

```
name: tool-cyclemodel
owner: nuclei
os:
version: 1.0.0
description: Nuclei Tools cyclemodel
details: Nuclei Tools cyclemodel
type: tool
keywords:
  - tool
 - cyclemodel
license: Apache-2.0
homepage:
## 扩展变量 tool-cyclemodel-1.0.0 与 tool-cyclemodel-1.0.0-proxy
environment:
  - key: cycelmodel_path
   value: bin
   description: cyclemodel location
    system: true
```

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```
    key: cycelmodel_executable
    value: bin/n300_best_config_cymodel_latest
    description: cyclemodel location
    system: true
    ## 这是另一个 NPK 中的代码,演示了如何使用 tool-cyclemodel
    debugconfig:
        - type: rvprof
        description: Nuclei RVProf
        configs:
            - key: ncycm_path
            value: ${tool-cyclemodel-1.0.0-cycelmodel_executable}
            - key: rvprof_path
            value: ${tool-rvprof-1.0.0-rvprof_executable}
```

templatemanage

内部使用的配置,这里不做详细说明。

2.4.3 NPK 中的 UI 组件

NPK 中提供了丰富的 UI 组件,这些组件的字段里面都会有 default, description, global 这些子字段,这些字 段均具备含义。

default 表示默认值, description 表示该选项的含义, global 表示这个选项是否在工程创建时显示 (true), 或者仅仅内部传参使用 (false)。

• Choice 单项选择框

```
choice_test:
 default_value: ground
 type: choice
 description: choice_test
  choices:
    - name: ground
      description: Ground Rules
      info:
        - name: app_commonflags
          value: >-
            -O3 -flto -fno-inline -funroll-loops -Wno-implicit -mexplicit-relocs
            -fno-builtin-printf -fno-common -falign-functions=4 -falign-jumps=4 -
\rightarrow falign-loops=4
    - name: inline
      description: Inline
      info:
        - name: app_commonflags
          value: >-
            -O3 -flto -finline -funroll-loops -Wno-implicit -mexplicit-relocs -fno-
→builtin-printf
            -fno-common -falign-functions=4 -falign-jumps=4 -falign-loops=4 -
⇔finline-functions
    - name: best
      description: Best Effort
      info:
        - name: app_commonflags
          value: >-
            -Ofast -flto -fwhole-program -finline -funroll-loops -Wno-implicit -
← mexplicit-relocs
```

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• list 单项选择框

```
list_test:
  default_value: rv32imac
  type: list
  global: true
  description: list_test
  value: >-
     [rv32imac,rv32imafc,rv32imafdc,rv32imafcb,rv32imafdcb]
```

rv32imac ~
rv32imac
rv32imafc
rv32imafdc
rv32imacb
rv32imafcb
rv32imafdcb

• checkbox 单项勾选框

```
checkbox_test:
  default_value: 0
  type: checkbox
  global: true
  description: checkbox_test
```

checkbox_test:

• multicheckbox 穿梭选择框

```
下面提供2种写法
```

```
multicheckbox_old:
    default_value: []
    type: multicheckbox
    global: true
    description: multicheckbox_old
    choices:
        - name: b
        description: Bitmanip Extension
        - name: p
        description: Packed SIMD Extension
        - name: v
        description: Vector Extension
```

(continued from previous page)

multicheckbox_old:	Bitmanip Extension Packed SIMD Extension Vector Extension	>>	
	,		

```
multicheckbox new:
```

rv32imafc description rv32imafdc description rv32imac description

• text 单行文本框

```
text_test:
 value: >-
   -02 -funroll-all-loops -finline-limit=600 -ftree-dominator-opts
   -fno-if-conversion2 -fselective-scheduling -fno-code-hoisting
   -fno-common -funroll-loops -finline-functions -falign-functions=4
   -falign-jumps=4 -falign-loops=4
   type: text
   description: text_test
```

text_test:

-O2 -funroll-all-loops -finline-limit=600 -ftree-dominator-opts -fno-if-cc

>>

<<

• multitext 多行文本框

```
multitext_test:
value: >-
    -02 -funroll-all-loops -finline-limit=600 -ftree-dominator-opts
    -fno-if-conversion2 -fselective-scheduling -fno-code-hoisting
    -fno-common -funroll-loops -finline-functions -falign-functions=4
    -falign-jumps=4 -falign-loops=4
type: multitext
description: multitext_test
```

• multichoice 多选下拉框

下面提供2种写法

```
multichoice_test1:
    default_value: []
    type: multichoice
    global: true
    description: multichoice_test1
    param:
        name: ["rv32imac","rv32imafc"]
        description: ["${name} description","${name} description
        ."]
```

multitext_test:	-O2 -funroll-all-loops -finline-limit=600 -ftree-dominator-opts -fno-if- conversion2 -fselective-scheduling -fno-code-hoisting -fno-common -funroll-loops -finline-functions -falign-functions=4 -falign-jumps=4 - falign-loops=4
multichoice_test1:	
multichoice_test2:	rv32imac description rv32imafc description
cascaderchoice test:	rv32imafdc description
switchbutton test:	



multichoice_test2:	rv32imac description,rv32imafdc description
cascaderchoice test:	rv32imac description
	rv32imafc description
switchbutton test:	rv32imafdc description
slider test:	

• cascaderchoice 级联选择框



• switchbutton 开关

```
switchbutton_test:
    default_value: 0
    type: switchbutton
```

(continues on next page)

cascaderchoice test:	shashi ✓ hubei	^
slider test:	wuhan ∽ jingzhou	
- spinner_test:	shashi	~
global: true		(continued from previous page)
description: switchbu	tton test	
switchbutton test:	O OFF	
• slider 数字选择框		
<pre>slider_test: default_value: 0 type: slider description: slider_t param: range: >- [0,100,1]</pre>	est	
slider_test: spinner_test:	< 10 0	>
• spinner 数字选择框		
<pre>spinner_test: default_value: 10 type: spinner description: spinner_ param: range: >- [-100,100,2]</pre>	test	
• multispinner 多数字选.	圣框	
<pre>multispinner_test: default_value: >- [3,4,6,4,6,4,6,4,6,7] type: multispinner global: true description: multispi param: range: >- [-100,100,1],[-100]</pre>] nner_test ,100,2],[-100,100,3],[-:	100,100,3],[-100,100,3],[-100,100,3],

- ↔ [-100, 100, 3], [-100, 100, 3], [-100, 100, 3], [-100, 100, 4]
 - multicheckbox_v2 多项勾选框

下面提供2种写法

```
multicheckbox_v2_test1:
default_value: >-
 [rv32imac]
```

(continues on next page)

spinner_test:	10	•
multispinner_test:	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	A V

```
(continued from previous page)
type: multicheckbox_v2
global: true
description: multicheckbox_v2 test1
param:
    name: ["rv32imac","rv32imafc","rv32imafdc"]
    description: ["${name} description","${name} description"]
```

```
multicheckbox_v2 test1:
```

rv32imac description
 rv32imafdc description

rv32imafc description

```
multicheckbox_v2_test2:
    default_value: >-
      [rv32imac]
    type: multicheckbox_v2
    global: true
    description: multicheckbox_v2 test2
    choices:
        - name: rv32imac
        description: rv32imac
        - name: rv32imafc
        description: rv32imafc2
        - name: rv32imafdc
```

• multiradio 单选框

下面提供2种写法

```
multiradio_test2:
    default_value: rv32imac
    type: multiradio
    global: true
    description: multiradio test2
    choices:
        - name: rv32imac
        description: rv32imac
        - name: rv32imafc
        description: rv32imafc2
        - name: rv32imafdc
        description: rv32imafdc
```

multicheckbox_v2 test2:	✓ rv32imac	rv32imafc2	🗌 rv32imafdc
multiradio test1:	 rv32imac desc rv32imafdc desc 	ription escription	○ rv32imafc description

2.4.4 NPK 的语法

YAML 语言

NPK 的描述文件 npk.yml, 是以 YAML 语言来编写,所以它支持标准的 YAML 语法,获取更多 YAML 相关的信息,可以参考: https://yaml.org/

变量定义

NPK 的描述语言中,允许用户自义定一个变量,并在有依赖关系的 NPK 中的任意位置使用

Note:

- 例子 NPK 中定义了一个变量 app_commonflags,在与该 NPK 有依赖关系的任意 npk.yml 文件内的 任意位置,我们可以通过 \${app_commonflags} 来使用 app_commonflags 的值。
- 例子 NPK 中定义了一个 list 对象 nuclei_core, 在与该 NPK 有依赖关系的任意 npk.yml 文件内的 任意位置,我们可以通过 \${nuclei_core.arch} 来使用 nuclei_core 对象中的 arch 值;通过 \$ {nuclei_core.abi} 来使用 nuclei_core 对象中的 abi 值;通过 \${nuclei_core.tune} 来使用 nuclei_core 对象中的 tune 值。

configuration:	
app_commonflags:	
value:	
type: text	
description: Application Compile Flags	
nuclei_core:	
default_value: n201	
type: choice	
global: true	
description: Nuclei RISC-V Core	
choices:	
- name: n200	
arch: rv32imc	
abi: ilp32	
cmodel: medlow	
tune: nuclei-200-series	
description: N200 Core(ARCH=rv32imc, ABI=ilp32)	
- name: n201	
arch: rv32iac	
abi: ilp32	
cmodel: medlow	
tune: nuclei-200-series	
description: N201 Core(ARCH=rv32iac, ABI=ilp32)	
<pre>## Set Configuration for other packages</pre>	
setconfig:	
	(continues on next page)

```
multiradio test2:
```

Inv32imac

○ rv32imafc2 ○ n

🔘 rv32imafdc

(continued from previous page)

```
- config: nmsislibarch
value: ${nuclei_core.arch}
## Build Configuration
buildconfig:
    - type: gcc
    common_flags: # flags need to be combined together across all packages
        - flags: ${app_commonflags}
```

关键字

为了更好的描述 NPK,我们定义了一些字段,以描述出各种关系,其中大部分字段如其字面意义,这里 重点介绍以下几个关键字。

• condition

condition 在 npk.yml 中,使用很频繁,是自定义的一个关键字,用来处理逻辑关系,类似 if,具体的使用如下。

ldflags:

```
flags: --specs=nosys.specs
condition: $( ${stdclib} == "newlib_full" )
flags: --specs=nano.specs --specs=nosys.specs -u _printf_float -u _scanf_float
condition: $( ${stdclib} == "newlib_fast" )
flags: --specs=nano.specs --specs=nosys.specs -u _printf_float
condition: $( ${stdclib} == "newlib_small" )
flags: --specs=nano.specs --specs=nosys.specs
condition: $( ${stdclib} == "newlib_nano" )
flags: --specs=${stdclib}.specs
condition: $( startswith(${stdclib}, "libncrt") )
# 上述描术中 flags 的值, 由 condition 决定, 当在不同的场景时, flags 的值会不同,
# 久因为 flags 是一个数组类型,所以上述例子中 flags 会有多个值,最终使用是,是 flags 的值拼接成
的字符串。
```

dependencies

dependencies 在 npk.yml 中, 用来描述 NPK 的依赖关系。

在很多的时候,NPK 需要依赖特定 owner 的某个 name,某个 version 版本的包,查找规则为 owner/ name:version,如果 owner 未定义,则默认为该 npk 文件中定义的 owner,如果 version 未定义,则优先 在同组件包查找,否则取最新的包。如果所依赖的包找不到,则该 NPK 将无法使用。

Note: 例子中 NPK 依赖了三个 npk, 如下:

- sdk-nuclei_sdk owner、version 未定义,则优先在同组件包查找,否则取最新的包
- tool-testmodel 明确了 owner 和 version
- tool-rvprof 明确了 owner 和 version

```
## Package Dependency
dependencies:
    - name: sdk-nuclei_sdk
    version:
    owner:
    - name: tool-testmodel
    version: 1.0.0
    owner: nuclei
    - name: tool-rvprof
```

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(continued from previous page)

```
version: 1.0.0
owner: nuclei
```

自定函数

在 NPK (npk.yml) 中,为了更好地满足各种不同的需求,我们特意定义了一些常用的函数。

• upper

将字符串变大写

```
${linker_script} = "test"
$(upper("${linker_script}CD")) => TESTCD
```

• lower

将字符串变小写

```
${linker_script} = "test"
$(lower("${linker_script}cd")) => testcd
```

• contains

判断字符串中是否包含另一个字符串

```
${linker_script} = "test"
$(contains(${linker_script}, nmsis)) => false
```

• join

将字符串连接数组

```
$(join([a,b,c,v], '') => abcv
```

• concat

连接字符串成为新一字符串

```
${linker_script} = "test"
$(concat(${linker_script}, v) => testv
```

• strip

去掉字符串两端空格

```
${linker_script} = " test "
$(strip(${linker_script})) => test
```

• startswith

判断字符串是否以 xxx 开头

```
${linker_script} = "testabcd"
$(startswith(${linker_script}, test)) => true
```

endswith

判断字符串是否以 xxx 结尾

```
${linker_script} = "testabcd"
$(endswith(${linker_script}, test)) => false
```

• arithop

数学运算符,支持+、-、*、/、%、?(三元运算)等常用运算符,不支持++、

```
$ (arithop(${linker_script}+22) > 1000)
$ (arithop(${linker_script}+22))
$ (arithop(${linker_script}>22?1:0))
```

npack/npack_installdir

npack 是否包含指定的 npk

npack_installdir 包含的 npk 的路径

```
# a.yml
   name: mwp-a
   owner: nuclei
   copyfiles:
       - path: ["common", "abc.ld", "src/openocd.cfg", "inc"]
# b.yml
   name: mwp-b
   owner: nuclei
   copyfiles:
       - path: ["common", "111.ld", "src", "inc"]
   debugconfig:
     - type: openocd
       description: Nuclei OpenOCD
       configs:
         - key: config
           value: "$(npack_installdir(mwp-a))/src/openocd.cfg"
           condition: $( npack(nuclei:mwp-a) )
# 这段描述,是当 b.yml 如果依赖 a.yml 时,就可以将 config 的值,设置为 a.yml 的目录下的/src/
⇔openocd.cfg
```

list_get

获取数组元素中指定脚标的值

\${nuclei_cache}=[ic,dc,ccm]
\$(list_get(\${nuclei_cache},0)) -> ic

list_set

修改数组元素中指定脚标的值

```
${nuclei_cache}=[ic,dc,ccm]
$(list_set(${nuclei_cache},1,aa)) -> [ic,aa,ccm]
```

list_del

删除数组元素中指定脚标的值

```
${nuclei_cache}=[ic,dc,ccm]
$(list_del(${nuclei_cache},1)) -> [ic,ccm]
```

list_add

在数组元素指定脚标插入值

```
${nuclei_cache}=[ic,dc,ccm]
$(list_add(${nuclei_cache},2,aa)) -> [ic,dc,aa,ccm]
```

list_size

获取数组元素 list 的长度

```
${nuclei_cache}=[ic,dc,ccm]
$(list_size(${nuclei_cache})) -> 3
```

list_sub

从 list 中指定的位置开始, 截取指定长度的 list

```
${nuclei_cache}=[ic,dc,ccm]
$(list_sub(${nuclei_cache},1,2)) -> [dc]
$(list_sub(${nuclei_cache},0,2)) -> [ic,dc]
$(list_sub(${nuclei_cache},1,)) -> [dc,ccm]
$(list_sub(${nuclei_cache},2)) -> [ic,dc]
```

• subst

对字符串内部的指定字符串进行替换, 第三个参数可为空

```
subst(libncrt_small,lib,) ==> ncrt_small
subst(libncrt_small,lib,ext) ==> extncrt_small
```

2.5 Nuclei Studio NPK 创建与共享

Nuclei Studio 2022.04 版中,提供了一个非常重要的功能,该功能主要通过提供的各种初始模板,方便开发者去创建自己的 NPK 组件包,并可以通过平台将自己的 NPK 组件包贡献出来,供其他开发者使用。

2.5.1 开发 NPK 组件包

认证开发者

在创建 NPK 组件包前,先需要认证一个开发者帐号,获取一个唯一的 owner ID, 这在 owner ID 对应的就 是前文中介绍的 owner,它能方便我们对 NPK 进行管理。

首先,登陆芯来科技的 RVMCU 社区的网站²,登陆成功后,依次进入 Nuclei Studio-> 贡献页面,就 可以看到认证按钮。

² https://www.rvmcu.com/user-login.html



软件包贡献流程

或者直接访问 认证地址³,按提示分别填写相关信息,其中 开发者对应的开发者空间地址的后辍将 会是您的 owner ID。

³ https://www.rvmcu.com/nucleistudio-developer.html

& Nuclei Studio	i chainnean an a	请输入搜索的内容	Q 首页	〔 软件包	动态	教程	FAQ	贡献	RVMCU社区 🔕
		认证开发者							
	软件包的贡献量和下载 来	混不断地增加,软件包的使用范围也 Nuclei Studio 的生态会更加丰富和强	越来越广,相(]]、	言不久的将					
	完成开发者认证,	您可以将自己的工程序包贡献出来,	供其他开发者的	吏用。					

提交信息	验证邮箱	平台审核
	2	3
开发者: *		
test		
开发者空间地址: *		
http://www.rvmcu.cn/npk/ test	这里就是owne	er ID
开发者简介: *		
NY TALE		
npk升友者		
联系邮箱: *		
xxxx@xx.com		
	认证开发者	

本站所有内容仪供学习和交流。如有转载明月元文章涉及版权问题 谁能系 告理员 删除

填写完相关内容后提交,系统审核通过后,即可完成认证。





创建 NPK 组件包

完成开发者认证后,在 Nuclei Studio 中新建一个 Nuclei Studio 组件工程,在菜单栏中,选择 File->New->Project->New Nuclei NPK Project。



首次使用需要登录开发者帐号,且登录后7天有效,超过时间后需要再次登录,登录需要使用微信 扫描二维码,见下图。登录成功后,owner可选框会列出绑定的相关开发者账号,其他的根据提示输入相 关信息。需要变更账号时,可点击 login again 重新登录。

•		
NPK package		
Create NPK package		
Project name:		
Туре:		~
Owner:	∨ Login ag	ain
V Please logging.	- 🗆 X	
0		
	Please use wechat scanning code to log in	~
	and then use it. Thank you.	
		Add
-		Del

开发者帐号登陆成功后,依据工程向导依次填入工程名、工程类型等等相关信息。

0				\times
NPK package				
😢 Please enter t	he project name			
Project name:	项目名,无其他意义			
Туре:	组件包类型			\sim
Owner:	拥有人,登录后才能选择,作为 </td <td>gin a</td> <td>igain</td> <td></td>	gin a	igain	
Version:	Example: 1.2.3, 1.2.4, 1.2.5-beta			
Description:	组件包的描述			
License:	许可证			\sim
Homepage:	组件包的主页			
Contributors:	参与者的信息			
Name	Email	[Add	
		[Del	

选择 Type 时,无对应模板时,会跳出对应提示,点击确定,进入 Nuclei Package Management 页面, 根据需要下载 Template Package 的对应模板,或点击下图右下角 Import 自行导入。

下面以 ssp 类型模板为例, 假设你的公司名称为 GreenTech, 你的 SoC 名称为 gt25nv, 适配的开发板 为 gt25nv_devkit, 采用了我们的 n307FD 处理器 (rv32imafdc) 配置, 并且配置了 dsp 特性, 并且提供了 ilm, flash,flashxip 三种下载方式。

Type 选择 ssp: Soc Support Package

۲

NPK package

Create NPK package

Project name:	gt25nv	
Туре:	ssp: SoC Support Package	~
Owner:	greentech 🗠 Login again	
Version:	1.0.0	
Description:	GreenTech gt25nv SoC Support Package	
License:	Apache-2.0	~~~
Homepage:	www.greentech.com/gt25nv	
Contributors:		
Name GreenTech Tea	Email software@greentech.com Add Del	
?	< <u>B</u> ack <u>N</u> ext > <u>F</u> inish Cance	el

其次进入缺少对应模板,进入 Nuclei Package Management 页面,选择 tpl-nsdk-soc-demosoc, 点击 Download 下载,下载完成后关闭该页面

Х

Name	Size	Statue	Owner	Description
	5120	Status	Owner	Description
Template Package				
 ✓ ■ nuclei 				
> 🗌 🖬 tpl-nsdk bsp				
> 🗌 🖬 tpl-hsdk csp				
>				
> 🔲 🖬 tpl-mwp-fatfs				
> 🔲 🖬 tpl-hbird_osp				
>] stpl-nsdk-FreeRTOS				
> 🔲 🖬 tpl-hbird-sdk-tpp				
> 🔲 🗟 tpl-nuclei-sdk-tpp				
> 🗌 🖬 tpl-hsdk-soc-hbirdv2				
👻 🖂 tpl-nsdk-soc-demosoc				
🖂 🍡 1.0.0	0 B	Not Installed	nuclei	TODO
> 🔲 🖬 tpl-nsdk_ucosii_app				
r				>

点击 Next, 在 Select a Template 中选择刚才下载的模板 tpl-nsdk-soc-demosoc, 左侧为 模板描述和相关的文件预览, 右侧为模板中部分可自定义的内容。

IPK package			-Extension parameters		
Create NPK package		_	Extension parameters	模板所用到的部分可自定义参数 	_
	樺板簡单说明		Your Company Name:	nuclei	4
elect a Template:	Nuclei SDK SoC Support Package Template	~	Your SoC Name:	nsoc	_
adk padk adk basadu	arrian 0.3.6 production		Your Board Name:	nuclei_fpga_eval	
sak-nsak_sak basea v	ersion 0.3.6 production		System Timer Frequency:	32768	
模板详细描述			SoC CPU Frequency:	1600000	
			Nuclei RISC-V Core:	N307FD Core(ARCH=rv32imafdc, ABI=ilp32d) ~	·
 Board nuclei_fpga_ev. Include 	## Package Base Information name: bsp-nsdk_\${soc}_\${board} owner: \${owner!*nuclei*} description: \${vendor!*Nuclei*} FPGA Evaluatior	^	Nuclei ARCH Extensions:	Bitmanip Extension Packed SIMD Extension Vector Extension	
openocd de	type: bsp		ECLIC Base Address:	0x0C00000UL	7
> Source	- board		ECLIC IRQ Number:	51	
build.mk.ftl	- risc-v		Systimer Base Address:	0x0200000UL	1
> Common	- \${vendor} license: \${license!""}		ILM Base Address:	0x80000000	Ī
模板包含文件预	homepage: \${homepage!""}		ILM Size:	64K	1
览, 点击相关文	packinfo:		DLM Base Address:	0x90000000	i l
件,石侧会显示 具体中容	vendor: \${vendor}		DLM Size:	64K	i l
吴仲内台。	doc:		Flash Base Address:	0x20000000	í.
	website:	~ -	Flash Size:	4M	ī l
< >	< >>		Debug UART Base Addres	0x10013000	ī.
			XIP QSPI Base Address:	0x10014000	ī l
			I-Cache Present:		
_			D-Cache Present:		

我们这里举例,公司名称为 GreenTech,SoC 名称为 gt25nv,适配的开发板为 gt25nv_devkit,采用了我们的 n307FD 处理器(rv32imafdc)配置,并且配置了 dsp 特性,并且提供了 ilm, flash,flashxip 三种下载方式。然后 Nuclei RISC-V Core 选择为 NX600,经过修改后如图。

tension parameters	
Your Company Name:	GreenTech
Your SoC Name:	gt25nv
Your Board Name:	gt25nv_devkit
System Timer Frequency:	32768
SoC CPU Frequency:	1600000
Nuclei RISC-V Core:	N307FD Core(ARCH=rv32imafdc, ABI=ilp32d)
Nuclei ARCH Extensions:	Bitmanip Extension Vector Extension
ECLIC Base Address:	0x0C00000UL
ECLIC IRQ Number:	51
Systimer Base Address:	0x0200000UL
ILM Base Address:	0x8000000
ILM Size:	64К
DLM Base Address:	0x9000000
DLM Size:	64К
Flash Base Address:	0x2000000
Flash Size:	4M
Debug UART Base Addres	0x10013000
XIP QSPI Base Address:	0x10014000
I-Cache Present:	\checkmark

然后点击 Finish 即成功生成对应 NPK 组件包,再根据需要,可以打开目录查看并修改对应的文件和 结构,修改完成后再导入该 NPK 组件包。

修改项目,根据需要自行修改。项目修改完成,导入 NPK 组件包。

	runtime-EclipseApplication - gt25m	v/gt25nv/Common/npk.yml -	- Eclipse Platform			- 0]	\times
File	Edit Navigate Search Project R	un RV-Tools Window Help)					
«	Run	FD_debug_jlink 🛛 🗸 🌼 🛨 🔻	n - II () II (II (II (II (II (II (II (II (I	🔕 🕸 🕶 🗿 🕶 💁 •	- 🛷 - 🔄 - ⅔ - ७ 🗢 🔶 - 🕞	C		B 🐂
Pro	oject E 🛛 🗖 📄 gt25nv.svd 🕅	npk.yml 🛛 🖻 main.c						
	🗏 😫 🍸 🕴 📑 Package Basic	Package Configuration						^
> 🕞	at25nv							
	Golpto	hi	s file.					
				Description:	greentech gt25nv Support Package			
	Show In	Alt+Shift+W >		Owner:	greentech			
	Show in Local Terminal	>	~	License:	Apache-2.0		\sim	
	Сору	Ctrl+C		Homepage:	www.greentech.com/gt25nv			
	Paste	Ctrl+V Delete	Add	Contributors:	GreenTech Team, software@greentech.com	Add		
- -	Remove from Context	Ctrl+Alt+Shift+Down	Del			Del		
	Move							
	Rename	F2						
र े ज	Import							~
4	Export							
æ	Refresh	F5			상 상 영 문 법 원 =	₿, 🛃 🖬 🦷	· 📑 🔻	- 8
	Close Project							~
	Close Unrelated Project							
Q.	Coverage As	>						
0	Run As	>						
*	Debug As	>						
	Profile As	>						
-	Restore from Local History							
	SDK Configuration Tools	Ctrl+6						
0	Team	>						
	Compare With	>						
	Configure	>						
	Source	>						
	Validate							>
1	Properties	Alt+Enter						

按照示例创建的 soc 在导入时,提示缺少依赖 sdk-nuclei_sdk,点击确定,进入 Nuclei Package Management 页面,根据提示,选中 sdk-nuclei_sdk,点击 Download。

Tips		\times
1	Lack of dependent resources:sdk-nuclei_sdk	
	确定	

Ruclei Package Management

Name	Size	Status	Owner	Description	~
🗸 🔳 🖬 Software Development Kit					
👻 🔳 😩 nuclei					
✓ ■ ■ sdk-nuclei_sdk					
🗌 🔁 0.3.5	22.81 MB	 Not Installed 	nuclei	Nuclei Software Developmer	
🗌 🍡 0.3.6	22.81 MB	 Not Installed 	nuclei	Nuclei Software Developmer	
🖂 🔁 0.3.7	39.56 MB	 Not Installed 	nuclei	Nuclei Software Developmer	
👻 🔲 😩 XinShengTech					
>] sdk-cm32m4xxr					
🗸 🗌 🖘 SoC Support Package					
👻 🔲 😩 greentech					
> 🗌 🖬 ssp-nsdk_gt25nv					
🗸 🔲 💵 Template Package					
👻 🗔 😩 nuclei					
> 🗌 🖬 tpl-nuclei-soc_tpp					
> 🔲 🖬 tpl-hsdk_baremetal_ap					~
<				>	
Refresh Available Nuclei Package List	t			Download Import Remo	bv

下载完成后,NPK 组件包工程导入成功后结果如下图。

Name	Size	Status	Owner	Description
🗌 🖬 Software Development Kit				
🗸 🔲 😩 nuclei				
👻 🔲 🖬 sdk-nuclei_sdk				
🗌 💁 0.3.7	128.4MB	Installed	nuclei	Nuclei Embedded Software [
🗌 🍡 0.3.5	22.81 MB	 Not Installed 	nuclei	Nuclei Software Developmer
🔲 💁 0.3.6	22.81 MB	 Not Installed 	nuclei	Nuclei Software Developmer
👻 🔲 😩 XinShengTech				
>] sdk-cm32m4xxr				
SoC Support Package				
🗸 🔲 😩 greentech				
✓ □ ssp-nsdk_gt25nv				
🗌 🍡 1.0.0	307.8KB	Installed	greentech	greentech gt25nv Support Pi
🗖 🔲 💷 Template Package				
🗸 🔲 😩 nuclei				
> 🗌 🖬 tpl-nuclei-soc_tpp				
. — —				

 \Box \times

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2.5.2 测试 NPK 组件包

创建测试项目

使用导入的 NPK 组件包工程创建一个工程,可以在菜单栏中,选择 File-> New-> Project-> New Nuclei RISC-V C/C++ Project。

New Project			\times
Select a wizard			-
New Nuclei RISC-V C/C++ Project			
Wizards:			
type filter text			
🖻 Arduino Project			~
🖻 C/C++ Project			
🖾 C++ Project			
C Project			
Makefile Project with Existing Code			
New Nuclei NPK Project			
Wew Nuclei RISC-V C/C++ Project			$\mathbf{\vee}$
? < Back Next >	Finish	C	ancel

点击 Next, 选择上面创建的 soc 内所包含的 soc 和 board

Creating Nuclei RISC-V C/C++ project				\times
Create Nuclei project				
Please choose the right development board				
 GreenTech GreenTech gt25nv SoC GreenTech gt25nv @1.0.0 Nuclei Nuclei FPGA Evaluation Demo SoC Nuclei FPGA Evaluation Board sdk-nuclei_sdk @0.3.7 GigaDevice GD32VF103 Nuclei GD32VF103 RVSTAR Board sdk-nuclei_sdk @0.3.7 Sipeed Longan Nano Board sdk-nuclei_sdk @0.3.7 GD32VF103V-EVAL Board sdk-nuclei_sdk @0.3.7 GD32VF103V-EVAL Board sdk-nuclei_sdk @0.3.7 GD32VF103V-EVAL Board sdk-nuclei_sdk @0.3.7 	Details SoC: GreenTech gt25nv SoC - Vendor: GreenTech - Version: 1.0.0 - description: greentech gt25nv Support Package - core_vendor: Nuclei BSP: GreenTech gt25nv_devkit Board - Vendor: GreenTech - description: GreenTech gt25nv_devkit Board Support Package			
0	< Back Next > Fi	inish	Car	ncel

点击 Next,填入 Project Name,并选择 Project Example 为 Helloworld,点击 Finish,完成测试 工程的创建。

\bigcirc Creating Nuclei RISC-V C/C++ project $ \Box$ \times									
Create Nuclei project									
Please select the relevant configuration item									
Project name:	N307FD								
Project Filter by:	no filter V Filters:								
Project Example:	Helloworld @)app-nsdk_hell	oworld			\sim			
Toolchain:	Nuclei GNU T	oolchain				~			
Nuclei ARCH Extensions:	Bitmanip Exte Vector Extens	nsion ion	>>	Packed SIME) Extensio	on			
Download/Run Mode:	FLASHXIP dov	wnload mode, p	orogram will to	be download	into flash	an 🖂			
Select NMSIS Library:	No NMSIS Lib	orary used				~			
Standard C Library:	newlib nano w	vithout printf/s	canf float			M			
Nuclei RISC-V Core:	i RISC-V Core: N307FD Core(ARCH=rv32imafdc, ABI=ilp32d)								
Application Compile Flags:	-02								
?		< Back	Next >	Finish	Can	cel			

编译调试测试工程

上文步骤中创建的一个工程,就是根据开发者的 NPK 组件包创建出来的一个测试工程,开发者可以按一个正常的工程进行对应的编码、调式、运行等操作。

鼠标点击选中上一步生成的项目 N307FD,然后编译成功,后续运行等步骤略去,至此已成功创建了一个 NPK 组件包,并使用此 NPK 组件包进行了导入使用。



2.5.3 共享 NPK 组件包

NPK 组件包共享

经过测试通过后,可以将您创建的 NPK 组件包分享出去,首先需要将您的 NPK 组件包工程导出为一个 zip 包,具体操作如下。

打开 NPK 组件包项目,双击最外层的 npk.yml,找到其 Name 为 ssp-nsdk_gt25nv,右键点击 NPK 组件包项目,点击 Export,选择 Archive File,选择需要导出的工程,然后根据提示指定导出 zip 文件存放的位置。
runtime-EclipseAp File Edit Navigate S	plication - gt2	5nv/gt25nv/Common/npk.yml - Ecl Run RV-Tools Window Help	ipse Platform			- [) ×
	√ No La	unch Configurations v on:	× 🏟 🖬 🔻 🛙	: ▼ © © & %	(a) (b) (b) (c) (c) (c) (c) (c) (c) (c) (c) (c) (c	(a ▼ ⇔) ⊲) 0	▼ 1 : ∞ 0, %
Project E 🛛 🗖 🗖	gt25nv.svd	ו npk.yml מ					
✓	General This section de	escribes general information about this file.					Î
v 🗁 Common	Name:	ssp-nsdk_gt25nv		Description:	greentech gt25nv Support Package		
> 🗁 Include	Version:	1.0.0		Owner:	greentech		
> Source	Туре:	ssp: SoC Support Package	~	License:	Apache-2.0		~
npk.yml	Category:			Homepage:	www.greentech.com/gt25nv		
🗋 build.mk 🗋 runmode.mk	Keywords:	soc risc-v	Add	Contributors:	GreenTech Team, software@greentech.com	Add	
		GreenTech	Del			Del	
	Package Inform Describe Packa	nation age Information.					
	Core_vendor:	Nuclei	~	Vendor:	GreenTech		
	Name:	GreenTech gt25nv SoC					
	Reference doc	uments and web sites.					
	Website:			Sch:			
	Datasheet: Design Source			Usermanual:			×
	🖹 Problems 📮 C	ionsole 🛛				201	. 📑 🗕 🗖
-	No consoles to di	splay at this time.					
< >							

🔵 Export

Archive file

Export resources to an archive file on the local file system.

 > □ ☺ N307FD > ☑ ☺ gt25nv 		.project		
Filter Types Select All	Deselect All			
To archive file: C:\Users\chendo	ng\Desktop\c	gt25nv.zip	~	Browse
 Save in zip format Save in tar format Compress the contents of the cont	ne file esources	 Create direct Create only 	ctory structure for selected director	or files ories
?	< Back	Next >	Finish	Cancel

导出的 zip 包,可以通过 rvmcu 社区进行分享贡献。进入 社区分享页面⁴,依据提示信息,依次填 写需要分享的 NPK 组件包的名称、所属类型、描述待信息,并上传刚导出的 zip 文件,信息提交后,待 管理员审核通过后,该 NPK 组件包就成功贡献了,其他的开发者就可以通过 Nuclei Studio 的 Nuclei Package Management 页面找到您的 NPK 组件包,并下载使用。具体操作如下图

 \times

⁴ https://www.rvmcu.com/nucleistudio-developer.html

🚯 Nuclei Studio	请输入搜索的内容	Q 首页 动态 教程 贡献 RVMCU社区	2
提交信息	平台审核	软件包发布	
项目名称: *			
ssp-nsdk_gt25nv			
项目空间地址: *			
http://www.rvmcu.cn/npk/ greentech	∽ ssp_nsd	lk_gt25nv	
项目图标: • + ·····			
标签(多个以,隔开): *			
ssp-nsdk_gt25nv,soc			
类型: *			
SSP ~			
主页:			
www.greentech.com/gt25nv			
licensec: *			
Apache Licence 2.0		~	
软件包简介: *			<u>^</u>
ト传物化句・ *			
托管给芯来 托管第三方			
版本:	上传zip包(不能大于50M):		
1.0.0	+ # #加一组		
	发布软件包		



分享的 npk 组件包通过审核后,在 Nuclei Studio 中打开 Nuclei Package Management 页面,然后点击 Refresh,刷新后即可找到刚分享的组件包。

Nuclei Packages							
Name	Size	Status	Owner	Description	homepage		-
🗸 🔲 🕬 Software Development Kit							
🗸 🔲 😩 nuclei							1
> sdk-nuclei_sdk							
👻 🔲 😩 XinShengTech							
> 🗌 🖬 sdk-cm32m4xxr							
✓ ✓ SoC Support Package							
✓ ☑							
👻 🖂 🖬 ssp-nsdk gt25nv							
☑ № 1.0.0	0 B	O Not Installed	greentech	根据nuclei soc生成	www.greentech.com	/gt25nv	
🗸 🔲 💷 Template Package							
👻 🔲 😩 nuclei							
>							
>] stpl-hsdk_baremetal_ap							
> stpl-hsdk_freertos_app							
> 🗌 🖬 tpl-hsdk rtthread app							
> 🗌 🖬 tpl-nsdk baremetal ap							
> stpl-nsdk_freertos_app							
>] stpl-nsdk_rtthread_app							
> 🗌 🗟 tpl-nsdk ucosii app							
> 🗌 🖬 tpl-hbird bdp							1
<						>	
Refresh Available Nuclei Package List					Download Imp	oort Rem	10

NPK 组件包升级

在 NPK 组件包共享后,如果有新的版本需要维护,在创建测试打包完成后,可以对原有的 NPK 组件包进行升级。共入 Nuclei Studio⁵ 页面,找到管理组件包入口,然后进组件包管理页面,点击升级组件包,然后之前的步骤,上传 NPK 组件包,等待审核通过,则组件包升级完成。



Nuclei Studio集成开发环境

功能强大的RISC-V集成开发环境,主要包括工程创建和管理,代码编辑,SDK管理,配置,构建配置,调试

マンMCU 首页 新闻资讯 快	速入门 专栏 论坛讨论 培训视频	Nuclei Studio	大学计划		Q 搜索 🌲 🖬 📾 admir
懂得分享的人,往往能收获 致力于RISC-V技术的推广,提供交流学习的 RISC-V IP I 海滨店铺 I 公众号 I 建农亚历山大	天更多 ^{开放平台}				❷ 提问题 ● 答问题
Butter admin	我的软件包				
7505 积分	已发布个软件包				发布软件包
兴 我的社区 (1) 我的主页	标题	时间	状态	NpK	操作
 ⑦ 我的新闻资讯 ⑦ 我的问答 	TinyMaix(Tiny NN Library)	2023-05-31	审核通过	1.0.0 2023-05-31 軍核遷	修改 <mark>升级版本</mark> 预览 过
⑦ 我的软件包					
⑦ 我的资料⑦ 我的音频	TFLite for MCU(TFLM)	2023-05-30	审核通过	0.2.0 2023-05-30 軍核選	修改 升级版本 预览 过
 ⑦ 我的积分兑换 ⑦ 我的视频 ⑦ 我的活动 	tpp-hbird_sdk	2023-01-17	审核通过	0.1.3 2023-01-17 軍機遇	修改 升级版本 预览 过
⑦ 我的小组⑦ 我的经验分享	tpp-nuclei_sdk	2023-01-17	审核通过	1.0.1 2023-01-17 审核通	修改 升级版本 预览 过
 ○ 我的作品展示 ○ 我的相册展示 				1.0.2 2023-01-17 軍核運	<u>id</u>
				1.1.0 2023-01-17 审核通	<u>it</u>

⁵ https://www.rvmcu.com/nucleistudio.html

description: *				
This is TinyMaix(a tiny infe	rence Neural Network library) NPK package, working on Nuclei SDK 0.	4.1,		
上传软件包: * 托管给芯来	七首弟三方 軟件包地址(必须是zip包地址):	Test On:	OS (摄作系统) :	
1.0.0	https://github.com/Nuclei-Software/npk-tinymaix/archive/re	2022.12	通用 ~	删除
版本:	软件包地址 (必须是zip包地址):	Test On: 请选择	OS (操作系统): 通用 ~	删除
	+ 壇	加一组		
	发布	次件包		

2.5.4 NPK 组件包在 Nuclei Studio 中的使用

NPK 组件包在 Nuclei Studio 中,丰富了其用户体验,通过 NPK 组件包我们可以定义各种不同的创建工程 流程,也能很方便的将成熟的工程或者组件共享给其人。

我们所有贡献的 NPK 包,都在 Nuclei Studio 的 NPK Package Managment 中进行管理,用户可以 在这里进行 NPK 的下载、导入、删除等操作。

Name	Size	Status	Owner	Description
sdk Software Development Kit				
✓ □ ② nuclei				
> 🗌 园 sdk-nuclei_sdk				
> 🗌 园 sdk-hbird_sdk				
∽ 🗌 😩 XinShengTech				
> 🗌 园 sdk-cm32m4xxr				
′ □ mup Middle-ware Package				
∽ 🗌 😩 nuclei				
> 🗌 园 mwp-nsdk_tinymaix				
> 🗌 🗔 mwp-nsdk_tflm				
' 🗌 🗤 Bundle Package				
🗸 🗌 😩 nuclei				
> 🗌 园 bdp-nuclei_board_labs				
🕐 🔄 📭 Template Package				
∽ 🗌 😩 nuclei				
> 🗌 🗖 tpp-nuclei_sdk				
> 🗌 园 tpp-hbird_sdk				
efresh Nuclei Studio EAO			Save to user path	Download Import Remo

2.6 Nuclei Studio NPK 应用

Nuclei Studio 中內建了对 Nuclei Package (NPK) 功能的完整支持,方便开发者或者创建不同的软件开发包,并且通过 Nuclei Package Management 方式导入到 Nuclei Studio 中使用,如果是 CPU IP 客户,可以将自己的芯片 SDK 略作改造以支持 NPK,并导入到 Nuclei Studio 中使用,如果是 SoC IP 客户,可以将提供的 SDK 打包成 Zip 包,导入使用,如果是开发者,也可以依赖某个特定的 NPK,创建对应的 BSP 包或者 APP 包并提供给第三方使用,关于 NPK 功能的详细介绍,以及后续更新说明参见 https://github.com/Nuclei-Software/nuclei-sdk/wiki/Nuclei-Studio-NPK-Introduction。通过在原有的 SDK 中引入 npk 功能,编写 npk.yml 可以达到 Project Wizard 功能的部分定制化。

开发者要使用 Nuclei Studio 进行工程的创建,需先将对应的 SDK NPK Zip 包安装到 IDE 中,方可根据不同的开发板快速新建不同的模板工程,并根据不同的模板添加需要的 SDK 源码,根据选项生成不同的编译链接选项设置。

2.6.1 NPK 软件包管理

导入本地 NPK 软件包

导入 zip 软件包

当用户拿到一个 zip 格式的软件包时,可以通过 Nuclei Package Management 导入一个 zip 格式的软件 包,你可以按照以下的步骤操作:

首先,点击 Nuclei Studio IDE 工具栏上的 Nuclei Package Management 按钮,这将打开 npk 软件包管 理页面。在这个页面上,你可以管理和浏览已安装的软件包,以及导入新的软件包。在这里,我们找到 并点击 Import 选项。这个选项用于从本地文件系统选择 zip 类型的软件包。

🚳 NucleiStudio_workspace - NucleiStudio IDE		– 🗆 🗙
File Edit Navigate Search Project RV-Tools Run Window Help		
🔦 🗿 🔳 🛛 Run 🗸 🗉 dlink Debug 🛛 💉 🗟 🖏 🥠	12 🔮 🕘 💷 💷 💷 🖉 🖉 🖉 🖉 🖉 🖉 🖉 🖉 🖉 🖉 🖉 🖉 🖉	Q 🔯 💀 😵
© Debug © Project Explorer ×		a ar x va a a a a a a a a a a a a a a a a a a
	Package Management for NucleiStudio 2024.6 – \Box X	
	Vuclei Status Owner Description Software Software	^
Row	2. 只击打开选择导入软件包,必须为ZIP格式	
I Conse No cons	e A meregisters sorrogress a Problems or Executables or reminal voluebugger Console II Memory a frace oles to display at this time.	
≥ nuclei-sdk-0.7.0		

在点击 Import 后,系统会提示你选择一个要导入的软件包文件。此时,你需要浏览到你的 zip 格式软件包所在的目录,并选中它。确保选中的是一个有效的 zip 包,点击 打开,系统会开始处理并导入这个软件包。



导入完成后,你应该能够在 Nuclei Studio IDE 的 Package Management 页面中看到新导入的软件包。

AlustaiChualla unadurana AlustaiChualla IDC		
Sila Edit Nucleistudio workspace - Nucleistudio IDC		- L X
File Edit Navigate Search Project RV-Tools Run Window Help		0
	CONTRACTOR CONTRACTORY CONTRACTORY CONTRACTOR CONTRACTORS	
→ mučlei-sdk [nučlei-sdk develop 14]		
	Package Management for NucleiStudio 2024.6 – D X	
	Nuclei Packages	
	Name Size Status Owner Description ^	
	■ 0.7.0 807.0 Installed(User) nuclei Nuclei Embedded Sof	
	\\$ 0.5.0 132/95C Not Installed nuclei Nuclei Software Devel \\$ 0.5.0 123/26C Not Installed nuclei Nuclei Software Devel \\$	^
	Refresh Nuclei Studio FAQ Save to user path Oownload Import Remove View log View log View log View log View log View log	
		×
© Cor	sole × ∰Registers ⊕Progress III Problems ⊙ Executables #Terminal @Debugger Console II Memory ■ Trace	
No co	sores to usplay at this office.	

导入未压缩的 npk 软件包

当用户拿到一个未压缩的 npk 软件包工程时,如果想将它导入到 NucleiStudio 中,最简单的方式就是 通过压缩软件,将其压缩成为一个.zip 压缩包,然后通过上述操作导入到 NucleiStudio 中,如果想一边修 改这个 npk 软件包工程,修改完后快速导入到 NucleiStudio 中进行测试,可以通过如下操作实现。

直接导入未压缩的软件包,先要将软件包导入到 Project Exlorer 视图中。点击菜单栏上的 File 选项, 在下拉菜单中,找到并点击 Import…选项。这将打开导入向导,帮助你从本地文件系统或其他来源导入 新的项目或文件。

Tools Run Window Alt+Shift+N >	Help * - 回回(ゆび) ■ ● □ = * * ひ (# 弓波) さま * ● * ● * ● * ● * ● * 回 * ジ * ひひや * ウ * [12	
Alt+Shift+N >	▘▾▧◙ば¢♡і◙◙∞ы⊪≡≡Х≳⊙≲┟⋫╕⋧(ѽ \$▼ ♀♀♀ ♀♥≈∅⋞∀≥∅ゃ♡♂♀०ゃ[₫	
3 -		Q 📴 🔁 🕇
		• • • • • × *, • • •
>		<u> 성</u> 역 타라라
Ctrl+W		
Ctrl+Shift+W		
Ctrl i S		
Cul+3		
Ctrl+Shift+S		
F2		
F5		
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然后选择 General 下的 Projects from Folder or Archive 选项, 点击 Next 按钮。

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接下来,点击 Directory…,这里浏览到你的软件包所在的目录,并选择要导入的文件或文件夹。确保你选择了正确的路径和文件,然后点击 Finish 按钮。

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此时软件包已导入到 Project Explorer 视图中,右键点击这个文件夹(代表你的软件包),在弹出的

上下文菜单中选择 Export to Package Management 并点击,系统会开始处理并导入这个软件包。

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导入过程中,会自动打开 Package Management 页面。待导入完成后,你应该能够在 Nuclei Studio IDE 的 Package Management 页面中看到新导入的软件包。

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下载云端 NPK 软件包

在 Nuclei Studio 中最大的更新,就是将 npk 云端化,用户直接在 Nuclei Studio 中就可以下查看到所有的 npk 并自行安装,在菜单栏选择 RV-Tools-->Nuclei Package Management 在弹出的 **Nuclei Package Management** 管理页进行 npk 管理。

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在 Nuclei Package Management 页面,先点击一下 Refresh 获取最新的 npk 信息, npk 安装前状态为 Not Installed。

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然后选中自己想要安装的 npk, 点击 Download 进行安装,本教程安装 sdk-nuclei_sdk 的 0.3.7 版本,最新版本为 0.5.0,请使用最新版本进行安装,最新版本支持 gcc13 工具链,之前版本支持的是 gcc10。

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安装完成后 npk 状态变为 Installed。

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在 NucleiStudio 2024.06 版本中,升级了 Nuclei Package Management 管理页中关于依赖的管理,大大简化了使用者关于 NPK 包依赖的问题。

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当用户在下载/安装某个 NPK 包时, NucleiStudio 会根据当前 NPK 包信息的依赖关系,再结合本地 已安装的包信息及云端共享的 NPK 信息,给出其的所有依赖,并提示用户进行关联下载安装。

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	aemu-system-riscv32.	exe: warning: GLib xe: warning: Glib-	-GIU: Unexpected GIO: Unexpectedly	y, UWP app Mich , UWP app `Mich	rosoft.Outlook psoft.OutlookFe	orWindows_1.20 prWindows_1.202	24.612.0 x64 8wekyb3 4.612.0 x64 8wekyb3d	Bobwe (AUMId Microsoft Bobwe' (AUMId `Microsoft
				· · · · · · · · · · · · · · · · · · ·				
	4							~
								5

当 NPK 包安装完成后,会提示用户,此安共计安装了多少个 NPK 包,每个 NPK 包安装的后状态以 及出错的原因。方便用户排查问题。极大的解决的之前版中用户因 NPK 包依赖的不正确而无法使用的 问题。

-	Name] sdk Software Development Kit	Size	Status		Owner	C	escriptio	n
	Installation Tips					—		×
1	Installed successfully.							
	Description				Resource			
-	▲ The gcc10 used in this compone	ent package do	oes not match the	IDE	sdk-nuclei	sdk@nuclei@	@0.4.1	
	Installation successful.				sdk-nuclei	sdk@nuclei@	@0.4.1	
	Installation successful.				mwp-nsdk_	tinymaix@n	uclei@1.0	.0
Ť	٢							>
						Next		
، <u>ا</u>								:

2.6.2 通过 NPK 创建工程

本章将在 RVSTAR 开发板上,以新建和修改 GD32VF103 的工程为例快速介绍 Nuclei Studio 功能, RVSTAR 开发板开发需要使用 nuclei_sdk 的 npk 包,详细的流程请参考之后的章节。

创建 NPK 示例工程

新建一个工程,可以在菜单栏中,选择File --> New --> New Nuclei RISC-V C/C++ Project

8	NucleiStudio_workspace - NucleiStud	IDF			ר							-		×
·iie	New Open File	Alt+Shift+N >	New Nuclei RISC-V C/C++ Project Makefile Project with Existing Code		1 2 • 12 (6)	8 • % • 🕒 I	x & @ Ø) 🖆 • 🍪 • 🖻 • 🕝 • 🕸	• • 0	• 🤮 • 💁	• 🙆 🖨 🛷	• 1 📾	П П С	-
-	Open Projects from File System Recent Files	,	C/C++ Project Project		-			c		BE Outline 🛙	Build Targ	ets 🗟	8 -	1 8
	Close Editor Close All Editors Save Save As Save All Revert Move	Ctrl+W Ctrl+Shift+W Ctrl+S Ctrl+S	Convert to a C/C++ Project (Adds C/C++ Source Folder Folder Source File Header File File from Template Class	Nature)						There is no act	tive editor that	provide	s an ou	line.
1	Rename	F2	Example											
ñ	Refresh	F5	Other	Ctrl+N										
	Convert Line Delimiters To	>												
ò	Print	Ctrl+P												
2	Import Export													
	Properties	Alt+Enter												
	Switch Workspace Restart Exit	>												
			🖹 Problems 🛛 🧔 Tasks 📮 Consol	e 🔲 Properties								7	8 -	
			0 items		D	1	-							
			Description	Resource	Path	Location	Type							
												-		

也可以在 Project Explorer 视图中选中 New Nuclei RISC-V C/C++ Project。

🚳 NucleiStudio_workspace - NucleiSt	udio IDE								-	×
File Edit Source Refactor Naviga	ate Search Project Run	RV-Tools Window Help								
 	V No Launch Config	urations 🗸 on:	~ 🌞 i 🗆	- 🛛 🗐 🖻 -	- 🔨 - 🕒 🔌	. 🕹 💼 🥝) 🖆 • 🚳 • 🖻 • 🚱 • 🔯 •	0 - 8 - 9	- 🖉 😄 🛷 -	R E T
· 헬 · 쥐 · ♡· ♡· ○ · ▷ · E	1									Q 🗄 😭 🔤
Project Explorer 🛛	🕒 🕏 🍸 🕴 🗖						- 8	E Outline 🛙	Build Targets	ə 8
There are no projects in your worksp. To add a project New Nuclei RISC-V C/C++ Project Create a new Ankefile project in adding code Create a new C or C++ project Create a project is Import projects	sce. st La clirectory containing.							There is no ac	ive editor that pro	ovides an outline.
		🖹 Problems 🛛 🤕 Tasks 💷 C	Console 🔲 Properties							₹ 8 = D
		Description	Resource	Path	Location	Туре				
									1	

在弹出的窗口中可以不同的厂商提供的不同版本的 SDK, 选种某一 Board 下的 SDK, 看到相关 SoC 及 Board 的介绍。这里以 RVSTAR 开发板为例,所以这一项选择 GigaDevice->GD32VF103->Nuclei

```
GD32VF103 RVSTAR Board->sdk-nuclei_sdk@0.5.0。点击 Next 进入下一步。
```

Note: 注意: 这里的 sdk 版本号会随着版本迭代做相应的更新,并且也可能依赖特定版本的 Nuclei Studio 使用



进入具体的项目配置页如图所示,因为 RVSTAR 的内核是固定的 N205,其对应的 arch 和 abi 分别 是 rv32imac 和 ilp32,所以 Core 选项不能修改。同样, RVSTAR 开发板仅支持一种 FLASHXIP 下载模式,所以 DOWNLOAD 这一选项也不能修改。点击 Finish 完成工程创建。在 2023.10 版本,增加了对 Arm 项目的支持。

🚳 NucleiStudio_workspace111 - NucleiStudio IDE					- 🗆 ×
File Edit Source Refactor Navigate Search Proje	B Creating Nuclei RISC-V C/	C++ project			
🔨 🔘 🔲 🗸 No Launch Confi				- 🤮 - 💁 - 😂 😂 🛷 -	• 🖻 🗉 🕤 💼 🥵 📮 🔌 🕹
월 두 월 두 박 라 수 두 아 두 1월	Create Nuclei project				Q. 🛙 😰 🛛 🚾
陷 Project Explorer × 🛛 🖻 😫 🍟 🗎 📟	Please select the relevant co	nfiguration item		- 8	B O × ■ T
There are no projects in your workspace. To add a project:	Project name:	test			There is no active editor that provides an
Create a new Makefile project in a directory containing existing code	Project Filter by:	no filter v Filters:	~		outline.
Create a new C or C++ project	Project Example:	Nuclei NMSIS DSP Library Demo @app-nsdk_demo_dsp	~		
New Nuclei RISC-V C/C++ Project New Nuclei NPK Project	Toolchain:	RISC-V GCC/Newlib (riscv64-unknown-elf-gcc)	~		
📑 <u>Create a project</u>	Select NMSIS Library:	NMSIS DSP Library	~		
Import projects	Download/Run Mode:	FLASHXIP download mode, program will to be download in	to flash anc $ imes $		
	System Clock in Hz:	108MHz HXTAL PLL	~		
	Select USB Driver Code:	No USB Driver Code	~		
	Nuclei RISC-V Core:	N205/Bumblebee Core(ARCH=rv32imac, ABI=ilp32)	~		
	Enable Semihosting:				
	Standard C Library:	newlib nano with printf float	~		
	Application Compile Flags:				
					7
	0	< <u>B</u> ack Next > <u>Finish</u>	Cancel		

Nuclei Studio 可以根据不同的工程模板添加不同的 SDK 源码,例如 FreeRTOS 模板工程会添加 对应的 OS 内容,Demo_dsp 模板工程可以添加 NMSIS 库文件。关于 NMSIS 详细信息请参考(https: //doc.nucleisys.com/nmsis/index.html)。这里以 Demo_dsp 为例,Project Example 选择 Nuclei NMSIS DSP Library Demo。因为使用 dsp 工程,需要添加 NMSIS 库,所以 Libraries 选择 NMSIS DSP Library。

Nuclei Studio 可以根据新建工程时的选项自动设置工程的选项。这里选择使用浮点打印,所以 NEWLIB 选择 newlib nano with printf float。之后一直选择 Next 直到 Finish。

SDK Configuration Tools 更改工程配置

在 Nuclei Studio 可以快速修改工程的设置选项,提供了 SDK Configuration Tools 工具, Nuclei Studio IDE 2022.12 版后,对 SDK Configuration Tools 工具进行了重构,变更为用户体验更好的 Nuclei Settings 菜单。

新建好的工程,单击要修改的工程名,右击打开右键菜单,选择 SDK Configuration Tools 打开设置选项工具。

File Edit Source Refact	_dsp/application/main.c - NucleiStudio or Navigate Search Project Run RV-Tools Window F	lelp	- D ×
🔨 💽 💌 🛛 Run	✓ CRVSTAR_demo_dsp_c < 0 □ • □ □ 0 0 • • 5 •	- 2 (2 × (0)×) 2 (2 × 0 × (2 × 0 × 0 × 0 × 0 × 0 × 0 × 0 × 0 × 0 ×	Quick Access 😰 🕅
Project Explorer #	🕒 🎭 😰 🗢 🗖 🖬 main.c 🛱		° 🗉 🛢 Outline 🛱 🗟 Task List 🖲 Build Tar 🛸 Docume ° 🗖
✓ Ø RVSTAR_demo_dsp	0 1 Hinclude Zetdint hs		A PE选择文·第 *
> p includes	Go Into		u stdio.h
 a nuclei ddi b MMSS a Core a Core a DSP a Libray a SoCi a gd32r013 a Board a Common RVSTAR_demo_dri 	Open in New Window Show in Local Terminal	pc.h*	unclei_sdk_soc.h ref_conv.h
	Copy Chi A Copy Chi A	<pre></pre>	<pre>diffum_coil # diffum_coil # diffum_coil</pre>
	Build Configurations	dsp	
	Politing Tools Valiate Ø Rin As Ø Dabug As Politik As Restore from Local History Ø SOK Configuration Tools Politik P Ran CC++ cold Analysis Team Compare With		
	Configure		
	Properties Alt+Ente		
		_	
< SRVSTAR demo dsp	> <		6) • • • • • • • • •

如果要修改编译优化等级,修改 Optimization Level 为 None (-00),点击 Save 修改选项。

🚷 NucleiStudio_workspace111 - test/test.nuproject - Nu	icleiStudio IDE								-		×
File Edit Source Refactor Navigate Search Project Image: Source Image: Source<	RV-Tools Run Wi	indow Help ▼ 🗟 🕼 🕲 ▼ 🍕 ▼ 🖡		♂ • * • 0 •	9: • 9 . • i @	9 😂 🛷 🕶 🗟 🗉 T 📲	8 D X	2 2 × 7 × 0	⊲≯ 🗢 ▼	⇒ •	d
🔓 Project Explorer × 📄 🕏 🍞 🐲 🖇 📟 🗖	🖻 main.c 🚳 test	/Nuclei Settings ×					- 0	월 O × 圓 T	⊛ B	Q D	
> 😂 test	General This section descri	General This section describes general information about this file.x									/ides an
	project name:	test	Configuration	n: Debug	\sim	Save settings (ctr	l+s)	outline.			
	Core Info										
	Core :	N205	~	Other extension	Other extensions \${nulei_archext}						
	AKCH :	rv32imac\${nulei_arche	xt}	ABI :							
	Tuning Into Tuning : Nuclei 200 series (-mtune=nuclei-200 × Code model : Medium Low (-mcmodel=medlow) ×										
	DownLoad :	FLASHXIP									
	Runtime Info. Optimization Level : None (-00)										
	Extra Common Flag	gs :									
	Extra C Flags :										
	Extra C++ Flags :										
	Extra Link Flags :	-WLcheck-sect	ions -Wlno-warn-	rwx-segments -u e	rrno						
							~			7 Fa	2 0 0
	0 errors, 5 warnings,	o others	roperties							6.	8 0
	Description	^	Resource	Path	Location	Туре					
	> Warnings (5 ite	ems)									
								1			

修改成功后在修改后的工程处右击打开右键菜单,选择 clean 清除一下工程,再点击锤子图标编译工程。

O B O Run	🕐 🖾 RVSTAR_demo_dsp_c ~ 🔅 🗄 💌 🗟 🔞 💌 🗞 💌 🚔 🖉	●▼ ◎ ★ 2 % ◎ ☆ ▼ 8 ▼ 8 ▼ 8 ▼ 6 ▼ 9 ▼ 9 ▼ 9 ▼ 9 ▼ 0 ▼ 1		Quick Access 🔡 😁
ect Explorer =	E % P T E B main.c #		" 🗆 🖹 Outline 😕 🗄 Ta	sk List @ Build Tar 🐄 Docume 🦈
≥ INVTAR demo dag) = 0 lockade) = application > = arutej ack > = notej > = 0.00P > = 0.00P = 0	1 #include <stdint.h> New Go Into</stdint.h>)	stdint.h	》日戊 戌 父。第
	Open in New Window Show in Local Terminal		nuclei sok ref_conv.h riscv_math.l READ_CYC!	n E
	Copy Curr+C Paste Curr+C Curr+Alt+Shift+Down Source Move Remove Top	get_vv_ycle e; e;	* * enter_cycle * * enter_cycle * * start_cycle : * * start_cycle : * * datt_cycle : * * ord; cycle : * * ord; cycle : * * ord; ord; cycle : *	: uint64_t uint64_t uint64_t uint64_t 4_t uint64_t uint64_t
	Export Build Project	- 0; ;	bench_ercd BENCH_TRS BENCH_INI BENCH_STA	: uint32_t TO 10 170 18TO
	Clean Project F5 Close Project Close Unrelated Project	ialized/n");	BENCH_ENI BENCH_ERI BENCH_STA BENCH_FIN BENCH_FIN	20 IOR0 TUS0 ISH0 Iout 132 A - float32 10
	Build Targets Index Build Configurations	operties #Terminal		
	Profiling Tools Validate © Run As © Debug As Profile As			
	Restore from Local History SDK Configuration Tools Run C/C++ Code Analysis Team Commune Mith			
	Configure Source Source			
	Properties Alt+Enter			

Note:

- 注意: SDK Configuration Tools 修改编译配置后对调试配置(Debug Configurations)不生效,请手动 修改对应的调试配置。
- 注意:后续版本中,将不再维护 SDK Configuration Tools 功能,由 Nuclei Settings 菜单功能 替代。

为了更好的用户使用体验, Nuclei Studio IDE 2022.12 版对 SDK Configuration Tools 进行了重构,新创建的工程中会多一个 Nuclei Settings 菜单,双击 Nuclei Settings 菜单,将打开工程配置工具其在功能上与 SDK Configuration Tools 无异,在 2023.10 版本及其后续版本,SDK Configuration Tools 将直接打开这个 Nuclei Settings 界面。

& NucleiStudio_workspace - test/test.nuproject - N	lucleiStudio IDE	- 🗆 ×
<u>File E</u> dit <u>S</u> ource Refactor <u>N</u> avigate Se <u>a</u> rch	<u>Project R</u> un <u>R</u> V-Tools <u>W</u> indow <u>H</u> elp	
🐔 🚺 🔳 🔕 Run 🗸 🖸 t	est_debug_qemu 🔰 🖓 🕶 🔛 🐑 🐂 🥵 🔻 🐝 🗣 🐘 🔛 🔍 😓 🖓 🖬 😂 👘 🖉 🖬 🔞 🖉 👘 🚱 🐨 📽 🕶 🚱 🕶 🚱 🕶	- 0 - 🤮 - 🂁 - 🤔 🖉 -
12 □ 11 12 ▼ 17 ▼ 17 47 47 47 ■ 1		Q 🗄 🖻 🔤
🎦 Project Explorer 🛛 🔲 🛱 🍸 🖇 🖵 🗖	SDK Configuration Tools 🛛 🗖 🗆	🗄 Outline 🛛 🛞 Build Targets 👘 🗖
✓ ^C _i test	General	6 9 8
(2) Nuclei Settings	This section describes general information about this file.	There is no active editor that provides an
> B includes	project name: test Configuration: Debug V Save settings (ctrl+s)	outline.
> 👝 nuclei_sdk	Core Info	
test_debug_jlink.launch	Core : N307FD v	
 test_debug_openocd.launch test_debug_gemu.launch 	Bitmanipulation Extension(RVB)	
	Packed SIMD/DSP Extension(RVP)	
	ARCH : rv32imafdc ABI : ilp32d	
	Tuning Info	
	Tuning : Nuclei 300 series(-mtune=nuclei-30(V Code model : Medium Low (-mcmodel=medlow) V	
	DownLoad :	
	Runtime Into	
	Science Randinie Eista newlib nano with printf float	
	Extra Common Hags : -fno-code-hoisting -fno-tree-vectorize -finline-functions -falign-functions=4 -falign-jumps=4 -falig	
	Extra C Flags :	
	Extra C++ Flags :	
	Extra ASM Flags :	
	Extra Link Flags :	
	NPK component package information	
	🖹 Problems 🖉 Tasks 📮 Console 🕴 🔲 Properties	🖻 🖳 🔻 📑 🖛 🗖
	No consoles to display at this time.	
4 1 item selected		

2.6.3 通过 NPK 导入工具

NPK 包除了可以导入 SDK, 还可以方便的导入各种工具包,来扩展 Nuclei Studio 的能力,2022.08 版本的 Nuclei Studio 增加 NPK Tools 的支持,为增加组件包的可扩展性,以及在编译和调试上使用更便捷,增加 类型为 tool 的 npk 组件包。tool 组件包可包含 gcc,qemu,cmlink-gdb 等内容,以 zip 包的形式导入到 IDE 去 使用。

以 tool-cmlink 包为例,一个工具包中有该工具的执行文件及 npk.yml,开发者在 npk.yml 文件中对该 工具做了一些简单的描述,如工具包的开发者、版本、支持的操作系统、可执行文件的路径等,包结构 和 npk.yml 内容如下示例。然后将工具包压缩成一个 zip 文件,可以参考导入本地 NPK 软件包 (page 73) 的内容,将 npk tools 导入到 ide 中,或共享到www.rvmcu.com⁶网站上。

- bin
- bin\cmlink_gdbserver.exe
- npk.yml

🥘 npk.yml - 记事本		-	×
文件(E) 编辑(E) 格式(Q) 查看(V) 帮助(H)			
name: tool-cmlink	name: 组件包名称		^
owner: XinShengTech			
os: win64	。。···伊州句话和亚公,日前古林win22/win64/lin6	: /	
version: 1.0.0	03.组件也但能十百,日前又好WIII32/WIII04/III10	94	
description: CM-IoT CM-Link Proxy Tool			
details: CM-IoT CM-Link Proxy Tool	type: 组件包类型, tool类型组件包为tool		
type: tool			
keywords:			
- tool			
- cmiot			
license: Apache-2.0			
homepage:			
environment:	anvironmant为扩展亦是,kay为扩展亦是夕,yalu		
- key: proxy	environment/分 版文里, Key/分 版文里石, Valu	e	
value: bin/cmlink_gdbserver.exe	为受重值,system为false/true。		
description: proxy location			
system: false			
 key: system_proxy 			
value: bin/cmlink_gdbserver.exe			
description: proxy location			
system: true			

在 Nuclei Package Management 管理页中同样可以对 npk tools 进行管理,下载该组件包后,打开任意 调试界面,点击 Variables 可以查看到该 npk tools 对应的参数,直接选中对应的参数就可以使用该工具了。

⁶ http://www.rvmcu.com

aunch Configuration.	Name: prinf_custom_cmlink_custom
🗋 Main 🏇 Debugger	▶ Startup 🦻 Source 🔲 Common 🚼 SVD Path
Setup ✓ Start locally Mode: GDB Serial Port :	Generic Serial V COM4 V
Executable path:	\${tool-cmlink-1.0.0-proxy} Browse Variables
Actual executable:	C:/Users/chendong/Desktop/nuclei-pack-npk/NPKs/XinShengTech/Tool_Package/tool-cmlink/1.0.0/cmlink-win64/bin/cmlink_gdDserver.exe
GDB port:	(It can be used in Config options by \$(gdb_port))
Config options:	-c telnet_port 4444 ^ -c tel_port 6666
GDB Client Setup	
Start GDB sessio	n
Executable name:	\${cross_prefix}gdb\${cross_suffix} Browse Variables
Actual executable:	riscv-nuclei-elf-gdb
Other options:	
Commands:	set mem inaccessible-by-default off
Remote Target	

一般我们在 npk tool 中为该组件包扩展变量有 4 个,每个包存在一个包路径,引用为 npk 名称-版本号,例如 \$ {tool-cmlink-1.0.0},其他变量的引用为 npk 名称-版本号-变量 名,例如 \$ {tool-cmlink-1.0.0-proxy},\$ {tool-cmlink-1.0.0-system_proxy},当变量 的 system 值为 true 时,额外新增一个不带版本号的变量,取最高版本的该变量,例如 \$ {tool-cmlink-system_proxy}。

🚳 Edit Configuration

Edit GDB Custom Debugging configuration prinf_custom_cmlink_custom for Debug

unch Configuration	Name: prinf_custom_cmlink_custom			
Main 🏇 Debugger	Startup by Source Common B SVD Path	<u>C</u> hoose a variable (? = any character,	* = any string):	
Setup Setup Start locally Mode: GDB Serial Port : Executable path: Actual executable: GDB port: Config options:	Generic Serial V COM4 V \${tool-cmlink-1.0.0-proxy} C:/Users/chendong/Desktop/nuclei-pack-npk/NPKs/Xii 3333 (It can be used in Config options by \${gdb_pri- c telnet_port 4444 -c tcl_port 6666	tool-cmlink-1.0.0 tool-cmlink-1.0.0-proxy tool-cmlink-1.0.0-system_proxy tool-cmlink-system_proxy		Browse Variables n/cmlink_gdbserver.exe
GDB Client Setup Start GDB sessic Executable name: Actual executable:	n \${cross_prefix}gdb\${cross_suffix} riscv-nuclei-elf-gdb			Browse Variables
Commands:	set mem inaccessible-by-default off	<u>A</u> rgument:	<u>E</u> dit Variables C <u>o</u> nfigure	
Remote Target	Idress: Incalhost	Variable Description: Package path	^	-
Port number:	3333		~	
Force thread list u	ıpdate on suspend	⑦ OK	Cancel	<u>Restore defaul</u>

2.7 Nuclei Studio 创建工程

这里以开发板为 Nuclei FPGA Evaluation Board, 评估处理器内核为 N307(rv32imafc) 为例, 详细介绍 Nuclei Studio 中创建项目的常见方式。

在 Nuclei Studio IDE 创建项目可以有以下几种常见方式:

使用 NPK 模板工程自动创建项目:

这是最简单快捷的方式,目前模板项目功能依赖于 Nuclei Studio NPK 功能,在导入对应的 SDK NPK Zip 包,即可在 Nuclei Studio 上进行模板工程的创建。芯来科技提供了 Nuclei SDK、HBird SDK、SoC IP SDK 的 NPK Zip 包,均可导入到 IDE 中进行工程的创建和使用。

从已有项目直接导入创建新项目:

这是最常见的方式,譬如,用户A可以将已有项目的文件夹直接进行打包保存,然后进行分享传播, 用户B可以在另外的电脑上直接导入该项目,从而以此为基础创建新的项目,在此基础上直接使用或者 开发修改。

无模板手动创建项目:

这是最繁琐的方式,该方法除了创建项目之外,还需要手动设置各种选项和路径。由于该方式比较 繁琐,所以在实际工作中较少使用,但是通过该方式的详细讲解,用户可以详细了解如何配置各中选项 和路径。

基于已有的 Makefile 创建项目:

这种方式比较适合于已经采用 Makefile 或者其他编译工具的项目,提供一种在 IDE 中编译工程,清 理工程,调试工程的方式。在不修改编译系统的基础上,提供良好的 IDE 调试环境。

下文将对这几种方式分别进行介绍。

2.7.1 通过 NPK 模板工程自动创建项目

本节将介绍如何使用模板自动创建项目的方式,在 Nuclei Studio IDE 创建一个简单的 Hello World 项目,详细步骤如下。

新建一个工程,可以在菜单栏中,选择 File --> New --> New Nuclei RISC-V C/C++ Project。

8	NucleiStudio_workspace - NucleiStudi	io IDE				7							-		×
File	e Edit Source Refactor Navigate	Search Projec	t R	Run RV-Tools Window Help											
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也可以在 Project Explorer 视图中选中 New Nuclei RISC-V C/C++ Project。

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在弹出的窗口中选择项目类型,这里我们在 Nuclei FPGA 板,内核是 N307, SDK 为 nuclei_sdk@0.3.9 版本来做一个测试开发,选对对应的 Board 下的 SDK,点击 Next 进入下一步。

在弹出的窗口中设定如下参数。

- Project name: 项目命名。这里设置为 1_helloworld
- Project Example: 选 Helloworld。

• Toolchains: 我们使用 Nuclei GUN Toolchain。

Note: 注意:此页面是通过 NPK Configuration 字段自动解析并生成的页面,不同的 SDK 或者不同的开发 板或者不同的例子都可能会有不同的选项页面,请注意。

我们的内核是 N307, 所以 Core 选择 N307。

蜂鸟开发板支持三种下载模式,以下为每种下载模式的简介,这里我们选择 ILM 模式。

• ILM

ILM 下载模式程序将被直接下载在 MCU 的 ILM 中,并从 ILM 开始执行。ILM 由 SRAM 组成,会 掉电丢失。

• FLASH

FLASH 下载模式程序代码段的物理地址约束 Flash 区间,将代码段的逻辑地址约束在 ILM 的地址区间,意味着程序将被直接下载在 MCU 的 Flash 中,但是上电后要通过引导程序将代码段搬运到 ILM 中,然后从 ILM 中开始执行。程序被烧写在 Flash 中,不会掉电丢失。

• FLASHXIP

FLASHXIP 下载模式程序代码段约束 Flash 区间,意味着程序将被直接下载在 MCU 的 Flash 中,并 直接从 Flash 开始执行。程序被烧写在 Flash 中,不会掉电丢失。

其他各项可以按需进行配置,点击 Finish 完成工程创建。

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Select NMSIS Library:	No NMSIS Library used			\sim
Standard C Library:	newlib nano with printf float			\sim
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	Tunnu Tunnu			

使用模板自动创建 Hello World 项目已经完成。

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Image: Second secon	<pre>@ main: 33 1 // See LICENSE for license det: 2 #include :stdio.h> 3 #include :stdio.h> 3 #include :stdib.h> 5 #include :stdib.h> 5 #include :stdib.h> 6 // Sevoid print_misa(void) 6 // Sevoid print_misa(void) 8 // Sevoid print_misa(hard[30]) 11 uint@t_index = 0; 12 if (misa_bits.b.mail == 1) 13 misa_chard[index+1] = 14 misa_chard[index+1] = 15 / selse if (misa_bits.b.mail 19 misa_chard[index+1] = 10 misa_chard[index+1] = 11 misa_chard[index+1] = 12 misa_chard[index+1] = 13 misa_chard[index+1] = 14 misa_chard[index+1] = 15 misa_chard[index+1] = 16 misa_chard[index+1] = 17 misa_chard[index+1] = 18 misa_chard[index+1] = 19 misa_chard[index+1] = 11 misa_chard[index+1] = 12 misa_chard[index+1] = 13 if (misa_bits.b.m) (14 misa_chard[index+1] = 15 if (misa_bits.b.m) (15 misa_chard[index+1] = 15 if (misa_bits.b.m) (16 misa_chard[index+1] = 17 misa_chard[index+1] = 18 if (misa_bits.b.m) (19 misa_chard[index+1] = 19 if (misa_bits.b.m) (10 misa_chard[index+1] = 11 misa_chard[index+1] = 12 if (misa_bits.b.m) (13 misa_chard[index+1] = 13 if (misa_bits.b.m) (14 misa_chard[index+1] = 15 if (misa_bits.b.m) (15 misa_chard[index+1] = 15 if (misa_bits.b.m) (16 misa_chard[index+1] = 17 misa_chard[index+1] = 18 if (misa_bits.b.m) (19 misa_chard[index+1] = 19 if (misa_bits.b.m) (10 misa_chard[index+1] = 10 misa_chard[index+1] = 11 misa_chard[index+1] = 12 if (misa_bits.b.m) (13 misa_chard[index+1] = 13 if (misa_chard[index+1] = 14 misa_chard[index+1] = 15 if (misa_chard[index+1] = 15 if (misa_chard[index+</pre>	<pre>ccsr_misA_T ccsr_misA_T c</pre>	уре) <u></u> RVС	758_READ (CSR_MISA);			~	Cutifice 22 to Build Targets to think	
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用户可以直接使用菜单栏 Project—> Build Project 或 🚺 💽 🔳 按钮,来对该项目进行编译。

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在 Hello World 项目自动生成过程中,其对应的 OpenOCD 配置已经同步完成。在项目编译完毕后,用 户可以右键点击项目列表 Hello World,点击 Debug As —>Debug Configurations 开启调试配置 面板进行查看。Debug 与 Run 使用相同的配置文件,所以也可通过 Run As —>Run Configurations 打开。

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用于调试使用的配置文件 Hello World_Debug_OpenOCD 已经自动生成。关于使用芯来蜂鸟调试器结合 OpenOCD 进行下载和调试的方法,可以查看使用蜂鸟调试器结合 OpenOCD 调试运行项目 (page 137)进行详细了解。

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1_helloworld_debug_openocd GDB PyOCD Debugging GDR OFMU Debugging	Build Configuration: Select Automatically			~
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2.7.2 通过应用关联文件导入工程

本节将介绍如何通过 Nuclei Studio IDE 的关联文件,将一个 Hello World 项目导入到 IDE 中。Nuclei Studio IDE 2022.12 版中,新增了应用文件关联的支持,可以将 IDE 的启动路径注册到系统注册表中,然后通过 特定的文件,可以实现 IDE 的启动、工程导入等功能,极大的方便了 Nuclei Studio IDE 用户在使用过程中,对工程的分享和快速导入。

将 Nuclei Studio IDE 写入到注册表

下载 Nuclei Studio IDE 2022.12 版,在安装包中多了两个文件 install.bat/install.sh,在 windows 系统下,双击 install.bat,因为这里需要写入注册表,所以需要一个用户授权,授权后安装成功;在 linux 系统下,需要在 shell 命令下执行 install.sh 文件。

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2022/12/22 17:15	XML File	184 KB
2021/1/11 16:20	应用程序	127 KB
2022/12/14 14:33	Windows 批处理	1 KB
2022/12/13 18:05	Shell Script	2 KB
2021/1/11 16:20	Chrome HTML D	10 KB
2022/12/22 17:15	WPS PDF 文档	9,503 KB
2021/1/11 16:20	应用程序	408 KB
2021/8/10 16:13	配置设置	1 KB
2022/12/22 17:15	TXT 文件	0 KB
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install.sh 文件在运行后,有一个用户授权的界面,同意授权。

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通过应用关联文件导入工程

Nuclei Studio IDE 2022.12 版创建工程 test,在工程中会有一应用关联文件 test.nuproject,如果 ide 的启动路径已写入注册表,双点 test.nuproject 文件,系统会自动启动 Nuclei Studio IDE 并将 test 工程导入到 IDE 中。

~ 名称	修改日期	类型	大小
settings	2022/12/27 11:19	文件夹	
application	2022/12/27 11:19	文件夹	
nuclei_sdk	2022/12/27 11:19	文件夹	
📝 .cproject	2022/12/27 11:19	CPROJECT 文件	50 KB
🔟 .project	2022/12/27 11:19	Project File	2 KB
💩 test.nuproject	2022/12/27 11:19	NUPROJECT 文件	1 KB
test_debug_link.launch	2022/12/27 11:19	LAUNCH 文件	8 KB
📄 test_debug_openocd.launch	2022/12/27 11:19	LAUNCH 文件	6 KB
📄 test_debug_qemu.launch	2022/12/27 11:19	LAUNCH 文件	7 KB

2.7.3 从已有项目直接导入创建新项目

本节将介绍如何使用 IDE 从已有项目直接导入创建新项目,本文以 N307 的项目包为例进行导入,项目 包存放在(https://github.com/riscv-mcu/Nuclei-Studio_IDE-Project-Package)。如需其它项目包请与芯来科 技联系。

在基于 Windows 的 Nuclei Studio IDE 开发环境中,如果用户使用 无模板手动创建工程,也需要加载 此项目包中的 nuclei-sdk 文件夹,相关内容会在无模板手动创建项目 (page 100) 中具体介绍。

README.md	Update README.md
nuclei-eclipse_demo.rar	update package

将 nuclei-eclipse_demo.rar 压缩包下载解压后,内容分别为:

名称	修改日期	类型
📜 .settings	2020/8/5 17:46	文件夹
application	2020/8/5 17:46	文件夹
📙 nuclei_sdk	2020/8/5 17:46	文件夹
.cproject	2020/8/5 17:46	CPROJECT 文件
project	2020/8/5 17:46	PROJECT 文件
hello_world_debug_openocd.launch	2020/8/5 18:11	LAUNCH 文件

• 项目包的描述文件.setting, .project和.cproject

- 项目包的 Debug 设置文件 *.launch
- nuclei_sdk 文件夹

该文件夹下存放部分 SDK 源代码。

• application 文件夹

此文件夹包含 hello_world 样例程序的 main 函数源代码。

下一步导入下载好的项目包,导入步骤如下:

- 在菜单栏中选择 File—>import。
- 如图所示,选择 Existing Project into WorkSpace 后,点击 Next。

💩 Import			×
Select Create new projects from an archive file or directory.			Ľ
Select an import wizard:			
type filter text			
 General Archive File Existing Projects into Workspace File System Preferences Projects from Folder or Archive C/C++ Git Install Oomph RPM Run/Debug Tasks Team TextMate Tracing XML 			
? < Back Next > Finish	1	Car	icel

• 点击 Browse,选择需要导入的项目路径,如图所示。

🚯 Import			\times
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Select root directory:	~	Brow	/se
◯ Select archive file:	~	Brow	/se
Projects:			
		Selec	t All
		Desele	ect All
		Refr	esh
Options			
Search for nested projects			
Close newly imported projects upon completion			
Hide projects that already exist in the workspace			
Working sets			
Add project to working sets		New	
Working sets:	\sim	Selec	t
		-	
C < Back Next > Finish		Can	cel

• 需要的导入的项目成功被 IDE 识别,点击 Finish。

lmport –		×
Import Projects Select a directory to search for existing Eclipse projects.		
Select root directory: D:\CPDE\hello_world	Bro	wse
Projects:	DIC	wsc
✓ hello_world (D:\CPDE\hello_world)	Sele	ect All
	Dese	lect All
	Re	fresh
Options Search for nested projects Copy projects into workspace Close newly imported projects upon completion Hide projects that already exist in the workspace		
Working sets		
Add project to working sets Working sets:	Sele	N ct
? < Back Next > Finish	Ca	ncel

• 在 IDE 的项目资源管理器中显示导入项目的目录结构如下图所示。已有项目默认为 N307 的编译选项, Nuclei SDK 仅包含 helloworld 使用到的文件。需要更多的 Nuclei SDK 源码请访问 Github (https://github.com/riscv-mcu/hbird-sdk)获取源码。

👻 🞏 hello_world

- Includes
- > > application
- > b nuclei sdk
 - hello_world_debug_openocd.launch

2.7.4 无模板手动创建项目

本节将介绍如何使用手动方式在 Nuclei Studio IDE 创建一个用户自定义的 Hello World 项目。开发板为 Nuclei FPGA Evaluation Board,内核为 N307。该方法除了创建项目之外,还需要手动设置各种选项和路径,详细步骤如下。

Note: 不建议使用,建议使用 NPK 模板的方式创建工程

手动创建项目

在 Nuclei Studio 的主菜单栏中, 依次选择 File-> New -> C/C++ Project。

CPDE - NucleiStudio				- 0	\times
File Edit Source Refactor Navigate	Search Project	Run RV-Tools Window Help			
New	Alt+Shift+N>	Makefile Project with Existing Code	2 = 0 = 2 = 2 = 2 = 2 = 0 = 0 = 0 = 0 =	Quick Acce	ss 🛛 😰 🗖
Open File		C/C++ Project	- 0	Cutline ti E Tack Li @ Build Docu	0
Open Projects from File System		Project		- Oddine - a lask bill - Duild 12 Docu	50 V
Recent Files	>	Convert to a C/C++ Autotools Project		An outline is not available.	v.
Close	Ctrl+W	 Convert to a C/C++ Project (Adds C/C++ Nature) Source Folder 			
Close All	Ctrl+Shift+W	S Folder			
🗟 Save	Ctrl+S	Source File			
Save As		Header File			
Save All	Ctrl+Shift+S	File from Template			
Revert		G Class			
Move		Currente			
🖻 Rename	F2	cxample			
 Refresh 	F5	Ctrl+N Ctrl+N			
Convert Line Delimiters To	>				
Print	Ctrl+P				
🔤 Import					
🖾 Export_					
Properties	Alt+Enter				
Switch Workspace	>				
Restart					
Exit					
		R Problems & Tasks Concole 11 D Propertie	e #Terminal	ri 0 ¥	• • • •
		No consoler to display at this time	5 9. ICITINIA		
					(II) # 7 (

然后在弹出的窗口中设定如下参数。

- Project name:项目命名。
- Use default location:如果勾选了此选项,则会使用默认 Workspace 文件夹存放此项目。
- Project type: 选择 Hello World RISC-V C Project。

&				×
C Project				\$
Create C project of selected type				
				_
Project name: 2_helloworld				
✓ Use <u>d</u> efault location				
Location: D:\CPDE\2_helloworld			B <u>r</u> owse	
Choose file system: default \vee				
Project type:	Toolchains:			
GNU Autotools	RISC-V Cross GCC			
Executable				
 Empty Project 				
 Hello World ANSI C Project 				
Hello World RISC-V C Project				
 Nuclei SDK Project For GD32VF103 SoC 				
 Nuclei SDK Project For HummingBird Sector 	oC			
Shared Library				
Static Library				
Makefile project				
<	>			
Show project types and toolchains only	if they are supported on t	the plat	form	
< <u>B</u> ack	<u>N</u> ext > <u>Finis</u>	sn	Cancel	

然后点击 Next 进入下一步, 在弹出的窗口中设置 Hello World 项目的基本信息。确保 Source 选项 内容为空,直接单击 Next 进入下一步。

&				×
Basic Settings				
Basic properties of a	project			
Author				
Copyright notice	Your copyright notice			
Hello world greeting	Hello RISC-V World!			
Source				
Linker other options:				
?	< <u>B</u> ack <u>N</u> ext > <u>Finis</u>	sh	Car	ncel

在弹出的窗口中设置项目的调试或者发布属性。该步骤可以使用默认信息不做任何修改,直接单击 Next 进入下一步。
8			\times
Select Configurations			->
Select platforms and configurations you wish to deploy on			
Project type: Executable			
Toolchains: RISC-V Cross GCC Configurations:			
Debug		Select a	I
✓ Selease		Deselect	all
	Adva	anced set	tings
Use "Advanced settings" button to edit project's properties.			
Additional configurations can be added after project creation. Use "Manage configurations" buttons either on toolbar or on prope	erty page	es.	
? < Back Next > Fin	ish	Can	icel

在弹出的窗口中设置项目所使用的 RISC-V 工具链。此处不要配置,直接选择 Finish,至此便完成了 HelloWorld 项目的创建。

Image: Source Reactor remainer Reactor Remainer R
Broject Epiorer II □ % 1 / * *** □ @ boutine II Itak Lit * Build Tar % Docume v #2 Delixorid 1 - ** ************************************
<pre>3 Contain 4 Contain 5 Contain 7 Description +HUD HISC+World in (8 **/ 1 Binclude (stdio.h) 1 Bincl</pre>
< Comparing a Task & Comparing a Dependence & Learning a State of the Comparing a State of t
COT Build Console [2] helioworld]

创建完成, Hello World 项目的展示界面如下。

Explorer #	@ main.c #			° 0	B Task List ® Build Tar.	Docume.
nclu New nain Go Into Open in New Window	>	Project File File File Folder Folder		Î	 stdio.h main(void) : int 	
Show in Local Terminal Copy Show in Local Terminal Deste Delete Remove from Context Source Move Rename	Ctrl+C Ctrl+V Delete Ctrl+Alt+Shift+Down F2					
≥ Import ≤ Export		is is a build-only project. Do not try to run it o ard, since it lacks the device specific startup.	J n a	- 1		
Clean Project Clean Project Refresh Close Project Close Unrelated Project	F5	o RISC-V World!" "\n");		~		
Build Targets Index Build Configurations	>	P Console # □ Properties J® Terminal elloworld]			÷ ÷ 🕄 🗆 🖉 =	ik∣ ≝ © ▼
Profiling Tools Validate © Run As © Debug As Profile As Restore from Local History © SDK Configuration Tools © Run C/C++ Code Analysis Team Compare With	> > Ctrl+6 > >					
Configure Source	>					
Properties	Alt+Enter					

新建一个 application 文件夹。在工程处右击选择 New —> Folder, 输入 application, 点击 Finish 完成新建工程。将 main.c 拖入 application 文件夹完成文件分类。

💩 New Folder			\times
Folder			
Create a new folder resource.			
Enter or select the parent folder:			
2_helloworld			
> 2_helloworld			
Folder name: application			
Advanced >>			
?	Finish	Can	cel

配置项目的 nuclei_sdk

本节介绍如何将 nuclei_sdk 加入到项目中, SDK 的具体内容本文不做详细介绍,可以参考https://doc. nucleisys.com/nuclei_sdk/index.html。如果需要使用 SDK 的其他源文件,请到 Github 获取全部的 Nuclei SDK 源码(这里以 0.3.9 版本为例),链接如下: https://github.com/Nuclei-Software/nuclei-sdk/releases。本 节仅介绍将 nuclei_sdk 中 helloworld 需要的文件加入到项目的步骤,如果使用新版本的 SDK,对应的目录 结构可能有所调整,请自行解决,具体步骤如下:

进入 Nuclei Studio 的 2_helloworld 项目,按照如下步骤添加 nuclei_sdk 源文件。

在 Project Explorer 栏中选中 2_helloworld 项目,单击鼠标右键,选择 Properties 打开工程设置页面。

5 0 e 0 Run	 limit hello_world_debug 	<u>o×</u> ♦ : :: • ::: :::: • • •	* 部・「日」/「ひ」が「〇」巻 * 〇 * 1 本 * 〇 * 9 * 6 * 1 巻 6 ペ * 1 巻 三 1 三 三 一 一 一 一 一 一 一 一 一 一 一 一 一 一 一 一	Quick A	ccess 🕴 🗃 📑
Project Explorer #	₿\$ ₽ ? " □		° 0 🐉 Outline 🔅	🛿 🖩 Task List 🐵 Build Tar 🖺 Docu	ime P D
> & Binaries > @ Includes	New Go Into	>	An outline is	s not available.	
 application Debug muclei sdk 	Open in New Window Show in Local Terminal	>			
■ hello_world_	Copy Paste Selete Remove from Context Source Move Pename	Ctrl+C Ctrl+V Delete Ctrl+Alt+Shift+Down >			
	import_	FZ.			
	Build Project Clean Project Refresh Close Project Close Unrelated Project	F5			
	Build Targets Index Build Configurations	>	a II ⊡Properties & Terminal I]	÷ ÷ 2	• 🖻 • 🖱 🛛
	Profiling Tools Validate O Run As © Debug As Profile As Restore from Local History	> >>			
	 SDK Configuration Tools Run C/C++ Code Analysis Team Compare With 	Ctrl+6			
	Configure	>			
	Source	>			
	Properties	Alt+Enter			
					~
			•		a = 7 ¢

在弹出的窗口中单击 Resource,在右侧的 Location 栏目中单击其最右侧的箭头图标 全弹出文件窗口进入 2_helloworld 项目的文件夹位置。

CPDE - NucleiStud Eile Edit Severe P	dio efector Nacionte Conch Projec	t Due DV Teels Window	Nels.	- 0	×
	hello world debug		nep	Quick Access	
Project Explorer #	0% > 7 0		B Qutine # II Task List @ Build Tar	Docume	- 1
 Shello_world Shello_world Shello_world Shello_world 	New Go Into	>	An outline is not available.		2
> application > Debug	Open in New Window Show in Local Terminal	>			
hello_world_	Copy Copy Paste Collete Context Source Move Rename	Ctrl+C Ctrl+V Delete Ctrl+Alt+Shift+Down F2			
	Import Export Build Project Clean Project Refresh Close Project Close Unrelated Project	FS			
	Build Targets Index Build Configurations	>	Re ™ ⊡Properties #Terminal 0.	: Ra	• • 0
	Profiling Tools Validate O Run As © Debug As Profile As Restore from Local History	>			
	 SDK Configuration Tools Run C/C++ Code Analysis Team Compare With 	Ctrl+6			
	Configure Source	>			
	Properties	Alt+Enter	1		
			•		
				a (a) c	* 7

将 nuclei-eclipse_demo.rar 压缩包中的 nuclei_sdk 文件夹复制放于 2_helloworld 项目的目录下。

÷

则

\delta Properties for	nello_world		—	
type filter text	Resource			↓ ↓ ↓ ▼
 Resource Builders C/C++ Build C/C++ General Linux Tools Pat MCU Project Natures Project Referer Run/Debug Se Task Repositor Task Tags Validation WikiText 	Path: Type: Location: Last modifier Text file end O Inherited O Other: New text fil O Inherited O Other:	/hello_world Project D:\CPDE\hello_world 2020年8月6日下午8:09:33 roding from container (GBK) BK encoding of derived resources separately e line delimiter from container (Windows) Vindows >>		
< >			Restore Defaults	Apply
?			Apply and Close	Cancel

回到 Nuclei Studio,在 Project Explorer 栏中选中 2_helloworld 项目,单击鼠标右键,选择 Refresh

🔳 🗸 No Lau	nch Configurations ~ on:	・ ご · 回 (b) · · · · · · · · · · · · · · · · · · ·			Quick Access
t Explorer #	8 % 2 * * *	9 mains #	• •	🐉 Outline 🗱 🖩 Task Li 🧐	Build 🕱 Docu
Proi		10/*	~		E /5 N √ + #
New Go Into Open in New Window Show in Local Terminal Copy Paste	> Ctrl+C Ctrl+V	2		 stdio.h main(void) : int 	
Delete Remove from Context Source Move Rename	Delete Ctrl+Alt+Shift+Down > F2	10 11 #include <stdio.h> 12 13 // " 14 / " and exit. 5 / "</stdio.h>			
import import Build Project Clean Project		17 * WARKING: This is a build-only project. Do not try to run it on a 18 * physical board, since it lacks the device specific startup. 19 */ 20			
Clean Project		23 mint			
Close Project Close Unrelated Project	15	23 { 24 print("Hello RISC-V World!" "\n"); 25 preturn 0:			
Build Targets Index Build Configurations	>	26) 27			
Profiling Tools Validate O Run As Debug As Profile As	>				
Restore from Local History SDK Configuration Tools Run C/C++ Code Analysis	Ctrl+6		>		
Team	>	Problems @ Tasks Console To Properties @ Terminal			🐘 🔜 🕪 🗹 💷 🔫 😁
Compare With	>	GNU MCU Eclipse Packs console			
Configure Source	>	<pre>Loading repos summaries Parsing cached content file "D:\Packages\.cache\.content_www_keil_com_pack_index_pidx.xml" file does not exist, ignored.</pre>			
Properties	Alt+Enter	Identifying Installed packages			
		Completed in 3ms. No installed packages. Completed in 3ms.			

Refresh 之后 2_helloworld 项目的下便可以看到 nuclei_sdk 文件夹,至此便完成了 nuclei_sdk 源文件的导入。

- Selloworld
 - Includes
 - application
 - > la main.c
 - 🖌 🗁 nuclei sdk
 - MMSIS
 - > 🗁 Core
 - 🗸 🗁 SoC
 - 🗸 🗁 hbird
 - > 🗁 Board
 - 👻 🗁 Common
 - > 🗁 Include
 - > > > Source

配置项目的编译和链接选项

为了使项目源代码能够被正确编译,需要配置编译和链接选项。

Note: 注意:本节中设置的编译与链接选项均为 GCC 工具链的常用选项,与在 Linux 环境中使用时的同 名选项含义一致,本节在此不做赘述介绍。

配置编译与连接选项的步骤如下:

在 Project Explorer 栏中选中 hello_world 项目,单击鼠标右键,选择 Properties。

在弹出的窗口中, 展开 C/C++ Build 菜单, 单击 Setting, 在右侧的 Tool Settings 栏目中进行设置。

- 选中 Target Processor,我们的内核是 N307,因此需要按照图所示勾选配置选项,分别如下。
- Architecture:选择 RV32I。
- Multiply extension (RVM): 需勾选。
- Atomic extension (RVA): 需勾选。
- Compressed extension (RVC): 需勾选。
- Integer API:选择 ILP32。
- Floting Point ABI: 选择 single precision
- Code model: 选择 Medium Any。
- 单击右下角的 Apply 按钮。

Properties for 2_I	helloworld				
type filter text	Settings				⇔ ▼ ⇔ ▼ ▼
 Resource Builders C/C++ Build Build Variable Environment Logging 	Configuration: Debug [Active]	Container Settings	» Build Steps 😤 Build Artifact 🖟	Manage Con	ifigurations or Parsers
Settings Tool Chain Ec > C/C++ General Linux Tools Path > MCU Project Natures Project Referenc Run/Debug Sett > Task Repository Task Tags > Validation WikiText	 Target Processor Optimization Warnings Debugging GNU RISC-V Cross Assembler Preprocessor Includes Warnings Miscellaneous Schu RISC-V Cross C Compiler Preprocessor Includes Optimization Warnings Miscellaneous Schu RISC-V Cross C++ Compiler Preprocessor Includes Optimization Warnings Miscellaneous Schu RISC-V Cross C++ Compiler Preprocessor Includes Optimization Warnings Miscellaneous Schu RISC-V Cross C++ Linker General Libraries Miscellaneous Schu RISC-V Cross Create Flash Image General Schu RISC-V Cross Create Listing General 	Architecture Multiply extens Constant of the second	RV32I (-march=rv32i*) ion (RVM) on (RVA) Single precision extension (RVF tension (RVC) ILP32 (-mabi=ilp32*) Single precision (f) Toolchain default Medium Any (-mcmodel=med Depilogue (-msave-restore) erations to call library functions fs (-mplt) divide/sqrt instructions (-mfdiv)	any) (-mmemcpy)	
< >	 SOLUTION STATE General 			Restore Defaults	4 Apply
?				Apply and Close	Cancel

选中 Optimization,按照图所示勾选配置选项。

• Optimization Level: 选择 Optimization Most (-02)。

Note: 注意:在 NucleiStudio 2024.06 版本中新增了 -Oz,用来优化编译后程序的尺寸。

依次勾选:

- Function Sections (-ffunction-sections)
- Data Sections (-fdata-sections)
- No common unitialized (-fno-common)

Note: 注意:上述选项均为通用的 GCC 编译优化选项,请用户自行查阅 GCC 手册了解其含义。

单击右下角的 Apply 按钮。

Properties for 2_h	nelloworld	- O X
type filter text	Settings	
type filter text > Resource Builders < C/C++ Build Build Variable Environment Logging Tool Chain Ec > C/C++ General Linux Tools Path > MCU Project Natures Project Referenc Run/Debug Sett > Task Repository Task Tags > Validation WikiText	Settings Configuration: Debug [Active] Tool Settings Toolchains Devices C Target Processor Coptimization C	Anage Configurations Image Configurations Image Configuration Image Configuration Image Configuration Image C
	 Miscellaneous GNU RISC-V Cross Create Flash Image General GNU RISC-V Cross Create Listing General GOU RISC-V Cross Print Size 	
	💩 General	Restore Defaults Apply
< >		Restore Delduits Apply
?		Apply and Close Cancel

选中 Debugging, 按照图中所示勾选配置选项,分别为:

- Debug Level:选择 Default (-g)。
- 单击右下角的 Apply 按钮。

🚯 Properties for my	Proj				
type filter text	Settings				⇔ ▼ ⇔ ▼ ▼
 Resource Builders C/C++ Build Build Variable Environment Logging Settings 1 	Configuration: Debug [Active] Tool Settings Toolchains Devices C Tool Settings Stoolchains Stoolchai	Container Settings 🎤 Buil Debug level	ld Steps 😤 Build Artifact Default (-g)	✓ Manage Co Binary Parsers	enfigurations Error Parsers
Tool Chain Ec > C/C++ General Linux Tools Path > MCU Project Natures Project Referenc Run/Debug Sett > Task Repository Task Tags > Validation WikiText	 Optimization Warnings Debugging Reprocessor Includes Warnings Miscellaneous Softu RISC-V Cross C Compiler Preprocessor Includes Optimization Warnings Miscellaneous Softu RISC-V Cross C Linker General Libraries Miscellaneous Softu RISC-V Cross Create Flash Image General GNU RISC-V Cross Create Listing General Softu RISC-V Cross Print Size General 	Debug format Generate prof inform Generate gprof infor Other debugging flags	Toolchain default nation (-p) mation (-pg)		~
					4
< >				Restore Defaults	<u>A</u> pply
?			Ap	oply and Close	Cancel

选中 GNU RISC-V Cross C Linker 的 General。按照如下步骤设置链接器的所需的链接脚本。

- 选中右上角的加号按键。
- 在弹出的窗口中单击 Workspace 按钮。
- 这里我们使用 HummingBird 评估板,所以可以选择 ILM 下载模式对应的 gcc_hbird_ilm. ld 文件。在弹出的窗口中选择 Nuclei Studio 文件包中的 nuclei_sdk/SoC/hbird/Board/ hbird_eval/Source/GCC 文件夹下 gcc_hbird_ilm.ld 文件。其他下载模式切换此处文件, 各文件详细介绍如下,可根据自己的实际情况选择。
 - gcc_hbird_ilm.ld 脚本将程序代码段约束在 ILM 的地址区间,意味着程序将被直接下载 在 MCU 的 ILM 中,并从 ILM 开始执行。ILM 由 SRAM 组成,会掉电丢失。
 - gcc_hbird_flash.ld 脚本程序代码段的物理地址约束 Flash 区间,将代码段的逻辑地址约 束在 ILM 的地址区间,意味着程序将被直接下载在 MCU 的 Flash 中,但是上电后要通过引导 程序将代码段搬运到 ILM 中,然后从 ILM 中开始执行。
 - gcc_hbird_flashxip.ld 脚本程序代码段约束 Flash 区间,意味着程序将被直接下载在 MCU 的 Flash 中,并直接从 Flash 开始执行。程序被烧写在 Flash 中,不会掉电丢失。
 - 用户可以按照自己的需求选择合适的链接脚本。本节示例选择 gcc_hbird_ilm.ld 作为演示。
- 设置完毕请单击右下角的 Apply 按钮。



按下图所示勾选配置选项,分别如下。

- Do not use standard start files (-nostartfiles) .
- Remove unused sections (gc-sections) -
- 单击右下角的 Apply 按钮。

Note: 注意:上述选项均为通用的 GCC 链接选项,请用户自行查阅 GCC 手册了解其含义。

text	Settings		(- + -) + (-)
uild /ariable nment	Configuration: Debug [Active]	Container Settings 🎤 Build Steps 🤗 Build	Manage Configurations Artifact Binary Parsers 9 Error Parsers
9	A Target Processor	Script files (T)	
i Ec ral ath res enc Gett Dry	 Optimization Warnings Debugging S GNU RISC-V Cross Assembler Preprocessor Includes Warnings Miscellaneous S GNU RISC-V Cross C Compiler Preprocessor Includes Optimization Warnings Miscellaneous S GNU RISC-V Cross C Linker General Libraries Miscellaneous S GNU RISC-V Cross Create Flash Image General S GNU RISC-V Cross Create Listing General S GNU RISC-V Cross Print Size General 	*\$(workspace_loc:/\$(ProjName)/nuclei_set) < Use the set of the set	dk/SoC/hbird/Board/hbird_eval/Source/(triles) tlibs)
		Print removed sections (-Xlinkerprin	nt-gc-sections)
		Omit all symbol information (-s)	
			Restore Defaults Apply
			Restore Defaults Apply

Note: 注意:在 NucleiStudio 2024.06 版本中 Libraries 支持 Group 功能,如果勾选了 Group 功能,所有的 Libraries 在编译时会用 -w1,--start-group, ……,--end-group, ,能解决 Libraries 内相互依赖的 问题。



选中 GNU RISC-V Cross C Linker 的 Miscellaneous,按照下图所示勾选配置选项。

- 勾选 Use newlib-nano。
- 因为 Hello World 程序的 Printf 不需要打印浮点数,所以不要勾选 Use float with nano printf。
- 单击右下角的 Apply 按钮。

🚯 Properties for my	Proj		— 🗆 X
type filter text	Settings		♦ ▼ <> ▼
 Resource Builders C/C++ Build Build Variable Environment Logging Settings Tool Chain Ec 	Configuration: Debug [Active] Tool Settings Toolchains Devices C Target Processor Optimization	iontainer Settings 🎤 Build Steps 🤗 Build Artifact 🗟 Bi Linker flags (-Xlinker [option])	✓ Manage Configurations hary Parsers ● Error Parsers ● ② ③ ⑦ ③ ◎
 C/C++ General Linux Tools Path MCU Project Natures Project Referenc Run/Debug Sett Task Repository 	 Warnings Debugging S GNU RISC-V Cross Assembler Preprocessor Includes Warnings Miscellaneous S GNU RISC-V Cross C Compiler Preprocessor Includes Optimization Warnings Miscellaneous S GNU RISC-V Cross C Linker General Libraries Miscellaneous S GNU RISC-V Cross Create Flash Image General S GNU RISC-V Cross Print Size General S GNU RISC-V Cross Print Size General 		
Task Tags > Validation WikiText		Other objects	和 和 知 위 원
		Generate map *\${BuildArtifactFileBaseName}.map Cross reference (-Xlinkercref) Print link map (-Xlinkerprint-map) Use newlib-nano (specs=nano.specs) Use float with nano printf (-u _printf_float) Use float with nano scanf (-u _scanf_float) Do not use syscalls (specs=nosys.specs) Verbose (-v) Other linker flags	
< >		Rest	core Defaults Apply
?		Apply a	nd Close Cancel

配置项目的包含路径和文件

- 为了能够正确编译 nuclei_sdk 文件夹中的源文件,需要按照如下步骤配置项目的包含路径和包含文件。
 - 在 Project Explorer 栏中选中 hello_world 项目,点击鼠标右键,选择 Properties。

CPDE - NucleiStud File Edit Source Re	dio efactor Navigate Search Projec	t Run RV-Tools Window H	Nn		- 0	\times
🐔 💿 🔳 🗿 Run	v v 🗈 hello_world_debug	0~* := • ::: 0: 0 • • •			Quick Access	e
Project Explorer #	0 10 10 10 10		° c	Cutline # Task List Build Tar.	🔁 Docume	• 0
 at Binaries at Binaries application bebug nuclei_sdk hello_world_ 	New Go Into Open in New Window Show in Local Terminal	>		An outline is not available.		5
	Copy Paste Delete Context Source Move Rename	Ctrl+C Ctrl+V Delete Ctrl+Alt+Shift+Down				
	Export_					
	Build Project Clean Project Refresh Close Project Close Unrelated Project	F5				
	Build Targets Index Build Configurations	> xle > dl > dl	II © Properties & Terminal	ê ê î î î î î	ik ≝ 0 • ₫ •	
	Profiling Tools Validate Run As Debug As Profile As Restore from Local History	> > >				
	 SDK Configuration Tools Run C/C++ Code Analysis Team Compare With 	Ctrl+6 >				
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	Properties	Alt+Enter				
						2
	<				an ion ion i	>

在弹出的窗口中,展开 C/C++ Build 菜单,单击 Setting,在右侧的 Tool Settings 栏目中进行设置。

选中 GNU RISC-V Cross C Assembler 的 Includes,按照图中所示配置包含文件,步骤如下。

text	Settings		⇔ ▼
ce rs Build d Variable	Configuration: Debug [Active]		V Manage Configurat
ronment	 Tool Settings Toolchains Devices C 	Container Settings 🎤 Build Steps 😤 E	Build Artifact 🗟 Binary Parsers 🧕 Error Parser
ings 1 I Chain Ec General ools Path : Natures : Referenc ebug Sett epository ags tion xt	 Target Processor Optimization Warnings Debugging S GNU RISC-V Cross Assembler Preprocessor Marnings Miscellaneous S GNU RISC-V Cross C Compiler Preprocessor Includes Add directory path Directory: OK Cancel General 	Include paths (-1) Include system paths (-isystem) X Workspace File system	Folder selection Select one or more Workspace Folders Sel
			Rectore Defaults
>			Restore Defaults App

• 在 Include paths 栏目单击加号键。

- 在弹出的窗口中单击 Workspace, 弹出 Folder selection 窗口。
- 在 Folder selection 窗口中选择项目的 nuclei_sdk 目录下的 NMSIS>Core>Include 文件夹。
- 在右下角单击 Apply 完成配置。

采用上述方法, 依次添加 nuclei_sdk 目录下的 SoC>hbird>Board>hbird_eval>Include, SoC>hbird>Common>Include 和 SoC>hbird>Common>Source>Stubs 文件夹作为包含路径, 并采用同样的方法为 GNU RISC-V Cross C Compiler 的 Includes 栏目设置包含路径。设置完成后的界面如下图所示。



2.7.5 基于已有的 Makefile 创建项目

本节将介绍如何使用已有的 Makefile 在 Nuclei Studio IDE 创建一个使用 Makefile 的 Hello World 项目。 开发板为 Nuclei FPGA Evaluation Board,内核为 N307。请先下载 Nuclei SDK,Github 链接为:https: //github.com/Nuclei-Software/nuclei-sdk。该方法除了创建项目之外,还需要手动设置各种选项和路径,这 里以 helloworld 为例,详细步骤如下。

手动新建项目

在菜单栏中选择 File-> New -> Makefile Project with Existing Code。

en file. en files been en	ICW	Alt+Shift+N :	Makefile Project with Existing Code	- @ ▼ \$\$ ▼ 0 ▼ 9, ▼ 9, ▼ # @ @ # ▼ # # # # # # # # #	Quick Access
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No consoles to display at this time.		E P	roblems 🕘 Tasks 🔍 Console 🗱 🗆 Properties 🍠 Terminal 📟 Disa:	ssembly BProgress	-
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在图标1处输入工程名,这里我们命名为 nuclei-sdk。在图标2处输入 SDK 的实际路径。在图标3 处选择 RISC-V Cross GCC。点击图标4 完成新建项目。

8 New Project		×
Import Existing Code		
Create a new Makefile project from existing code in that same directory		
Project Name		
nuclei-sdk		
Existing Code Location 2		
C:\Users\24954\Desktop\nuclei-sdk	Brow	wse
Languages C C ++		
Toolchain for Indexer Settings		
<none> Cross GCC GNU Autotools Toolchain 3</none>		
RISC-V Cross GCC		
Show only available toolchains that support this platform		
⑦ Finish	Cance	9 1

设置 Makefile 路径和 Build 选项

右击新建好的工程,选择 Properties 打开设置页面,选择 C/C++ uild,在 Build Location中选择 Workspace。在弹出的弹窗中选择 application > baremetal > helloworld 点击 OK 再点击 Apply 保存。

type filter text	C/C++ Build 🗘 🗢 💌 💌	Select a folder from workspace:	
 Resource Builders C/C++ Build C/C++ General Linux Tools Path MCU 	Configuration: Default [Active] Manage Configurations Builder Settings Behavior Refresh Policy	 ✓ [™] nuclei-sdk > [™] .ci > [™] .settings ✓ [™] application < [™] baremetal 	ŕ
 MCU Project Natures Project Referenc Run/Debug Sett Task Repository Task Tags 	Builder Builder type: External builder Use default build command Build command: \${cross_make} Variables	 > benchmark > demo_dsp > demo_eclic > demo timer > helloworld 	
 Validation WikiText 	Makefile generation Generate Makefiles automatically Expand Env. Variable Refs in Makefiles Build location Comparison Com	main.c Makefile Po freetos rethread main.c	
	Build directory: [stworkspace_loc:/nuclei-sdk/application/baremetal/helloworld] Workspace File system Variables	 > board-labs > build > doc > MMSIS 	
< >	Restore Defaults Apply		
?	Apply and Close Cancel	(?) OK	Cancel

在 C/C++ Build 中选择 Behavior 栏目,确保勾选 Build (Incremental Build)选项并 输入 all CORE=n307 DOWNLOAD=ilm。其中 CORE 选项根据实际的内核变化,这里以 n307 为例。 DOWNLOAD 选项可以修改不同的下载模式,详细请参考 5.1 节,这里以 ilm 模式为例。因为例程使用 HummingBird Evaluation Board,所以 SoC 和 Board 都不必修改,如果使用其他开发板,以 RVSTAR 为 例,请在此处设置增加 SOC=gd32vf103 BOARD=gd32vf103v_rvstar,并且由于 RVSTAR 仅支持 FLASHXIP 模式,需要将 DOWNLOAD 设置为 flashxip,同时 CORE 修改为 n205。完成后点击 Apply 保存修改。

💩 Properties for nu	clei-sdk	—	
type filter text	C/C++ Build		<> ▼ <> ▼ ▼
 Resource Builders C/C++ Build C/C++ General Linux Tools Path MCU 	Configuration: Default [Active] 2 Builder Settings Behavior & Refre	V Manage Co esh Policy	onfigurations
Project Natures Project Referenc Run/Debug Sett Task Repository Task Tags	Build settings ✓ Stop on first build error	 Enable parallel build Use optimal jobs (8) Use parallel jobs: Use unlimited jobs 	
Validation WikiText	Workbench Build Behavior		
	Build on resource save (Auto build)	all	Variables
	Note: See Workbench automatic build	preference	N/ 1 1 1
	Build (Incremental build)	all CORE=n307 DOWNLOAD=IIm	Variables
	✓ Clean	clean	Variables
			4
< >		Restore Defaults	Apply
?		Apply and Close	Cancel

在完成上述操作后,打开工具链配置页,点击 Apply 保存修改。

& Properties for nuclei-sdk-master				- 🗆 🗙
	Settings			<
> Resource Builders Y C/C++ Build	Configuration: Default	[Active]	∽ Ma	nage Configurations
 C/C++ Build Build Variables Environment Logging Settings Tool Chain Editor C/C++ General Linux Tools Path MCU Project Natures Project References Run/Debug Settings Task Repository Task Tags Validation WikiText 	Configuration: Default Toolchains Binar Name: RISC-1 Architecture: RISC-1 Prefix: riscv-r Suffix:	y Parsers O Error Parsers / Nuclei GCC (riscv-nuclei-elf- / uclei-elf- g: these definitions do not af rse_home}\toolchain\gcc\bin	•gcc) •gcc) •]]] [ffect the build and are for	the benefit of the inde
	(to cha Build tools path: <mark>\${eclip</mark> (to cha	nae it use the alobal or work ise_home}\toolchain\build-too nge it use the <u>global</u> or <u>work</u>	<u>espace preferences pages</u> ols\bin <u>espace</u> preferences pages Restore <u>D</u>	or the project proper or the <u>project</u> proper efaults
?			Apply and Clo	ose Cancel

2.8 Nuclei Studio 编译工程

在 NucleiStudio 中,支持多种 Toolchain,以便用户在创建工程时,可以选择不同的 Toolchain 对工程进行 编译。NucleiStudio 中已经集成了 GCC 13、Clang 17、ZCC Lite 三款编译器,用户无需下载即可使用。

& Properties for dddd			– D X
type filter text	Settings		
> Resource			
Builders	Configuration: Deb	pug [Active]	 Manage Configurations
✓ C/C++ Build Build Variables			
Environment	W Tool Courses W		(
JSON Compilation	Tool Settings	Toolchains Devices / Build Steps Build Arti	
Logging	Name:	RISC-V GCC/Newlib (riscv64-unknown-elf-gcc)	~
Tool Chain Editor	Architecture:	RISC-V GCC/Newlib (riscv64-unknown-elf-gcc) RISC-V Nuclei GCC (riscv-nuclei-elf-gcc)	
> C/C++ General	Prefix:	Terapines ZCC (zcc)	
Linux Tools Path	Suffix:	RISC-V Clang/Newlib (riscv64-unknown-elf-clang)	
> MCU Project Natures	C compiler:	RISC-V GCC/RTEMS (riscv64-unknown-ritems-gcc)	
Project References	C++ compiler:	Custom (riscv-none-elf-gcc)	
Refactoring History	Archiver:	ar	
Run/Debug Settings	Hex/Bin converter:	obicopy	
Task Repository	Listing generator:	obidump	
> Validation	Size command	size	
WikiText	Build command:	make	
	Remove command:		
	Remove command.		
	Prefer local xpace	ks/.bin path	
	Toolchain path:	{eclipse_home}\toolchain\gcc\bin	
		(to change it use the global or workspace preferen	ces pages or the project properties page
	Build tools path:	\${eclipse_home}\toolchain\build-tools\bin	
		(to change it use the <u>global</u> or <u>workspace</u> preferen	ces pages or the project properties page
	Create flash imag	je listing	
	Print size	isting	
< >			Restore Defaults Apply
٢			
\bigcirc			Apply and Close Cancel

• RISC-V Nuclei GCC (riscv-nuclei-elf-gcc)

早期 NucleiStudio 对 GCC 10 编译器的支持, Nuclei Studio 2023.10 及之后版本弃用,如果用户需要 对 GCC 10 的支持,需要自行下载 Nuclei RISC-V Toolchain 2022.12(gcc10) 并替换 <NucleiStudio>/ toolchain/gcc10 目录内容。

• RISC-V GCC/Newlib (riscv64-unknown-elf-gcc)

Nuclei Studio 2023.10 及之后对 GCC 13 编译器的支持,对应的软件包存放在 <NucleiStudio>/ toolchain/gcc 目录。

• RISC-V Clang/Newlib (riscv64-unknown-elf-clang)

Nuclei Studio 2023.10 及之后对 Clang 17 编译器的支持,对应的软件包存放在 <NucleiStudio>/ toolchain/gcc 目录。

• Terapines ZCC (zcc)

Nuclei Studio 2024.06 版本对 ZCC 编译器的支持,对应的软件包存放在 <NucleiStudio>/

toolchain/zcc 目录。Terapines ZCC 工具链工程的创建需要依赖 Nuclei SDK > 0.6.0 之后的版本才可以,目前可以通过 Nuclei SDK 命令行的方式进行测试。

2.8.1 编译工具

Nuclei GNU Toolchain

GNU Toolchain 是由 GNU 项目提供的一套完整的软件开发工具链,它包括了编译器、调试器、链接器、 库文件等一系列用于软件开发和构建的必需工具。GNU Toolchain 以其开源、跨平台、高度可定制和强 大的功能特性,成为了全球开发者社区广泛使用的开发工具集。Nuclei Studio 2023.10 之前的版本中集成 了 GCC 10; Nuclei Studio 2023.10 及之后的版本中,集成了 GCC 13。

在 nuclei_sdk 0.5.0 之后的版中,在创建工程时,用户可以选择 Toolchain 为 RISC-V GCC/Newlib (riscv64-unknown-elf-gcc)则可以创建一个支持 GCC 13 编译的工程, NucleiStudio 将默认将相对 应的编译选项配置好。关于 GCC 10 与 GCC 13 工程的问题,可以参阅通过工具将工程转换成支持 gcc 13 的工程 (page 177)。

& Create Nuclei RISC-V C/C++	- project using npk sdk-nuclei_sdk @0.5.1-dev —		×
Create project for SoC:Nucle Please select the relevant conf	ei FPGA Evaluation SoC,Board:Nuclei FPGA Evaluation Bo		
Project name:	test] ^
Project Filter by:	no filter v Filters:	~	
Project Example:	Coremark Benchmark @app-nsdk_coremark	~	
Toolchain:	Terapines ZCC (zcc)	~	
Download/Run Mode:	RISC-V GCC/Newlib (riscv64-unknown-elf-gCC) RISC-V Clang/Newlib (riscv64-unknown-elf-clang) Terapines ZCC (zcc)		
Select NMSIS Library:	No NMSIS Library used	~	
Nuclei RISC-V Core:	N307FD Core(ARCH=rv32imafdc, ABI=ilp32d)	~	
ARCH Extensions(ARCH_EXT=):	_zba_zbb_zbc_zbs_xxldsp]
Nuclei Cache Extensions:	□ ICache □ DCache □ CCM		
Nuclei SMP Count:	0	•	3
Boot HartID:	0	•	3
Heap Size:	4K		
Stack Size Per CPU:	4K		
Enable Semihosting:			
Standard C Library(STDCLIB=):	newlib_small: newlib nano with printf float	~	
Select Benchmark Options:	Options for Nuclei 300 Series	~	~
?	< Back Next > Finish	Cancel	

在工程上 右键->Properties->C/C++ Build->Setting->Toolchains 中可以看到工程所用 到的 Toolchains 有一些工具,以及 Toolchains 所在的路径。

Properties for test			– D X
type filter text	Settings		⟨¬ ▼ ¬⟩ ▼ 8
 Resource Builders C/C++ Build Build Variables Environment 	Configuration: Del	bug [Active] Toolchains 🏾 Devices 🎤 Build Steps 🧟 Build Artifact 🐻 Binary Parsers 🧔 Error Parsers	 ✓ Manage Configurations
JSON Compilation Logging	Name:	RISC-V GCC/Newlib (riscy64-unknown-elf-acc)	~
Settings	Architecture:	RISC-V V	
> C/C++ General	Prefix:	riscv64-unknown-elf-	
Linux Tools Path	Suffix:		
 MCU Project Natures 	C compiler:	gcc	
Project References	C++ compiler:	g++	
Run/Debug Settings	Archiver:	ar	
Task Tags	Hex/Bin converter:	objcopy	
 Validation WikiText 	Listing generator:	objdump	
THUT ON	Size command:	size	
	Build command:	make	
	Remove command:	:	
	Prefer local xpac	ks/.bin path	
	Toolchain path:	{eclipse_home}\toolchain\gcc\bin	
		(to change it use the <u>global</u> or <u>workspace</u> preferences pages or the <u>project</u> properties page)	
	Build tools path:	Steclipse_home}\toolchain\build-tools\bin (to change it use the global or worksnace preferences pages or the project properties page)	
		(to change it use the groups of morespace preferences pages of the project properties page)	
	Create flash imag	ge	
	Create extended	listing	
< >			Restore Defaults Apply
?			Apply and Close Cancel

Nuclei LLVM Toolchain

LLVM Toolchain 是一套为 C 系列编程语言设计的完整工具链,旨在提供从源代码到可执行文件的编译和 链接过程。LLVM Toolchain 的核心组件包括 Clang 编译器、LLVM 编译器基础设施以及相关的工具和库。 LLVM Toolchain 是一套功能强大、灵活可扩展的编译工具链,它采用了先进的编译技术和设计理念,为 开发者提供了高效、便捷的编译和构建解决方案。Nuclei Studio 2023.10 及之后的版本中,集成了 LLVM Toolchain。

在 nuclei_sdk 0.5.0 之后的版中,在创建工程时,用户可以选择 Toolchain 为 RISC-V Clang/Newlib (riscv64-unknown-elf-clang)则可以创建一个支持 Clang 17 编译的工程, NucleiStudio 将默认 将相对应的编译选项配置好。

& Create Nuclei RISC-V C/C++	- project using npk sdk-nuclei_sdk @0.5.1-dev —		×
Create project for SoC:Nucle Please select the relevant conf	ei FPGA Evaluation SoC,Board:Nuclei FPGA Evaluation Bo		
Project name:	test] ^
Project Filter by:	no filter v Filters:	~	
Project Example:	Coremark Benchmark @app-nsdk_coremark	~	
Toolchain:	Terapines ZCC (zcc)	~	1
Download/Run Mode:	RISC-V GCC/Newlib (riscv64-unknown-elf-gcc) RISC-V Clang/Newlib (riscv64-unknown-elf-clang) Terapines ZCC (zcc)		
Select NMSIS Library:	No NMSIS Library used	~	
Nuclei RISC-V Core:	N307FD Core(ARCH=rv32imafdc, ABI=ilp32d)	~	
ARCH Extensions(ARCH_EXT=):	_zba_zbb_zbc_zbs_xxldsp		
Nuclei Cache Extensions:	□ ICache □ DCache □ CCM		
Nuclei SMP Count:	0	▲ ▼]
Boot HartID:	0	•]
Heap Size:	4K]
Stack Size Per CPU:	4K]
Enable Semihosting:			
Standard C Library(STDCLIB=):	newlib_small: newlib nano with printf float	~	
Select Benchmark Options:	Options for Nuclei 300 Series	~	`
?	< Back Next > Finish	Cancel	

在工程上 右键->Properties->C/C++ Build->Setting->Toolchains 中可以看到工程所用 到的 Toolchains 有一些工具,以及 Toolchains 所在的路径。

Properties for test		– 🗆 X
type filter text	Settings	↓ ↓ ↓ 8
 Resource Builders C/C++ Build Build Variables Environment 	Configuration: Debug [Active]	V Manage Configurations
JSON Compilation	🛞 Tool Settings 🛞 Toolchains 🔳 Devices 🎤 Build Steps 🟆 Build Artifact 🖬 Binary Parsers 😢 Error Parsers	
Settings Tool Chain Editor > C/C++ General Linux Tools Path > MCU Project Natures Project References Run/Debug Settings > Task Repository Task Tags	Name: INSC-V Clang/New/ID (risova-unknown-eif-clang) Architecture: RISC-V Prefix: risova-unknown-eif- Suffix:	~
 Validation WikiText 	Listing generator: objdump	
WIKITEAL	Size command: size	
	Build command: make	
	 □ Prefer local xpacks/.bin path Toolchain path: §{eclipse_home}\toolchain\gcc\bin (to change it use the global or workspace preferences pages or the project properties page) Build tools path: §{eclipse_home}\toolchain\build-tools\bin (to change it use the global or workspace preferences pages or the project properties page) ☑ Create flash image ☑ Create extended listing ☑ Print size 	
< >		Restore Defaults Apply
?		Apply and Close Cancel

Terapines ZCC

Terapines ZCC 是兆松科技研发的高性能 RISC-V 编译器。Nuclei Studio 2024.06 版中对 Terapines ZCC 进行支持,集成了 ZCC Lite 版本的工具链,如果需要更新,可以自行下载好 Terapines ZCC 后,替换 <NucleiStudio>/toolchain/zcc 目录下的内容,可以在 NucleiStudio 中直接创建一个支持 Terapines ZCC 的工程,并使用 Terapines ZCC 进行编译。

关于 Terapines ZCC 参见: https://products.terapines.com/downloads

& Create Nuclei RISC-V C/C++	- project using npk sdk-nuclei_sdk @0.5.1-dev —		×
Create project for SoC:Nucle Please select the relevant conf	ei FPGA Evaluation SoC,Board:Nuclei FPGA Evaluation Bo		
Project name:	test		^
Project Filter by:	no filter v Filters:	``	
Project Example:	Coremark Benchmark @app-nsdk_coremark	``	
Toolchain:	Terapines ZCC (zcc)	`	2
Download/Run Mode:	RISC-V GCC/Newlib (riscv64-unknown-eif-gcc) RISC-V Clang/Newlib (riscv64-unknown-eif-clang) Terapines ZCC (zcc)		
Select NMSIS Library:	No NMSIS Library used		-
Nuclei RISC-V Core:	N307FD Core(ARCH=rv32imafdc, ABI=ilp32d)	``	-
ARCH Extensions(ARCH_EXT=):	_zba_zbb_zbc_zbs_xxldsp		
Nuclei Cache Extensions:	□ ICache □ DCache □ CCM		
Nuclei SMP Count:	0		•
Boot HartID:	0		•
Heap Size:	4К		
Stack Size Per CPU:	4K		
Enable Semihosting:			
Standard C Library(STDCLIB=):	newlib_small: newlib nano with printf float		/
Select Benchmark Options:	Options for Nuclei 300 Series		~
?	< Back Next > Finish	Cance	

在工程上 右键->Properties->C/C++ Build->Setting->Toolchains 中可以看到工程所用 到的 Toolchains 有一些工具,以及 Toolchains 所在的路径。在这里可以配置用户所下载的 ZCC 编译器的 路径。

& Properties for test			—	
type filter text ×	Settings		<	> ▼ ↔ ▼ 8
 > Resource Builders ~ C/C++ Build Build Variables 	Configuration: Debug [Active]	 Manage Con 	ifigurations
Environment ISON Compilation	🛞 Tool Settings 🛞 Toolc	hains 🔳 Devices 🎤 Build Steps 😤 Build Artifact 🗟 Binary Parsers 🧕 Error Parsers		
Logging	Name: Tera	pines ZCC (zcc)		~
Settings Tool Chain Editor	Architecture: RISC	2-V v		
> C/C++ General	Prefix:			
Linux Tools Path	Suffix:			
Project Natures	C compiler: zcc			
Project References Run/Debug Settings	C++ compiler: z++			
> Task Repository	Archiver:	-ar		
Task Tags	Hex/Bin converter: IIvm	objcopy		
WikiText	Size command:	-size		
	Build command: mak	ie la		
	Remove command: rm			
	Prefer local xpacks/.bi	n path		
	Toolchain path:	hance it use the global or workspace preferences pages or the preject properties page)		
	Build tools path: \${ec	lipse home]\toolchain\build-tools\bin		
	(to c	hange it use the <u>global</u> or <u>workspace</u> preferences pages or the <u>project</u> properties page)		
	🗹 Create flash image			
	Create extended listing	9		
	✓ Print size			
< >			Restore Defaults	Apply
?		A	pply and Close	Cancel

2.8.2 Nuclei SDK 工程设置工具

在 Nuclei Studio 中可以通过 Nuclei SDK 工程设置工具一键修改通过 Nuclei SDK Project Wizard 创建的工程的编译链接选项。

Note: 本工具目前仅支持 Nuclei SDK, HBird SDK, Nuclei Subsystem SDK, 不支持无模板手动创建的项目 和基于 Makefile 创建的项目, 或者是自行创建维护的项目

单击选中需要修改的工程,之后如图 6-1 打开 RV-Tools>SDK Configuration Tools,可以打 开修改编译选项的弹窗,在 2023.10 版本以后,将直接打开 Nuclei Settings 页面。也可以单击要修改的工 程后,点击工具栏的工程设置工具图标。

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或者单击要修改的工程后,键盘按下 ctrl+6。

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也可以单击要修改的工程后,右击打开右键菜单,选择 SDK Configuration Tools。

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SDK Configuration Tools 各选项详细功能如下:

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- projectName 为当前选中的工程名。
- Core 为当前工程对应的内核。由于工具根据 ARCH 和 ABI 选项反推出对应的内核,而不同的内核 可能有相同的 ARCH 和 ABI 选项,所以显示上可能会有所偏差,只要 ARCH 与 ABI 为正确的选项 即可。此选项为方便快速切换内核选项使用。
- 四个勾选项: Bitmanipulation Extension(RVB), Cryptography Extension(RVK), Packed SIMD/DSP Extension, Vector Extension(RVV) 用于选择对应的扩展指令集 (B/ K/P/V)。

Note: 本功能在 2023.10 版本中移除,使用 Other Extensions 输入框来制定额外的扩展。

- ARCH 对应的当前工程的 arch 选项, 根据 Core 和勾选项自动组合。
- ABI 对应的当前工程的 abi 选项。
- Tuning 根据不同级别处理器优化的 gcc 选项,选择 Core 会自动选择正确的 Tuning 选项,不建议自己调整。
- Code Model 针对 RV32 处理器,自动选择为 Medium Low,而针对 RV64 处理器自动选择为 Medium High,选择 Core 以后会自动选择合适的 Code Model,其中 RV64 处理器必须使用 Medium High。
- Download 对应当前工程的下载模式,可以切换选择不同的下载模式,目前仅 Nuclei FPGA 评估 开发板支持切换下载模式, RVSTAR 仅有 FLASHXIP 模式。其中切换到 flash 模式会额外定义 VECTOR_TABLE_REMAPPED 宏,其他模式不会定义这个宏
- Select C Runtime Library 对应的使用标准 C 库,本功能在 2023.10 版本中移除。在工程创建的时候,如果创建的工程采用的是 Newlib,则这里只能进行 newlib 版本的切换,如果创建的工程 才用的是 Nuclei C Runtime Library (libncrt),则这里只能进行 libnert 版本的切换。
- Optimization Level 对应编译的优化等级。
- Extra Common Flags 对应的是额外的通用编译选项。可以添加额外的通用编译选项。
- Extra C Flags 对应的是额外的 C 编译选项。可以添加额外的 C 编译选项。
- Extra C++ Flags 对应的是额外的 C++ 编译选项。可以添加额外的 C++ 编译选项。
- Extra ASM Flags 对应的是额外的汇编编译选项。可以添加额外的汇编编译选项。
- Extra Link Flags 对应的是额外的链接选项。如果此选项已经有默认选项并且需要增加编译选项,可以在编译选项开头或结尾处相隔一个空格字符再增加编译选项。

根据需要修改以上的选项,这里我们修改优化等级为 -Os 优化生成可执行文件大小。点击 save 一 键修改编译选项, save 以后一定要先 clean project, 之后右击修改后的工程打开右键菜单,选择 Clean Project 清理一下工程,再点击锤子图标即可完成修改编译选项后重新编译工程。

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这里的 SDK Configuration Tool 切换不会对 Debug Configuration 选项做任何改动,因此如果切换了 Core 以后,对应的调试配置 (OpenOCD/QEMU/JLink) 也需要手动修改。

需要注意的是如果要切换工程从 32 位变为 64 位,需要打开调试设置页面,修改 command 中 set arch riscv:rv32 为 set arch riscv:rv64,从 64 位切换回 32 位也应当修改这里的参数为对应的数值。

2.8.3 Nuclei Studio 中编译 Hello World 项目

在 Nuclei Studio 中编译 Hello World 项目的步骤如下。

在编译工程前,建议先将项目清理一下。在 Project Explorer 栏中选中 hello_world 项目, 单击鼠标右键,选择 Clean Project。

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单击 Launch Bar 菜单上的锤子按钮,开始对项目进行编译。如果编译成功,能够看到生成可执行文件的代码体积大小,包括 text 段、data 段和 bss 段,以及总大小的十进制和十六进制数值。使用 Makefile 方式新建的工程需要在右键菜单中选择 Build Project 进行编译。

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编译成功后可以看到增加了 Debug 文件夹,各文件作用如下:

- hello_world.elf 是生成的可执行文件。
- hello_world.hex 是生成的 Hex 文件。
- hello_world.lst 是生成的 list 文件,可以看到反汇编和简单的代码分部信息。

• hello_world.map 是生成的 map 文件,可以详细的看到生成的代码分布情况。

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2.9 Nuclei Studio 调试运行工程

2.9.1 调试模式管理

在 NucleiStudio 中,使用 Launch Bar 管理不同的调试器,默认情况下, NucleiStudio 会为 OpenOCD、Jlink、 Qemu 生成对应的 *.launch 调试文件, NucleiStudio 识别到 *.launch 文件后,会将其加入到 Launch Bar 中进行管理,用户可以通过以下三种方式来使用指定的调试模式。

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通过点击工程中的*.launch 文件切换不同的调试模式,当用户单击工程中的某一个*.launch 文件时,NucleiStudio 会将该文件设置为 Launch Bar 中的选中文件,然后就可以通过 Launch Bar 执行 Run/ Debug 操作。

& NucleiStudio_workspace - test/application/main.c - NucleiStudio IDE						
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🖻 😫 🏹 👹	1 // See LICENSE for license details					
∽ 👺 test	<pre>2 #include <stdio.h></stdio.h></pre>					
🚳 Nuclei Settings	<pre>3 #include <time.h></time.h></pre>					
	<pre>4 #include <stdlib.h></stdlib.h></pre>					
> BP Includes	5 #include "nuclei_sdk_soc.h"					
> 🗁 application	6					
> 🗁 nuclei sdk	^{7⊖} void print_misa(void)					
x test debug ilink.launch	8 {					
test_debug_enenged launch	<pre>9 CSR_MISA_Type misa_bits = (CSR</pre>					
Ist_debug_openocd.iaunch	<pre>10 static char misa_chars[30];</pre>					
I test_debug_qemu.launch	<pre>11 uint8_t index = 0;</pre>					
	12 if (misa_bits.b.mxl == 1) {					
	<pre>13 misa_chars[index++] = '3';</pre>					
	<pre>14 misa_chars[index++] = '2';</pre>					
	45 1					

在工程展开文件,找到*.launch文件并在*.launch文件上点击鼠标右键,在弹出菜单中选中 Debug As/Run As,在下一级菜单中点对应的模式开始 Run/Debug 操作。

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用户可以通过 Launch Bar 中的下接框,来切换成不同的调试模式,在 Launch Bar 中点击展开按钮,然后选中对应的调试模式,并执行 Run/Debug 操作。

🚳 NucleiStudio_workspace - test/application/main.c - NucleiStudio IDE				
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2.9.2 使用蜂鸟调试器结合 OpenOCD 调试运行项目

安装蜂鸟调试器驱动

Note: Nuclei Studio 自 2021.02 版本起 openocd 实现 windows 免驱功能,使用此版本及以上 windows 环境的用户可跳过此节,Linux 环境仍需配置驱动。低于此版本的用户需按照以下方法安装驱动。

在 Windows 系统中安装驱动

程序编译成功后,便可以将程序下载到 FPGA 原型开发板运行。首先将原型开发板与主机 PC 进行 连接,步骤如下。

将蜂鸟调试器的一端插入主机 PC 的 USB 接口,另一端与原型开发板连接。由于蜂鸟调试器还包含 了 将原型开发板输出的 UART 转换成 USB 的功能,因此如果蜂鸟调试器被主机 PC 识别成功(且驱动 安装成功),那么将能够被主机识别成为一个 COM 串口。在主机 PC 的设备管理器中的 端口(COM 和 LPT)栏目中可以查询到该 COM 的串口号(譬如 COM11)。此串口在后续的程序运行过程中将充当原型 开发板运行程序的 printf 输出显示接口。



Note: 注意:如果使用蜂鸟调试器,主机 PC 的 Windows 系统不能够识别蜂鸟调试器的 USB,需要安装 驱动,可以在 https://www.nucleisys.com/developboard.php#debuggerkit 下载驱动程序并安装。

Note: 注意: 在通过 蜂鸟调试器下载之前,需要注意 蜂鸟调试器被 Windows 正确识别,检验的标准即 为本节中所述正确地安装了 HBird-Driver.exe 的驱动,且能够在设备管理器中查询到 COM 的串口号。

在 Linux 系统中安装驱动

在 Linux 环境下安装驱动步骤如下:

•1:连接开发板到 Linux 中,确保 USB 被 Linux 识别出来。如果使用虚拟机,确保开发板连到了虚 拟机当中。



• 2: 在控制台中使用 lsusb 指令查看信息,参考的打印信息如下:

```
Bus 001 Device 010: ID 0403:6010 Future Technology Devices International, Ltd. 

GFT2232xxxx
```

• 3: 控制台中输入 sudo vi /etc/udev/rules.d/99-openocd.rules 指令打开 99-openocd.rules 文件, 输入如下 内容, 保存退出。

```
SUBSYSTEM=="usb", ATTR{idVendor}=="0403",
ATTR{idProduct}=="6010", MODE="664", GROUP="plugdev"
SUBSYSTEM=="tty", ATTRS{idVendor}=="0403",
ATTRS{idProduct}=="6010", MODE="664", GROUP="plugdev"
```

- •4: 断开调试器再重新连接到 Linux 系统中。
- 5:使用 1s /dev/ttyUSB* 命令查看 ttyUSB 信息,参考输出如下:

```
/dev/ttyUSB0
```

/dev/ttyUSB1

• 6: 使用 ls -1 /dev/ttyUSB1 命令查看分组信息,参考输出如下:

crw-rw-r-- 1 root plugdev 188, 1 Nov 28 12:53 /dev/ttyUSB1

可以看到 ttyUSB1 已经加入 plugdev 组,接下来我们要将自已添加到 plugdev 组(不同环境可能名字不同,请根据实际情况修改)。使用 whoami 命令查看当前用户名,我们将其记录为 < your_user_name > 。

• 7: 使用 sudo usermod -a -G plugdev <your_user_name> 命令将自已添加进 plugdev 组。 加入以后一定要重启或者注销操作系统。
- 8: 再次确认当前用户名已属于 plugdev 组,使用 groups 命令,可以看到打印信息中有 plugdev 即成功将当前用户添加至 plugdev 组。如果没有可以尝试重启。
- 9: 查看 gcc 的依赖是否完整, 如果有依赖需要安装, 可以执行 sudo apt install libncursesw5libtinfo5 进行安装

```
cd Nuclei Studio/toolchain/gcc/bin/
```

```
ldd ./riscv-nuclei-elf-gdb
```

```
linux-vdso.so.1 (0x00007fffc83f3000)
libtinfo.so.5 => not found
libncursesw.so.5 => not found
libdl.so.2 => /lib/x86_64-linux-gnu/libdl.so.2 (0x00007f4df6d08000)
libm.so.6 => /lib/x86_64-linux-gnu/libm.so.6 (0x00007f4df6c21000)
libpthread.so.0 => /lib/x86_64-linux-gnu/libpthread.so.0 (0x00007f4df6c1c000)
libc.so.6 => /lib/x86_64-linux-gnu/libc.so.6 (0x00007f4df69f2000)
/lib64/ld-linux-x86-64.so.2 (0x00007f4df6d1e000)
```

Debug Configuration

使用 Nuclei Studio 生成的 Debug Configuration

为了方便用户调试, Nuclei Studio 在创建工程时, 会根据 NPK 的配置, 默认的生成 Debug Configurations 的 Launch 文件。



用户可以展开工程,选中对应的test_debug_openocd.launch文件,在右键菜单中,可以Run as/Debug as->test_debug_openocd,就可以按照对应的Debug Configurations操作工程程了。

						-	
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Project Explorer 🛛		- 8					
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∨ 📂 test							
> 🐉 Binaries							
> 🗊 Includes							
> 🔁 application							
> 🔁 Debug							
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test debug open							
test_debug_qemu		New	>				
		Open					
		Show In	Alt+Shift+W >				
		Open With	>				
		Show in Local Terminal	>				
	Þ	Сору	Ctrl+C				
	Ē	Paste	Ctrl+V				
	×	Delete	Delete				
		Move					
		Rename	F2				
	è	Import					
	4	Export					
		Build Project					
	\$	Refresh	F5				
		Profiling Tools	>				
	Б	Run As	>	c 1 test de	ebug openoco	d	
	*	Debug As	>		figurations		
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0 items	(1	Export to Package Management					
Description	٨	SDK Configuration Tools	Ctrl+6	Location	Туре		
	200	Due ClCus Cada Arabata					

具体的 Debug Configurations 的内容可以在 Launch Bar 中进行详情查看。

🚳 NucleiStudio_workspace - NucleiStudi	DE	
<u>F</u> ile <u>E</u> dit <u>S</u> ource Refac <u>t</u> or <u>N</u> avigate	Se <u>a</u> rch <u>P</u> roject <u>R</u> un <u>R</u> V-Tools	<u>W</u> indow <u>H</u> elp
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Project Explorer 🛛 🖓 🗖		
□ \$ 7 8		
∨ 👺 test		
> 🖑 Binaries		
> 🗊 Includes		
> 🔁 application		
> 🔁 Debug		
> > ⊱ nuclei_sdk		
📄 test_debug_jlink.launch		
test_debug_openocd.launch		
test_debug_qemu.launch		

🚳 Edit Configuration			×				
Edit GDB OpenOCD	Debugging configuration test_debug_openocd for <u>R</u> un						
Launch Configuration I	Name: test_debug_openocd						
📄 Main 🏇 Debugge	r 🕨 Startup 🦃 Source 🔲 <u>C</u> ommon 🔀 SVD Path						
OpenOCD Setup							
Start OpenOCD	locally						
Executable path:	{openocd_path}/\${openocd_executable}	Browse	Variables				
Actual executable:	$\label{eq:c:Users} C: \label{eq:users} C: \l$	penocd\bin/	openocd.exe				
	(to change it use the <u>global</u> or <u>workspace</u> preferences pages or the <u>project</u> properties pa	ge)					
GDB port:	3333						
Telnet port:							
Tcl port:	6666						
Config options:	-f "nuclei_sdk/SoC/demosoc/Board/nuclei_fpga_eval/openocd_demosoc.cfg"		^				
Allocate console	for OpenOCD Allocate console for the telnet connect	ion	~				
GDB Client Setup							
Start GDB sessio	n						
Executable name:	\${cross_prefix}gdb\${cross_suffix}	Browse	Variables				
Actual executable:	riscv-nuclei-elf-gdb						
Other options:							
Commands:	set mem inaccessible-by-default off		~				
	set remotetimeout 250						
			\checkmark				
Remote Target							
Host name or IP a	ddress: localhost						
Port number:	3333						
Force thread list u	pdate on suspend						
Restore defaults							
		014					

新建并配置 Debug Configuration

通过 Nuclei Studio 新建并配置 Debug Configuration 内容的步骤如下。

在 Nuclei Studio 的主菜单栏中选择 Run—>Debug Configurations。

OPDE - NucleiStudio			- 0	×
File Edit Source Refactor Navigate Search Project	Run RV-Tools Window Help Run Ctrl+F11	1001日・2011日(日・1011日)、1011日(日)、1011日(日)、1011日)、1011日(日)、1011日)、1011日(日)、1011日)、1011日(日)、1011日)、1011日(日)、1011日)、1011日(日)、1011日)、1011日(日)、1011日)、1011日(日)、1011日)、1011日(日)、1011日)、1011日(日)、1011日)、1011日(日)、1011日)、1011日(日)、1011日)、1011日(日)、1011日)、1011日(日)、1011日)、1011日(日)、1011日)、1011日(日)、1011日)	Ouick Acces	
Se Project Explorer # O S P P O	Debug F11 Profile	• •	Boutline B Task List Build Tar	
<pre>Frider Explorer # Cover = * @ 1 helioworld > @ application > @ Debug > @ nucle_sdk</pre>			In Outline is not evaluable.	
10 1	External Tools	erninat		3 • • •
CDT	T Build Console [1_helloworld]			
21:	<pre>3/11 "Lean-only Build of contage (c team.ulei_sdk/SoC/hbird/Common/Sou .ff ./nullei_sdk/SoC/hbird/Common/Sou 37:11 Build Finished. 0 errors, 0 warn.</pre>	<pre>vation used for project i_tellewria **** rce/Stubs/fstat.o ./nuclei_sdk/SoC/hbird/Common/Source/Stubs/fstat.o ./nuclei_sdk/SoC/hbird/Common/So ings. (took 171ms)</pre>	µurce/Stubs/gettimeofday.o ./nuclei_sdk/So	ıC/hbi

在弹出的窗口中,如果没有当前工程的调试设置内容,右键单击 GDB OpenOCD Debugging,选择 New,将会为本项目新建出一个调试项目 hello_world_demo Debug。确保 Project 是当前需要调试的工程, C/C++ Application 中选择了正确的需要调试的 ELF 文件。

🚯 Run Configurations			_		×
Create, manage, and run	configurations				
[] @ @ @ ¥ = ≯ ▼	Configure launch settings from	this dialog:			
type filter text	- Press the 'New Configuration	on' button to create a configura	ation of the se	elected t	vne
 Build Docker Image C/C++ Application C/C++ Container Lau C/C++ Remote Appli C/C++ Unit Docker Compose GDB OpenOCD De hello_world_det GDB PyOCD Debu GDB QEMU Debuc GDB SEGGER J-Lini 	 Press the 'New Prototype' bu Press the 'Export' button to Press the 'Duplicate' button Press the 'Delete' button to Proce the 'Eilter' button to New Configuration New Prototype Export Duplicate Delete 	tton to createonfiguration pro o export the selected configurat o remove the selected configura o remove the selected configura onfigure filtering options. guration by selecting it. and then senk Prototype' menu and then ses' menu item to re-	itotype of the ions. ation. ition. nu item to lir i item to unlir eset with pro	e selected nk a prot nk a prot totype v	otype. otype. otype. alues.
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Filter matched 15 of 15 iter	T I I I I I I I I I I I I I I I I I I I				
?			Run	Clos	se

选择调试项目 hello_world_demo Debug 的 Debugger 菜单,在 Config options 栏目中填入 -f "nuclei_sdk/SoC/evalsoc/Board/nuclei_fpga_eval/openocd_evalsoc.cfg",以确 保 OpenOCD 使用正确的配置文件。这里的配置文件 (*nuclei_sdk/SoC/evalsoc/Board/nuclei_fpga_eval/ openocd_evalsoc.cfg*) 根据实际工程中 openocd 的配置文件路径而定。例如:如果使用 makefile 方式导入工 程,修改此处的内容为 -f "SoC/evalsoc/Board/nuclei_fpga_eval/openocd_evalsoc.cfg"。 如果当前内核是 RISC-V 32 位内核,请确保 Commands 内容包含 set arch riscv:rv32

如果当前内核为	64位。	应确保恭换为	sot	arch	riscu.ru6/
如木当前内极内	04 12,	应确怀有秩入	set	arcn	LISCV:LV04

8 Run Configurations	_		×
Create, manage, and run configurations			
Image type filter text Build Docker Image C/C++ Application C/C++ Remote Application C/C++ Loint Docker Compose GDB OpenOCD Debugging GDB POCD Debugging GDB ExCGERD-Link Debugging GDB ExCGERD-Link Debugging GLaunch Group Launch Group Launch over Serial GR Nu Docker Image	Name: hello_world_debug_openocd Main & Debugger > Startup > Source Common > SVD Path Project: relio_world C/C++ Application: Debug/hello_world.eff Variables Search Project Build (if required) before launching Build Configuration: Select Automatically C Enable auto build Disable auto build Use workspace settings Configure Workspace Settings	Brows	e
	Run	Clos	se

选择调试项目 hello_world_demo Debug 的 Startup 菜单,确保 Debug in RAM, Pre-run/ Restart reset, Set Breakpoint at Main和Continue 被勾选。

cute, manage, and ran configura					
P 🕫 🗎 🗶 🖻 🍄 🔻	Name: hello world o	lebug openocd			
vpe filter text	🗈 Main 🏇 Debugge	Startup \$ Source Common \$ SVD	Path		
 Build Docker Image C/C++ Application C/C++ Container Launcher C/C++ Remote Application C/C++ Unit Docker Compose GDB OpenOCD Debugging chello_world_debug_openocd GDB PyOCD Debugging GDB SEGGER J-Link Debugging Launch Group Launch Group (Deprecated) Launch over Serial 	OpenOCD Setup Start OpenOCD Executable path: Actual executable: GDB port: Telnet port: Tcl port: Config options: Allocate console	locally \${openocd_path}/\${openocd_executable} C:\Users\24954\Desktop\NucleiStudio_IDE (to change it use the <u>global</u> or <u>workspace</u> p 3333 4444 6666 -f *nuclei_sdk/SoC/hbird/Board/hbird_eva for OpenOCD A	202008\NucleiStudio_IDE_202 preferences pages or the project Nopenocd_hbird.cfg*	Browse Variabl 008\NucleiStudio properties page)	es >\\to
🖥 Run Docker Image	GDB Client Setup	n			
	Executable name:	\${cross_prefix}gdb\${cross_suffix}	1	Browse Variabl	es
	Actual executable:	riscv-nuclei-elf-gdb			
	Other options:				
	Commands:	set remotetimeout 250 set arch riscv:rv32			^
	Remote Target	Idease Is a lb a st			
	Port number:	3333			
	Force thread list	Ipdate on suspend			
ter matched 15 of 18 items			R	evert A	oply

完成配置后点击右下方 Apply 保存设置。

& Run Configurations	-	
Create, manage, and run conf	igurations	
🗋 🖻 ն 🗎 🗮 🖻 🌩 🔻	Name: hello world debug openord	
 type filter text Build Docker Image C/C++ Application C/C++ Container Launche C/C++ Remote Applicatio C/C++ Unit Docker Compose GDB OpenCD Debuggin GDB QEMU Debugging GDB QEMU Debugging GDB SEGER J-Link Debug Launch Group Launch Group (Deprecate Launch over Serial Run Docker Image 	Name: Intello_work_debug_operiod Main & Debugger > Startup > Source Common > SVD Path Initialization Commands Initial Reset. Type: init Commands Initial Reset. Type: init Commands Common > SVD Path Commands Com	File System
۲ ۵	Set program counter at (hex): Set breakpoint at: main Continue	Restore default
Filter matched 15 of 19 items	Run	Close

在原型开发板上调试程序

在开发板上调试之前,需要打开串口以便观察 Printf 函数打印信息。

使用 Windows 系统打开串口的方法如下:

打开 Nuclei Studio 自带的串口打印通道,选择 Window>Show View>Terminal,如图 7-13 所示, 点击显示器图标打开串口设置选项。



在其窗口中设置 Choose terminal (选择串口,即 Serial Terminal)、串口号(这里以 COM11 为例)、波 特率(设置为 115200)等参数后,单击 OK 按钮。

6	Launch Te	rminal —	
	Choose term	ninal: Serial Ter	minal ~
	Settings		
	Serial port:	COM11	~
	Baud rate:	115200	\sim
	Data size:	8	~~
	Parity:	None	
	Stop bits:	1	~
	Encoding:	Default (ISO-88	59-1) ×
	?	OK	Cancel

使用 Linux 系统打开串口方法如下:

打开 Nuclei Studio 自带的 Terminal 终端,选择 Window>Show View>Terminal,点击显示器图标 打开串口设置选项。choose terminal 选择 Local Terminal,点击 OK 打开 Terminal 终端。

😮 🗊 Launch Terminal
Choose terminal: Local Terminal Settings
Encoding: UTF-8
Cancel OK

在框口中输入minicom /dev/ttyUSB1 115200 打开串口,即可在 Nuclei Studio 中查看串口打印 信息。

🖳 hbird (ubuntu) 🖾 Welcome to minicom 2.7 OPTIONS: I18n Compiled on Nov 15 2018, 20:18:47. Port /dev/ttyUSB1, 14:38:05 Press CTRL-A Z for help on special keys CTRL-A Z for help | 115200 8N1 | NOR | Minicom 2.7 | VT102 | Offline | ttyUSB1

如果程序员希望能够调试运行于原型开发板中程序,可以使用 Nuclei Studio IDE 进行调试。由于 IDE

运行于主机 PC 端, 而程序运行于原型开发板上, 因此这种调试也称为 在线调试或者 远程调试。

这里以 1_helloworld 为例,使用 Nuclei Studio IDE 对 evalsoc 原型开发板进行在线调试的步骤如下:

Note: 注意 demosoc 在 Nuclei SDK .5.0 中被移除,请使用 evalsoc 作为替代。

确保 Debug 设置内容正确,可以打开 Debug 设置选项确认。在 1_helloworld 工程处右击,选择 Debug As >Debug Configuration 打开 Debug 设置页面选择之前新建的设置进行检查。



确定设置无误后,在下拉框选中 Debug,之后左侧图标会变为甲虫图标,单击即可进入调试模式并 下载程序进入开发板中。



切换至 Debug 模式,如果下载成功,则会启动调试界面。

- 如图1号标注位置,这里功能包括单步,运行,汇编级调试等。
- 如图 2 号标注位置,这个箭头表示当前程序运行位置。

- 如图 3 号标注位置,在代码的左侧双击即可在该行设置断点,再次双击可以取消断点。
- 如图 4 号标注位置,这里可以切换编辑模式和调试模式。
- 如图5号标注位置,这里是函数内变量显示的位置。
- 如图 6 号标注位置,这里是查看寄存器数值的位置。图中显示的是 PC 寄存器当前的数值。
- 如图7号标注位置,点击这里红色按钮可以退出调试模式。
- 如图 8 号标注位置的下方,这里可以使用 GDB 控制台指令进行调试。

OucleiStudio_workspace - helloworld/application/main.c - NucleiStudio	IDE		– a ×
File Edit Source Refactor Navigate Search Project Run RV-Tools W	indow Help 🚺		0
🔨 💿 🔳 🏶 Debug 🚽 🖻 helloworld_debug_or 🗠 🗄 🖬 🖬	≝♥♀♀♀♡♡⊁₨≠╚◙@♂⋦⋈⋹⋼⋒⋑≠₽₽₩		🚯 🔍 😰 🔜 🕫
Debug R beroject Explorer	main.c * @ main.c © (adb11).proc[42000].threadGroup[i1].adb[1].proc[42000].OSthread[1]).thread[1].frame[0]	" □ ••• V ≈ •• B ≪ E \$\$M % P *	🕮 Registers 😫 🛍 🖻 📑 😁 🗆
E helloworld debug openocd [GDB OpenOCD Debugging]	65 if (misa_bits.b.p) {	▲ (10 년 년 8	Name
✓ 2 helloworld.elf	<pre>66 misa_chars[index++] = 'P';</pre>	Name Type	uu t4
 P Thread #1 (Suspended : Step) 	67 }	⇔i int	107 t5
main() at main.c:95 0x80000fdc	69 misa_chars[index++] = 'T':	w rval uint32_t	III t6
J openocd.exe	70 }	∞ misa rv_csr_t	^{III} pc
√l riscv-nuclei-elf-gdb	71 if (misa_bits.b.u) {		III ft0
	72 misa_chars[index++] = 'U';		188 ft1
	73 J 74 if (misa hits h y) J		111 ft2
	75 misa chars[index++] = 'V';		111 ft3
	76 }		III ft4
	77 if (misa_bits.b.x) {		100 ft5
	70 Bisa_chars[index++] = A ; 79 }		IN RO
	80		10 m fe0
	<pre>81 misa_chars[index++] = '\0';</pre>		100 fp1
	82		100 fs0
	<pre>83 printt("MISA: KV%s(r\n", misa_cnars); 84 }</pre>		W fa1
	85		III fa2
	86=int main(void)		III fa3
	87 (III fa4
	<pre>srand(_get_rv_cycle() _get_rv_instret() Kv_csk_kEAU(csk_MCYCLE)); sq uint32 + rval = rand();</pre>		III fa5
	90 rv csr t misa = RV CSR READ(CSR MISA);		_ illi fa6 ⊻
	91	< >	< >
	<pre>92 printf("MISA: 0x%lx\r\n", misa);</pre>	Name : misa 🛛 🔿	Name : pc 🔨
Q Current Position.	93 print_misa();	Details:1075089709	Decimal: - 2147479588
XX	95 for (int i = 0: i < 20: i ++) {	Detault:1075089709	Octal:020000007734
· · · · · · · · · · · · · · · · · · ·	96 printf("%d: Hello World From Nuclei RISC-V Processor!\r\n", i);	Hex:0x4014912d	Binary:10000000000000000
Streak Point	97 }	Binary:10000000001010010	Default:0x80000fdc <mair< td=""></mair<>
	98	Octal:010005110455	
	Jan J	-	
	101		
	102	✓	~
		\rightarrow \langle \rightarrow	< >
	🛛 Console 🐘 Problems 🔍 Executables 🦉 Debugger Console 🔅 🕽 Memory		🕜 🗖 🗸 – 🗆
	nelloworld debug openocd [GDB OpenOCD Debugging] \${cross prefix}gdb\${cross suffix} (???)		
	Breakpoint 3, main () at/application/main.c:92		^
	<pre>J2 printf("MISA: 0x%lx\r\n", misa);</pre>		
	print misa();		
	<pre>// / / / / / / / / / / / / / / / / / /</pre>		
			~
	<		>
			🔞 🗠 🛤 🖉 🖉 🖉

下载运行程序

调试程序没有出现问题后,可以将程序下载进开发板。点击下拉框切换至运行模式,此时左侧图标会切换为绿色运行按键,单击即可将程序下载至开发板并运行。由于调试和下载运行使用相同的设置文件, 所以不需要再次设置。

CPDE - NucleiStudio		– a ×
File Edit Source Refactor Navigate Search Pro	ject Run RV-Tools Window Help	
S O B O Run ^ E 1_helloworld_de	y or a second a line way of the second s	Quick Access 🛛 😰 🔯 🕸
Se Project Explore a non a second a sec		Southine H Task List Build Tar Docume
✓ ∅ 1_hellow		
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程序正常运行后,可以看到串口正确打印出 helloworld 等信息。

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如果想要结束程序运行并需要断开连接,在 console 栏目下点击红色按钮断开连接。

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2.9.3 使用 J-Link 调试运行项目

安装 J-Link 驱动并导入 RTT 文件

HummingBird Evaluation Board 也支持使用 J-Link 调试。前往 SEGGER 官网 J-Link 页面 (https://www.segger. com/downloads/jlink/#J-LinkSoftwareAndDocumentationPack), 根据自己的操作系统下载最新的 J-Link 驱动并安装。注意, J-Link 的版本必须高于 v6.62 版本。

如果使用串口进行打印输出,则可以略过本节后续内容。如果想使用 J-Link 的 RTT 打印输出,请按照以下步骤配置。

打开当前工程的设置页面,在 Resource 选项点击红框标注的图标快速打开工程所在的目录。

Properties for 1_helloworld				×
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0	Apply and Clo	se	Cancel	

在 nuclei_sdk/SoC/evalsocsoc/Common/Source/Stubs 路径下新建一个 SEGGER 文件夹, 此文件夹用来存放 RTT 相关文件。

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■ 图片	🤍 read.c	2020/8/6 20:06	C 文件	
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安装完成后打开 J-Link 驱动的根目录,将 Samples -> RTT 路径下的 SEGGER_RTT_V680d. zip 解压缩(具体压缩包名可能因版本不同而变化)。解压缩后文件内容,将 RTT 文件夹下的

SEGGER_RTT.c, SEGGER_RTT.h和 SEGGER_RTT_Conf.h 三个文件以及 Syscalls 文件夹下的 SEG-GER_RTT_Syscalls_GCC.c 这些文件复制到之前新建的 SEGGER 文件夹中。

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最后在 IDE 中打开 SEGGER_RTT_Syscalls_GCC.c , 注释 #include <reent.h> 所在的这一行。

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v e puclai rdk	48 49			
> MACIO SUK	59 File : SEGGER RIT Syscalls GC.c.			
x = Sof	51 Purpose : Low-level functions for using printf() via RTT in GCC.			
× hbird	52 To use RTT for printf output, include this file in your			
> as Board	53 application.			
x & Common	54 Revision: \$Rev: 17697 \$			
> @ Include	55 */			
x a Source	57 #if (defined GNUC) && !(defined SES ARM) && !(defined CROSSWORKS ARM)			
> Drivers	58			
300 =	59 //#include <reent.h> // required for _write_r</reent.h>			
 Stubs 	60 #include "SEGGER_RTT.h"			
× In SEGGER	62	_		
> R SEGGER RTT Conf.h	639 /*****			
SEGGER RTT Syscalls GCC	.c 64 *			
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> 🗟 close.c	07 58 */			
> 🗟 fstat.c	69=//			
> 🧟 gettimeofday.c	70 // If necessary define the _reent struct			^
> 🗟 isatty.c	71 // to match the one passed by the used standard library.			
> 🗟 lseek.c	72 //			
> 🗟 read.c	73 struct _reent;			
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文件添加完成后添加 SEGGER 文件夹路径至 include, 打开当前工程的设置页面, 添加 SEGGER 文件夹路径至 include 中。



接下来移除原有的 write 函数。在 nuclei_sdk/SoC/evalsoc/Common/Source/Stubs 下的 write.c 文件处右击,选择 Resource Configurations > Exclude from Build。如图 7-30, 选择 Select All,点击 OK。

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Beard B	Rename Import Export	F2	<pre>a_bits.b.x) { a_chars[index++] = 'X'; findex++ = 'X'; findex++ = 'X'; findex++ = 'A'; f</pre>							
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以后如果想切换回使用串口打印,可以使用相同的方式移除 SEGGER 文件夹并把 write.c 文件添加回工程。



Debug Configuration

使用 Nuclei Studio 生成的 Debug Configuration

为了方便用户调试, Nuclei Studio 在创建工程时, 会根据 NPK 的配置, 默认的生成 Debug Configurations 的 Launch 文件。

🛞 NucleiStudio_workspace - NucleiStudio	DE
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📄 test_debug_jlink.launch	
test_debug_openocd.launch	
test_debug_qemu.launch	
	⊑ Console ⊠
	No consoles to display at this time.

用户可以展开工程,选中对应的 test_debug_jlink.launch 文件,在右键菜单中,可以 Run as/Debug as->test_debug_jlink,就可以按照对应的 Debug Configurations 操作工程程了,

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		Replace With			>							
	✓	Validate										
		Properties			Alt+Enter							

具体的 Debug Configurations 的内容可以在 Launch Bar 中进行详情查看。

🚳 NucleiStudio_workspa	ce - NucleiStudio	DIDE						
<u>F</u> ile <u>E</u> dit <u>S</u> ource Refa	c <u>t</u> or <u>N</u> avigate	Se <u>a</u> rch	<u>P</u> roject	<u>R</u> un	<u>R</u> V-Tools	<u>W</u> indow	<u>H</u> elp	
🔨 💽 🔳 💽 R	un	~ ©	test_debu	ıgjlink	c	√ ‡	1	- 8 6
월 - 월 - 한 라 🔶	• \$ • 1							
Project Explorer 🛛								
 test \$ Binaries Binaries Includes application Debug Debug Pounclei_sdk test_debug_jlink.la test_debug_opend test_debug_qemu 	aunch ocd.launch i.launch							

8 Edit Configuration			×
Edit GDB SEGGER	J-Link Debugging configuration test_debug_jlink for Run		
Launch Configuration	Name: test_debug_link		
Main 🌾 Debugge	r 🗭 Startup 🦃 Source 🔲 Common 🛣 SVD Path		
J-Link GDB Server S			
Executable path	Connect to running target (filink path//filink adhrenver)	Browse	Variables
Executable path:		browse	variables
Actual executable:	C:/Program Hies/SEGGER/JLink/JLink/GDBServerCL.exe	t proportio	- paga)
Device name:	rv32	Supported	device names
Endianness:	Little O Big		
Connection:	USB O IP USB serial or IP nam	ne/address)	
Interface:	⊖ CJTAG		
Initial speed:	● Auto ○ Adaptive ○ Fixed kHz		
GDB port:	2331		
SWO port:	2332 Verify downloads 🗸 Ir	nitialize regis	sters on start
Telnet port:	2333 🗹 Local host only 🗌 Si	ilent	
Log file:			Browse
Other options:	-singlerun -strict -timeout 0 -nogui		
Allocate console	o for the GDB server ☑ Allocate console for semihostin	ng and SWO)
GDB Client Setup			
Executable name:	\${cross_prefix}gdb\${cross_suffix}	Browse	Variables
Actual executable:	riscv-nuclei-elf-gdb		
Other options:	-		
Commands:	set mem inaccessible-by-default off		~
			~
Remote Target			
Host name or IP a	ddress: localhost		
Port number:	2331		
Force thread list u	pdate on suspend		
		l	<u>Restore defaults</u>
2 Duplicate	Delete	OK	Cancol
Duplicate	Delete	UK	Cancel

新建并配置 Debug Configuration

新建并配置 J-Link 调试下载的 Debug Configuration 步骤如下:

在菜单栏中选择 Run—>Debug Configurations。在弹出的窗口中,如果没有当前工程的调试 设置内容,右键单击 GDB SEGGER J-Link Debugging,选择 New Configuration,将会为本项 目新建出一个调试项目 1_helloworld Debug。



确保 Project 是当前需要调试的工程, C/C++ Application 中选择了正确的需要调试的 ELF 文件。

Bebug Configurations						_		×
Create, manage, and run configura	ations						ł	ð.
								5
□ 2 % 10 ¥ 10 3> ▼	Name: 1 helloworld Det	bug						
type filter text	🗈 Main 🔅 Debugger	Startup Source Comme	on 🔀 SVD Path					
C/C++ Application	Project:							
© C/C++ Container Launcher	1_helloworld						Browse	e
C/C++ Postmortem Debugger	C/C++ Application:							
C/C++ Remote Application	Debug\1_helloworld.elf							
GDB Hardware Debugging					Variables	Search Project	Browse	e
✓ ■ GDB OpenOCD Debugging	Build (if required) befo	re launching						
I_helloworld_debug_openoc	Build Configuration: S	elect Automatically						\sim
New_configuration GDB PvOCD Debugging	O Enable auto build			O Disable auto build				
© GDB QEMU Debugging	Use workspace setti	ngs		Configure Workspace Settings				
✓ ■ GDB SEGGER J-Link Debugging								
I helloworld Debug								
 Launch Group (Deprecated) 								
Filter matched 16 of 18 items						Revert	Apply	/
(?)						Debug	Close	ρ
<u> </u>						Jobag	0.03	-

打开 Debugger 栏目,确保1号位置 Start the J-Link GDB server locally 被选中。

2号位置正确指向 JLinkGDBServerCL.exe 的路径。

3 号内是当前使用的内核,这里以 N307 为例,输入 N307 即可。如果使用 RV-STAR 开发板,这 里输入 GD32VF103VBT6。如果使用其他开发板请参考 J-Link Support Device 网页,链接如下: https: //www.segger.com/downloads/supported-devices.php

4号选择 Interface 为 JTAG, initial speed 为 Auto。

5号确认与使用的 GDB 设置一致。

如果有修改的内容,点击6号位置 Apply 保存。

🚯 Run Configurations					- 🗆 X
Create, manage, and run configura	itions				
	Name: 1_helloworld	Debug			
Build Docker Image	🖹 Main 🌣 Debugge	🔹 🕒 Startup 💱 Source 🗖 Common 🖥	SVD Path		
C/C++ Application	J-Link GDB Server S	etup 1	•		
C/C++ Container Launcher	✓ Start the J-Link	GDB server locally	2	Connect to running target	
C/C++ Remote Application	Executable path:	\${jlink_path}/\${jlink_gdbserver}			Browse Variables
ت C/C++ Unit	Actual executable:	C:/Program Files (x86)/SEGGER/JLink	/JLinkGDBServerCL.exe		
Docker Compose		(to change it use the <u>global</u> or <u>works</u>	<u>Dace</u> preferences pages or t	the <u>project</u> properties page)	
GDB OpenOCD Debugging	Device name:	N307 3			Supported device names
I_nelloworld_debug_openocd	Endianness:	● Little ○ Big			
cos debug openocd	Connection:	● USB ◯ IP	USB serial or IP name/addr	ess)	
c demodsp debug openocd	Interface:	🔿 SWD 🖲 JTAG			
demotimer_debug_openocd	Initial speed:	Auto	4		
dhrystone_debug_openocd	GDB port:	2331			
Itashhelloworld_debug_openocd	SWO port:	2332		Verify down	loads 🗌 Initialize registers on start
le helloworld debug openocd	Telpet port:	2222			
New configuration	i ci	2335		V Local Host C	
plic_debug_openocd	Log file:				Browse
rtth_debug_openocd	Other options:	-singlerun -strict -timeout 0 -nogui		_	
whetstone_debug_openocd	Allocate console	e for the GDB server		Allocate console for semihosting and SWO	
GDB PYOCD Debugging	GDB Client Setup	6			
GDB SEGGER J-Link Debugging	Executable name:	\${cross_prefix}gdb\${cross_suffix}			Browse Variables
1_helloworld Debug	Actual executable:	riscv-nuclei-elf-gdb			
Launch Group	Other options:				
Launch Group (Deprecated)	Commands:	set mem inaccessible-by-default off			^
Run Docker Image					×
Fran Docker mage	D T .				-
	Remote Target				
	Host name or IP ac	Idress: localnost			
	Port number:	2331			
	Force thread list	update on suspend			
					Restore defaults
					6
Filter matched 28 of 30 items					Revert Apply
Ø					Run Close

打开 Startup 栏目,确保 JTAG/SWD Speed 为 Auto, set Breakpoint at main, Continue, Pre-run/Restart reset 和 RAM application 选项被勾选,并且取消勾选 Initial Reset and Halt 选项。

🚯 Run Configurations			- 🗆 X
Create, manage, and run configurati	ons		
1° 🖻 🕫 🗎 🗮 🗮 🖛 🛪	Name: 1 helloworld Debug		
 type filter text Build Docker Image C/C++ Application C/C++ Container Launcher C/C++ Container Launcher C/C++ Unit Docker Compose GDB OpenOCD Debugging 1_helloworld_debug_openocd GDB PyOCD Debugging GDB SEGER J-Link Debugging GDB SEGER J-Link Debugging Launch Group Launch Group (Deprecated) Launch over Serial Run Docker Image 	Name: [1_helloworld Debug Main % Debugger ▶ Startup Source □ Common % SVD Path Initialization Commands Initial Reset and Halt Type: Low speed: 1000 kHz JTAG/SWD Speed: ● Auto ● Adaptive ● Fixed kHz ☑ Enable flash breakpoints ☑ Enable semihosting Console routed to: ☑ Telnet ☑ GDB client ☑ Enable SWO CPU freq: 0 Hz. SWO freq: 0 I Load Symbols and Executable ☑ Load symbols ● Use project binary: 1_helloworld.elf ● Use file: ☑ Load executable ● Use file: ☑ Runtime Options ☑ RaM application (reload after each reset/restart) Run/Restart Commands	Workspace	File System
	Set program counter at (hex): Set breakpoint at: Continue	Pewert	Restore defaul
			,
?		Run	Close

以上设置内容完成后,如果有变动需要点击右下角 Apply 保存设置,如果没有变动点击 close 即可。

在原型开发板上调试程序

使用 J-Link 在 HummingBird Evaluation Board 调试需要连接跳线。红框标注的部分是 J-Link 需要连接到板子的部分。

	1		
VTref	1 💽	• 2	NC
nTRST	3 •	• 4	GND
TDI	5 •	• 6	GND
TMS	7 •	• 8	GND
тск	9 •	• 10	GND
RTCK	11 •	• 12	GND
TDO	13 🔹	• 14	*
RESET	15 •	• 16	*
DBGRQ	17 •	• 18	*
5V-Supply	19 🔹	• 20	*
			1

其中 VTref 连接到板子上 V3.3的接口,其他部分连接到 JTAG 接口,各引脚的丝印就在旁边,一一对应连接即可,最后实物连接如下图。



在开发板上调试之前,如果使用串口打印,需要连接JTAG上的串口引脚到自己的主机上,再打开 串口以便观察 Printf 函数打印信息。如果使用 RTT 打印,需要打开 J-Link RTT Viewer 查看 printf 打 印信息。按照图中内容设置,选择 USB 方式连接。Specify Target Device 根据使用的内核来修改,这里以 N307 为例。Target Interface & Speed 设置为 1000kHz,可根据实际使用情况来修改。RTT Control Block 选择 Auto Detection。

🔜 J-Link RTT Viewer V6.80d Co	nfigura	?	×
Onnection to J-Link	erial No		
O Existing Session			
Specify Target Device			_
N307		~	
Script file (optional)]
Target Interface & Speed			
JTAG	•	1000 l	kHz 🝷
RTT Control Block Auto Detection Address J-Link automatically detects the	⊖ s RTT cont	Gearch I rol blo	Range ock.
	OK	Ca	ancel

在 Launch Bar 的下拉框选中 Debug, 之后左侧图标会变为甲虫图标,单击即可进入调试模式并下载程序进入开发板中。

CPDE - 1_helloworld/application/main.c - Nuclei	Studio		– a ×
File Edit Source Refactor Navigate Search Pro	iect Run RV-Tools Window Help		Quick Assess i at 150 to
O Run O	<pre>Brmanc =</pre>	• •	E Outline II BTask List ♥Build Tar_ \$COUTINE = U u stdio.h u timeh u stdib.h u nuclei sdk soc.h
 >>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>	<pre>6</pre>		 print_mise(void); void main(void); int
	85 printf("MLSA: 0x51g(r\n", mise); < Srokens @ Taks ©Console H □ Properties #Terminal Ⅲ Disasembly %Progress	>	
	CDT Build Console [] helioworld] 10:5:38 **** Increamental Build of configuration Debug for project i_helloworld **** make all Inovking: 000 RISC-V Cross Print Size riscv-nuclei-elf-size -roformatberkelay 'i_helloworld.elf" text data bis isé her filanese text data bis isée her filanese finished building: i_helloworld.siz		^
	19:15:38 Build Finished. 0 errors, 0 warnings. (took 325ms)		
< >>	< Writable Smart Insert 95	d1	> 3 a = * * 0

如果程序下载成功,并且 Nuclei Studio 会启动调试界面。

- 如图1号标注位置,这里功能包括单步,运行,汇编级调试等。
- 如图 2 号标注位置,这个箭头表示当前程序运行位置。
- 如图 3 号标注位置,在代码的左侧双击即可在该行设置断点,再次双击可以取消断点。
- 如图 4 号标注位置,这里可以切换编辑模式和调试模式。
- 如图5号标注位置,这里是函数内变量显示的位置。
- 如图6号标注位置,这里是查看寄存器数值的位置。
- 如图7号标注位置,点击这里红色按钮可以退出调试模式。
- 如图 8 号标注位置下方,这里可以使用 GDB 控制台指令进行调试。

& NucleiStudio_workspace - helloworld/application/main.c - NucleiStudio	IDE		- a ×
File Edit Source Refactor Navigate Search Project Run RV-Tools V	indow Help 0		0
🔨 💿 🔳 🏶 Debug 🚽 🖻 helloworld_debug_or - 🌣 🗄 🖬 🖬	ڲٳڛヽOヽዔヽ@@@ダヽ[J□ <mark>ヽ ▶॥■∀⋋⊙∠ ⊭≒∞ と</mark> も@ @ @ヽñヽ♡♂⇔ヽヽヽ!™	6	0 q 🕫 🔜 🛚
👁 Debug 🗷 🖕 Project Explorer 🛛 🗎 👘 🗉 🗖	a main.c a main.c (gdb[1].proc[42000].threadGroup[i1].gdb[1].proc[42000].OSthread[1].thread[1].frame[0]	□ ⊷V ≈ %B ≪E ☎M % P * □ □	Registers 🛛 🖾 🖻 🗅 😁 🗆
Construction of the second debug of row of ro	<pre>alp - 0 - 0 - 0 - 0 - 0 - 0 - 0 - 0 - 0 -</pre>	Name v = v = v = v = v = v = v = v = v = v	Registers C
© Current Position	<pre>90 rv_con⁺_t tiss = _RV_CGR_READ(CSR_NISA); 91 printf("NSS: 0xKlx(\n", miss); 92 printf("NSS: 0xKlx(\n", miss); 93 printf("SS: 0xKlx(\n", miss); 94 printf("SS: 0xKlx(\n", miss); 95 printf("SS: 0xKlx(\n", miss); 96 printf("SS: 0xKlx(\n", miss); 97 printf("SS: 0xKlx(\n", miss); 98 printf("SS: 0xKlx(\n", miss); 99 printf("SS: 0xKlx(\n", miss); 90 printf("SS: 0xKlx(\n", miss); 90 printf("SS: 0xKlx(\n", miss); 90 printf("SS: 0xKlx(\n", miss); 91 printf("SS: 0xKlx(\n", miss); 92 printf("SS: 0xKlx(\n", miss); 93 printf("SS: 0xKlx(\n", miss); 94 printf("SS: 0xKlx(\n", miss); 95 printf("SS: 0xKlx(\n", miss); 96 printf("SS: 0xKlx(\n", miss); 97 printf("SS: 0xKlx(\n", miss); 98 printf("SS: 0xKlx(\n", miss); 98 printf("SS: 0xKlx(\n", miss); 99 printf("SS: 0xKlx(\n", miss); 99 printf("SS: 0xKlx(\n", miss); 90 printf("SS: 0xKlx(\n", miss); 91 printf("SS: 0xKl</pre>	Name: misa Detail::1075089709 Default:1075089709 Hex:0x4014912d Bhary:10000000011001f Octal:010005110455	Vame: pc Hex:0x80000fdc Decimal:214747588 Octal:02000007734 Binary:10000000704 Default:0x80000fdc <mmir< td=""></mmir<>
	< <u>0</u> >	< >	< >
	🛛 Console 🐘 Problems 🔍 Executable 🖉 Debugger Console 🖄 Demory		0 🗖 🗸 🗸 🖓
	<pre>elebword debug operacd (DBD OperatXD Debuggang) Stores peraphots 1, main () atapplication/main(:cig2 printf("MISA: extlx\r\n", misa); } print_misa(); for (int i = 0; i < 20; i ++) {</pre>		
	<		>
			70 (A) (C) ≠ ¥ (

下载运行程序

调试程序没有出现问题后,可以将程序下载进开发板,点击下拉框切换至运行模式,此时左侧图标会切 换为绿色运行按键,单击即可将程序下载至开发板并运行。



由于调试和下载使用相同的设置文件,所以不需要再次设置。可以看到 RTT Viewer 正确打印出 helloworld 等信息。

🔜 J-Link RTT Viewer V6.80d	_		×
File Terminals Input Logging Help			
All Terminals Terminal 0			
<pre>00> Nuclei SDK Build Time: Aug 17 2020, 00> Download Mode: ILM 00> CPU Frequency 5000724 Hz 00> MISA: 0x4014912d 00> MISA: RV32IMACFDSPU 00> 0: Hello World From Nuclei RISC-V Pr 00> 1: Hello World From Nuclei RISC-V Pr 00> 2: Hello World From Nuclei RISC-V Pr 00> 3: Hello World From Nuclei RISC-V Pr 00> 4: Hello World From Nuclei RISC-V Pr 00> 5: Hello World From Nuclei RISC-V Pr 00> 5: Hello World From Nuclei RISC-V Pr 00> 6: Hello World From Nuclei RISC-V Pr 00> 7: Hello World From Nuclei RISC-V Pr 00> 8: Hello World From Nuclei RISC-V Pr 00> 9: Hello World From Nuclei RISC-V Pr 00> 10: Hello World From Nuclei RISC-V Pr 00> 10: Hello World From Nuclei RISC-V Pr 00> 11: Hello World From Nuclei RISC-V Pr 00> 12: Hello World From Nuclei RISC-V Pr 00> 13: Hello World From Nuclei RISC-V Pr 00> 13: Hello World From Nuclei RISC-V Pr 00> 14: Hello World From Nuclei RISC-V Pr 00> 15: Hello World From Nuclei RISC-V Pr 00> 16: Hello World From Nuclei RISC-V Pr 00> 17: Hello World From Nuclei RISC-V Pr 00> 16: Hello World From Nuclei RISC-V Pr 00> 17: Hello World From Nuclei RISC-V Pr 00> 16: Hello World From Nuclei RISC-V Pr 00> 17: Hello World From Nuclei RISC-V Pr 00> 18: Hello World From</pre>	18:52: rocesso	11 r! r! r! r! r! r! r! r! or! o	<
	F+	<i>C</i> 1	
	Furet.	Clear	
LOG: Temp. halted CPU for NumHWBP detect LOG: HW instruction/data BPs: 8 LOG: Support set/clr BPs while running: LOG: HW data BPs trigger before executio	ion No	nst	^
LOG: RTT Viewer connected.			
<		>	\sim
RTT Viewer connected.	0.004 1	MB	

如果需要断开连接,在 console 栏目下点击红色按钮即可断开连接。



2.9.4 使用 DLink 调试运行项目

DLink 是芯来科技基于 RV Link,并在其基础上做功能迭代升级后,所研发的 RISC-V 调试器,使之更适应于 Nuclei Studio 的应用场景。目前 Dlink 仅针对单核 RISC-V 工程实现调试运行,且已实现 量产,具体实物如下,具体关于 Dlink 固件下载参见 https://github.com/Nuclei-Software/nuclei-dlink/wiki/ upload-dlink-firmware。

Note: 在 芯来科技视频号中有 如何在 Nuclei Studio 中通过 Dlink 调试程的视频,您可以在微信中搜索 芯来科技视频号点击查看相关内容。



如需使用 Dlink 进行调试,可以在 NucleiStudio 菜单中 Run -> Run Configurations 打开 Run Configurations 的配置页面,并配置一个 Dlink Debug Configuration,双击 GDB Custom Debugging 新建一个 配置项,并在 Main 选项卡中配置内容如下:

& Run Configurations						
Create, manage, and run configurations						6
(Name: test_dlink Debug	isable auto build figure Workspace Set	Variables	Search Project	Browse	
Filter matched 19 of 19 items				Pup	Class	
				Kun	ciose	

在 windows 环境下安装驱动步骤如下:

打开 GB 网站并搜索 GD32VF1,在列表中打到 GD 32 Dfu Drivers,下载并安装。

地址: https://www.gd32mcu.com/en/download/7?kw=GD32VF1

GD32 Dfu Drivers	3.6.6.6167		none 20	20-06-09
Introduction: The drivers for the GD32 Dfu device				
在 Linux 环境下安装驱动步骤如下:				
1: 连接开发板到 Linux 中,确保 U	SB 被 Linux 识别出来。			
2: 在控制台中使用 lsusb 指令查看信	言息,参考的打印信息如-	下:		
003 Device 057: ID 28e9:018a	GDMicroelectronics D	link Low C	ost Schem	e
3: 控制台中输入 sudo vi /etc/	udev/rules.d/50-dl	ink.rules	指令打开5	50-dlink.rule

文 件,输入如下内容,保存退出,并执行 sudo udevadm control --reload。

SUBSYSTEM=="usb", ATTR{idVendor}=="28e9",

ATTR{idProduct}=="018a", MODE="664", GROUP="plugdev"

SUBSYSTEM=="tty", ATTRS{idVendor}=="28e9",

ATTRS{idProduct}=="018a", MODE="664", GROUP="plugdev"

- 4: 断开调试器再重新连接到 Linux 系统中。
- 5: 使用 1s /dev/ttyACM* 命令查看 ttyACM 信息,参考输出如下:

/dev/ttyACM0 /dev/ttyACM1

Bus

• 6:使用 1s -1 /dev/ttyACMO 命令查看分组信息,参考输出如下,可以看到 ttyACMO 已经被加入到 dialout 组,接下来我们要将自己添加到 dialout 组(不同环境可能名字不同,请根据实际情况修改)。使用 whoami 命令查看当前用户名,我们将其记录为 < your_user_name >。

shell crw-rw-r-- 1 root dialout 166, 0 6月 28 15:25 /dev/ttyACMO

- 7: 使用 sudo usermod -a -G dialout <your_user_name> 命令将自己添加进 dialout 组。 加入以后一定要重启或者注销操作系统。
- 8:再次确认当前用户名已属于 dialout 组,使用 groups 命令,可以看到打印信息中有 dialout 即成功 将当前用户添加至 dialout 组。如果没有可以尝试重启。

然后在 Debugger 选项卡内配置内容如下,因为在 Custom Debugging 中支持多种 Mode,我们现在需要使用 Dlink,所以选中 Dlink; Server check flag 是在 NucleiStudio 中用以确认服务是否正常启动,在 Custom GDB Server 中如果服务正常启动,会输出一段字符串,NucleiStudio 通过判断该字符串以确认 Custom GDB Server 正常启动,在使用 Dlink 时这里可以为空;在 Config options 中需要配置对应的链接文件 dlink_gdbserver.cfg,参考配置文件可以在 <NucleiStudio>/toolchain/dlink 目录下找到。

se Variable: r_console.exe
se Variable: r_console.exe
se Variable: r_console.exe
se Variables
se Variables
r_console.exe
r_console.exe
se Variable
v

Edit GDB Custom Debugging configuration test_debug_dlink for Debug	
Launch Configuration Name: test_debug_dlink	
Main ≫ Debugger ► Startup ♥ Source □ Common & SVD Path	
	^
	~
Load Symbols and Executable	
O Use file: Vorkspace File Syste	m
Symbols offset (hex):	
☑ Load executable	
Use project binary: test.elf	
O Use file: Workspace File Syste	m
Executable offset (hex):	
Runtime Options	
Debug in RAM	
Run/Restart Commands	
	^
	~
Set program counter at (hex):	
Set breakpoint at:	
Continue	
Restore.	defaults
Duplicate Delete OK Car	cel

在 windows 下, Dlink 连接上 PC 和开发板后, 亮一个绿色灯和一个蓝色灯, 说明 Dlink 处理正常工作状态, 否则不正常, 可以安 NRST 键尝试复位。



Dlink 连接后,在串口工具下,可以看到两个 COM 口,一个 COM 串用于串口输出,一般情况下数字低的 COM 口是调试的,另一个用于串口数据交换,用户需要在 dlink_gdbserver.cfg 指明用于数据交互的 COM 口,并配置 serial port 和 serial baud,例于在 Windows 下 serial port COM1、 serial baud 115200;在 Linux 下 serial port ttyACM0、 serial baud 115200,如果用户不配置,Dlink 会使用 COM 口中编号较小的那个为 serial port 默认值,并且以其对应的设备号为 serial baud 默认值,以 Windows 下为例,可以参考配置如下:

& NucleiStudio_workspace - test/dlink_gd	bserver.cfg - NucleiStudio IDE			
File Edit Navigate Search Project RV-	-Tools Run Window Help			
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 	Cloxi0 Commine Config 1## Dlink Debug Config 2#debug true 3 4## Gdb Server Port Config 5gdb port 3333 6 7## Dlink Config 8#serial port CMM26 10# serial port CMM26 10# serial port CMM26 11# serial number SNS7AF085 12# serial vid 0x28e9 13# serial pid CMM28 14 15## Debug Interface Config 16# transport select jtag 17# transport select cjtag 19		 Ma × ● Br I Ex I VIs Name Marne Marne	Q in the product of t
	10 19## SPI And XIP Address Config 20# flash spi_base 0x10014000 21# flash xip_base 0x20000000 22# flash xip_size 0x10000000 73# flash block size 0x10000 © Console × ⅢRegisters ☜ Progress 舵 Problem	s 📀 Executables 🗟 Debugger Console 🛙 Memo	≺ ory 4 ⁹ Terminal ■ X 🖗 🔒 🗗	, , , , , ,
	test debug dlink [GDB Custom Debugging] Using gdb port 3333 specified by command line argument -pl Using auto probed dlink debug serial port "COM41". Using serial port "COM41" as dlink debug port! Opened "COM41" bauk: 115200 Started by GNU MCU Eclipse Dlink GDB Server: v0.9.1 Version Server listen to port: 3333 Server socket connected: 3333 Server socket connect success. Dlink Firmware: v0.9.1 Version read misa: "0x4094912b"			
			Launching tes	st debug dlink: (100%) 💻 🕾

开始 Debug,如果配置正确,则在 Console 中有输出如下,并且 Dlink 亮绿灯。

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Eile Edit Navigate Search Project RV-Tools Run W	indow <u>H</u> elp					
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🏶 Debug × 陷 Project Explorer 🛛 🖻 🕷 🛤 🗧 🗖	🗈 main() at 0x8000024a × 🖻 main.c 📄 dlink_gdbserver.cfg	🗉 🔅 Va × 🗣 Br 🛠 Ex 😤	Vi 📟 Di 🔓 Pe 📍 🗖			
✓	No source available for "main() at 0x8000024a"		🗄 🎫 🖯 📑 😫			
 [®] test_dlink.elf 	View Disassembly	Name	Туре			
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[Server listen to port: 3333		^			
	portName: "COM41" serialNumber: "SN587A0AAF" Open: "COM41" baud: 115200					
	Dlink GDB Server: v0.9.0 Version					
	Started by GNU MCU Eclipse Dlink Finnware: v1 0 0 Version					
	Server socket connect: 3333					
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通过串口工具,联接上另一个串口。
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Settings		
Serial port:	COM43	~
Baud rate:	COM41	
Data cizar	COM43	
Data size:	ð	~
Parity:	None	~
Stop bits:	1	~
Encoding:	Default (ISO-8859-1)	~
?	OK	Cancel

并可以查看到串口中有正确的内容输出,与预期一致,则 Dlink 可以正常调试,其他操作步骤与 OpenOCD 大体一致。

& NucleiStudio_workspace - Source not found NucleiSt	udio IDE			
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	Got rand integer 358317 using seed 214274081.			^
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	4: Hello World From Nuclei RISC-V Processor!			
	5: Hello World From Nuclei RISC-V Processor! 6: Hello World From Nuclei RISC-V Processor!			
	7: Hello World From Nuclei RISC-V Processor!			
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	14: Hello World From Nuclei RISC-V Processor!			
	16: Hello World From Nuclei RISC-V Processor!			
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				~
Closed - Encoding: UTF-8	1		Launching test of	llink Debug: (100%)

2.10 Nuclei Studio 其它功能

2.10.1 导入旧版本 Nuclei Studio 创建的工程

Nuclei Studio 2023.10 版导导入旧工程

在 Nuclei Studio 2023.10 版本中,因为工具链、sdk 等增均做了较大的修改,如果用户在新的 Nuclei Studio 中想要使用旧版的 Nuclei Studio 创建的工程,或者使用旧的 sdk,需要参考本章节内容进行操作。

将旧的 Nuclei Studio 中的工程导入到 Nuclei Studio 2023.10 中时(具体导入工程的方法,可以阅读*Nuclei Studio 2022.12* 之后版本导入旧工程(page 180)),或者使用旧的 sdk(旧的 sdk 指的是在 Nuclei Studio 2023.10 发布之前所发布的 sdk)所创建的工程,因为工程配置使用使用的是 gcc 10,当找不到对应的工具链,会出现编译报错等问题,导致工程无法正常使用。



我们提供了两种解决方案,第一种方案是手动导入 gcc 10 工具链,第二种方案是通过 Nuclei Studio 2023.10 所带的转换工具进行转换。在此推荐使用第二种方案,能比较好的将工程转换成 Nuclei Studio 2023.10 所支持的工程,并能使用其最新特性。

手动导入 GCC 10 工具链

为了方便用户使用,在 Nuclei Studio 2023.10 中保留了 GCC 10 相关的配置,但没有将 GCC 10 打包 到 IDE 中,如果用户想要继续在 GCC 10 下进行开发,可以手动将 GCC 导入进来。

首先,在旧版 Nuclei Studio 的安装目录中的 toolchain\gcc\目录找到 GCC 10,并将其中内容复制到 Nuclei Studio 2023.10 的安装目录下的 toolchain\gcc10\内。然后重新编译工程,工程可以正常编译,但这种方法,Nuclei QEMU 是无法正常使用,如果有 Nuclei QEMU 需求的项目,需要收到修改下 QEMU 对应的调试配置。

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openocd	2023/9/5 17:26	文件夹	openocd	2023/10/27 14:44	文件夹	
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🥁 ReadMe.txt	2023/1/6 16:07	TXT 文件	and Me.txt	2023/10/27 12:25	TXT 文件	1 KB

通过工具将工程转换成支持 GCC 13 的工程

为了方便用户导入旧的工程,并能正常使用 Nuclei Studio 2023.10 特性,我们提供了快速转换工具 Convert GCC 10 Project to GCC 13,选中工程点击鼠标右键,在弹出的菜单中找到 Convert GCC 10 Project to GCC 13并点击。

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ing Expert-		22 $\frac{1}{2}$ if (miss hits, b, f) (
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8 Refresh	15	22 miss_there[index++] = 'W';	
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and the second se			

工程转换成功后,重新编译工程,此时 Nuclei Studio 将调用 GCC 13 编译工程,并且 QEMU 等功能也能正常使用。



批量将工程转换成支持 GCC 13 的工程

为了方便用户导入旧的工程,并能正常使用 Nuclei Studio 2023.10 以上版本的特性,批量将工程转换 成支持 GCC 13 的工程。



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			Writable	Smar	rt Insert	154 : 1 : 7	7464	5

打开转换工具,然后选择需要转换的工程,开始转换。





Nuclei Studio 2022.12 之后版本导入旧工程

为了方便工程共享, Nuclei Studio 2022.12 版对工程的导入做了优化,在 IDE 中将一个工程导出后,可以 双击打开 .nuproject 的方式,快速将工程在 Nuclei Studio 中导入并打开。

首先,在 Nuclei Studio 2022.12 版中导出一个工程,在需要导出的工程上右键,选中 Export。



在弹出的 Export 对话框中 General->File System, 按向导依次操作,可以把工程导出到指定文件夹。

Export				_		×
r Export resources to	the local file			2	5	
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Options <u>O</u> verwrite existing files without warr <u>C</u> reate directory structure for files Create only selected directories <u>R</u> esolve and export linked resource	ning s				
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其次,导入工程。查看导出的工程,可以看到工程中有一个 test.nuproject 文件,点击这个文件,就可以将工程导入到 Nuclei Studio 中去了,具体的可以参考通过应用关联文件导入工程 (page 94)。

新建文	【件夹 → test →			在 test 中搜索
^		修改日期	类型	大小
	settings	2022/12/30 15:57	文件夹	
1	application	2022/12/30 15:57	文件夹	
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*	📔 .cproject	2022/12/30 15:50	CPROJECT 文件	46 KB
*	.project	2022/12/30 15:50	Project File	1 KB
*	🚯 test.nuproject	2022/12/30 15:50	NUPROJECT 文件	1 KB
	test_debug_jlink.launch	2022/12/30 15:50	LAUNCH 文件	8 KB
	test_debug_openocd.launch	2022/12/30 15:50	LAUNCH 文件	6 KB
	📄 test_debug_qemu.launch	2022/12/30 15:50	LAUNCH 文件	7 KB

Nuclei Studio 2022.12 之前版本导入旧工程

Nuclei Studio 2023.10 版本工具链名称从 riscv-nuclei-elf-gcc 更名为 riscv64-unknown-elf-gcc,且gcc版本从gcc10升级到gcc13。

Nuclei Studio 从 2020.08 版本开始, 官方工具链从 RISC-V Nuclei GCC (riscv-nuclei-elf-gcc) 升级到 GNU MCU RISC-V GCC (riscv-none-embed-gcc), 因为编译前缀发生变化,所以使用 201909 及其之前版本的 IDE 生成的工程,经过调整设置后才可以在新版本 IDE 中使用。这里以 201909 版本的 Nuclei Studio 生成的 helloworld 工程为例,其导入及修改设置的详细步骤如下:

- · 导入 201909 版本生成的 helloworld 工程,详细的导入方式请参考 [25.2 节,这里不做赘述。
- 导入工程后右击选择 Properties 打开设置页面,选择 C/C++ Build ?? Settings,打开 Toolchains 栏目然后修改 Name 下拉选项为 RISC-V Nuclei GCC (riscv-nuclei-elf-gcc) 。修改后点击 Apply 保存修改。

\delta Properties for he	llo_world	— D X
type filter text	Settings	(⇒ ▼ ⇔) ▼ ▼
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Tool Chain Ec	Architecture:	RISC-V V
> C/C++ General Linux Tools Path	Prefix:	riscv-nuclei-elf-
> MCU	Suffix:	
Project Natures	C compiler:	gcc
Run/Debug Sett	C++ compiler:	g++
> Task Repository	Archiver:	ar
Task Tags	Hex/Bin converter:	objcopy
WikiText	Listing generator:	objdump
	Size command:	size
	Build command:	make
	Remove command:	rm
	Toolchain path:	{eclipse_home}\\toolchain\\gcc\\bin
		(to change it use the <u>global</u> or <u>workspace</u> preferences pages or the <u>project</u> properties page)
	Build tools path:	<pre>\${eclipse_home}\toolchain\build-tools\bin</pre>
		(to change it use the <u>global</u> or <u>workspace</u> preferences pages or the <u>project</u> properties page)
	Create flash imag	e
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?		Apply and Close Cancel

• 修改后右击工程选择 Clean Project 再选择 Build Project 即可。

2.10.2 LST View

在 Nuclei Studio 2024.06 版本中,集成了 LST View 工具,LST View 可以单独使用,也可以在 Trace 工具 或 GProf 工具中被呼起,主要功能,是帮助用户方便的查看 LST 文件,并实现 LST 文件与源码的联动。

在 Nuclei Studio 中依次 Window -> Show View -> Other, 在弹出的 Show View 中搜索 LST View。

Window Help			
New Window Editor Appearance	> > >		📲 : 🚯 : 💷 : 🏪 : 🌂 💵
Show View	> e _e	Breakpoints	Alt+Shift+Q, B
Perspective Navigation Preferences	> > %	Console Debug Debugger Console	Alt+Shift+Q, C
		Debug Sources Disassembly Error Log Executables Expressions	Alt+Shift+Q, L
		Memory Memory Browser Modules Outline	Alt+Shift+Q, O
		Peripherals Problems Progress	Alt+Shift+Q, X
	1935 1935	Project Explorer Registers Signals Templates	
		Terminal Trace Control Variables Visualizer	Alt+Shift+Q, V
		Other	Alt+Shift+Q, Q

打开 LST View 工具。

×
_

LST View 的顶部有一个工具栏,在工具栏中有搜索下接框,可以输入您想要搜索的 Addr; Open File 菜单,点击会弹出一个文件选择器,可以选择想要打开的.lst 文件; Find 菜单,可以查找任意您想从 LST View 中查找的内容。



Open File 菜单, 在弹出的文件选择器中, 找到我们想要查看的 lst 文件, 一般在工程编译后的 Debug 目录。



打开文件后,可以进行查找操作,同时,当我们选中某行文字,并且文字中包含一个正确的 Addr 时, LST View 会通过这个 Addr 定位到对应的源码所在的文件及行数,并通过程序打开对应的源码文件,并 将光标定位到对应的行,通过 lst 文件反定位的源文件,实现两种文件的联动查看。

test/N	uclei Settings I intexc ns core0.5 I ns misc.c I ns usart.c ×	- 0	100- Variables 🗟 LST View × 💁 Breakpoints 🍕 Expressions 🕿 Multicore Visualizer 🖏 Perioherals
54 55 56 57 58 59 60 61 62 63 64 65 66 65 66 67 68	<pre>kines.comp. us mines.cp.coress. us us mands. uf h6_UARIZ ^A temp_div = f(mark)(SystemCoreClock) / USART_InitStruct->USART_BaudRate - 1; temp_div = temp_div - (int)temp_div; if (temp_div > 0, -5) { fraction_div > 0, -5) { less if (temp_div > 0, -5) { less if (temp_div > 0, -5) { less if (temp_div > 0, -5) { fraction_div > 0, -5) { less if (temp_div > 0</pre>		Interview Interview <thinterview< th=""> Interview <th< td=""></th<></thinterview<>
69 70 71 72 73 74 75 76 77 77 78 79 80 81 81 82 83	<pre>/ Gorfigure USARTx FXCTRL */ /* Configure USARTx-TXCTRL */ /*</pre>		1633 S000000066: 70e2 1d rs.56(sp) 1669 S000000066: 7442 1d s0,48(sp) 1661 S000000066: 7442 1d s0,48(sp) 1661 S000000066: 7442 1d s2,32(sp) 1661 S000000066: 69e2 1d s2,32(sp) 1663 S000000066: 69e2 1d s2,32(sp) 1664 S000000066: 69e2 1d s5,8(sp) 1665 S000000066: 612 1d s5,8(sp) 1665 S000000066: 612 add sp, sp, 64 1668 S000000066: 612 add sp, sp, 64 1669 USARTA->DIT * SystemCoreClock / USART InitStruct->USART_BaudRate = 1; 1670 S0000000664: 00200797 aulpc 1671 S0000000664: 00200797 aulpc

2.10.3 Code Coverage 和 Profiling 功能

在 Nuclei Studio 2023.10 版以上版本中,集成了Eclipse Linux Tools⁷,并对Eclipse Linux Tools⁸工具进行了 部分优化,使其可以支持 Nuclei Studio 工程使用 Code Coverage 和 Profiling 相关功能。在 Nuclei Studio 2024.06 版本中对Eclipse Linux Tools⁹的功能做了进一步的优化和升级,使其更容使用。

关于 Coverage、Profiling 和 Call Graph 的使用教程请查看Coverage、Profiling 和 Call Graph 使用 (page 191)。

关于 Eclipse Linux Tools 的详细参见 Eclipse Linux Tools¹⁰

在使用过程,如有问题,可以查看 https://github.com/Nuclei-Software/nuclei-studio 相关内容,也可以 向我们提交相关 issue。

Note: 在 芯来科技视频号中有 如何在 Nuclei Studio 中使用 Code Coverage 和 Profiling 功能的视频,您可以在微信中搜索 芯来科技视频号点击查看相关内容。

 $^{^{7}\} https://github.com/eclipse-linuxtools/org.eclipse.linuxtools/blob/master/RELEASE_NOTES.md#eclipse-linux-tools-release-notes$

 $[\]frac{8}{100} \text{ https://github.com/eclipse-linuxtools/org.eclipse.linuxtools/blob/master/RELEASE_NOTES.md\#eclipse-linux-tools-release-notes \text{ and } \text{ started} = 100 \text{ started} \text{$

⁹ https://github.com/eclipse-linuxtools/org.eclipse.linuxtools/blob/master/RELEASE_NOTES.md#eclipse-linux-tools-release-notes

 $^{^{10}\} https://github.com/eclipse-linuxtools/org.eclipse.linuxtools/blob/master/RELEASE_NOTES.md\#eclipse-linux-tools-release-notes$

关于 Code Coverage 功能

Nuclei Studio 中的 Code Coverage 功能是借助于 gcc 编译器提供 gcov 工具来查看指定源码文件的代码覆盖率,可以帮助开发人员确定他们的测试用例是否足够充分,是否覆盖了被测代码的所有分支和路径。

在 Nuclei Studio 中,通过给工程中的文件或者文件夹添加 --coverage 编译选项编译,在实际开发板上运行时,可以配合 semihost 功能实现文件读写到主机电脑上,就可以收集到需要的 coverage 文件 (gcda/gcno 文件),或者通过 Nuclei SDK 提供的 profiling 库¹¹ 来实现将 coverage 数据打印到串口上,然后 通过 IDE 来解析并保存到主机上。

Note: 注意:此处只需要将编译选项 --coverage 加到特定的应用目录或者源码文件上,而不能加到整个工程,否则在程序运行时将会消耗大量内存,导致运行失败。

- .gcno 文件是在使用 GCC 编译器的 -ftest-coverage 选项编译源代码时生成的。它包含了重 构基本块图和为块分配源代码行号的信息。
- .gcda 文件是在使用 GCC 编译器的 -fprofile-arcs 选项编译的目标文件运行时生成的。每个 使用该选项编译的目标文件都会生成一个单独的 .gcda 文件。它包含了弧转移计数、值分布计数 以及一些摘要信息。

而一般情况下直接使用 --coverage 选项就可以让指示编译器产生上述文件,注意*.gcda 文件 是运行时产生的,也就是说需要实际运行的环境支持文件的读写才可以产生这样的文件,这里我们采用 的是 semihost 技术,通过 openocd 的 semihost 功能,将文件写到主机上。

Note: 注意:进行 coverage 的时候,建议是使用 OO 编译,这样 coverage 的信息才会尽可能的准确。

关于 Code Coverage 的功能详细参见

- Gcov Intro (Using the GNU Compiler Collection (GCC))¹²
- Gcov Data Files (Using the GNU Compiler Collection (GCC))¹³
- Code Coverage for Embedded Target with Eclipse, gcc and gcov | MCU on Eclipse¹⁴

关于 Profiling 功能

Nuclei Studio 中的 Profiling 功能是借助于 gcc 编译器和 binutils 中的 gprof 工具,来查看指定文件中函数的运行时间和调用次数,以及调用关系。gprof 可以用来确定程序的瓶颈,以便进行性能优化。gprof 通过 在程序运行时收集数据来工作,然后生成一个报告,该报告显示每个函数在程序中占用 CPU 时间的百分 比以及函数之间的调用关系。

在 Nuclei Studio 中,通过带特定的编译选项 -pg 编译指定源码文件,在实际开发板上运行时,可以 配合 semihost 功能实现文件读写到主机电脑上,就可以收集到需要的 coverage 文件 (gcda/gcno 文件),或 者通过 Nuclei SDK 提供的 profiling 库¹⁵ 来实现将 coverage 数据打印到串口上,然后通过 IDE 来解析并保 存到主机上。

Note: 注意:此处只需要将编译选项 -pg 加到特定的应用目录或者源码文件上,而不能加到整个工程, 否则在程序运行时将会消耗大量内存,导致运行失败。

产生这个 gmon.out 文件需要配合编译器并且实际上板运行,并且运行环境支持文件的读写,才可 以进行有效的 Profiling 功能。

关于 Profiling 的功能详细参见

¹¹ https://github.com/Nuclei-Software/nuclei-sdk/tree/master/Components/profiling

¹² https://gcc.gnu.org/onlinedocs/gcc/Gcov-Intro.html

¹³ https://gcc.gnu.org/onlinedocs/gcc/Gcov-Data-Files.html

¹⁴ https://mcuoneclipse.com/2014/12/26/code-coverage-for-embedded-target-with-eclipse-gcc-and-gcov/

¹⁵ https://github.com/Nuclei-Software/nuclei-sdk/tree/master/Components/profiling

- Introduction (GNU gprof)¹⁶
- Using GNU Profiling (gprof) With ARM Cortex-M DZone¹⁷

关于 Call Graph 功能

Call Graph (调用图) 是一个强大的工具,它允许开发人员直观地理解程序中函数或方法之间的调用关系。 通过 Call Graph,开发人员可以迅速识别出哪些函数被频繁调用,哪些函数是关键的入口点,以及函数之 间的依赖关系。Nuclei Studio 中 Call Graph 主要是通过分析 Profiling 的数据,来获取到程序的调用关系。

在 NucleiStudio 中依次 Window -> Show View -> Other, 在弹出的 Show View 中搜索 Call Graph, 打开 Call Graph 工具。Call Graph 工具中提供了多处视图,其中常用到的视图有以下几个。

Radial View

本视图中展示了程序的调用关系,在左侧的菜点中,双击选中某个父节点,在右侧的区域将显示以这个父节点开始的所有的调用关系,也可以通过菜单在其他视图中以不同的方式查看所选中的调用关系。



Tree View

展示了 Radial View 中所选中的程序的调用关系、耗时所占比率、调用次数等信息;选中某一个函数,可以查看到它的父节点以及子节点等信息。

¹⁶ https://sourceware.org/binutils/docs/gprof/Introduction.html

¹⁷ https://dzone.com/articles/using-gnu-profiling-gprof-with-arm-cortex-m

III Call Graph ×	■ ● © ♥ 🐘	i 🗙 🕴 🗝 <i>e</i>
This call graph file is in : C:\Users\	rs\11653\NucleIStudio_workspace\profiling_semihosting/callgraph.out	
	main: 100.00%	
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Level View

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与 Tree View 有点类似,展示了程序的调用关系以及调用次数。

Aggregate View

₩ Call Graph ×			■ ► © 🈕 🛼 🔢 💥 🕴 🖛 #
This call graph file is in : C:\Users\11653\NucleiStudio_workspace	\profiling_semihosting/callgraph.out		
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以方图的方式,非常直观的展示了程序的耗时关系。

Coverage、Profiling 和 Call Graph 使用

在 NucleiSudio 2024.06 版中使用 Coverage、Profiling 和 Call Graph 方法很简单,下面以 NucleiSudio 2024.06、 nuclei_sdk 0.6.0 为例,通过两种方式分别演示如何使用 Coverage、Profiling 和 Call Graph 工具。

通过串口使用

nuclei_sdk 0.6.0 及以上版本的 nulclei_sdk 中,包含一个 Profiling demo to show how to use gprof and gcov 测试工程,在 NucleiSudio 安装了 nuclei_sdk 0.6.0 后,可以创建此测试工程。关于 Profiling demo to show how to use gprof and gcov 测试工程,可参考 demo_profiling¹⁸。

¹⁸ https://doc.nucleisys.com/nuclei_sdk/design/app.html#demo-profiling

& Create Nuclei RISC-V C/C++	project using npk sdk-nuclei_sdk @0.6.0-dev — 🗆 🗙	
Create project for SoC:Nucle Please select the relevant confi	i FPGA Evaluation SoC,Board:Nuclei FPGA Evaluation Bc guration item	
Project name:	test_gprof	
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Project Example:	Coremark Benchmark @app-nsdk_coremark ~	
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Select NMSIS Library:	FreeRTOS SMP Task Demo @app-nsdk_freertos_smpdemo FreeRTOS Task Demo @app-nsdk_freertos_demo	
Download/Run Mode:	Lowpower Demo for Nuclei Lowpower Feature @app-nsdk_lowpower Nuclei Cache Demo using Nuclei CCM feature @app-nsdk_demo_cache	
Nuclei RISC-V Core:	Nuclei NICE Extension Demo @app-nsdk_demo_nice Nuclei NMSIS DSP Library Demo @app-nsdk_demo_dsp Nuclei Vector NICE Extension Demo @app-nsdk demo vnice	
ARCH Extensions(ARCH_EXT=):	Physical Memory Protection(PMP) Demo @app-nsdk_pmp Probe and dump Nuclei RISC-V Processor Info @app-nsdk_cpuinfo	
Nuclei Cache Extensions:	Profiling demo to show how to use gprof and gcov @app-nsdk_demo_profiling RTThread MSH Demo @app-nsdk rtthread msh	
Nuclei SMP Count:	RTThread Task Demo @app-nsdk rtthread demo S-Mode ECLIC Interrupt Demo @app-nsdk demo smode eclic	
Boot HartID:	S-Mode Physical Memory Protection(sPMP) Demo @app-nsdk_spmp SMP Cluster Interrupt Distribution Unit Demo @app-nsdk_demo_cidu	
Heap Size:	SMP Helloworld in baremetal environment @app-nsdk_smpnello Simple Helloworld Demo @app-nsdk_helloworld Stack Check Demo for Nuclei Hardware Stack Check Feature, @app-nsdk demo st	ack check
Stack Size Per CPU:	ThreadX Task Demo @app-nsdk_threadx_demo Timer and Software Interrupt Demo @app-nsdk_demo_timer	v
Enable Semihosting:		
Standard C Library(STDCLIB=):	newlib_small: newlib nano with printf float	
Select Benchmark Options:	Options for Nuclei 300 Series 🗸	
?	< Back Next > Finish Cancel	

工程创建后,需要对想要进行代码分析的文件或文件夹设置一个-pg--coverage的编译选项,然后编译工程。

Note: 注意:此处只需要将编译选项 -pg --coverage 加到特定的应用目录或者源码文件上,而不能加 到整个工程,否则在程序运行时将会消耗大量内存,导致运行失败。



在编译通过的工程的 Debug 目录中,可以看到,已经生成了几个.gcno 的文件。

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> 5% profiling_gprof.elf - [riscv/le]					
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profiling_gprof_debug_link.launch					
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Image:					

工程编译完后,可以运行或调试工程,我们可以选择在 QEMU 下进行,也可以调试实际的开发板。 本例以 QEMU 为例进行运行程序,在 NucleiStudio 的 Console 窗口中可以看到 Profiling 信息输出,如果是 在开发板上调试,则是在串口输出中可以找到 Profiling 信息输出。



输出的 Profiling 信息需要解析后 NucleiStudio 才可以正确读取,在 Console 框内点击鼠标右键,然后在弹出的菜单中点击 Select All,来选中所有输出,再次击鼠标右键,在弹出菜单中选择 Parse and Generate HexDump 菜单。



此时 NucleiStudio 会对输出的文件进行分析,并将结果存别分存放在对应的文件中。



再次查看工程的 Debug 目录,可以看到产生了对应的.gcda 文件。



双击.gcda 文件, 打开 Gcov 工具, 就可以看到对应用程序的分析结果, 在结果中显示了某个文件 或某个方法在程序执行过程中是否执行到, 以及代码执行复盖比等数据。



双击 Gcov 中的某一行, NucleiStudio 就会自动打开对应的文,并对文件中的代码着色,绿色表示在 程序执行过程中有执行到,红色代表在程序过程中没有被执行到。开发者可以参考 Gcov 的结果,并对代 码做出相应的优化。

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code coverage 也提供了以直方图的方式查看数据,选中想要查看的数据项,点击菜单中的直方图菜单,并按需求配置。

🖹 Problems 🧔 Tasks 🖳 Co	onsole 🔲 Pro	perties 🍠 Tei	minal 🕞 gcov 🛿 📱	🖗 gprof 💊 Chart View	💊 Chart View	🕀 🖻 🧐 🖓 🛃 🔛 🚔 💽 🍡 💽 🍡
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双击 gmon.out 文件, 弹出一个文件选择框, 提示填写与选中与 gmon.out 文件相关的 elf 文件和 *.lst 文件, 默认会根据当 gmon.out, 自动填入对应的工程内的 elf 文件和 *.lst 文件, 点击 OK 按钮。

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Ret appointing out	

Gprof 工具会启动,就可以看到对应用程序的分析结果,显示了文件、方法的调用关系等。

双击 Gprof 中的某一行,NucleiStudio 就会自动打开对应的源文件并定位到对应的行,同时打开 LST View 工具,并根据 addr 定位那那一行,实现 Gprof、源代码、反汇编码的联系,帮用户快速了解程序结构及调用关系。

& NucleiStudio_workspace - test_gprof/applicat	ion/main.c - NucleiStudio IDE				
File Edit Source Refactor Source Navigate	Search Project RV-Tools Run Window Help				
🐔 🗿 🔳 🗿 Run 🗸 🖸 test	gprof_debug_qemu 💿 🔅 🗄 🕶 🔛 🐚 🛛 💌 🚳 🔹 🦿 📓 🤃) 🗠 💼 🚯 💷 🔍	2 👩 - 1	· 🚳 + 🖻 + 🞯 + i 🎋 + 🔘 + 🚱 + 隆 + i 🅭 🗁 🖋 + i 🕖 😜 📴 🗉	
				Q 181 🖬	*
陷 Project Explorer 🗵 😑 🧐 🍞 🛛 🖶 🗖	🖻 aes.c:173 🔹 main.c 🗵		- 0	3 🗄 Outline 🗟 LST View × 🗐 Task List . ● Build Targets 📟	
Conject txplorer × E S i i s S ■ C ✓ Set group A Nuclei Settings S Sincludes ✓ Settings ✓	<pre>28 29 29 29 29 29 29 29 20 20 20 20 20 20 20 20 20 20 20 20 20</pre>			2 Couline SIST View × Enack List ® Build Targets 10448 a0004d2c: ceda 10448 a0004d2c: ceda 10449 a0004d2c: ceda 10451 in [1] = _RV_CSR_EAD (CSR_EAD (CSR VC)(E) & Vorff: 10452 a0004d3c: b0002773 10453 a0004d3c: cesr 10453 a0004d3c: b0002773 10453 a0004d3c: b0002773 10455 a0004d3c: b0002773 10455 a0004d3c: b0002773 10455 a0004d3c: b03 10455 a0004d3c: b03 10455 a0004d3c: b03 10455 a0004d3c: b198 10455 a0004d3c: b198 10455 a0004d4c1: 4505 10458 a0004d4c1: 4505 10458 a0004d4c1: c505 10458 a0004d4c1: c50 10451 a00004d4c1:	
	✓ Summary	63	Culla	100.0%	
	✓ main.c	2		3.17%	
	∽ main	2	0	3.17%	
	 main (main.c:33) 	1		1.59%	
	0xa0004d34 sw a5,-32(s0)	1		1.59%	
	 main (main.c:79) 	1		1.59%	
	0xa0004f34 jal a0005022	1		1.59%	
	> gprof.c	6		9.52%	
	> aes.c	55		87.3%	
	C\Users\11653\NucleiStudio_workspace\test_gproftDeb	oug//application/main	.c:79	Swart Incent 33-1-714	84
		V	vitable	33:1:714	0

同样在 Nuclei Studio 中,可以查看 profiling 数据的直方图信息。



打开 Gprof 的同时, NucleiStudio 会根据 gmon.out 文件解析出程序的 Call Graph 并生成 callgraph.out 文件。双击 callgraph.out 文件,也可以点击 Gprof 工具的菜单栏中 Open Call Graph View 按钮,来启动 Call Graph 工具。关于 Call Graph 的具体使用,可以参考关于 Call Graph 功能 (page 189)。



通过 Semihosting 使用

NucleiSudio 安装了 nuclei_sdk 0.6.0 后,可以创建一个 Profiling demo to show how to use gprof and gcov 的测试工程,此时需要选中 Enable Semihosting。关于 Profiling demo to show how to use gprof and gcov 测试工程,可参考 demo_profiling¹⁹。

¹⁹ https://doc.nucleisys.com/nuclei_sdk/design/app.html#demo-profiling

& Create Nuclei RISC-V C/C++	project using npk sdk-nuclei_sdk @0.6.0-dev — 🛛	×	:
Create project for SoC:Nucle	ei FPGA Evaluation SoC,Board:Nuclei FPGA Evaluation Bc		
Project name:	profiling_semihosting		^
Project Filter by:	no filter v Filters:	~	
Project Example:	Profiling demo to show how to use gprof and gcov @app-nsdk_demo_pr	~ ~	
Toolchain:	RISC-V GCC/Newlib (riscv64-unknown-elf-gcc)	~	
Select NMSIS Library:	No NMSIS Library used	~	
Download/Run Mode:	SRAM download mode(sram mode use sram for 200/300, ddr for 600/900) ~	
Nuclei RISC-V Core:	N307FD Core(ARCH=rv32imafdc, ABI=ilp32d)	~	
ARCH Extensions(ARCH_EXT=):	_zba_zbb_zbc_zbs_xxldsp		
Nuclei Cache Extensions:	□ ICache □ DCache □ CCM		
Nuclei SMP Count:	0	* *	
Boot HartID:	0	* *	
Heap Size:	4K		
Stack Size Per CPU:	4K		
Enable Semihosting:			
Standard C Library(STDCLIB=):	newlib_nano: newlib nano without printf/scanf float	~	
Application Compile Flags:	-00		¥
?	< Back Next > Finish Can	icel	

工程创建后,需要对想要进行代码分析的文件或者文件夹设置一个-pg --coverage的编译选项,然后编译工程。



同时,需要修改程序中 gprof_collect(2);为 gprof_collect(1);、gcov_collect(2); 为 gcov_collect(1); (测试工程中在 main 函数的最后),则在运行过程中,将会通过 Semihosting 将 结果输出为文件。



开始编译工程,在编译通过的工程的 Debug 目录中,可以看到,已经生成了几个.gcno的文件。

陷 Project Explorer 🗵	트 🕏 🍸 👕 🕴 🗖 🗖
✓	
🚳 Nuclei Settings	
> 🖑 Binaries	
> 🗊 Includes	
> 📂 application	
🗸 🗁 Debug	
🗸 🗁 application	
> 🗟 aes.o - [riscv/le]	
> 🗟 gmult.o - [riscv/le]	
> 🗟 main.o - [riscv/le]	
📄 aes.d	
🐷 aes.gcno	
🗎 gmult.d	
😼 gmult.gcno	
🗎 main.d	
🐷 main.gcno	
🚡 subdir.mk	
> 🗁 nuclei_sdk	
> 🕸 profiling_gprof.elf - [riscv/le]	
🚡 makefile	
objects.mk	
profiling_gprof.hex	
profiling_gprof.lst	
profiling_gprof.map	
ources.mk	
> 🗁 nuclei_sdk	
profiling_gprof_debug_jlink.launch	
profiling_gprof_debug_openocd.launch	
profiling_gprof_debug_qemu.launch	

工程编译完成后,可以运行或调试工程,我们可以选择在 QEMU 下进行,也可以调试实际的开发板。



本例以 QEMU 为例进行运行程序,程序运行结束后,刷新工程,可以看到工程下多出了几个文件, *.gcda 文件以及 *.out 文件。至此,后面查看结果与上面类似。



在 Nuclei Studio 中通过 gcov 工具查看应用程序的 Code Coverage 信息。

& NucleiStudio_workspace - profiling_semihosting/applic	ation/aes.c - NucleiStudio IDE								
<u>File Edit Source Refactor Source Navigate Search</u>	Project RV-Tools Run Window H	lelp							
🔨 💿 🔳 🛛 Run 🗸 🖸 profiling_semi	hosting_debi 🗠 🔅 🗄 👻 🔛 🕼 🗎 📸	000	8 : 🛛 : 🗙 🕩	0 = M 3. (ə in 🗰 🗮 📰 🕹 i 🏘 🔹 (• 0	94 • 💩 🖾 🛷 • 🇾 🛛		
								Q	i 🗈 🗟 🔯
🏕 Debug 💁 Project Explorer 🗙 🖻 😫 🍞 😂 🖇 🗖 🗖	main() at 0x80000244	.c 💽 aes.c	×		-	• 🗆	(X)- V.,. X • B.,. 65 E.,.	🕿 V 🗟 L 📟 D 🧏	
✓ S profiling semihosting	166					^		K_ ⇒ti	D D P 8
Nuclei Settings	167⊖/*						Name	Type	
> 🗱 Binaries	168 * Transformation in t	he Cipher a	nd Inverse	Cipher in wh	nich a Round				
> 🔊 Includes	169 * Key is added to the	State usin	ig an XOR op	eration. The	e length of a				
✓	171 * Key length equals the state (1.e., for no = 4, the round 171 * Key length equals 128 bits/16 bytes).								
> 🗟 aes.c	172 */		-,,-						
> 🖻 aes.h	1738 void add_round_key(uin	t8_t *state	e, uint8_t *	w, uint8_t n	r) {				
> 🗟 amult.c	174								
> 🗎 amult.h	175 uint8_t c;								
> 🗋 main.c	177 for (c = 0; c < Nb	; c++) {							
Y 🗁 Debug	178 state[Nb*0+c]	= state[Nb*	0+c]^w[4*Nb	*r+4*c+0];	//debug, so it works				
Application	179 state[Nb*1+c]	= state[Nb*	1+c]^w[4*Nb	*r+4*c+1];		1			
> 🗟 aes.o - [riscv/le]	180 state[Nb*2+c]	= state[Nb*	2+c]^w[4*Nb	*r+4*c+2];			1		
> 🗟 gmult.o - [riscv/le]	182 }	 state[ND. 	3+c] W[4.ND	·[·+4·C+5];					
> 🛅 main.o - [riscv/le]	183 }								~
aes.d	184								
👺 aes.gcda	185 [©] /*			11 . 6	1				
👺 aes.gcno	185 ~ Transformation in t 187 * State and mixes the	ne Cipner t ir data (in	nat takes a	of one and	ther) to				
📄 gmult.d	<	11 0000 (11	dependenciy	or one unor	>		<		>
gmult.gcno		0.5						🖻 🚳 . A 💷 l 🕞 🖂 .	
🗎 main.d	Console and Registers 🖾 Problem	is 🕖 Executat	oles 🧬 Termina	al 🗠 Debugge	r Console U Memory 🕼 gcc	N X			- -
👺 main.gcda	program rups = 0								
👺 main.gcno	program file : C\Users\11653\Nuclei	Studio worksp	ace\profiling se	emihosting\Deh	ua\nrofiling semihosting elf				
🗟 subdir.mk	timestamp : 2024/6/21 18:54		ace (protining_o	, in the second second	ag protinig_contributingion				
> 🗁 nuclei_sdk	P type filter text								
> profiling_semihosting.elf - [riscv/le]	Name	Total Lines	Instrument	Executed Li	Coverage %				^
🗋 makefile	✓ aes.c	468	157	153	97.45%				
🗋 objects.mk	Rcon		10	10	100.0%				
profiling_semihosting.hex	add round key		7	7	100.0%				
profiling_semihosting.lst	aes cipher		18	18	100.0%				
profiling_semihosting.map	aes init		7	7	100.0%				
🗋 sources.mk	aes inv cipher		18	18	100.0%				_
> 🗁 nuclei_sdk	aes key expansion		23	23	100.0%				
👺 gmon.out	coef add		6	6	100.0%				
profiling_semihosting_debug_jlink.launch	coef mult		6	6	100.0%				
profiling_semihosting_debug_openocd.launch	gadd		2	0	0.0%				
profiling_semihosting_debug_qemu.launch	gsub		2	0	0.0%				~
	-			Writable	Smart Insert	173	.1.6216		-

在 Nuclei Studio 中通过 gprof 工具查看应用程序的 Profiling 信息。

& NucleiStudio_workspace - profiling_semihosting/nucle	i_sdk/Components/profiling/gprof.c - NucleiStudio IDE						
Eile Edit Source Refactor Source Navigate Search	Project RV-Tools Run Window Help						
🔨 💿 🔳 🛛 Run 🗸 🖸 profiling_semi	ihosting_debi 🛩 🌞 🗄 😁 👻 🔛 🐘 🗟 🖉 😒 🖢 🗎 👟 🖡	▶ II ■ N 3. G .	e i= = z 🕹	* • 0 •	🌯 • 🙋 🗁 🛷 •	<u>ø</u>	
· · · · · · · · · · · · · · · · · · ·							Q 🔡 🖬 🎋
🏶 Debug ଢ Project Explorer 🗵 🖻 🕱 🍞 🐲 🕴 🗖 🗖	🖸 main() at 0x80000244 🗈 main.c 🗈 aes.c 🖻 gprof.	c ×		- 8	(x)- V 🗣 B 🕸 E.	🏦 v 🖻 L × 💷 () 🔓 P 🔍 🗖
✓	264 } else {			^		Enter Addr h	ere 🗸 🗁 🔾
> 🖻 aes.c	<pre>265 p->scale = SCALE_1_T0_1;</pre>				4196 a00018dc	: 43dc	^
> 🖻 aes.h	266 } 267 moncontrol(1); /* start */				4197 a00018de	: e385	dia mankana
> 🖻 gmult.c	268 }				4199 4199	n->already setup	$= 1 \cdot$
> 🖻 gmult.h	_269				4200 a00018e0	: fdc42783	1w
> 🗟 main.c	270 [©] void _mcount(uint32_t *frompcindex)				4201 a00018e4	: 4705	
🗸 🗁 Debug	271 {				4202 a00018e6	: c3d8	de la manda de la
Y 🗁 application	272 register uint52_t "selfpc asm(ra); 273 register struct tostruct *top:				4203C:\Users	VII603 (Nucleistu)	<pre>110_WORKSpa +) PROCRAM</pre>
> 🗟 aes.o - [riscv/le]	274 register struct tostruct *prevtop;				4205 a00018e8	: a00007b7	lui
> 🗟 gmult.o - [riscv/le]	275 register long toindex;				4206 a00018ec	: 24078713	add
> 🗎 main.o - [riscv/le]	<pre>276 struct gmonparam *p = GMONPARAM;</pre>				4207 a00018f0	: a00077b7	lui
aes.d	2// 279 if (lp-)alpoady cotup) {				4208 a00018f4	: ae878793	add
aes.gcda	279 p ->already_setup = 1:				4210 a0001818	. 853a	
aes.gcno	<pre>280 monstartup((size_t) PROGRAM_LOWPC,</pre>	(size_t) PROGRA	M_HIGHPC);		4211 a00018fc	: 33ed	
🖹 gmult.d	281 }				4212 C:\Users	\11653\NucleiStu	dio_workspa
gmult.gcno	2820 /*				4213 }		
🗎 main.d	283 * check that we are protiling	woked			4214 /*	chock that we	aro profili
main.gcda	285 */	WOREU.		~	4216 *	and that we ar	en't recurs Y
main.gcno	<			>	<		>
🗟 subdir.mk	🖪 Concolo 🕮 Pagistary 💌 Problems 🕥 Evecutables 🖉 Term	inal 🖪 Debugger Co	ncolo 🖪 Momo	a 🕞 acou 🗖	annof V 🕀 🖻 🕏	5 - A 🖽 🛛 🐼 🐼 - C (
> 🗁 nuclei_sdk	Console in Registers Problems @ Executables @ Term	nal se Debugger Co	onsole u wemor	y 🖝 gcov 🗃	gpior × ··········		
> \$ profiling_semihosting.elf - [riscv/le]	program file: C:/Users/11653/NucleiStudio_workspace/profiling	semihosting/Debug/	profiling semihor	sting.elf			
🚡 makefile	program listing file: C:/Users/11653/NucleiStudio workspace/pro	filing semihosting/E	bebug/profiling s	emihosting.lst			
🗟 objects.mk	timestamp: 2024/6/21 18:54	v_ v.					
profiling_semihosting.hex	4 bytes per bucket, each sample counts as 1.000ms						
profiling_semihosting.lst	P type filter text						
profiling_semihosting.map	Name (location)	Samples	Calls	Time/Call	% Time		^
🚡 sources.mk	✓ gprof.c	4			4.17%		
✓	> monstartup	1			1.04%		
 Components 	✓ _mcount	3			3.12%		
Y 🗁 profiling	 _mcount (gprof.c:271) 	1			1.04%		
> 🗁 images	0xa00018ba add sp,sp,-64	1			1.04%		
> 🖻 gcov_api.h	 _mcount (gprof.c:280) 	1			1.04%		
> 🖻 gcov.c	0xa00018fc jal a00016e6	1			1.04%		
> 🖻 gprof_api.h	 _mcount (gprof.c:289) 	1			1.04%		
> gprof_stub.c	0xa0001908 lw a5,-36(s0)	1			1.04%		
> i gprof.c v	✓ aes.c	91			94.79%		~
		Writable	Smart Insert	280	:1:9418		

在 Nuclei Studio 中通过 Call Graph 查看调用关系信息。



2.10.4 Trace 功能的使用

Trace 技术是一种强大的调试工具,它能够帮助开发人员跟踪和记录程序执行过程中的关键信息,从而有 效地诊断问题、优化性能和提升系统的稳定性。

Nuclei Studio 集成了 Trace 工具,结合相对应的硬件和 Nuclei OpenOCD,用户在对工程进行 Debug 时,也可查看到 Trace 日志,并结合源码时行问题排查。

Note: 在 芯来科技视频号中有 如何在 Nuclei Studio 中使用 Trace 功能的视频,您可以在微信中搜索 芯 来科技视频号点击查看相关内容。

Note: 关于 OpenOCD 的 Nuclei ETrace 的一些命令,请参加 OpenOCD 下的 openocd.pdf 手册。

在使用过程,如有问题,可以查看 https://github.com/Nuclei-Software/nuclei-studio 相关内容,也可以 向我们提交相关 issue。

Trace 界面介绍

Trace View

在 Nuclei Studio 中,通过菜单 Window->Show View->Other 打开 View 管理器,在里面找到 RV Trace->Trace 菜单,打击打开 Trace 菜单。

🔂 Trac	e X							
10 () 🗄 🕏	E. E.	8 🖻 🕇	🖡 Search f	or Addr	(n m)	✓ 11111 is Selected	
Record	Coreld	Addr	CPU Clock	Clock Diff	Instructio	Instruction	File	File Line

Trace 的视图分两部分,上面为 Trace 工具栏,下面是 Trace 记录表格。Trace 工具栏的介绍和功能分别如下:

• Trace setting

trace 的配置信息, 在这里配置 Trace ATB2AXI Config Addr、Trace Buffer Base Addr、Trace Buffer Size in Bytes、Trace Wrap

- Start trace/stop trace
- 设置开始/停止 trace 操作。
- Trace clear

清空硬件上的所有的 trace 设置。

• Dump trace file

从硬件上 Dump trace 文件。

• Reload trace file

本地重新加载 trace 记录表内容。

• Clear viewer

清空 trace 记录表内容,以及 Trace Decode 相关的配置,如 HartID 和 Thread 的关系等。

Save trace log

将 trace 记录表保存为 csv 表格。

• Toggle instruction stepping

当选种某条记录时,可以打开并定位到该条记录所对应的源码和反汇编码。

• step into previous line

当选种某条记录时,跳转到该条记录的上一条记录,并定位到所对应的源码和反汇编码。

• step into next line

当选种某条记录时,跳转到该条记录的下一条记录,并定位到所对应的源码和汇编码。

• Search for Addr

搜索框,可以通过 Addr 搜索到对应的那一行 trace 记录。

search backward

搜索结果的记录是多条时,可以查看上一条搜索结果。

search forward

搜索结果的记录是多条时,可以查看下一条搜索结果。

• Page

多页的翻页, trace 如果条数很多时, 为了方便查看, 会采用多页显示。

Trace 记录表格,是 Nuclei Studio 将 dump 到的 trace 文件进行解密之后,生成的记录进行展示,并且当用户点击某条记录时,会自动定位到对应的源代码和反汇编代码的行数。

- Record:记录 id
- CoreId: Coreid, 主要是在多核时可以用于区分不同的 Core
- Addr: 指令地址
- CPU Clock:时钟 Cycle 计数
- Clock Diff:时钟 Cycle 差
- Instruction Code: 十六进制表示的指令码
- Instruction: 指令码

- File:指令码对应的源码所在的文件
- File Line:指令码对应的源码所在的文件的行数

Trace Configuration

用户可以在这里配置 Trace 的 Trace ATB2AXI Config Addr、Trace Buffer Base Addr、Trace Buffer Size in Bytes、Trace Wrap。具体的信息,根据不同的硬件而不同。

🔹 Set Trace Configuration for core0_hello 🛛 🚽 🗙						
Settings ☑ Trace need to be configured						
Trace Module Configuration						
Trace ATB2AXI Config Addr: 0x10310000						
Trace Buffer Base Addr:	0x1c050000					
Trace Buffer Size in Bytes: 0x10000						
Trace Wrap:	☑ Trace will be wrap back from Trace Base Address					
Save						

- Trace need to be configured:如果需要配置 Trace 模块就勾选,如果其他地方已经配置过了,就千万 不要勾选了,例如多核 SMP/AMP 的情况下,SoC 上只有一个 Trace 模块,假设其中一个核心已经 勾选配置了,其他的核心就不能勾选了,或者是配置是在 C 代码中或者其他地方做了,也千万不 要勾选。
- Trace ATB2AXI Config Addr: ATB2AXI 模块控制器的基地址。
- Trace Buffer Base Addr:存放 trace 记录的开始地址,例如:针对某个 SoC,举例如下在 flashxip 模式,使用 ilm (0x1c000000)作为缓存 buffer;在 sramxip 模式,使用 dlm (0x08010000)作为缓存 buffer。
- Trace Buffer Size in Bytes:存放 trace 记录的 Buffer 大小,单位为字节。
- Trace Wrap: 是否允许自动复盖,允许则在 Buffer 满时,将再次从头开始覆盖记录。
Trace Decoder Configuration

Set Current Debug hart Configuration 弹框中,用户可以自定义 trace decoder 的参数,具体如下。

🔹 Set current debug hart configuration for test 🛛 🚽 🖂 🗙									
Local trace related files ELF File Path									
C:\Users\11653\NucleiStudio_workspace\test\Debug\test.elf									
Trace File Path									
C:/Users/11653/NucleiStudio_wo	orkspace/test/Debug/test.trace	Workspace	Eile System						
Objdump Path									
G:\woke\NucleiStudio\testIDE\N	lucleiStudio_IDE_202406-win64\N	<u>F</u> ile System							
Hart decoding configuration									
Selected Project:	test								
HartID(-hartid=):	0		▲ ▼						
Trace Data Align Size(-tdasize=)	64		~						
Display Address Bits(-addrsize=)	32		~						
	Save								

- ELF File Path: trace 生产时执行的 elf 文件的地址。
- Trace File Path: 需要解析的 trace 文件的地址。
- **Objdump Path**: trace decode 过程中,需要用到 objdump 工具,所以这里需要指定所使用到的 objdump 工具的地址。
- HartID: trace decode 时需要指定当前需要查看的 trace 对应的 HartID, 单核工程默认 HartID=0。
- Trace Data Align Size: 跟踪数据对齐大小,一般与硬件的 trace 输出位宽对齐,默认有 8、32、64。
- Display Address Bits: trace decode 后显示地址的位数,一般是 32、64、128 位。

Trace 的使用

在使用 trace 功能时,必须在工程 Debug 时,通过 Nuclei OpenOCD 或者 Dlink 将 Trace 命令下发到硬件, 目前通过 OpenOCD,可以实现在单核、多核 SMP 和多核 AMP 应用下进行 Trace 记录,而 Dlink 仅支持 在单核应用下的 trace 记录。

下面我们以 OpenOCD 为例, 演示如何使用 Trace 功能。

在单核应用中使用 Trace

如果您已获取到芯来授权的 CPU 和相关配套硬件并准备好硬件环境,这里不详细说明。然后创建好 对应工程并确保它能在硬件上运行和调试。以下示例是在我们自己构建的一个测试环境上的流程举例说 明。

我们在这里创建了一个 N900 的单核应用 helloworld,并让它跑在 FLASHXIP 模式下。

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我们可以记录整个应用运行完的 trace,也可以记录某一段 Debug 断点之间的 trace。进入 Debug 模式后,打开 Trace 视图。

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设置 Trace Configuration,设置 trace 配置信息并保存 (Save),如果不想保存,就关闭窗口。

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Trace 配置完毕后,可以设置两个断点,一个断点用于 Trace 开始点,一个断点用于 Trace 结束点,在 开始点断点停下后就可以点击 start trace 按钮,就可以继续 debug 操作 (如单步或者运行等)了,在 结束点断电停下后,就可以点击 stop trace 按钮来结束 Trace。上面只是 Start/Stop Trace 的一种使用 示例,也可以更灵活一些,请根据自己需要进行使用。当 trace 结束时 (多核情况下请确保每个 CPU 的 Trace 都结束了),就可以点 Dump trace file 按钮,将 trace 文件从硬件上下载到本地,默认下载的

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trace 文件存在工程目下的 debug 目录下,有一个 工程名.trace 的文件。

Trace 文件下载完后, Nuclei Studio 会弹出一个 Set current debug hart configuration 框。

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Save		

在框中填写确正信息(这里的 HartID 指的是对应的 Thread 的 hartid,请不要填错了)并确认,Nuclei Studio 对 trace 文件开始解析,并生成 trace 记录表格。在 trace 记录表格,选中任意一条记录,Nuclei Studio 会自动找到源码和反汇编码,并定位那对应的那一行(因反汇编码与源码在同一个视图中打开,需要用 户自己把反汇编码移到另一个视图中)。

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	2	0	200002c6	4087	2	e426	sd	s1,8(sp)		C:/Users/11653/NucleiStudio_workspa	93	1
	□ 3	0	200002c6	6135	2048	e426	sd	s1,8(sp)		C:/Users/11653/NucleiStudio workspa	93	1
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	□ 5	0	200002c8	10606	4469	f1402673	csrr	a2.mhartid		C:/Users/11653/NucleiStudio workspa	762	1
		0	200002cc	10608	2	f14025f3	csrr	a1.mhartid		C:/Users/11653/NucleiStudio workspa	747	1
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也可以双击 工程名.trace 文件,以文本的方式查看 trace 文件。



在 SMP 多核应用中使用 Trace

在 SMP 多核应用中使用 trace 与单核大体相似, 差别在于 SMP 多核在 Debug 时,不同的 thread 共用 一个 Trace Configuration,且需要通过选择不同的 Thread 来对不同的 CPU Hart 核心单独 start trace/ stop trace。在 Debug 视图中,点击任意一个 Thread,然后点击 Trace 工具栏中的 trace setting 来设置 Trace Configuration。



在 Debug 视图中,可以通过点击不同的 Thread,来切换不同的 Core,如下图点击 Thread #1 或者 Thread #1 下对应的函数名来选中对应的是 SMP 多核应用中的 Core 0,可以对 Core 0 开启或者关闭 Trace,在 SMP 多核应用中,只要有一个 Core 在完成 start trace 操作时,Trace Configuration 中的信息就会在硬件中设置好,其他的 core 在 start trace 操作时,就不会重复设置 trace Configuration。

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同理,在 Debug 视图中点击 Thread #2 或者 Thread #2 下对应的函数名,来切换到 Core 1 上进行 start trace/stop trace 的操作。

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V 📸 04 Ismphello.elt	72 73	spinlock_in lock ready	it(&lock); = 1;							
SysTimer_GetLoadValu	74	finished =	0; \.							
measure_cpu_freq() at	76	ret = boot_	hart_main(harti	.d);						
get_cpu_freq() at ns_co	78	<pre>} else { // oth</pre>	er <u>harts</u> lock initializ	ed						
skip init() at syste	79 80	while (lock	_ready == 0); harts main(har	tid):						
P Thread #2 [ristv0.cpu.1]	81	}								
main() at main.c:70 0xi	82 83 }	return ret;								
j openocd.exe	84 85⊜ int	boot hart main(unsigned long h	artid)						
N Inscrot+runknown-en-gub	86 {			- 0-						
	88	spinlock_lock(&	lock);	. = 0;						
	89 90	<pre>printf("Hello w cpu count += 1;</pre>	orld from hart	%d\n", hartid)	;					
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在 dump trace file 操作时,在 SMP 多核应用中,只有当所有的 Core 都 stop trace,才可 以执行 dump trace file 的指令并成功下载 Trace 文件。Trace 文件的下载,在 SMP 多核应用中,只 需要下载一份,在对 trace 文件进行 decode 时,注意设置 Hart ID,就可以解析出不同的 trace 记录表,如下图,当 Hard ID=0 时,就可以查看到 Core 0 对应的 Trace 记录。







Chapter 2. Nuclei Studio IDE

在 AMP 多核应用中使用 Trace

在 AMP 多核应用中使用 trace 也类似, trace 配置也是共享。不同的 thread 共用一个 trace configuration, 但可以通过不同的 thread, 对不同的核单独 start trace/stop trace。如下图,在 Debug 视图,点击 Thread #1 或者 Thread #1 下的函数名,切换到 AMP 多核应用中 Core 0,然后点击 Trace 工具 栏中的 trace setting 来设置 Core 0 对应的 Trace Configuration。



在 Debug 视图,点击 Thread #2 或者 Thread #2 下的函数名,切换到 AMP 多核应用中 Core 1,然后点击 Trace 工具栏中的 trace setting 来设置 Core 1 对应的 Trace Configuration,因为在 AMP 多核应用中 trace 配置是共用,所以此处设置需要将 Trace need to be configured 的勾去掉,表示可以使用 trace 功能,但不需要有任何设置。

NucleiStudio_workspace - core1_	hello/nuclei_s	dk/SoC/ns_cluster	_core1/C	Common/S	ource/ns_commo	n.c - Nucleis	tudio IDE					-	- 🗆	×
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Trace Configuration 设置完成后,同样的通过 Debug 视图的 Thread 来切换不同的 Core,进行 start trace/stop trace/dump trace file 操作,注意,设置了 Trace Configuration 的 Core 需要优先于其 它 Core 开始 start trace,并将 Trace Configuration 的信息设置好,其他的 Core 才可以正常的 start trace/stop trace/dump trace file 操作。

在 dump trace file 操作时,在 AMP 多核应用中,请确定所有的 Core 都 stop trace,才执行 dump trace file 的指令,否则可能在某一下 Core 在 dump trace file,其他的 Core 还在记录 trace,最后得到的 Trace 文件并与预期不符。Trace 文件下载,在 AMP 多核应用中,需要每一个工程应用 单独 dump 一份 trace 文件,其实 dump 到的 trace 文件内容是一样的,在对 trace 文件进行 decoder 时,同样需要注意设置 Core Hart ID,就可以解析出对应的 trace 记录表。其他操作与上文内容中所述类似。

查看脱机 Trace

在某些场景下,用户可能通过命令行或其他方式,得到了一个 trace 文件,这时只需打开 Set Current Debug hart Configuration,并按要求配置好参数,即可通过 NucleiStudio 的 trace 工具 解析这个 trace 文件了。

🔹 Set current debug hart configuration for test 🛛 🚽 🗸										
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Trace File Path										
C:/Users/11653/NucleiStudio_workspace/test/Debug/test.trace										
Objdump Path										
G:\woke\NucleiStudio\testIDE\N	lucleiStudio_IDE_202406-win64\N	<u>F</u> ile System								
Hart decoding configuration										
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	Save									

2.10.5 RVProf 功能的使用

RVProf 是芯来科技针对 cpu cycle model 开发的性能分析工具, Nuclei Studio 在 2024.02.dev 版本中, 完成 对 RVProf 的支持。在实际使用中, RVProf 功能分三步完成, 首先通过 Cycle model 工具, 运行代码, 产生.rvtrace 文件, 然后 RVProf 工具,将.rvtrace 解析成对应的.json 文件, 最后通过 google 的开 源工具 Perfetto Trace Viewer 对.json 文件进行解析并展示。因为 cpu cycle model 当前仅提供了 linux 版本, 所以本文档均是在 linux 环境下演示此功能。

在使用过程,如有问题,可以查看 https://github.com/Nuclei-Software/nuclei-studio 相关内容,也可以 向我们提交相关 issue。

测试环境

cpu cycle model 在运行过程中,对硬件环境的性能要求较高,在实际使用,四核及以上的系统中运行效果 较好,一般不建议在虚拟机环境下使用。为了较好的体验效果,本测试在工作站上进行。

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^{米円} : CPU 运行: 字节序: Address sizes: CPU: CPU 列表: CPU 列表: 在令个座 节点: TO 系列: CPU 系列: 型号: 2名称:		x86_64 32-bit, 64-bit Little Endian 46 bits physical, 48 bits virtual 32 0-31 2 8 2 2 GenuineIntel 6 85 Intel(R) Xeon(R) Gold 5217 CPU @ 3.00GHz
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准备测试 NPK 软件或者工具包

目前此功能仅提供测试用的 NPK 包,将相关的包安装到 Nuclei Studio 中,关于安装 NPK 包,可以 查看 Nuclei Studio 手册中相关章节,因为 RVProf 测试包没有公开,请联系我们索取。

- cymodel.zip cymodel 的 NPK Tools 包
- rvprof.zip RVProf 的 NPK Tools 包
- Rvprof helloworld.zip 测试 demo NPK App 包

创建 rvprof 测试工程

创建工程前,先查看 Nuclei Package Management 中 NPK 是否安装正确,因为测式 demo 是依赖于 nuclei_sdk,所以也要先安装 sdk-nuclei_sdk,具体如下:

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然后创建一个 test 测试工程, 在创建工程的向导中, 依次 New Nuclei RISC-V C/C++ Project -> sdk-nuclei_sdk@0.5.0 -> next, 在工程配置页面, 依次填写工程名、选择 Project Example: rvprof helloworld@app-nsdkrvprof_helloworld, Nuclei RISC-V Core: N307FD (这里的 code 要跟 cpu cycle model 对应)。



在 Project Example 可以看到我们导入的 demo NPK App 中的 Rvprof helloworld 工程,选择此工程,然后下一步,完工程的创建。

	Create Nuclei RISC-V C/C++ project ×
Create Nuclei RISC-V C/C++	project
Project name:	test
Project name.	
Project Filter by:	no filter V Filters: V
Project Example:	rvprof helloworld @app-nsdk_rvprof_helloworld ~
Toolchain:	RISC-V GCC/Newlib (riscv64-unknown-elf-gcc) ~
Download/Run Mode:	ILM download mode, program will be download into ilm/ram and run directly $$
Select NMSIS Library:	No NMSIS Library used
Nuclei RISC-V Core:	N307FD Core(ARCH=rv32imafdc, ABI=ilp32d) ~
Nuclei ARCH Extensions:	_zba_zbb_zbc_zbs_xxldsp
Nuclei Cache Extensions:	ICache DCache CCM
Nuclei SMP Count:	0 - +
Boot HartID:	0 - +
Heap Size:	4К
Stack Size Per CPU:	4К
Enable Semihosting:	
Standard C Library:	newlib nano without printf/scanf float
Application Compile Flags:	-02
?	< Back Next > Cancel Finish

在创建的 test 工程中,可以看到多了一个 test_debug_rvprof.launch 文件, rvprof 相关的配置 在此文件中,可以查看内容如下。其中 Cycle Model 的 time out 时间,用来设置 Cycle Model 超时时间,因 为 Cycle Model 运行时比较耗时,如果工程比较简单,可以设置一个较短的起时时间,到时间后,可以及 时中断 Cycle Model 的运行; RVProf 中的超时时间的功能也是类似。

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查看 rvprof 的结果

创建完工程后,在 Nuclei Studio 的 launch bar 上,选中 test_debug_rvprof.launch,并点击工具栏中的运行按钮,Nuclei Studio 依次完成以下任务,并将最终的结果在在 Perfetto Trace Viewer 中展示。

- 编译工程代码
- 启动 Cycle Model 并产生 trace 文件
- 启动 RVProf 解析 trace 文件生成 json 文件
- 启动 Perfetto Trace Viewer 展示结果

Cycle Model 启动及 log 输出

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perfetto 启动本地服务



Perfetto Trace Viewer 的官方地址是 https://ui.perfetto.dev/。Nuclei Studio 默认会尝试打开 https:// ui.perfetto.dev/,同时自动载入 json 文件并解析。如果因为网络原因(国外服务器)打开失败,Nuclei Studio 会在本地启一个 Perfetto Trace Viewer 本地服务,并自动打开本地 localhost:5000/,此时需要用 户手动载入工程目录下的 Debug/test.json 文件。在 Perfetto Trace Viewer 中可以看到 trace 的展示结 果。

Nuclei Studio 会在本地启一个 web 服务,同时打开 Perfetto Trace Viewer。



点击 Open trace file, 找到工程中生成的 json 文件, 手动将 json 文件 load 到 Perfetto Trace Viewer 中。

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些时,在 Perfetto Trace Viewer 就可以查看到 rvprof trace 结果展示了,用户可以通过键盘的 W/A/S/D 按键查看更详细的信息。

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2.10.6 使用 Nuclei Near Cycle Model 仿真性能分析

在 Nuclei Studio 2024.06 版中,集成了 Nuclei Near Cycle Model,它是由芯来科技自主研发的仿真测试和 性能分析工具,可以帮助研发人员在项目初期进行一些必要的仿真测试和程序性能分析。

Nuclei Near Cycle Model 当前只有 Linux 版本, 其具体介绍和命令行上使用参见(https://doc.nucleisys.com/nuclei_tools/xlmodel/intro.html),下面将在 Nuclei Studio 上演示如何使用 Nuclei Near Cycle Model 进行仿真和性能分析。

在使用过程,如有问题,可以查看 https://github.com/Nuclei-Software/nuclei-studio 相关内容,也可以 向我们提交相关 issue。

创建测试工程

Nuclei Near Cycle Model 对芯来全类型的 Core 都有支持,可以创建任意一个 demo 工程并编译。创建任意 一个 demo 工程并编译。

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Project name:	model_test	
Project Filter by:	no filter v Filters:	~
Project Example:	Simple Helloworld Demo @app-nsdk_helloworld	~
Toolchain:	RISC-V GCC/Newlib (riscv64-unknown-elf-gcc)	~
Download/Run Mode:	ILM download mode, program will be download into ilm/ram and run directly	~
Nuclei RISC-V Core:	N307FD Core(ARCH=rv32imafdc, ABI=ilp32d)	~
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Nuclei Near Cycle Model 采用 Nuclei Studio 中的 RVProf 运行配置来进行运行测试,选中编译好的测试工程,然后打开 Nuclei Studio 的 Run Configurations。

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并创建一个 RVProf 的配置,具体的配置及参数说明如下。

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Filter matched 20 of 20 items	Revert	Apply
(?)	Close	Run

其中在 Config options 中需要配置 --trace=1 --gprof=1 --logdir=Debug, --trace=1 表示 开启 rvtrace, --gprof=1 表示开启 gprof 功能, --logdir=Debug 则表示最终生成的.rvtrace 文件、 .gmon 文件存存放的路径为当前工程下的 Debug 目录。

	Run Configurations	×
Create, manage, and run configurations		
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0		Close Run

运行工程并生成性能分析结果

点击运行(Run)工程, NucleiStudio 会依次调用 Nuclei Near Cycle Model 来仿真程序执行,并产生. rvtrace 文件,再调用 rvprof 来解析.rvtrace 文件并生成.json 文件,最后启用一个 perfetto 服务 来用来查看 rvprof 解析.rvtrace 文件所产生的.json 文件。

点击 Run 按钮,开始运行程序。

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程序在 Nuclei Near Cycle Model 中成功执行,输出了对应的 Log 信息。

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在工程的 Debug 目录中可以查看到已经生成.rvtrace 文件、.json 文件、.gmon 文件。

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🗵 model_test_debug_qemu.launch	

Nuclei Studio 会在本地启一个 web 服务,同时打开 Perfetto Trace Viewer。通过 Perfetto Trace Viewer,可以查看.json 文件。

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Support Documentation & Bugs													

Nuclei Near Cycle Model 中支持通过 gprof 来分析程序,所以当我们配置了 --gprof,在程序运行时,也会在 Debug 目录 (--logdir=XX 所配置的目录)下同步产生一个.gmon 文件,双击.gmon 文件,将调用 gprof 工具来分析程序执行所消耗的 cycle 数及调用关系;同时也会产生对应的 callgraph.out 文件,双击 callgraph.out 文件,调用 Call Graph 查看程序的调用关系。

调用 gprof 工具,可以查看生成的.gmon 文件中的内容。

		NucleiStudio_wor	rkspace - mod	el_test/nucle	i_sdk/NMSIS/Core/Include/core_feature_base.h - NucleIStudio IDE		ø x
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gprof 工具在查看.gmon 文件的同时,会根据其内容,解析出程序的调用关系,并生成 callgraph.out 文件,双击 callgraph.out 调用 Call Graph 工具查看。

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2.11 Nuclei Studio 升级

一般情况下,如果 Nuclei Studio 没有大的版本变动,Nuclei Studio 升级工作可以由用户下载最新的 GNU 工具链以及其他相关工具和升级 IDE Plugins 的方式来完成。

2.11.1 GCC/OpenOCD 等工具链的安装

Nuclei Studio 已经把工具链集成在 IDE 内部,工具链存放在 Nuclei Studio_IDE_XXX 文件夹内,路径为: Nuclei Studio_IDE_XXX\\NucleiStudio\\toolchain。IDE 默认使用此路径的工具链,所以 请不要移动 toolchain 此文件夹,使用 IDE 创建工程后也不需要进行工具链的相关配置。

由于工具链升级的速度会比 IDE 快,所以后期需要用户手动升级工具链,工具链升级方法如下:

- 首先删除需要更新的 GCC 或者 OpenOCD 文件内的内容,然后在芯来科技官网下载最新版本的 GCC 或者 OpenOCD。
- 将 GCC 或者 OpenOCD 的内容复制到对应的文件夹下,即可完成 IDE 工具链的更新, IDE 自带的 工具链的版本号记录在 ReadMe.txt 中。

Note: 注意:要保证 gcc 所在的这一级目录文件夹名字不变,替换后保证 bin 文件夹所在层级是图中文件夹的子目录,中间不要有其他文件夹。

📒 build-tools	2020/7/30 10:35	文件夹
📒 gcc	2020/7/30 10:35	文件夹
📒 openocd	2020/7/30 10:35	文件夹
ReadMe.txt	2019/9/25 13:48	文本文档

2.11.2 IDE Plugins 升级

Nuclei Studio 支持 IDE 内在线升级,步骤如下。

打开安装软件弹窗,在菜单栏选择 Help 🛛 Install New Software。

CPDE - 1_helloworld/application/main.c - NucleiStudio File Edit Source Refactor Navigate Search Project Run RV-Tool	Is Window Help			– a ×
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点击 already installed 打开已安装界面。

🚯 Install				×
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type filter text			Select /	All
Name ① ① There is no site selected.	Version		Deselect	All
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				¢
Show only the latest versions of available software	Hide items that are already installed	1		
Group items by category	What is already installed?			
Show only software applicable to target environment				
Contact all update sites during install to find required software				
0	< Back Next >	Finish	Cancel	

选择 Nuclei Studio, 点击 update 即可自动完成在线更新。

ype filter text		
Name	Version	ld
🖗 GCov Integration	7.0.1.2018091215	org.eclipse.linuxtools.gcov
> 🖗 GDB Tracepoint Analysis	4.1.0.2018091209	org.eclipse.tracecompass.
> Integration for Eclipse	5.1.0.2018091115	org.eclipse.egit.feature.gr
GNU MCU C/C++ ARM Cross Compiler	2.6.4.2018093006	ilg.gnumcueclipse.manage
GNU MCU C/C++ CodeRed Debug Perspective	1.1.2.2018093006	ilg.gnumcueclipse.codere
GNU MCU C/C++ Generic Cortex-M Project Template	1.4.4.2018093006	ilg.gnumcueclipse.templa
🖗 GNU MCU C/C++ J-Link Debugging	4.3.4.2018093006	ilg.gnumcueclipse.debug.
🖗 GNU MCU C/C++ OpenOCD Debugging	4.3.3.2018093006	ilg.gnumcueclipse.debug.
🖗 GNU MCU C/C++ Packs (Experimental)	2.2.2.2018093006	ilg.gnumcueclipse.packs.fe
🖗 GNU MCU C/C++ PyOCD Debugging	1.3.3.2018093006	ilg.gnumcueclipse.debug.
🎨 GNU MCU C/C++ QEMU Debugging	3.3.3.2018093006	ilg.gnumcueclipse.debug.
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🖗 GProf Integration	7.0.1.2018091215	org.eclipse.linuxtools.gpro
Library Hover help for devhelp documentation	7.0.1.2018091215	org.eclipse.linuxtools.cdt.l
ITTng Kernel Analysis	4.1.0.2018091209	org.eclipse.tracecompass.
> 🖗 LTTng Tracer Control	4.1.0.2018091209	org.eclipse.tracecompass.
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> 🖗 Marketplace Client	1.7.2.v20180829	org.eclipse.epp.mpc.featu
> 🖗 Mylyn Context Connector: C/C++ Development	5.20.0.v20180905	org.eclipse.cdt.mylyn.feat
> 🖗 Mylyn Context Connector: Eclipse IDE	3.24.2.v20180905	org.eclipse.mylyn.ide_feat
> 🖗 Mylyn Context Connector: Team Support	3.24.2.v20180905	org.eclipse.mylyn.team_fe
> 🖗 Mylyn Task List	3.24.2.v20180905	org.eclipse.mylyn_feature.
Mylyn Task-Focused Interface	3.24.2.v20180905	org.eclipse.mylyn.context
> 🖗 Mylyn Tasks Connector: Bugzilla	3.24.2.v20180905	org.eclipse.mylyn.bugzilla
> 🖗 Mylyn WikiText	3.0.25.201806201	org.eclipse.mylyn.wikitext
🖗 Nuclei Studio	1.0.0	com.nucleisys.ide.feature.
RPM Tools	7.0.1.2018091215	org.eclipse.linuxtools.rpm
> 🖗 TM Terminal	4.5.0.2018091014	org.eclipse.tm.terminal.fea
TM Terminal Serial Connector Extensions	4.5.0.2018091014	org.eclipse.tm.terminal.co
Valgrind Tools Integration	7.0.1.2018091215	org.eclipse.linuxtools.valg
<		>
1. Brand-new Nuclei Studio, deeply integrated with Nuclei Sl	DK,Nuclei RISC-V Toolo	hain and Nuclei
OpenOCD	IN 1 11 1 1	
 New Nuclei SDK Project template wizard for GD32VF103 a provided in Nuclei Studie 	ina Nuclei HummingBi	rd Evaluation SoC is

2.12 常见问题

2.12.1 Nuclei Studio 启动慢

Nuclei Studio 是基于 eclipse 进行开发,继承了 eclipse 的可扩展性的特点的是同时,也存在着启动较慢的问题,第一次启动时,软件需要验证环境;生成常用的缓存文件;创建 Workspace.在 2021.09 版的 Nuclei Studio 中,我们针对启动做了优化,在电脑性能足够的前提下,第一次启动 Nuclei Studio 能在一分钟内完成。

Nuclei Studio 最佳运行环境:

- Windows 10 操作系统
- 4G 以上内存(2G 可以被 Nuclei Studio 分配使用)

2.12.2 Nuclei Studio 编译程序很慢

在测试使用过程中,我们发现 Nuclei Studio 在编译项目时会出现很慢的现像,经过排查发现,当电脑安装 360 杀毒软件时,编译指令执行很慢,退出 360 杀毒软件时,编译指令可以按正常速度执行。为了保障 Nuclei Studio 的正常使用,建议在使用时退出 360 等杀毒软件。

2.12.3 找不到 New Nuclei Risc-V C/C++ Project 菜单

New Nuclei Risc-V C/C++ Project 是创建工程的快捷入口,有时候如果找到不到 New Nuclei Risc-V C/C++ Project 菜单。

&	NucleiStudio_workspace - NucleiStudio IDE						
File	Edit Source Refactor Navigate	Search Project	t Ru	un RV-Tools Window Help			
	New	Alt+Shift+N >	&	New Nuclei RISC-V C/C++ Project			
	Open File		&	New Nuclei NPK Project			
È,	Open Projects from File System		C.	Makefile Project with Existing Code			
	Recent Files	>	C	C/C++ Project			
	Close Editor	Ctrl+W	Ľ	Project			
	Close All Editors	Ctrl+Shift+W	C++	Convert to a C/C++ Project (Adds C/C++ Nature)			
	Save	Ctrl+S	63	Source Folder			
	Save As		Ċ	Folder			

可以在菜单 Window->Perspective->Reset Perspective 里进行视图重置, New Nuclei Risc-V C/C++ Project 就会重新出现。

ols	Window Help					
jen °€	New Window Editor Appearance	> >	8) 🔻 🔦 🗶 🔜 🔛 🗮 🔍	2	Ø: i i ▼ ii ▼ [
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	Perspective	>	E	Open Perspective	>	
	Navigation	>		Customize Perspective		
	Preferences			Save Perspective As Reset Perspective	重智	冒视图
				Close Persp Reset Persp	ective	
				Close All Perspectives		

或者将当前视图切换到 C/C++ 视图。



2.12.4 打开/关闭 Launch Bar

Nuclei Studio2022.12 及以后的版本中, 默认是开户启了 Launch Bar 功能。打开菜单栏 Window -> Preferences,搜索 bar,取消勾选第一个选项即可关闭 Launch Bar。同理,想要使用 Launch Bar 功能,请勾选此选项。

E Preferences				×
bar 🖉	Launch Bar		⇔ ▼ ⊂	⇒ ▼ ▼
◆ Run/Debug ◆ Launching Launch Ba	Preferences for the Launch Bar ☐ Enable the Launch Bar ☑ Enable the build button ☐ Always show the target selector ② 取消勾选第一个选项			
< >>	Restore Defau	lts	Арр	ıly
? 🖻 🗹 🖲	Apply and Close		Cancel	

2.12.5 使用 Launch Bar

Nuclei Studio 的 Launch Bar (下图中蓝色框内标注部分)是对后边下拉框中选中的调试配置对应的工程进行编译、调试和下载等操作,如需使用此部分请注意,图标是与下拉框中调试配置内容相绑定。下面详细介绍 Launch Bar 各部分功能:

	🗘 Run 🔥	E helloworld_debug_openoc
Project Explorer	Run 4	
▶ 🚰 helloworld	参 Debug	

图标 1:编译选中的调试配置对应的工程。此处选中的工程为 5 号下拉框选中的调试配置对应工程,并非 Project Explorer 中选中的工程。

图标 2:运行/调试选中的调试配置对应的工程。此处图标会根据下拉框 4的内容变化。

图标3:退出下载/调试模式。

下拉框4: 切换选择下载/调试模式。切换后会改变图标2的显示内容。

下拉框 5: 选中调试配置文件。此处的内容会影响图标 1、2、3 对应的工程。

齿轮图标6:打开当前选中的调试配置页面,可直接进行修改保存。

2.12.6 不使用 Launch Bar 进行运行/调试

对于初次新建的工程,如果不使用 Launch Bar 功能,可以右键工程,选择 Debug As -> Debug Configurations。在弹窗中选择工程对应的设置选项,这里以 helloworld 工程为例,选择 hel-loworld_debug_openocd, 之后选择 Debug 开始调试。

同理,初次运行需要右击工程,选择 Run As -> Run Configurations。在弹窗中选择工程对应的设置选项,之后选择 Run 开始运行。

pe filter text C/C++ Application	Main * Debugger > Startup * So							
C/C++ Application	□ Main 参 Debugger ► Startup 🕏 Source 🗉 Common 🔓 SVD Path							
= c, c · · · · · · · · · · · · · · · · ·	Project:							
C/C++ Attach to Application	helloworld							
C/C++ Container Launcher	C/C++ Application:							
C/C++ Postmortem Debugger	Debug/helloworld.elf							
C/C++ Remote Application			Variables	Search Project	Browse			
Debug Adapter Launcher	Build (if required) before launching							
OSF PDA Application Build Configuration Select Automatically								
GDB Hardware Debugging	/are Debugging							
GDB Jumper Debugging Other and a settings Configure Workspace settings Configure Workspace settings				nas				
GDB SEGGER J-Link Debugging Launch Group								
ter matched 17 of 17 items				Revert	Apply			
				Debug	Close			

速选择对应的工程设置进行调试。对于运行,可以在_____的下拉选项,快速选择对应的设置。

2.12.7 Debug 页面查看寄存器

进入 Debug 模式后,可能有些页面并不能第一时间找到,这里以查看寄存器栏目为例。在菜单栏选择 Window -> Show View -> Registers 打开寄存器栏目,在 Register 页面可以通过 Ctrl F 来查找 寄存器。同样,如果想查看内存,可以选择 Window -> Show View -> Memory,想打开调试控制 台,可以选择 Window -> Show View -> Debugger Console,其他页面此处不做过多介绍,请 用户自行体验。

2.12.8 Debug 页面结束进程

在 Debug 页面要退出调试,可点击 🔜 退出调试。为防止打开多个进程导致报错,在 Debug 页面,右击 Debug 栏目中的进程,选择 Terminate / Disconnect All 关闭所有 Debug 进程。

2.12.9 Nuclei Studio 工具栏中各按键功能

在 Nuclei Studio 中,常见的工具栏图标如下,本节将依次介绍各按键的功能。





2.12.10 显示其他窗口



在 IDE 的右上角 按键可以切换不同的显示模式,常用的是 C/C++ 页面和 Debug 页面。其中,在进入 Debug 模式时,若不在 Debug 页面,会有弹窗提示,此时点击 Switch 选项可以切换至 Debug 页面。 在菜单栏中选择 Window -> Perspective -> Open Perspective 可以快速切换显示窗口。

在不同的窗口下, Window -> Show View显示的内容也不尽相同。在 Debug 窗口中可以选择显示如寄存器 (Registers),内存 (Memory) 和调试控制台 (Debugger Console)。

J	Window	Help				
	New	Window		i a	D► 00 ■ N R. 7. R i	→ ≂, 😿 🕹 i 🏪 🥝 i 🎋 🗸
	Edito	or	>			
	Арре	Appearance >				
	Show View >		• Breakpoints	Alt+Shift+Q, B		
	Persp	Perspective		E	Console	Alt+Shift+Q, C
	Navi	Navigation		**	Debugger Console	
	Prefe	erences		ø	Debug Sources	
					Disassembly	
				<u>@</u>	Error Log	Alt+Shift+Q, L
				Ø	Executables	
				ଙ୍କୁ	Expressions	
				0	Memory	
				0	Memory Browser	
				=\	Modules	
					Outline	Alt+Shift+Q, O
				묾	Peripherals	
				2	Problems	Alt+Shift+Q, X
				=0	Progress	
				6	Project Explorer	
				1010 0101	Registers	
					Signals	
				E	Templates	
				\$	Terminal	
				8	Trace Control	
				(x)=	Variables	Alt+Shift+Q, V
				8	Visualizer	
					Other	Alt+Shift+Q, Q

2.12.11 恢复默认窗口布局

在菜单栏中选择 Window -> Perspective -> Reset Perspective, 在弹窗中选择 Reset Perspective 可以恢复窗口默认布局。

2.12.12 对比历史文件

右击要查看历史的文件,选择 Compare With -> Local History 打开历史记录。在打开的 History 栏目双击选择要对比的文件历史版本,可以查看文件变动历史。

le main.c [™] Compare main.c Current and Local Revision [™]	- D				
C Compare					
V 🗈 Translation Unit					
• print misa					
C Compare Viewer	M 🖸 🗐 🛆 🏖 43 🗟				
Local: main.c	Local history: main.c 2020年12月30日下午2:33:30				
4#include <stdlib.h></stdlib.h>	4#include <stdlib.h></stdlib.h>				
5#include "nuclei_sdk_soc.h"	5#include "nuclei_sdk_soc.h"				
/void print_misa(void)	/void print_misa(void)				
\circ (CSP MISA Type mice hits - (CSP MISA Type) - BV CSP PEAD	\circ_1 \circ CSP MISA Type miss hits = (CSP MISA Type) DV CSP P				
10 static char misa chars[30]:	10 static char misa chars[30]:				
10 $\frac{1}{11}$ $\frac{1}{1$	10 $\frac{1}{11}$ $\frac{1}{1$				
12 if (misa bits b mx] == 1) {	$\frac{11}{12} \text{if (misa hits h mx] == 1) }$				
13 misa chars[index++] = '3':	13 misa chars[index++] = '3':				
14 misa chars[index++] = '2':	14 misa chars[index++] = '2':				
<pre>15 } else if (misa bits.b.mxl == 2) {</pre>	15 } else if (misa bits.b.mxl == 2) {				
16 misa_chars[index++] = '6';	<pre>16 misa_chars[index++] = '6';</pre>				
17 misa_chars[index++] = '4';	17 misa_chars[index++] = '4';				
<pre>18 } else if (misa_bits.b.mxl == 3) {</pre>	<pre>18 } else if (misa_bits.b.mxl == 3) {</pre>				
<pre>19 misa_chars[index++] = '1';</pre>	<pre>19 misa_chars[index++] = '1';</pre>				
20 misa_chars[index++] = '2';	<pre>20 misa_chars[index++] = '2';</pre>				
21 misa_chars[index++] = '8';	<pre>21 misa_chars[index++] = '8';</pre>				
22 }					
	23 1f (misa_bits.b.1) {				
24 IT (MISA_DITS.D.1) {	24 misa_chars[index++] = 1;				
25 misa_chars[index++] = 1;	25 } 26 if (mice bite b m) {				
20 f 27 if (miss bits b m) f	$\frac{26}{27} \qquad \text{misa chans[index+1] - 'M':} \qquad \qquad$				
()	()				
Problems 🖉 Tasks 🖳 Console 🗀 Properties 🔮 History 🛛					
main.c					
Revision Time					
▣ 2020/12/31 上午10:22					
□ 2020/12/31 上午9:30					
■ 2020/12/31 上午9:29					
D 2020/12/30 下午2:33					
2.12.13 新建工程时可能出现报错

新建工程时 IDE 需要索引整个工程,根据主机性能其所用时间不同。如果主机性能较差,可能会看到索引时产生 error,索引结束后 error 会消失。如出现以上现象,请以编译时是否报错为准。

2.12.14 新增 Include 路径出现缓存

在 include 页面新增路径时,可能会出现缓存的路径内容,此时点击 Workspace 或 File System 选中后可覆 盖其内容。

2.12.15 设置页面栏目找不到

有时可能因为弹窗大小,部分设置栏目被隐藏起来,可点击红框中左右方向图标显示隐藏栏目。

ype filter text	Settings	⇔ ▼ ↔
 Resource Builders C/C++ Build Build Variable 	Configuration: Deb	ug [Active]
 Code Analysi Code Analysi Documentati File Types Formatter Indexer Language Ma Paths and Syi Preprocessor Profiling Cate 	 Tool Settings Tool Settings Name: Architecture: Prefix: Suffix: C compiler: C compiler: C++ compiler: Archiver: Hex/Bin converter: Listing generator: Size command: 	oolchains Devices O Container Settings M Build Steps Build Artifact RISC-V Nuclei GCC (riscv-nuclei-elf-gcc) RISC-V ~ riscv-nuclei-elf- gcc g++ ar objcopy objdump size
MCU Project Natures Project Referenc Run/Debug Sett Task Repository	Remove command: Toolchain path:	rm \${eclipse_home}\toolchain\gcc\bin (to change it use the <u>global</u> or <u>workspace</u> preferences pages or the <u>project</u> prope
Task Tags Validation WikiText	Build tools path:	<pre>\${eclipse_home}\toolchain\build-tools\bin (to change it use the global or workspace preferences pages or the project prope </pre>
	Create extended	listing

2.12.16 开发板下载速度很慢

如果遇到开发板下载速度很慢,甚至出现超时的报错,请切换至使用 USB3.0 接口,如果使用虚拟机开发,也请同时将 USB 接口设置为 3.0。

2.12.17 Linux 环境下多用户使用 Nuclei Studio

如果需要多用户同时使用 Nuclei Studio (不推荐),用户在运行 Nuclei Studio 时首先要打开菜单栏的 Window->Preferences。在弹窗中需要修改三个地方:

打开 MCU->Global OpenOCD Path , Executable 输入 openocd , Folder 输入 $\$ {eclipse_home}/toolchain/openocd/bin \circ

打升 MCU->Global QEMU Path, Executable 输入 qemu-system-riscv32, Folder 输入 $\ell \in \mathbb{R}^{+}$

打开MCU->Global RISC-V Toolchains Paths,Default toolchain选中RISC-V Nuclei GCC, Toolchain folder 输入 \${eclipse_home}/toolchain/gcc/bin。

修改后点击 Apply and Close 保存并关闭设置弹窗。

2.12.18 设备管理器中识别出两个串口

可能连接设备后在任务管理器中识别出两个串口,其中 COM 编号较大的是串口打印使用,可以使用串口调试助手等工具连接查看打印信息,但是请不要占用 COM 编号较小的串口。

- ✓ ∰ 端口 (COM 和 LPT) USB Serial Port (COM36) 💭 USB Serial Port (COM37) > 📓 固件 > 🔜 计算机 > 🗾 监视器 > 🔤 键盘 > 🚯 蓝牙 > 🔤 人体学输入设备 > 📔 软件设备 > 🖹 软件组件 > 氯 生物识别设备 > 💵 声音、视频和游戏控制器 > 📗 鼠标和其他指针设备 ✔ ● 通用串行总线控制器 🏺 Intel(R) USB 3.1 可扩展主机控制器 - 1.10 (Microsoft) USB Composite Device USB Composite Device USB Serial Converter A USB Serial Converter B USB 根集线器(USB 3.0) 🏺 通用 SuperSpeed USB 集线器
 - 🏺 通用 USB 集线器

2.12.19 Linux 下使用时报 Could not determine GDB version after sending:riscvnuclei-elf-gdb version,response: 的错误

第一次在 linux 下使用 Nuclei Studio 时, 会报错 Could not determine GDB version after sending:riscv-nuclei-elf-gdb version,response:.



riscv-nulcei-elf-gdb 在 Nuclei studio 2023.10 及之后的版本变更为 riscv64-unknown-elf-gdb。

```
可以使用命令 ldd $(which riscv-nulcei-elf-gdb) 查看, 依赖缺失
```



使用命令 sudo apt install libncursesw5 libtinfo5 安装相关依赖后, ide 运行正常, 具体可以参考 https://github.com/riscv-mcu/riscv-gnu-toolchain/issues/9

2.12.20 在 linux 下使用 QEMU 时报错

例如在 Ubuntu 20.04 上使用 QEMU 时,可能会报错:

这是因为缺少 libfdt.so 等依赖所致,只需要在对应版本的 linux 上安装对应的依赖。例如针对 Ubuntu 20.04 可以使用如下命令:

安装 libfdt 等依赖:sudo apt install libfdt1 libpixman-1-0 libpng16-16 libasound2 libglib2 0-0

2.12.21 工程编译链接 C 库找不到符号报错

这个问题在 Nuclei Studio 2024.06 可以得到解决, 只需要在 Linker -> Libraries 页面勾选 Group Libraries 即可。

type filter text	Settings		⟨□▼□⟩▼
 Resource Builders C/C++ Build Build Variables Environment 	Configuration: Debug [Active]		Manage Configurations
Logging	🚯 Tool Settings 🛞 Toolchains 🔳 Device	s 🎤 Build Steps 🙅 Build Artifact 🗟 Binary Pars	ers 😣 Error Parsers
Tool Chain Editor > C/C++ General Coverage > MCU Project Natures Project References Run/Debug Settings WikiText	 Target Processor Optimization Warnings Debugging S GNU Arm Cross Assembler Preprocessor Includes Warnings GNU Arm Cross C Compiler Preprocessor Includes Optimization Warnings Miscellaneous S GNU Arm Cross C Compiler Preprocessor Includes Optimization Warnings Miscellaneous S GNU Arm Cross C++ Compiler Preprocessor Includes Warnings Miscellaneous S GNU Arm Cross C++ Compiler Preprocessor Includes Optimization Warnings Miscellaneous S GNU Arm Cross C++ Linker General Libraries 	Libraries (-I) abc def	-group) € € € € £
?	-52 МЕРОНАВЛИР	Cancel	Apply and Close

因为在对 Libraries 的处理中,没有能很好的处理链接之间的内部依赖关系,当使用的链接之前互相 有依赖时,可能会导至编译不通过,详细参见 https://github.com/eclipse-embed-cdt/eclipse-plugins/issues/592。 解决这个问题,可以有两种办法。



通过调整 Libraries 的顺序或者添加多个链接来实现



打开 C/C++ Build -> Settings -> Tool Settings ->GUN RISC-V Cross C++ Linker ,并修改 Command line paatern 内容,将其修改为









2.12.22 编译工程报错 fatal error: rvintrin.h: No such file or directory

在 Nuclei Studio 2023.10 中,如果使用旧的 sdk 所创建的工程,如果编译时报错 fatal error: rvintrin.h: No such file or directory,是因为在 GCC 10 时,工程中 #include <rvintrin.h> ,而在 GCC 13 中,不需要再 #include <rvintrin.h>,只需要删除此行,即可编译通过。



2.12.23 Debug 时报错 Error: Couldn ' t find an available hardware trigger.

在 Nuclei Studio 环境中,当工程在没有硬件断点的 CPU 硬件上运行时,且选择程序下载到 Flash 中运行 以 Nuclei SDK/Nuclei N100 SDK 为例就是 (flash/flashxip DOWNLOAD 模式),可能会遇到程序 Debug 无法 停住的问题,并收到错误提示: Error: Couldn't find an available hardware trigger。 这是因为程序运行在 Flash 上,软件断点无法被成功写入,而 CPU 上又没有硬件断点可以被使用,从而 导致报错。



这种情况下需要将程序编译到 RAM 上才可以支持 IDE 上进行调试 (软件断点),如果需要调试则暂时只能通过命令行的方式进行调试。

2.13 其他未注明或者遇到的版本问题

如本文档中有疏漏的地方,请关注 https://www.rvmcu.com/NucleiStudio-faq.html²⁰ 这里将列出不同版本后 续遇到的常见问题。

²⁰ https://www.rvmcu.com/nucleistudio-faq.html

CHAPTER THREE

NUCLEI TOOLCHAIN

3.1 GNU Toolchain

3.1.1 About GNU Toolchain

The official toolchain repository is located at https://github.com/riscv-collab/riscv-gnu-toolchain.git. Nuclei maintained toolchain repo is located at https://github.com/riscv-mcu/riscv-gnu-toolchain, and the branch is nuclei/ 2024-gcc13, in which the tools included versions are: gcc13, binutils2.40, gdb13.2, and also have merged some important patches from their upstream, as well as additional support for Nuclei custom extensions and pipelines, etc.

3.1.2 Extensions Support

Standard Extensions

• Basic Extensions

i, m, a, f, d, c, h, q(Assembly only), zicsr, zifencei, zicond, zawrs, zfh, zfhmin, zmmul, svinval, svnapot.

• Z*Inx Extensions

zfinx, zdinx, zhinx, zhinxmin.

CMO Extensions

zicboz, zicbom, zicbop.

• Bitmanip Extensions

zba, zbb, zbc, zbs

Crypto Extensions

zbkb, zbkc, zbkx, zknd, zkne, zknh, zkr, zks, zksed, zksh, zkt.

• Vector Extensions

zve32x, zve32f, zve64x, zve64f, zve64d, zvfh, zvfhmin, v.

• Zc Extensions

zca, zcb, zce, zcf, zcd, zcmp, zcmt(Assembly only).

- zce = zca + zcb + zcmp + zcmt
- f + zce = zca + zcb + zcf + zcmp + zcmt
- f + d + zce = zca + zcb + zcf + zcd + zcmp + zcmt
- Zvb Extensions

zvbb, zvbc

Zvk Extensions

zvkg, zvkned, zvknha, zvknhb, zvksed, zvksh, zvkn, zvknc, zvkng, zvks, zvksc, zvksg, zvkt.

• BFloat 16 Extensions

Zfbfmin, Zvfbfmin, Zvfbfwma

• Zilsd Extensions

Zilsd, Zcmlsd

Nuclei Custom Extensions

- Packed SIMD Extension 0.5.4
 - xxldsp, xxldspn1x, xxldspn2x, xxldspn3x.
 - xxldsp: P-spec-v0.54 + Nuclei Custom EXPD* instructions
 - xxldspn1x: xxldsp + Nuclei Custom N1
 - xxldspn2x: xxldsp + Nuclei Custom N1 & N2
 - xxldspn3x: xxldsp + Nuclei Custom N1 & N2 & N3
- Xxlcz Extensions

xxlczpstinc, xxlczbmrk, xxlczbitop, xxlczslet, xxlczabs, xxlczmac, xxlczbri, xxlczbitrev, xxlczgp.

Note: Extensions starting with \mathbf{x} are generally reserved for manufacturers to customize, and should be placed after extensions starting with \mathbf{z} when used.

3.1.3 General Options

-march=ISA-string

Generate code for given RISC-V ISA. ISA strings must be lower-case. Examples include rv64i, rv32g, rv32e, and rv32imaf. When -march= is not specified, use the setting from -mcpu. If both -march and -mcpu= are not specified, the default for this argument is system dependent, users who want a specific architecture extensions should specify one explicitly.

-mabi=ABI-string

Specify integer and floating-point calling convention. ABI-string contains two parts: the size of integer types and the registers used for floating-point types. For example <code>-march=rv64ifd</code> <code>-mabi=lp64d</code> means that **long** and **pointers** are 64-bit (implicitly defining **int** to be 32-bit), and that floating-point values up to 64 bits wide are passed in F registers. Contrast this with <code>-march=rv64ifd</code> <code>-mabi=lp64f</code>, which still allows the compiler to generate code that uses the F and D extensions but only allows floating-point values up to 32 bits long to be passed in registers; or <code>-march=rv64ifd</code> <code>-mabi=lp64</code>, in which no floating-point arguments will be passed in registers.

The default for this argument is system dependent, users who want a specific calling convention should specify one explicitly. The valid calling conventions are: ilp32, ilp32f, ilp32d, lp64, lp64f, and lp64d. Some calling conventions are impossible to implement on some ISAs: for example, -march=rv32if -mabi=ilp32d is invalid because the ABI requires 64-bit values be passed in F registers, but F registers are only 32 bits wide. There is also the ilp32e ABI that can only be used with the rv32e architecture. This ABI is not well specified at present, and is subject to change.

-mcmodel=medlow

Generate code for the medium-low code model. The program and its statically defined symbols must lie within a single 2 GiB address range and must lie between absolute addresses -2 GiB and +2 GiB. Programs can be statically or dynamically linked. This is the default code model.

-mcmodel=medany

Generate code for the medium-any code model. The program and its statically defined symbols must be within any single 2 GiB address range. Programs can be statically or dynamically linked.

The code generated by the medium-any code model is position-independent, but is not guaranteed to function correctly when linked into position-independent executables or libraries.

-mtune=processor-string

Optimize the output for the given processor, specified by microarchitecture or particular CPU name. Permissible values for this option are: nuclei-100-series, nuclei-200-series, nuclei-300-series, nuclei-600-series, nuclei-900-series, nuclei-1000-series, nuclei-1000

When -mtune= is not specified, use the setting from -mcpu, the default is rocket if both are not specified.

The size choice is not intended for use by end-users. This is used when -Os is specified. It overrides the instruction cost info provided by -mtune=, but does not override the pipeline info. This helps reduce code size while still giving good performance.

Optimization Options

-00

Reduce compilation time and make debugging produce the expected results. This is the default.

-0/-01

With -O, the compiler tries to reduce code size and execution time, without performing any optimizations that take a great deal of compilation time.

-02

Optimize even more. GCC performs nearly all supported optimizations that do not involve a spacespeed tradeoff. As compared to -O, this option increases both compilation time and the performance of the generated code.

-03

This option turns on all options in -O2, as well as several other optimizations to improve the performance of the object code.

-0s

This optimization option is often used to tell the compiler to reduce the size of the object code as much as possible while maintaining performance. It will remove some optimization strategies that increase the object code size from all options enabled by -O2.

-Ofast

Disregard strict standards compliance. -Ofast enables all -O3 optimizations. It also enables optimizations that are not valid for all standard-compliant programs.

For more information about RISC-V Options used in GCC, please check https://gcc.gnu.org/onlinedocs/gcc-13. 1.0/gcc/RISC-V-Options.html

For RISC-V ELF psABI Document, please check https://github.com/riscv-non-isa/riscv-elf-psabi-doc

3.1.4 Libraries

Note:

- glibc is used in Linux GNU Glibc toolchain used to compile linux kernel, opensbi, uboot, and linux applications.
- newlibc is used in Baremetal or RTOS toolchain, used to compile baremetal or rtos source code, which contains newlib, newlib-nano and libnort

glibc

glibc stands for GNU C Library which is the standard system C library for all GNU systems. It provides the system API for all programs written in C and C-compatible languages such as C++ and Objective C; the runtime facilities of other programming languages use the C library to access the underlying operating system. This library is only supported on Nuclei linux toolchain, not on Nuclei bare-metal toolchain.

newlib

newlib is written as a glibc replacement for embedded systems. It can be used with no OS (" bare metal ") or with a lightweight RTOS. Newlib is the default library for embedded GCC distributions.

newlib-nano

Newlib-nano is a derivative of the newlib C library for embedded systems. It is smaller and faster than newlib by code and data size reduction through optimization and removal of non-MCU features.

libncrt

libnort is short of Nuclei C Runtime Library, which currently support Nuclei RV32 processor, which is released by Nuclei to reduce c library code size, and improve math library speed, for details, please refer to the user guide located in gcc\share\pdf\Nuclei C Runtime Library Doc.pdf

3.1.5 Significant Changes Brought by GCC13 Compared to GCC10

- Instead of using single-letter bkp to enable these extensions as we did on gcc10, we split them all into corresponding sub-extensions, for example, _zba_zkr_zve32f, please check https://doc.nucleisys.com/nuclei_ sdk/develop/buildsystem.html#arch-ext to learn about how to adapt Nuclei SDK to support gcc13 upgraded from gcc10.
- Implement new style of architecture extension test macros: each architecture extension has a corresponding feature test macro, which can be used to test its existence and version information. In addition, we add several custom macros, __riscv_dsp, __riscv_bitmanip.
- Add new option -misa-spec=* to control ISA spec version. This controls the default version of each extensions. The official version is 20191213, but it is set to 2.2 when configuring nuclei toolchain. The difference between them is that in 20191213 version, Zicsr and Zifencei are separated from the i extension into two independent extensions, and using -misa-spec=2.2 can avoid incompatible errors when the Zicsr and Zifencei are not passed to -march=. See for details at https://github.com/riscv-collab/riscv-gnu-toolchain/issues/1315
- Support for vector intrinsics as specified in version 0.12 of the RISC-V vector intrinsic specification.
- The toolchain component prefix is riscv-nuclei-elf- on gcc10, but is riscv64-unknown-elf- on gcc13.
- On gcc10, RISCV intrinsic api heads contain riscv_vector.h, riscv_vector_itr.h, rvintrin.h, rvp_intrinsic.h, but now only riscv_vector.h, rvp_intrinsic.h, riscv_nuclei_xlcz.h are provided in gcc13, if you want to find b or k intrinsic API, please check https://github.com/riscv/riscv-crypto/blob/main/benchmarks/share/rvintrin.h and https://github.com/ riscv/riscv-crypto/blob/main/benchmarks/share/riscv-crypto-intrinsics.h , and for RVV intrinsic API, we support 0.12 in gcc13 now, see https://github.com/riscv-non-isa/rvv-intrinsic-doc/releases/tag/v1.0-rc0
- The version of the libnert was changed from v2.0.0 to v3.0.0, and libnert is now split into three parts, 'libnert', 'heapops' and 'fileops', click https://doc.nucleisys.com/nuclei_sdk/develop/buildsystem.html#stdclib to learn about how the newlib/libnert are used in Nuclei SDK with gcc13.

3.1.6 Install and Setup

Build Toolchain

For more information about how to build a toolchain, see https://github.com/riscv-mcu/riscv-gnu-toolchain/tree/ nuclei/2024-gcc13/scripts/toolchain. (Only for Nuclei internal use, no technical support is provided)

Development

The process of user compilation and development can see from https://github.com/riscv-mcu/riscv-gnu-toolchain/ blob/nuclei/2024-gcc13/README.md. To get other technical support, please send issues directly to the upstream repository https://github.com/riscv-collab/riscv-gnu-toolchain.

Examples

- 1. If you choose a core of Nuclei N300FD, then the parameter you pass to 'march' should be rv32*fd*, and 'mabi' should choose ilp32d.
- 2. If you want to bring the full B/K/P extension, then you also need to bring all the subsets of them in the 'march'. For example, for the B extension, the parameter you pass to 'march' is _zba_zbb_zbc_zbs.

3. When using a library, we can tell the linker which library we need to link by using the '-l', for example, -lc for newlib-full, -lc_nano for newlib-nano. For libncrt, you should pass --specs=libncrt_xxx.specs when using gcc. In addition, you need to link extra 'fileops' and 'heapops' static libraries during the linking phase by using the '-l', and for the 'fileops', you must select one of the three options: 'uart', 'semi' or 'rtt', and for the 'heapops', you must select one of the three options: 'uart', 'minimal'.

3.2 LLVM Toolchain

3.2.1 About LLVM Toolchain

The current llvm toolchain is developed based on the upstream V17.0, and only Nuclei custom CSR is supported.

3.2.2 Extensions Support

Ratified Extensions

• Basic Extensions

i, m, a, f, d, c, h(Assembly only), zicsr, zifencei, zihintpause(Assembly only), zicond, zawrs(Assembly only), zfh, zfhmin, zmmul, svinval(Assembly only), svnapot(Assembly only), svpbmt.

• Z*inx Extensions

zfinx, zdinx, zhinx, zhinxmin.

• CMO Extensions(Assembly only)

zicboz, zicbom, zicbop.

• Bitmanip Extensions

zba, zbb, zbc, zbs

• Crypto Extensions

zbkb, zbkc, zbkx, zknd, zkne, zknh, zkr, zks, zksed, zksh, zkt.

Vector Extensions

zve32x, zve32f, zve64x, zve64f, zve64d, zvfh, zvfhmin, v.

Zc Extensions

zca, zcb, zce, zcf, zcd, zcmp(Assembly only), zcmt(Assembly only).

• Zvb Extensions

zvbb, zvbc

• Zvk Extensions

zvkg, zvkned, zvknha, zvknhb, zvksed, zvksh, zvkn, zvknc, zvkng, zvks, zvksc, zvksg, zvkt.

Experimental Extensions

LLVM supports (to various degrees) a number of experimental extensions. All experimental extensions have experimental- as a prefix. Listed below:

smaia, ssaia, zacas, zfa, zfbfmin, zvfbfmin, zvfbfwma, zicond, zihintntl, ztso, zvbb, zvbc, zvkg, zvkn, zvknc, zvkned, zvkng, zvknha, zvknbb, zvks, zvksc, zvksed, zvksg, zvksh, zvkt.

Note: To use an experimental extension from *clang*, you must add -menable-experimental-extensions to the command line, and specify the exact version of the experimental extension you are using. To use an experimental extension with LLVM 's internal developer tools (e.g. *llc*, *llvm-objdump*, *llvm-mc*), you must prefix the extension name with experimental-.

3.2.3 General Options

-march=<cpu>

Specify that Clang should generate code for a specific processor family member and later. For example, if you specify -march=i486, the compiler is allowed to generate instructions that are valid on i486 and later processors, but which may not exist on earlier ones.

-mcmodel=<arg>

-mcmodel=medany (equivalent to -mcmodel=medium), -mcmodel=medlow (equivalent to -mcmodel=small)

-mcpu=help, -mtune=help

Print out a list of supported processors for the given target (specified through --target=<architecture> or -arch <architecture>). If no target is specified, the system default target will be used.

Optimization Option

-00

Means "no optimization": this level compiles the fastest and generates the most debuggable code.

```
-0/-01
```

Somewhere between -O0 and -O2.

-02

Moderate level of optimization which enables most optimizations.

-03

Like -O2, except that it enables optimizations that take longer to perform or that may generate larger code (in an attempt to make the program run faster).

-Ofast

Enables all the optimizations from -O3 along with other aggressive optimizations that may violate strict compliance with language standards.

-*O*s

Like -O2 with extra optimizations to reduce code size.

For more about RISC-V options used by LLVM toolchain, please check https://releases.llvm.org/17.0.1/docs/RISCVUsage.html

3.2.4 Install and Setup

More information on building and running LLVM, see https://llvm.org/docs/GettingStarted.html# getting-the-source-code-and-building-llvm

CHAPTER FOUR

NUCLEI OPENOCD

4.1 About OpenOCD

4.1.1 Repository and Doc

openocd

- github riscv-openocd: https://github.com/riscv-mcu/riscv-openocd/tree/nuclei/2024.06
- gitee riscv-openocd: https://gitee.com/riscv-mcu/riscv-openocd/tree/nuclei/2024.06

openflashloader

Note: OpenOCD Flashloader is developed to support various different customized flash programming without modify openoed and rebuilt it, please check the source code repo's doc.

- github openflashloader: https://github.com/riscv-mcu/openflashloader
- gitee openflashloader: https://gitee.com/riscv-mcu/openflashloader

openocd doc path: openocd/doc/pdf/openocd.pdf

4.2 How to Use

4.2.1 How to determine the version of OpenOCD

- start a cmd(Windows)/terminal(Linux)
- run the *openocd* -*v* command

```
nuclei@nuclei-v:~$ openocd -v
Open On-Chip Debugger 0.11.0+dev-02424-g787e48e66 (2022-12-29-08:49)
Licensed under GNU GPL v2
For bug reports, read
    http://openocd.org/doc/doxygen/bugs.html
nuclei@nuclei-v:~$
```

Note: git commit id: 787e48e66

compile date: (2022-12-29-08:49)

4.2.2 Start OpenOCD

Frequently used command line parameters

parameter	description
-V	display version info
-d	set debug level to 3
-d0	error messages only
-d1	error warning
-d2	error warning info (default)
-d3	error warning info debug
-d4	error warning info debug low-level-debug
-f file	use configuration file
-s dir	dir to search for config files
-1 logfile	redirect log output to logfile

4.3 Nuclei Customized Features

Display CPU information

Usually we don't know what instruction sets a CPU supports, what functional components it contains, and the various configurations of the components. The only way to get the desired information is to read the corresponding CSR registers and then do the math. It would be a pain in the ass to do this for every function point that needs to be known.

This command is designed to solve this problem by automatically reading the CSRs and doing the cpu feature probing, and then formatting the output.

nuclei cpuinfo

Nuspi(nuclei spi) driver

Nuclei's SPI controller, used in Nuclei RISC-V fpga evaluation board and other boards.

flash bank name nuspi base size chip_width bus_width target spi_base
[simulation]

Custom driver and open-flashloader

Custom exists for compatibility with any SPI controller and any Flash. It also needs to be used in conjunction with openflashloader to achieve the desired results.

flash bank name custom base size chip_width bus_width target spi_base
flashloader_path [simulation] [sectorsize=]

Nuclei Customized CSRs

Nuclei released openocd supports a number of nuclei customized CSRs, please check here https://github.com/riscv-mcu/riscv-openocd/blob/nuclei/2024.06/src/target/riscv/encoding.h#L3109-L3223

Nuclei embedded trace

Note: Still in experiment stage, not for production usage.

Some Nuclei cpus are equipped with trace support, which permits examination of the instruction activity. Trace activity is controlled through an Embedded Trace(Etrace) Module on the core 's scan chains. The following commands are for etrace.

Currently, we only implemented RISC-V ETrace Instruction Trace in CPU, Data Trace not yet ready.

nuclei etrace config etrace-addr buffer-addr buffer-size wrap

This command is used to initialize Etrace and configure related parameters.

nuclei etrace enable

This command triggers the Etrace enable signal by setting the Core internal trigger.

nuclei etrace disable

This command triggers the Etrace disable signal by setting the Core internal trigger.

nuclei etrace start

This command is used to enable Etrace data collection.

nuclei etrace stop

This command is used to disable Etrace data collection.

nuclei etrace dump filename

This command is used to dump the data captured by Etrace.

nuclei etrace clear

This command is used to clear the read and write pointers for Etrace.

nuclei etrace info

This command displays the current Etrace status.

You can also use ETrace feature in Nuclei Studio IDE, please check its documentation for more details.

Nuclei Debug Map Feature

The debug map for each hart is automatically read and printed during OpenOCD startup, or you can read the debug map at runtime with the examine_cpu_core command.

About the detailed nuclei debug map feature, please contact with our AE for more documentation.

nuclei expose_cpu_core

Configure a list of index for *nuclei_examine_cpu_core* to expose in this must be executed before init.

nuclei examine_cpu_core

Return the 64-bit value read from dm-custom1 and dm-custom2 value = dm-custom2 $\,<<\,$ 32 $\,+\,$ dm-custom1.

Init resethalt command

In practice, usually encountered due to software problems caused by the CPU stuck, then the debugger will not be connected to the development board, only to the development board power off. If your code is running in flash, powering down the board will not solve the problem. resethalt is designed to solve this problem.

```
init resethalt
```

FTDI nscan1_mode command

Enable or disable Nuclei CJTAG mode. Usage is the same as ftdi oscan1_mode.

```
ftdi nscan1_mode on|off
```

4.4 About the configuration file

The openocd configuration file is used to configure how to connect to the development board 's window through the Debug interface. nuclei provides an example of the openocd configuration file, which can be modified based on the example.

Here we take example using Nuclei HBird Debugger(FTDI based) as to explain this openocd configuration file.

Here is an working example for openocd configuration file https://github.com/Nuclei-Software/nuclei-sdk/blob/ master/SoC/evalsoc/Board/nuclei_fpga_eval/openocd_evalsoc.cfg

Modify debugger rate

adapter_khz 1000 or adapter speed 1000

Select debugger interface

```
adapter driver ftdi
ftdi vid_pid 0x0403 0x6010
transport select jtag
ftdi layout_init 0x0008 0x001b
ftdi layout_signal nSRST -oe 0x0020 -data 0x0020
ftdi layout_signal TCK -data 0x0001
ftdi layout_signal TDI -data 0x0002
ftdi layout_signal TDO -input 0x0004
ftdi layout_signal TMS -data 0x0008
ftdi layout_signal JTAG_SEL -data 0x0100 -oe 0x0100
```

The above code are used to select fdti debugger, the ftdi chip pid/vid must match selected id, transport is selected as JTAG, and ftdi layout is setup to match HBird Debugger hardware settings.

Modify debugger mode

There are two debugging modes JTAG and cJTAG.

- JTAG <-> ftdi nscan1_mode off
- cJTAG <-> ftdi nscan1_mode on

Describe the JTAG link

• single core

```
set _CHIPNAME0 riscv0
jtag newtap $_CHIPNAME0 cpu -irlen 5 -expected-id 0x10900a6d
set _TARGETNAME0 $_CHIPNAME0.cpu
target create $_TARGETNAME0 riscv -chain-position $_TARGETNAME0 -coreid 0
```

smp system

· amp system

Note:

```
• -rtos hwthread
```

OpenOCD includes a pseudo RTOS called hwthread that presents CPU cores ("hardware threads") in an SMP system as threads to GDB. With this extension, GDB can be used to inspect the state of an SMP system in a natural way. After halting the system, using the GDB command info threads will list the context of each active CPU core in the system. GDB' s thread command can be used to switch the view to a different CPU core. The step and stepi commands can be used to step a specific core while other cores are free-running or remain halted, depending on the scheduler-locking mode configured in GDB.

Describe the workarea

workarea is mainly used to speed up certain operations, such as reading and writing large chunks of memory, running small program fragments, reading and writing flash, and so on.

```
$_TARGETNAME0 configure -work-area-phys 0x08000000 -work-area-size 0x10000 -work-
→area-backup 1
```

Note: The workarea should be a readable, writable, and executable area of memory.

 0×08000000 workarea base address, modified according to the actual situation.

0x10000 workarea size of byte, modified according to the actual situation.

Describe the nor flash

```
set _FLASHNAME0 $_CHIPNAME0.flash
flash bank $_FLASHNAME0 nuspi 0x20000000 0 0 0 $_TARGETNAME0.0 0x10180000
```

Note: nuspi openocd flash drivers type, modified according to the actual situation.

0x2000000 qspi-xip address, modified according to the actual situation.

0x10180000 qspi controller base address, modified according to the actual situation.

Connect to the specified debugger

When there is more than one debugger in a debugging environment, we need to connect to specify the debugger, in this case you can use the following command to specify.

ftdi_serial FT4YR31I

How to set up gdb/telnet/tcl ports

openocd provides three kinds of debugging service ports are gdb/telnet/tcl, choose the appropriate service according to the situation, and set the port number of the corresponding service by the following command.

```
gdb_port 3333
telnet_port 4444
tcl_port 6666
```

Note: The above shows the default port number, you are free to change the port number if it is free. Of course we can also disable the port numbers we don ' t need, it ' s easy just change the port number to *disable*.

semihosting

OpenOCD also supports the ARM semihosting feature, use the following command to enable it.

arm semihosting enable

For more detailed information about how to use openocd, please check the <code>openocd.pdf</code> distributed in openocd release.

4.5 Frequently asked questions

There are a few more FAQs please see:

- Github: https://github.com/riscv-mcu/riscv-openocd/wiki
- Gitee: https://gitee.com/riscv-mcu/riscv-openocd/wikis

4.6 Low-cost debugger solution

We also provided a low cost mcu solution to debug RISC-V CPU, which support JTAG and cJTAG, please check the following repo to learn more about it, and it is also supported in Nuclei Studio.

Nuclei Dlink: https://github.com/Nuclei-Software/nuclei-dlink

NUCLEI QEMU

5.1 About Nuclei QEMU

Nuclei QEMU is developed based on QEMU version 8.0, supporting the machine features of Nuclei Demosoc and Evalsoc. In terms of extensions, it supports RVV 1.0, Nuclei DSP extension, ZC extension (RISC-V Code Size Reduction), Nuclei Xlcz extension, as well as features like the B extension, K extension, and Nuclei Nice instructions.

If you want to access the code of Nuclei QEMU, you can visit our opensource Nuclei QEMU Github Repository²¹.

5.2 Design and Architecture

Nuclei QEMU has several types of parameters that can be configured. You can enter <code>qemu-system-riscv32</code> --help to view the parameters that can be configured in Nuclei QEMU.

Nuclei QEMU supports two main programs: qemu-system-riscv32 and qemu-system-riscv64. qemu-system-riscv32 is used to support 32-bit programs, while qemu-system-riscv64 supports 64-bit programs.

Nuclei QEMU supports two machine types: nuclei_evalsoc and nuclei_demosoc. Among them, nuclei_demosoc will be deprecated in future versions, and currently only nuclei_evalsoc is supported.

The following image shows the relevant information of the Nuclei CPU types supported by Nuclei QEMU.

5.3 Description of Parameters

Nuclei QEMU adds some custom features and functionalities based on the original capabilities of qemu. If you want to learn more about the usage of qemu, you can refer to the documentation at https://www.qemu.org/docs/master/.

This is an example of a fully functional parameter for Nuclei QEMU: qemu-system-riscv32 -M nuclei_evalsoc,download=ddr,soc-cfg=evalsoc.json,debug=1-cpu nuclei-n300fd, ext=_v_xxldsp,vlen=128,elen=64,s=true -m 512M -smp 1 -icount shift=0 -nodefaults -nographic -serial stdio -kernel dhrystone.elf.

Let 's describe the meaning of this complete command:

• -M nuclei_evalsoc,download=ddr,soc-cfg=evalsoc.json,debug=1:

-M represents machine, which means selecting the type of machine. Currently, Nuclei QEMU has added nuclei_demosoc (which will be deprecated in future versions) and nuclei_evalsoc to the existing options. This option must exist.

²¹ https://github.com/riscv-mcu/qemu/tree/nuclei/8.0

	N级别 (32位架构)	U级别 (32位架构,MMU)	NX级别 (64位架构)	UX级别 (64位架构,MMU)
1000系列				UX1000FD
900系列	N900 N900F N900FD	U900 U900F U900FD	NX900 NX900F NX900F	UX900 UX900F UX900FD
600系列	N600 N600F N600FD	U600 U600F U600FD	NX600 NX600F NX600FI	UX600 UX600F UX600FD
300系列	N300 N300F N300FD N305 N307 N307FD			
200系列	N200 N201 N201E N203 N203E N205 N205E			
100系列	N100 N100M N100ZMMUL N100E N100EM N100EZMMUL			

download= is used to choose the download mode, and currently, it supports four download modes: sram, flashxip, flash, ilm, and ddr.If this parameter is not present, the default value is flashxip.

soc-cfg= is an optional option to pass dynamic modifications to the initial configuration of the machine with a json file. If this parameter is not set, the default value of qemu will be used .Here is an example:

```
{
    "general_config": {
        "ddr": {
                "base":"0x70000000",
                "size":"2G"
        },
        "ilm": {
                "base":"0x90000000",
                "size":"0x100000"
        },
        "dlm": {
                "base":"0xA0000000",
                "size":"0x100000"
        },
        "sram": {
                "base":"0xB0000000",
                "size":"0x1000000"
        },
        "norflash": {
                "base":"0x30000000",
                "size":"32M"
        },
        "uart0": {
                "base":"0x20013000",
                "irq":"34"
        },
        "uart1": {
                "base":"0x20023000",
                "irq":"35"
        },
        "qspi0": {
```

(continues on next page)

(continued from previous page)

```
"base":"0x20014000",
                "irq":"36"
        },
        "qspi2": {
                "base":"0x20034000",
                "irq":"37"
        },
        "iregion": {
                "base":"0x1000000"
        },
        "cpu_freq":"50000000",
        "timer_freq":"32768",
        "irqmax":"100"
    },
    "download": {
        "ilm": {
                 "startaddr": "0x90000000"
        },
        "flashxip": {
                "startaddr":"0x3000000"
        },
        "flash": {
                "startaddr":"0x3000000"
        },
        "sram": {
                 "startaddr":"0xB0000000"
        },
        "ddr": {
                "startaddr":"0x70000000"
        }
    }
}
```

general_config : mainly used to configure the board resource or chip base address

base: module base address, only support hex format

size: module size, support hex, dec, size string format

irq: peripheral interrupt id, dec format

download: firmware startup address

The irq peripheral interrupt id is equal to hardware interrupt wire connect number plus one, users should follow this rule when configuring irq.

IRQ_HW_ID	PLIC Interrupt ID	Source
32	33	uart0
34	35	qspi0
35	36	qspi1
36	37	qspi2

In the above script, if there is no **download startaddr** information, the program entry will be the start address of the address range relative to the download mode. For example, when download=ilm, if the following configuration is not in the script,

```
"download": {
    "ilm": {
        "startaddr":"0x90000000"
    }
```

then the ilm base in general_config will be used as the program start address by default.

```
"general_config": {
    "ilm": {
        "base":"0x90000000",
        "size":"0x100000"
}
```

Other configurations follow this rule as well.

Note: In the **general_config** JSON configuration script, the **base** attribute must coexist with either **size** or **irq**, and the format requires **base** to be written first, followed by either **size** or **irq**.

debug=1 list the start address of the current device 's peripherals and memory distribution information or irq info for debugging purposes. It is generally not recommended to enable this feature under normal circumstances.

• -cpu nuclei-n300fd,ext=_v_xxldsp,vlen=128,elen=64,s=true:

Using the -cpu option, nuclei-n300fd represents the selectable CPU type for Nuclei, and the complete list of types can be referred to in the diagrams within the Design and Architecture section. This operation is necessary.

ext= This parameter is optional, used to pass different riscv extension, The way to enable different extensions is to add them inside it, for example, xxldsp represents enable the nuclei DSP extension, v represents enable RISC-V V-Extension, When enabling multiple extensions, they are connected through _. Currently, Nuclei QEMU supports the following common RISC-V instruction set extension types:

Extension	Functionality	
V	RISC-V V-Extension	
h	RISC-V H-Extension	
zicbom	RISC-V Zicbom Extension	
zicboz	RISC-V Zicboz Extension	
zicond	RISC-V Zicond Extension	
zicsr	RV32/RV64 Zicsr Standard Extension	
zifencei	RV32/RV64 Zifencei Standard Extension	
zihintpause	ZiHintPause extension	
zilsd	Zilsd extension (RV32 ONLY)	
zcmlsd	Zcmlsd extension (RV32 ONLY)	
zawrs	Zawrs extension	
zfh	Zfh Extension	
zfa	Zfa Extension	
zfhmin	Zfhmin Extension	
zfinx	Zfinx Extension	
zdinx	Zdinx Extension	
zca	RISC-V ZC* Extension	
zcb	RISC-V ZC* Extension	
zcf	RISC-V ZC* Extension	
zcd	RISC-V ZC* Extension	
zce	RISC-V ZC* Extension	
zcmp	RISC-V ZC* Extension	
zcmt	RISC-V ZC* Extension	
zba	RISC-V Bitmanipulation Extension	
zbb	RISC-V Bitmanipulation Extension	
zbc	RISC-V Bitmanipulation Extension	
zbkb	RISC-V Bitmanipulation Extension	
zbkc	RISC-V Bitmanipulation Extension	

continues on next page

Extension	Functionality
zbkx	RISC-V Bitmanipulation Extension
zbs	RISC-V Bitmanipulation Extension
zk	RISC-V Scalar Crypto Extension
zkn	RISC-V Scalar Crypto Extension
zknd	RISC-V Scalar Crypto Extension
zkne	RISC-V Scalar Crypto Extension
zknh	RISC-V Scalar Crypto Extension
zkr	RISC-V Scalar Crypto Extension
zks	RISC-V Scalar Crypto Extension
zksed	RISC-V Scalar Crypto Extension
zksh	RISC-V Scalar Crypto Extension
zkt	RISC-V Scalar Crypto Extension
zve32x	RISC-V V-Extension
zve32f	RISC-V V-Extension
zve64x	RISC-V V-Extension
zve64f	RISC-V V-Extension
zve64d	RISC-V V-Extension
zvfh	RISC-V V-Extension
zvfhmin	RISC-V V-Extension
zhinx	Zhinx Extension
zhinxmin	Zhinxmin Extension
smaia	Smaia Extension
ssaia	Ssaia Extension
sscofpmf	Sscofpmf Extension
sstc	Sstc Extension
svadu	Svadu Extension
svinval	Svinval Extension
svnapot	Svnapot Extension
svpbmt	Svpbmt Extension
xxldsp	Nuclei DSP Extension based on P-ext 0.5.4 + default 8 EXPD instructions
xxldspn1x	Xxldsp + Nuclei N1 extension
xxldspn2x	Xxldspn1x + Nuclei N2 extension
xxldspn3x	Xxldspn2x + Nuclei N3 extension
xxlcz	Nuclei code size reduction extension

Table 5.1 - continued from previous page

vlen=128,elen=64: The VLEN and ELEN are only effective when the V extension instructions of RISC-V are enabled. The default value of VLEN is 128, and it must be a multiple of 2 when set, with a value range of [128, 1024]. The default value of ELEN is 64, and ELEN must also be a multiple of 2, with a value range of [8, 64].

s=true: This parameter is optional, If you wish for RISC-V to support the S (supervisor) privilege mode, you can add s=true to the parameters to meet this requirement. Nuclei QEMU currently only supports interrupt handling in M-privilege mode.

• -m 512M: To set the DDR size in QEMU, if the DDR size is not passed with -m, then the JSON config will be used to determine the size, and lastly, if neither is specified, it will initialize with 32MB.

Note: The following is the current default qemu memory size configuration, xip: 32MB, ddr:64MB, ilm: 8MB, dlm: 8MB, sram: 512MB. You can change the size of the DDR by using -m size. When -m 128M or no -m is passed, the default DDR size configured in the JSON or the size initialized by the program will be used. If the DDR size is configured too large and the computer does not have enough memory to allocate, an error such as qemu-system-riscv32: cannot set up guest memory 'riscv.evalsoc. ram.sram' may occur.

• -smp 1: Nuclei Qemu currently supports up to 16 CPUs. If this parameter is not set, the uses 1 CPU.

- -icount shift=0: This parameter is optional, Qemu TCG Instruction Counting. By enabling this option, you can enable qemu's instruction count. For more detailed information, refer to https://www.qemu.org/ docs/master/devel/tcg-icount.html
- -nodefaults: QEMU is used to disable all default devices and configurations, and some custom parameters and commands can be passed.
- -nographic: Disable qemu's graphical interface and redirect standard output to the console.
- -serial stdio: Direct standard output to the console.
- -kernel or -bios: Choose the boot mode for the firmware. By default, programs on nuclei-sdk load using the -kernel mode, while on Linux, they load using the -bios mode. In the design of Nuclei Qemu, -kernel enables the use of ECLIC. For bare metal or RTOS, -kernel is used to transfer ELF file, while -bios is used to enable PLIC+CLINT timers, which are more suitable for Linux applications.

5.4 Use Nuclei QEMU in Nuclei SDK

Setup Tools and Environment

- 1. Download the nuclei-sdk²², checkout to master branch.
- 2. Download RISC-V GNU Toolchain form Nuclei Download Center²³.
- 3. Download Nuclei Qemu form Nuclei Download Center²⁴.
- 4. Set up the system environment variables to ensure that the directories containing riscv64-unknown-elf-gcc and qemu-system-riscv32 are included in the global system variable environment.

Example

If you want to use QEMU on Nuclei-SDK. The example here uses the CPU of the nx900fd, but other CPU types can also be used for testing. The example is xxdsp.

First, you need to configure the toolchain, nuclei-sdk, and qemu environments according to the documentation, https://doc.nucleisys.com/nuclei_sdk/quickstart.html

Where **ARCH_EXT** can be used to pass the extension name. Under normal circumstances, you should see the final output NMSIS_TEST_PASS, which indicates that all test cases have passed successfully.

And Nuclei QEMU and Nuclei SDK are deeply integrated in Nuclei Studio, you can also use it in Nuclei Studio, see https://nucleisys.com/upload/files/doc/nucleistudio/Nuclei_Studio_User_Guide.202406.pdf

²² https://github.com/Nuclei-Software/nuclei-sdk

²³ https://nucleisys.com/download.php

²⁴ https://nucleisys.com/download.php

5.5 Use Nuclei QEMU in Nuclei Linux SDK

Nuclei QEMU can also used to boot and test RISC-V Linux Kernel using emulated Nuclei EvalSoC, please check documentation here https://github.com/Nuclei-Software/nuclei-linux-sdk#booting-linux-on-nuclei-qemu.

An example of a typical Nuclei QEMU running Nuclei Linux SDK is as follows:

```
qemu-system-riscv64 -M nuclei_evalsoc,download=flashxip,soc-cfg=soc.json -cpu_

onuclei-ux900fd,ext= -smp 8 -m 2G -bios freeloader_qemu.elf -nographic -drive_

ofile=disk.img,if=sd,format=raw
```

This command sets up QEMU to emulate a Nuclei processor and environment specifically for the Nuclei Linux SDK. Here 's a breakdown of the parameters:

- qemu-system-riscv64: This is the QEMU emulator for the RISC-V 64-bit architecture.
- -M nuclei_evalsoc: Specifies the machine type for nuclei_evalsoc, nuclei_demosoc will be deprecated in future versions.
- download=flashxip: The download mode of firmware, which is an optional parameter. If not set, the default download mode is flashxip.
- soc-cfg=evalsoc.json: optional, additional configuration scripts can customize the interrupt information and memory address information of peripherals. For details, see Description of Parameters.
- -cpu nuclei-ux900fd: Selects the Nuclei UX900FD CPU model for emulation.
- -ext=: You can pass the extensions supported by riscv, and connect multiple extensions with _, eg. _zba_zbb_zbc_zbs_zicond.
- -smp 8: Enables Symmetric Multi-Processing (SMP) with 8 CPU cores.
- -m 2G: Allocates 2GB of RAM to the virtual machine.
- -bios freeloader_qemu.elf: Specifies the BIOS or bootloader to use, in this case a freeloader named freeloader_qemu.elf specifically for QEMU.
- -nographic: Disables graphical output, making QEMU run in a text-only mode.
- -drive file=disk.img, if=sd, format=raw: Attaches a virtual disk image named disk.img to the virtual machine, using the SD card interface (if=sd) and a raw file format (format=raw). This disk image likely contains the Nuclei Linux SDK filesystem.

NUCLEI MODEL

6.1 About Nuclei Near Cycle Model

The Nuclei Near Cycle Model (referred to as *xlmodel*) is a co-simulation using **SystemC TLM-2 combined with xlspike**. Xlspike uses spike as the RISC-V ISA simulator and adds support for Nuclei 's N/NX/UX RISC-V processors. SystemC establishes the TLM 2.0 interaction relationships among the components under **Nuclei EvalSoC**.

- The *xlmodel* can be obtained in Nuclei Studio 2024.06.
- The *xlmodel* is only supported on Linux system.
- The *xlmodel* is a **near cycle model** that can test the performance of firmware with different ISA configurations.
- The *xlmodel* has SystemC built-in and uses version 2.3.4 by default.
- The *xlmodel* has built-in **gprof** functionality, allowing for a more intuitive display of the function call stack, the cycle count proportion of each function within the test code.
- The *xlmodel* can easily extend user-defined instructions, namely Nuclei NICE instructions.
- Xlspike supports RV32IMAFDCBPV and RV64IMAFDCBPV ISA.

6.2 SystemC components

Brief description of the *xlmodel* SystemC components:

- Top: Top-level entity that builds & starts the SystemC simulation
- Cluster: Cluster contains multiple cores and can be used to start xlspike for co-simulation
- Bus: Simple bus manager
- · Memory: Memory comprises both instruction memory and data memory, as well as the loading of ELF sections
- Timer: Nuclei timer unit
- EvalUart: Nuclei EvalSoC uart
- EvalQspi: Nuclei EvalSoC qspi

6.3 How to run

6.3.1 model help

Frequently used command line parameters

parameter	description
version	display version info
time= <n></n>	set simulation time(us); otherwise, it is unlimited
bpu= <str></str>	core bpu type config, defaults tobpu=n300 and can be set to n900
smp= <n></n>	SMP system core number configuration, with a maximum of 16
trace= <n></n>	whether generate the trace file,trace=1 means generating
gprof= <n></n>	whether to use profiling,gprof=1 means using profiling
varch= <str></str>	RISCV Vector uArch config, defaults tovarch=vlen:128,elen:64
log= <str></str>	logging system level, defaults tolog=info and can be set to error, tlm, debug
logdir= <str></str>	the directory to save trace and gprof files

You need to pass the different parameters above based on the results you want to obtain and the specific test code. In most cases, you only need to pass the path of the ELF file.

6.3.2 normal test case

When you want to use the model, you can select the *bin/xl_cpumodel* as the executable file.

The default test codes ELF files are provided in the *tests* directory, this is an example of demo timer test code below:

```
./xl_cpumodel ../tests/demotimer/demotimer_nx900.elf
```

xuzt@whml1:/Local/xuzt/clib/model_ide/nuclei_cpu_model/build\$./xl_cpumodel ../tests/demotimer/demotimer_nx900.elf

```
SystemC 2.3.4-Accellera --- May 16 2024 16:02:03

Copyright (c) 1996-2022 by all Contributors,

ALL RIGHTS RESERVED

[XLMODEL-INFO] filename[0]: ../tests/demotimer/demotimer_nx900.elf

[XLMODEL-INFO] Found the following .elf files:

[XLMODEL-INFO] Created Cluster0

[XLMODEL-INFO] created Cluster0

[XLMODEL-INFO] orgv[1]: -p1

[XLMODEL-INFO] argv[0]: -t

[XLMODEL-INFO] argv[2]: +permissive-off

[XLMODEL-INFO] argv[2]: +permissive-off

[XLMODEL-INFO] argv[3]: ../tests/demotimer/demotimer_nx900.elf

Nuclei SDK Build Time: Mar 27 2024, 10:30:49

Download Mode: ILM

CPU HartID: 0

init timer and start

MTimer IRQ handler 1

MTimer IRQ handler 2

MTimer IRQ handler 3

MTimer IRQ handler 4

MTimer IRQ handler 3

MTimer SW IRQ handler 3

MTimer SW IRQ handler 4

MTimer SW IRQ handler 5

MTimer SW IRQ handler 5

MTimer SW IRQ handler 4

MTimer SW IRQ handler 5

MTimer SW IRQ handler 4

MTimer SW IRQ handler 5

MTimer SW IRQ handler 4

MTimer SW IRQ handler 5

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MTimer SW IRQ handler 4

MTimer SW IRQ handler 5

MTimer SW IRQ handler 4

MTimer SW IRQ handler 5

MTimer SW IRQ handler 4

MTimer SW IRQ handler 5

MTimer SW IRQ handler 4

MTimer SW IRQ handler 5

MTIMER SW IRQ handleR 4

MTIMER SW IRQ handLER 5

MTIMER
```

The *xlmodel* can select different **BPU strategies** based on Nuclei core types, which will affect the cycle count of branch and jump instructions.

You can pass the parameter bpu=n300, which is applicable to Nuclei cores up to and including N300 (<= N300). You can also pass the parameter bpu=n900, which is applicable to Nuclei cores from N300 onwards (> N300):

./xl_cpumodel ../tests/demotimer/demotimer_nx900.elf --bpu=n300

xuzt@whmll:/Local/xuzt/clib/model_ide/nuclei_cpu_model/build\$./xl_cpumodel ../tests/demotimer/demotimer_nx900.elf --bpu=n300

SystemC 2.3.4-Accellera May 16 2024 16:02:03
Copyright (c) 1996-2022 by all Contributors,
ALL RIGHTS RESERVED
[XLMODEL-INFO] filename[0]:/tests/demotimer/demotimer nx900.elf
[XLMODEL-INFO] Found the following .elf files:
[XLMODEL-INFO]/tests/demotimer/demotimer nx900.elf
[XLMODEL-INFO] Created Cluster0
[XLMODEL-INFO] start pc: 0x80000200
[XLMODEL-INFO] rv64 file
[XLMODEL-INFO] argv[0]: -t
[XLMODEL-INFO] argv[1]: -p1
[XLMODEL-INFO] argv[2]: +permissive-off
<pre>[XLMODEL-INF0] argv[3]:/tests/demotimer/demotimer_nx900.elf</pre>
Nuclei SDK Build Time: Mar 27 2024, 10:30:49
Download Mode: ILM
CPU Frequency 692715 Hz
CPU HartID: 0
init timer and start
MTimer IRQ handler 1
MTimer IRQ handler 2
MTimer IRQ handler 3
MTimer IRQ handler 4
MTimer IRQ handler 5
MTimer SW IRQ handler 1
MTimer SW IRQ handler 2
MTimer SW IRQ handler 3
Milmer SW IRQ handler 4
Milmer SW IKU nandler S
Milmer msip and mtip interrupt test finish and pass

[XLMODEL-INFO] total run 431608 instruction

Info: /OSCI/SystemC: Simulation stopped by user. [XLMODEL-INFO] Total elapsed time: 2.609912s [XLMODEL-INFO] Press Enter to finish

When testing an SMP system case, you need to pass the parameter smp=n, specifying the number of cores, to the command line:

./xl_cpumodel ../tests/smphello_nx900/smphello_nx900.elf --smp=4

xuzt@whmll:/Local/xuzt/clib/model_ide/nuclei_cpu_model/build\$./xl_cpumodel ../tests/smphello_nx900/smphello_nx900.elf --smp=4
SystemC 2.3.4-Accellera --- May 16 2024 16:02:03
Copyright (c) 1996-2022 by all Contributors,
ALL RIGHTS RESERVED
[XLMODEL-INF0] fulcer0 smp num: 4
[XLMODEL-INF0] fulcer0 smp num:

Info: /OSCI/SystemC: Simulation stopped by user. [XLMODEL-INFO] Total elapsed time: 0.766246s [XLMODEL-INFO] Press Enter to finish

If you need to test Vector extension case and specify vlen or elen, you need to pass the parameter *varch=vlen:n,elen:n*. Note that vlen and elen must comply with the RISC-V Vector specifications:

./xl_cpumodel ../tests/rvv_conv_f32/rvv_conv_f32.elf --varch=vlen:1024,elen:64

xuzt@whmll:/Local/xuzt/clib/model_ide/nuclei_cpu_model/build\$./xl_cpumodel ../tests/rvv_conv_f32/rvv_conv_f32.elf ··varch=vlen:1024,elen:64



6.3.3 test case with trace

When you want to see the complete trace of the firmware elf, you need to pass the parameter trace=1 in the command line:

You can obtain information such as the pc, opcode, disassembly, and others for each instruction in generated *<elf-name>.rvtrace* file:

```
pc opcode disassemble
rv64 file
1 hart0 (1) IT 80000200 30047073 3 :csrci mstatus, 8
1 hart0 R CSR 0x300:CSR MSTATUS:0xa00000000
2 hart0 (2) IT 80000204 f1402573 3 :csrr a0, mhartid
2 hart0 R x10:0x0
3 hart0 (3) IT 80000208 0ff57513 3 :andi a0, a0, 255
3 hart0 R x10:0x0
4 hart0 (4) IT 8000020c 00004581 3 :c.li a1, 0
4 hart0 R x11:0x0
5 hart0 (5) IS 8000020e 12b51463 3 :bne
                                        a0, a1, pc + 296
5 hart0 B 0x80000336
6 hart0 (6) IT 80000212 10001197 3 auipc gp, 0x10001
6 hart0 R x3:0x90001212
7 hart0 (7) IT 80000216 83e18193 3 :addi gp, gp, -1986
7 hart0 R x3:0x90000a50
8 hart0 (8) IT 8000021a 10001217 3 :auipc tp, 0x10001
8 hart0 R x4:0x9000121a
9 hart0 (9) IT 8000021e 93e20213 3 :addi tp, tp, -1730
9 hart0 R x4:0x90000b58
10 hart0 (10) IT 80000222 10080117 3 :auipc sp, 0x10080
10 hart0 R x2:0x90080222
```
6.3.4 test case with log

The *xlmodel* has multiple log levels, listed from least to most detailed as *error*, *info*, *tlm*, *debug*. By default, it provides log information at the *info* level, which can be changed by passing *log=xxx*.

When *log=tlm* is selected, logs related to all TLM memory reads and writes can be printed:

SystemC 2.3.4-Accellera --- May 16 2024 16:02:03 Copyright (c) 1996-2022 by all Contributors, ALL RIGHTS RESERVED [XLMODEL-INFO] filename[0]: ../tests/helloworld/helloworld.elf [XLMODEL-INFO] Found the following .elf files: [XLMODEL-INFO] ../tests/helloworld/helloworld.elf [XLMODEL-INFO] Created Cluster0 [XLMODEL-INFO] start pc: 0x80000100 [XLMODEL-INFO] rv32 file [XLMODEL-INFO] argv[0]: -t [XLMODEL-INFO] argv[1]: -p1 [XLMODEL-INFO] argv[2]: +permissive-off [XLMODEL-INFO] argv[3]: ../tests/helloworld/helloworld.elf [XLMODEL-TLM] TLM Write: Address=0x900004f8 Data=0x0 Size=4 [XLMODEL-TLM] TLM Write: Address=0x900004fc Data=0x0 Size=4 [XLMODEL-TLM] TLM Write: Address=0x90000500 Data=0x0 Size=4 [XLMODEL-TLM] TLM Write: Address=0x90000504 Data=0x0 Size=4 [XLMODEL-TLM] TLM Write: Address=0x90000508 Data=0x0 Size=4 [XLMODEL-TLM] TLM Write: Address=0x9000050c Data=0x0 Size=4 [XLMODEL-TLM] TLM Write: Address=0x90000510 Data=0x0 Size=4 [XLMODEL-TLM] TLM Write: Address=0x90000514 Data=0x0 Size=4 [XLMODEL-TLM] TLM Write: Address=0x90000518 Data=0x0 Size=4 [XLMODEL-TLM] TLM Write: Address=0x9000051c Data=0x0 Size=4 [XLMODEL-TLM] TLM Write: Address=0x90000520 Data=0x0 Size=4

When *log=debug* is selected, TLM information and more detailed instruction trace information, including register updates, exceptions, and CSRs, will be printed:

SystemC 2.3.4-Accellera --- May 16 2024 16:02:03 Copyright (c) 1996-2022 by all Contributors, ALL RIGHTS RESERVED [XLMODEL-INFO] filename[0]: ../tests/helloworld/helloworld.elf [XLMODEL-INFO] Found the following .elf files: [XLMODEL-INFO] ../tests/helloworld/helloworld.elf [XLMODEL-INFO] Created Cluster0 [XLMODEL-INFO] start pc: 0x80000100 [XLMODEL-INFO] rv32 file [XLMODEL-INFO] argv[0]: -t [XLMODEL-INFO] argv[1]: -p1 [XLMODEL-INFO] argv[2]: +permissive-off [XLMODEL-INFO] argv[3]: ../tests/helloworld/helloworld.elf [XLMODEL-DEBUG] 1 hart0 (1) IT 80000100 30047073 3 :csrci mstatus, 8 [XLMODEL-DEBUG] 1 hart0 R CSR ID 0x300 value 0x0 [XLMODEL-DEBUG] CSR MSTATUS [XLMODEL-DEBUG] 2 hart0 (2) IT 80000104 f1402573 3 :csrr a0, mhartid [XLMODEL-DEBUG] 2 hart0 R x10: 0x0 [XLMODEL-DEBUG] 3 hart0 (3) IT 80000108 0ff57513 3 :andi a0, a0, 255 [XLMODEL-DEBUG] 3 hart0 R x10: 0x0 [XLMODEL-DEBUG] 4 hart0 (4) IT 8000010c 00004581 3 :c.li a1, 0 [XLMODEL-DEBUG] 4 hart0 R x11: 0x0 [XLMODEL-DEBUG] 5 hart0 (5) IS 8000010e 10b51a63 3 :bne a0, a1, pc + 276 [XLMODEL-DEBUG] 5 hart0 B 0xfffffff80000222

6.3.5 test case with gprof

If you want to use the model 's built-in **gprof** functionality, you need to pass *gprof=1* to the command line:

./xl_cpumodel ../tests/whet/whet_nx900.elf --gprof=1

xuzt@whml1:/Local/xuzt/clib/model_id@/nuclei_cpu_model_old/nuclei_cpu_model/xlmodel/klmodel/bin\$./xl_cpumodel ../tests/whet/whet_nx900.elf --gprof=1

SystemC 2.3.4-Accellera May 16 20 Copyright (c) 1996-2022 by all Contr: ALL RIGHTS RESERVED [XLMODEL-INFO] filename[0]:/tests/whet/whet (XLMODEL-INFO] found the following .elf file: (XLMODEL-INFO] created Cluster0 [XLMODEL-INFO] created Cluster0 [XLMODEL-INFO] argv[0]: -t (XLMODEL-INFO] argv[0]: -t (XLMODEL-INFO] argv[0]: -t (XLMODEL-INFO] argv[1]: -p1 [XLMODEL-INFO] argv[1]: -p1 (XLMODEL-INFO] argv[2]:/tests/whet/whet_n: Nuclei SDK Build Time: Mar 21 2024, 19:02:22 Download Mode: ILM CPU Frequency 830013 Hz CPU HartID: 0	024 16:02:03 Lbutors, et_nx900.elf S: (900.elf			
######################################	32 Bit			
Use 1 passes (x 100)				
Double Precision C/C++ Whetstone Be Loop content Result	enchmark MFLOPS MO	PS Seconds		
N1 floating point -1.12441415430188418 N2 floating point -1.12239951147853723 N3 if then else 1.000000600000000 N4 fixed point 12.000000000000000 N5 sin,cos etc. 0.49907428465337039 N6 floating point 0.99999988495142078 N7 assignments 3.00000000000000000 N8 exp,sqrt etc. 0.75095530233203855	0.667 0.751 10.277 8.251 0.026 0.794 3.094 0.017	0.029 0.179 0.010 0.038 3.142 0.679 0.060 2.221		
MWIPS	1.573	6.358		
MWIPS/MHz	1.895	6.358		
CSV, Benchmark, MWIPS/MHz CSV, Whetstone, 1.895 IPC = Instret/Cycle = 4629917/6813377 = 0.679)			
[XLMODEL-INF0] total run 4652262 instruction				
Info: /OSCI/SystemC: Simulation stopped by us [XLMODEL-INFO] Total elapsed time: 69.523014: [XLMODEL-INFO] Press Enter to finish	5er. 5		-	

You can obtain the *gprof*<*n*>.*log* files when the simulation is complete, where n represents the hart ID:

🗋 gprof0.gmon	2024/6/27 11:38	GMON 文件	34 KB
gprof0.log	2024/6/27 11:38	文本文档	21 KB

To use them further, you need to import them into the IDE, then you can refer to the model usage guide in the **Nuclei Studio** for detailed instructions on using **gprof**.

6.4 NICE support

The current NICE example in *tests/demonice* demonstrates how to use Nuclei NICE feature:

./xl_cpumodel ../tests/demonice/demonice_nx900.elf

xurtgummal://ucal/xurt/cli/model_ide/nuclei_pu_model/builds ./xl_cpumodel ..//tests/demonice/demonice_nu900.etf
System 2.3.4.Accellers --- May 16 2024 16:02:03
Copyright (c) 1006-0222 by all Contributors,
[XIMOBEL-INFO] Filename(D): ./tests/demonice/demonice_nu900.etf
[XIMOBEL-INFO] Fund the following.etf Tiles:
[XIMOBEL-INFO] -./tests/demonice/demonice_nu900.etf
[XIMOBEL-INFO] created Luster@
[XIMOBEL-INFO] reperimisive-off
[XIMOBEL-INFO] argv[3]: ../tests/demonice/demonice_nu900.etf
[XIMOBEL-INFO] argv[3]: ..

If you need to validate your custom **NICE** instructions, you need to contact Nuclei Support to obtain software package of model.

The directory structure of the package is as follows:

nice directory	description
nice	header and source files for the NICE interface
systemc	SystemC 2.3.4 header files and static libraries
xl_model	xlmodel header files and library files
xl_spike	xlspike header files and library files
tests	test codes
CMakeLists.txt	CMake file required for compilation

CHAPTER SEVEN

CHANGELOG

Nuclei Tools official releases can be found in https://nucleisys.com/download.php#tools, you can download it from there.

7.1 2024.06

This is 2024.06 release of Nuclei Tools.

This release introduced *About Nuclei Near Cycle Model* (page 279) first release which can be used in Ubuntu 20.04 environment.

Find release note below:

- Nuclei Studio 2024.06²⁵
- Nuclei RISC-V Toolchain 2024.06²⁶
- Nuclei QEMU 2024.06²⁷
- Nuclei OpenOCD 2024.06²⁸

Click https://github.com/Nuclei-Software/nuclei-tool-guide/issues/4 for this release known issues.

7.2 2024.02

This release is a bugfix release for 2023.10, which fix many issues reported by 2023.10.

See https://github.com/Nuclei-Software/nuclei-tool-guide/issues/1

7.3 2023.10

This is 2023.10 release of Nuclei Tools.

Find release note below:

- Nuclei Studio 2023.10²⁹
- Nuclei RISC-V Toolchain 2023.10³⁰
- Nuclei QEMU 2023.10³¹

²⁵ https://github.com/Nuclei-Software/nuclei-studio/releases/tag/2024.06

²⁶ https://github.com/riscv-mcu/riscv-gnu-toolchain/releases/tag/nuclei-2024.06

²⁷ https://github.com/riscv-mcu/qemu/releases/tag/nuclei-2024.06

²⁸ https://github.com/riscv-mcu/riscv-openocd/releases/tag/nuclei-2024.06

²⁹ https://github.com/Nuclei-Software/nuclei-studio/releases/tag/2023.10

³⁰ https://github.com/riscv-mcu/riscv-gnu-toolchain/releases/tag/nuclei-2023.10

³¹ https://github.com/riscv-mcu/qemu/releases/tag/nuclei-2023.10

• Nuclei OpenOCD 2023.10³²

Click https://github.com/Nuclei-Software/nuclei-tool-guide/issues/1 for this release known issues.

³² https://github.com/riscv-mcu/riscv-openocd/releases/tag/nuclei-2023.10

CHAPTER EIGHT

GLOSSARY

API

(Application Program Interface) A defined set of routines and protocols for building application software.

ISR

(Interrupt Service Routine) Also known as an interrupt handler, an ISR is a callback function whose execution is triggered by a hardware interrupt (or software interrupt instructions) and is used to handle high-priority conditions that require interrupting the current code executing on the processor.

XIP

(eXecute In Place) a method of executing programs directly from long term storage rather than copying it into RAM, saving writable memory for dynamic data and not the static program code.

CHAPTER NINE

APPENDIX

- Nuclei Tools and Documents: https://nucleisys.com/download.php
- Nuclei Software Opensource Organization: https://github.com/Nuclei-Software
- RISC-V MCU Opensource Organization: https://github.com/riscv-mcu
- Nuclei Toolchain Repo: https://github.com/riscv-mcu/riscv-gnu-toolchain
- Nuclei OpenOCD Repo: https://github.com/riscv-mcu/riscv-openocd
- Nuclei QEMU Repo: https://github.com/riscv-mcu/qemu
- Nuclei SDK: https://github.com/Nuclei-Software/nuclei-sdk
- NMSIS: https://github.com/Nuclei-Software/NMSIS
- Nuclei RISC-V IP Products: https://www.nucleisys.com/product.php
- RISC-V MCU Community Website: https://www.riscv-mcu.com/
- Nuclei RISC-V CPU Spec: https://doc.nucleisys.com/nuclei_spec
- RISC-V ELF psABI Document: https://github.com/riscv-non-isa/riscv-elf-psabi-doc#navigation
- RISC-V ISA Specifications(Ratified): https://riscv.org/technical/specifications
- RISC-V Architecture Profiles: https://github.com/riscv/riscv-profiles
- RISC-V Bitmanip(B) Extension Spec: https://github.com/riscv/riscv-bitmanip
- RISC-V Packed SIMD(P) Extension Spec: https://github.com/riscv/riscv-p-spec
- RISC-V Cryptography(K) Extension Spec: https://github.com/riscv/riscv-crypto
- RISC-V Vector(V) Extension Spec: https://github.com/riscv/riscv-v-spec
- RISC-V Vector Intrinsic API Spec: https://github.com/riscv-non-isa/rvv-intrinsic-doc
- RISC-V ISA Extension Spec Status: https://wiki.riscv.org/display/HOME/Specification+Status
- Nuclei Bumblebee Core Document: https://github.com/nucleisys/Bumblebee_Core_Doc

CHAPTER

TEN

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