

# Nuclei Studio Supply

## Documents



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# Nuclei Studio Supply Documents¶

 Deploy MkDocs passing

 pages-build-deployment passing

This repository is utilized for providing supply documents, user guides, wikis, and facilitating discussions related to Nuclei Studio.

## Note

- The latest version of Nuclei Studio IDE is 2025.02, which can be found in <https://github.com/Nuclei-Software/nuclei-studio/releases/tag/2025.02>
- In Ubuntu 20.04, you must install libncursesw5 libtinfo5 libfdt1 libpixman-1-0 libpng16-16 libasound2 libglib2.0-0 to make riscv64-unknown-elf-gdb and qemu able to run.

PDF Version can be found here: [https://doc.nucleisys.com/nuclei\\_studio\\_supply/pdf/nuclei\\_studio\\_supply.pdf](https://doc.nucleisys.com/nuclei_studio_supply/pdf/nuclei_studio_supply.pdf)

- Nuclei Studio IDE Documentation: [https://doc.nucleisys.com/nuclei\\_tools/ide/index.html](https://doc.nucleisys.com/nuclei_tools/ide/index.html)
- Nuclei Tools(Toolchain/OpenOCD/Qemu/Model) Documentation: [https://doc.nucleisys.com/nuclei\\_tools/](https://doc.nucleisys.com/nuclei_tools/)
- Nuclei Studio NPK Introduction:
- <https://github.com/Nuclei-Software/nuclei-sdk/wiki/Nuclei-Studio-NPK-Introduction>
- [https://doc.nucleisys.com/nuclei\\_tools/ide/npkoverview.html](https://doc.nucleisys.com/nuclei_tools/ide/npkoverview.html)

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如果您在文档中发现任何拼写错误或不完善之处，我们欢迎您提交Pull Request或Issue，以协助我们进行改进！

If you come across any spelling errors or areas that need improvement in the document, feel free to submit a Pull Request or Issue to help us enhance it!

## Documents¶

Generated by python3 update.py @ 2025-02-25 09:25:15

Document	Description
<a href="#">1-cannot-setup-guestmemory.md</a>	

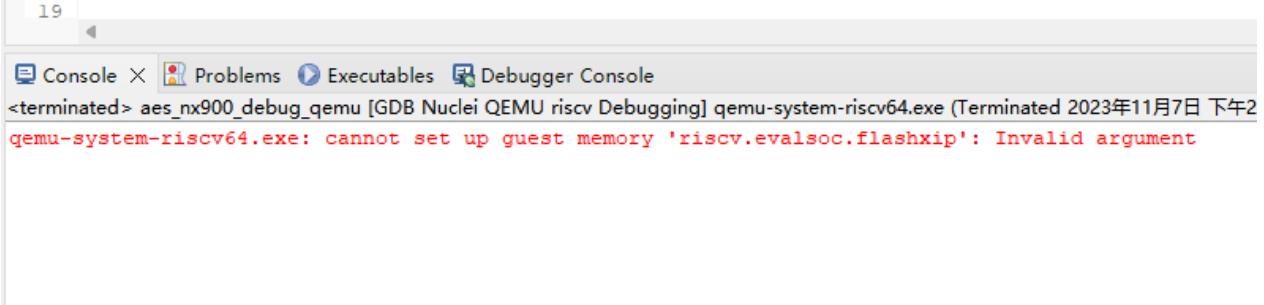
Document	Description
<a href="#">2-qemu-glib-gio-unexpectedly.md</a>	因内存不足，导致在 Nuclei Studio中启动 qemu失败
<a href="#">3-print_memor_usage_in_ide.md</a>	windows 11下使用 Nuclei Studio进行 qemu调试程序时报错
<a href="#">4-use_pre_build_or_post_build.md</a>	How to print memory usage in Nuclei Studio
<a href="#">5-update_npk_to_support_nucleistudio_202310.md</a>	在编译工程时，使用了Pre-build Command/Post-build Command时报错
<a href="#">6-gcc13_gen_rvv_instructions_when_rvv_enabled.md</a>	升级npk.yml以支持 Nuclei Studio 2023.10
<a href="#">7-update_nucleistudio_202310_to_fixed_version.md</a>	GCC13 auto generated RVV instructions when RVV enabled
<a href="#">8-openocd_202310_flashloader_flaws.md</a>	更新 Nuclei Studio 2023.10 到最新修正版本
<a href="#">9-modify_the_cproject_file_to_change_the_project_to_gcc13.md</a>	OpenOCD在操作容量大于16M-Byte的nor-flash时的问题
<a href="#">10-compiling_projects_with_headless_in_nuclei_studio.md</a>	通过修改.cproject文件，升级工程工具链到GCC 13
<a href="#">11-openocd_reported_error_not_known_as_fespi_capable.md</a>	在Nuclei Studio下用命令行编译工程
	OpenOCD烧写程序时报错Error:Device ID 8xle2g8a6d is

Document	Description
<a href="#">12-nucleisdk-0.5.0-dhrystone-score-lower-than-expected-in-IDE.md</a>	not known as FESPI capable
<a href="#">13-error_could_not_find_an_available_hardware_trigger.md</a>	关于dhrystone在 IDE上跑分和NSDK 0.5.0命令行跑分不一致的问题
<a href="#">14-cannot_find_Incrt_balanced_no_such_file_or_directory.md</a>	Error: Couldn't find an available hardware trigger / Error: can't add breakpoint: resource not available
<a href="#">15-unsatisfiedLinkError_of_swt-win32-4965r8_dll_on_windows7.md</a>	cannot find - Incrt_balanced: No such file or directory
<a href="#">16-incomplete_data_output_when_using_profiling_function.md</a>	UnsatisfiedLinkError of swt-win32-4965r8.dll on Windows 7
<a href="#">17-an_example_to_demonstrate_the_use_of_profiling_and_code_coverage.md</a>	使用 Profiling 功能时可能遇到的一些问题
<a href="#">18-demonstrate_NICE_VNICE_acceleration_of_the_Nuclei_Model_through_profiling.md</a>	Nuclei Studio使用 Profiling功能进行性能调优举例
	通过Profiling展示 Nuclei Model NICE/VNICE指令加速

# 因内存不足，导致在Nuclei Studio中启动qemu失败¶

在实际开发中发现，因电脑同时运行了很多的进程或者电脑本身的系统内存不足，致使在Nuclei Studio中，使用qemu进行程序调试时，可能出现如下报错：

```
qemu-system-riscv64.exe: cannot set up guest memory 'riscv.evalsoc.flashxip' Invalid argument
```



The screenshot shows a terminal window in Nuclei Studio. The title bar says "19". The tabs at the top are "Console X", "Problems", "Executables", and "Debugger Console". The main area of the terminal shows the command "aes\_nx900\_debug\_qemu [GDB Nuclei QEMU riscv Debugging] qemu-system-riscv64.exe (Terminated 2023年11月7日 下午2:19:19)". Below this, a red error message is displayed: "qemu-system-riscv64.exe: cannot set up guest memory 'riscv.evalsoc.flashxip': Invalid argument".

一般可以通过关闭某些应用，释放一部分内存以供qemu使用，即可解决些问题。

# windows 11下使用Nuclei Studio进行qemu调试程序时报错¶

windows 11下使用Nuclei Studio开发时，当使用qemu调试程序时,会有报错如下，是因为在 windows 11下缺少相关依赖，但一般不影响qemu的正确使用，可以忽略此错误。

```
qemu-system-riscv32.exe: warning: GLib-GIO: Unexpectedly, UWP app `Microsoft.ScreenSketch_11.2309.16.0_x64_8wekyb3d8bbwe` (AUMId 'Microsoft.ScreenSketch_8wekyb3d8bbwe!App') supports 29 extensions
qemu-system-riscv32.exe: warning: GLib-GIO: Unexpectedly, UWP app `Clipchamp.Clipchamp_1.8.1.0_neutral_yxz2enhyzhart` (AUMId 'Clipchamp.Clipchamp_yxz2enhyzhart!App') supports 41 extensions
qemu-system-riscv32.exe: QEMU: Terminated via GDBstub
```

```
<terminated> 050hello_debug_qemu [GDB Nuclei QEMU riscv Debugging] qemu-system-riscv32.exe (Terminated 2023年11月7日 下午2:52:59)
GDB Server listening on: 'tcp:1234'...
Nuclei SDK Build Time: Nov 7 2023, 14:46:26
Download Mode: ILM
CPU Frequency 2295653007 Hz
CPU HartID: 0

qemu-system-riscv32.exe: warning: GLib-GIO: Unexpectedly, UWP app `Microsoft.ScreenSketch_11.2309.16.0_x64_8wekyb3d8bbwe` (AUMId 'Microsoft.ScreenSketch_8wekyb3d8bbwe!App') supports 29 extensions
qemu-system-riscv32.exe: warning: GLib-GIO: Unexpectedly, UWP app `Clipchamp.Clipchamp_1.8.1.0_neutral_yxz2enhyzhart` (AUMId 'Clipchamp.Clipchamp_yxz2enhyzhart!App') supports 41 extensions
qemu-system-riscv32.exe: QEMU: Terminated via GDBstub
```

# How to print memory usage in Nuclei Studio¶

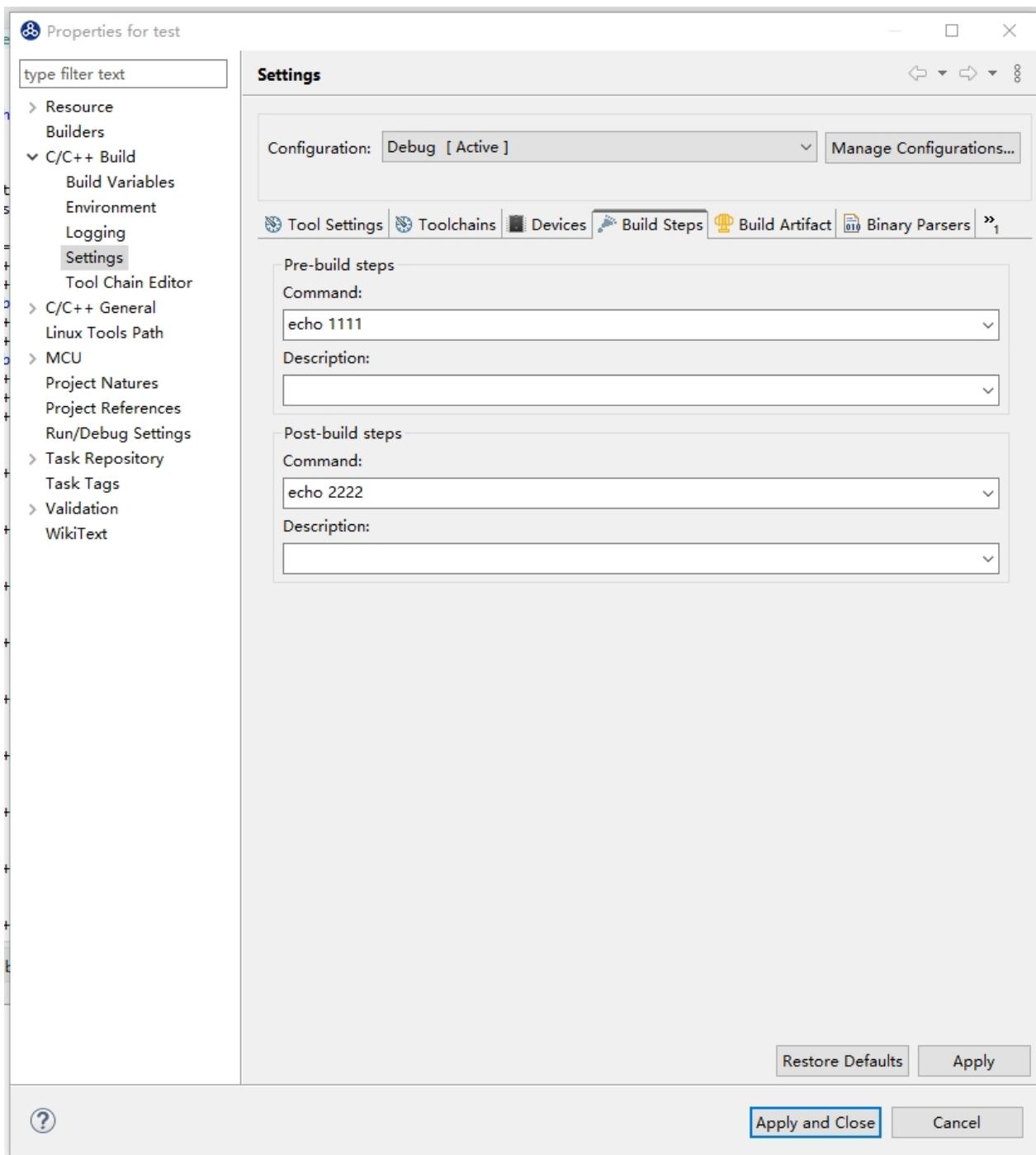
See this issue #4

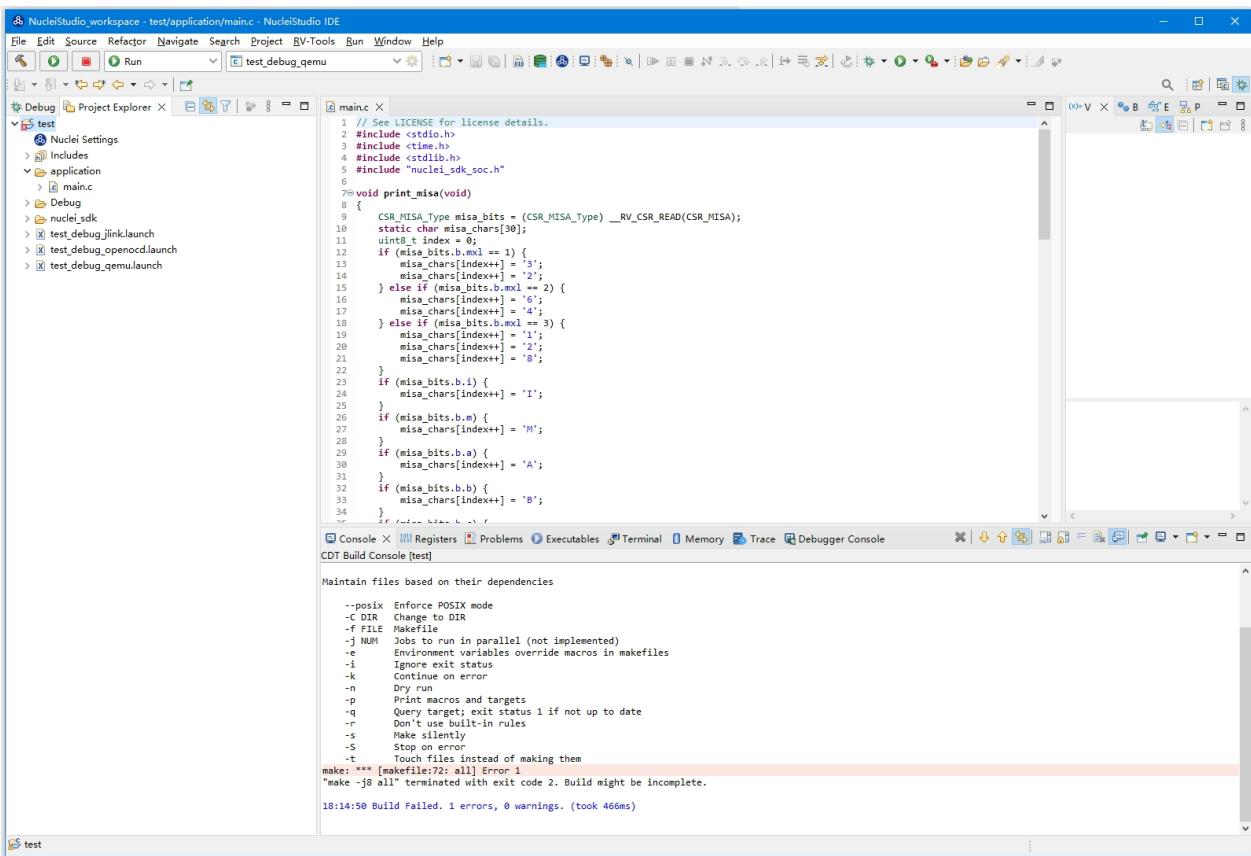
# 在编译工程时，使用了Pre-build Command/ Post-build Command时报错¶

在 Nuclei Studio 2023.10.17上传的2023.10 更正版本中修正，参见[本文](#)

参见 [eclipse-embed-cdt/eclipse-plugins#597](#)

在Nuclei Studio 2023.10版本中，如果在工程编译中需要使用到Pre-build Command/Post-build Command，因Nuclei Studio中集成的build-tools为v4.4.0版本，而上游CDT中在处理Pre-build Command/Post-build Command的方法，在build-tools v4.4.0无法正常使用，所以会出现报错问题。





遇到这种情况时，可以下载 [https://www.nucleisys.com/upload/files/toochain/build-tools/build-tools\\_202002.zip](https://www.nucleisys.com/upload/files/toochain/build-tools/build-tools_202002.zip)，并替换工具链中的build-tools，问题可以得到解决。

NucleiStudio\toolchain\build-tools

# 升级npk.yml以支持Nuclei Studio 2023.10

在Nuclei Studio 2023.10中，一个重要变更，是支持GCC 13，所以之前发布的NPK Package也需要做对应的变更，以更好的适用于Nuclei Studio 2023.10，其中有以下几个变更点。

需要注意新版的npk.yml 不再支持以前 2022.12版本的IDE

## npk.yml中的工具链升级

在npk中，我们定义了buildconfig来自定义工程build时的各种参数，Nuclei Studio通过type标识使用的是那一种toolchain，如gcc、clang等，通过 type->toolchain\_name & cross\_prefix 来标识使用的toolchain里面具体的那个发行版本。升级SDK以支持GCC 13，对比以下两个例子不难看出，只需要修改 toolchain\_name: RISC-V GCC/Newlib 和 cross\_prefix: riscv64-unknown-elf-，就可以使SDK支持在创建工程时，可以选择GCC 13工具链。

以下内容是支持gcc 10 的buildconfig配置（为了方便举例，隐藏了部分参数，具体参数根据实际情况定义）。

```
## Build Configuration
buildconfig:
- type: gcc
  description: Nuclei GNU Toolchain
  cross_prefix: riscv-nuclei-elf- # optional
  common_flags: # flags need to be combined together across all packages
  ldflags:
  cflags:
  asmflags:
  cxxflags:
  commonDefines:
  prebuild_steps: # could be override by app/bsp type
    command:
    description:
  postbuild_steps: # could be override by app/bsp type
    command:
    description:
```

下以内容，是支持GCC 13和Clang的buildconfig配置（为了方便举例，隐藏了部分参数，具体参数根据实际情况定义）。

```
## Build Configuration
buildconfig:
- type: gcc
```

```
description: Nuclei GNU Toolchain
# 升级到GCC13时，这里进行如下两行的改变
# 且针对所有npk.yml的文件只要包含buildconfig的都需要进行修改，不仅仅限于ssp/bsp类型，还
toolchain_name: RISC-V GCC/Newlib
cross_prefix: riscv64-unknown-elf- # optional
common_flags: # flags need to be combined together across all packages
ldflags:
cflags:
asmflags:
cxxflags:
commonDefines:
prebuild_steps: # could be override by app/bsp type
    command:
    description:
postbuild_steps: # could be override by app/bsp type
    command:
    description:
- type: clang
description: Nuclei LLVM Toolchain
toolchain_name: RISC-V Clang/Newlib
cross_prefix: riscv64-unknown-elf- # optional
common_flags: # flags need to be combined together across all packages
ldflags:
cflags:
asmflags:
cxxflags:
commonDefines:
prebuild_steps: # could be override by app/bsp type
    command:
    description:
postbuild_steps: # could be override by app/bsp type
    command:
    description:
```

## 除标准的IMAFDC之外的扩展(ARCHEXT)的升级¶

以下示例以Nuclei SDK 0.5.0的evalsoc的npk.yml升级举例，仅考虑GCC的支持，如果需要考虑CLANG的支持，请参见SDK中evalsoc的npk.yml的详细变更

在GCC 13中，对RISC-V 指令扩展使用有了很大的变更，具体内容可以查看Nuclei Studio用户手册2.1.4章内容和Nuclei SDK中ARCH\_EXT说明。

- [Nuclei Studio用户手册](#)

- ARCH\_EXT说明

升级npk.yml时，如果SDK中使用到了RISC-V 除了标准的IMAFDC之外指令扩展，例如B/P/K/V，也需要升级对应的配置。

在NPK中，RISC-V 指令扩展以是 -march=xxx的方式传递给Nuclei Studio，Nuclei Studio接收到相关配置，就会存储并应用到编译的过程中。以Nuclei SDK中的npk.yml为例，通过下面这段配置我们就可以得到-march=的值，不难看出与RISC-V指令扩展相关的是NPK中的变量nuclei\_archext。

```
## (为了方便举例，隐藏了部分参数，具体参数根据实际情况定义)
## Build Configuration
buildconfig:
  - type: gcc
    description: Nuclei RISC-V GNU Toolchain #must
    cross_prefix: riscv-nuclei-elf- # optional
    common_flags: # flags need to be combined together across all packages
      # 这里 -march 传递的值就是 nuclei_core.arch 和 nuclei_archext 两个变量拼接而来
      # 例如 nuclei_core.arch设置为rv32imafdc, nuclei_archext设置为 _zba_zbb_zbc_zbs
      # 那么传递的就是 -march=rv32imafdc_zba_zbb_zbc_zbs_xxldspn1x
      # 如果你的march是已知和确定的，这里直接就可以给定 -march/-mabi的选项，无需通过 config
      - flags: -march=${nuclei_core.arch}$(join(${nuclei_archext},'')) -mabi=${nuclei_archext}
    ldflags:
    cflags:
    asmflags:
    cxxflags:
    common_defines:
    prebuild_steps: # could be override by app/bsp type
      command:
      description:
    postbuild_steps: # could be override by app/bsp type
      command:
      description:
```

在旧版的SDK中，nuclei\_archext定义的是一个multicheckbox，用户可以自己选择，而在新版的SDK中nuclei\_archext定义的是一个text输入框，这样用户可以更灵活的使用RISC-V 指令扩展，如果在某些工程或场景下，想要预设一些RISC-V 指令扩展，建议给一个默认值就可以了，可以参考下代的示例代码。

- 用于支持Nuclei RISC-V Toolchain 2022.12的写法

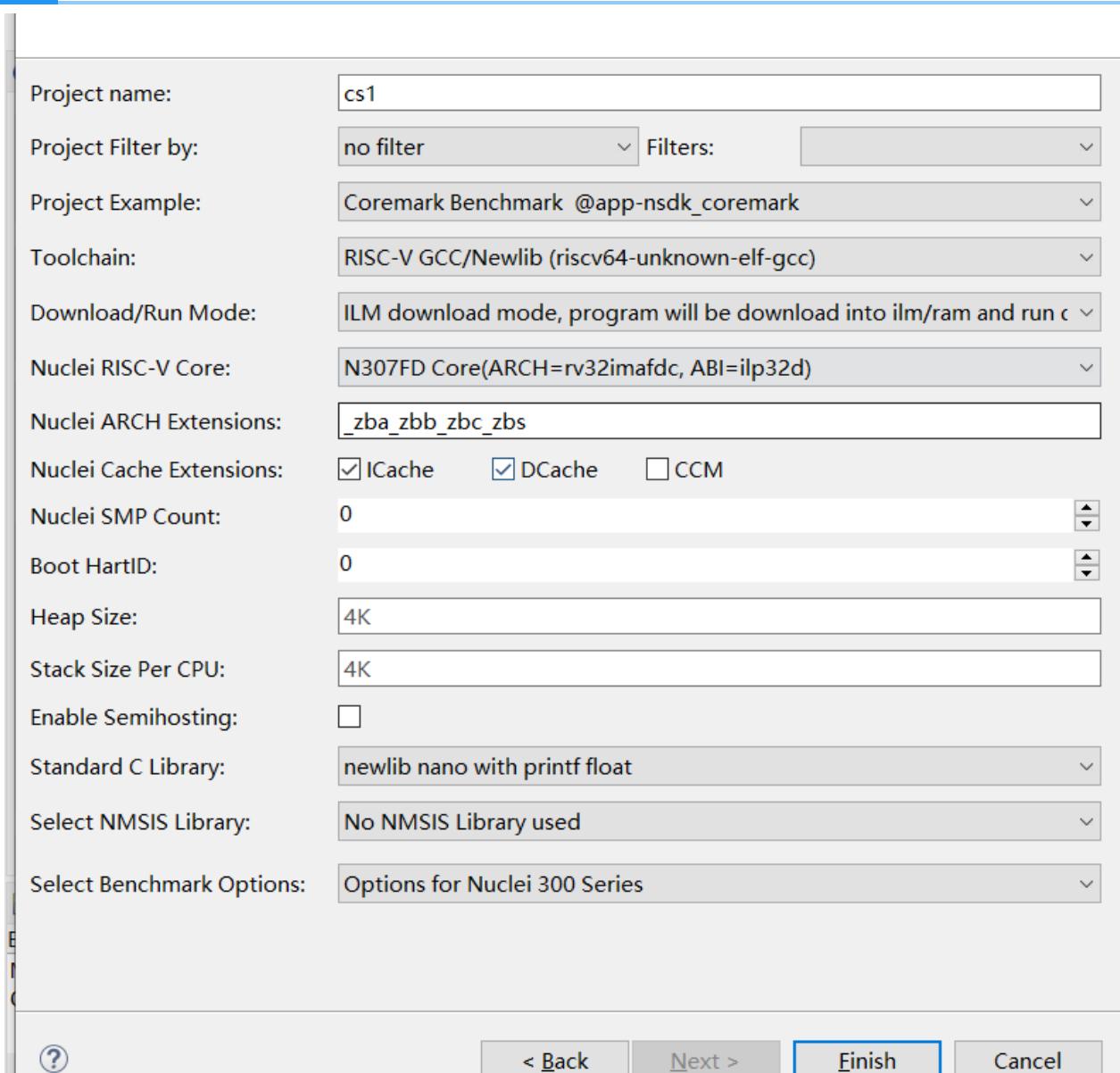
```
## 旧版的SDK中，nuclei_archext定义的是一个multicheckbox
## (为了方便举例，隐藏了部分参数，具体参数根据实际情况定义)
nuclei_archext:
  default_value: []
```

```
type: multicheckbox
global: true
description: Nuclei ARCH Extensions
choices:
  - name: b
    description: Bitmanip Extension
  - name: p
    description: Packed SIMD Extension
  - name: v
    description: Vector Extension
```

- 用于支持Nuclei RISC-V Toolchain 2023.10的写法

```
## 新版的SDK中nuclei_archext定义的是一个text输入框
## Package Configurations
configuration:
nuclei_archext:
  default_value: "_zba_zbb_zbc_zbs"
  type: text
  global: true
  # hints and tips are introduced in Nuclei Studio 2023.10
  # used to show tool tips and input hints
  tips: "Possible other ISA extensions, seperated by underscores, like '_zb"
  hints: "_zba_zbb_zbc_zbs_xxldspn1x"
  description: Nuclei ARCH Extensions
```

最终显示创建项目的时候显示效果如下



## libncrt的升级¶

libncrt较之前也有了些许变化，在NPK中使用libncrt之前，新旧版SDK中都是一样的在configuration中定义了一个变量stdclic，它的值是一个下拉框，可以选择不同的值。不同点是在得到stdclic后，在common\_flags或者其它地方使用stdclic时略有不同。

关于stdclic的一些说明，可以参见[这里](#)

```
## 定义stdclic变量
## (为了方便举例，隐藏了部分参数，具体参数根据实际情况定义)
## Package Configurations
configuration:
  stdclic:
    default_value: newlib_nano
    type: choice
```

```

global: true
description: Standard C Library
choices:
  - name: newlib_full
    description: newlib with full feature
  - name: newlib_fast
    description: newlib nano with printf/scanf float
  - name: newlib_small
    description: newlib nano with printf float
  - name: newlib_nano
    description: newlib nano without printf/scanf float
  - name: libncrt_fast
    description: nuclei c runtime library, optimized for speed
  - name: libncrt_balanced
    description: nuclei c runtime library, balanced, full feature
  - name: libncrt_small
    description: nuclei c runtime library, optimized for size, full feature
  - name: libncrt_nano
    description: nuclei c runtime library, optimized for size, no float support
  - name: libncrt_pico
    description: nuclei c runtime library, optimized for size, no long/long support
  - name: nostd
    description: no std c library will be used, and don't search the standard library
  - name: nospec
    description: no std c library will be used, not pass any --specs options

```

在新版的SDK中，如果使用`--specs=libncrt_xxx.specs` 或者链接库里面包含`-lncrt_xxx`（表示采用libncrt c库），则需变更为`-lncrt_xxx -lfileops_uart -lheapops_basic`，这也是旧SDK变更为支持GCC 13的新SDK的原则。

下面配置为在旧版SDK中的npk变量`stdclib`,当变量`stdclib`以`libncrt`开头时，会直接定义一个`--specs=${stdclib}.specs`，按照上面我们说的原则，这里应该变成设置`-l$(subst(${stdclib},lib,)) -lfileops_uart -lheapops_basic`，所以在新版SDK中的写法就变成了下面的配置方式。

```

## 在旧版SDK中使用stdclib变量
## (为了方便举例，隐藏了部分参数，具体参数根据实际情况定义)
## Build Configuration
buildconfig:
  - type: gcc
    description: Nuclei GNU Toolchain
    cross_prefix: riscv-nuclei-elf- # optional
    common_flags: # flags need to be combined together across all packages
      - flags: --specs=${stdclib}.specs

```

```
condition: $(startswith(${stdclib}, "libncrt"))  
ldflags:  
cflags:  
asmflags:  
cxxflags:  
commonDefines:  
prebuildSteps: # could be override by app/bsp type  
    command:  
    description:  
postbuildSteps: # could be override by app/bsp type  
    command:  
    description:
```

转变为

```
## 在新版SDK中使用stdclib变量  
## (为了方便举例，隐藏了部分参数，具体参数根据实际情况定义)  
## Build Configuration  
buildconfig:  
    - type: gcc  
        description: Nuclei GNU Toolchain  
        toolchainName: RISC-V GCC/Newlib  
        crossPrefix: riscv64-unknown-elf- # optional  
        commonFlags: # flags need to be combined together across all packages  
            - flags: --specs=${stdclib}.specs  
                condition: $(startswith(${stdclib}, "libncrt"))  
ldflags:  
    - flags: -l$(subst(${stdclib}, lib,)) -lheapops_basic -lfileops_uart  
        condition: $(startswith(${stdclib}, "libncrt"))  
cflags:  
asmflags:  
cxxflags:  
commonDefines:  
prebuildSteps: # could be override by app/bsp type  
    command:  
    description:  
postbuildSteps: # could be override by app/bsp type  
    command:  
    description:
```

## Link Warning的消除¶

在Nuclei Studio 2023.10中集成的GCC 13,在使用过程中会有warning, 链接选项增加一个-Wl,--no-warn-rwx-segments可以隐藏warning。

具体可以参考以下配置 (为了方便举例, 隐藏了部分参数, 具体参数根据实际情况定义)

```
## Build Configuration
buildconfig:
  - type: gcc
    description: Nuclei GNU Toolchain
    toolchain_name: RISC-V GCC/Newlib
    cross_prefix: riscv64-unknown-elf- # optional
    common_flags: # flags need to be combined together across all packages
    ldflags:
      # 用于消除gcc13链接阶段的warning
      - flags: -Wl,--no-warn-rwx-segments
    cflags:
    asmflags:
    cxxflags:
    commonDefines:
    prebuild_steps: # could be override by app/bsp type
      command:
      description:
    postbuild_steps: # could be override by app/bsp type
      command:
      description:
```

## 关于Nuclei SDK 0.5.0 npk.yml 详细变更¶

关于支持Nuclei Studio + Nuclei RISC-V Toolchain 2023.10的npk.yml变更, 可以参考nuclei-sdk 0.5.0的变更。

- gd32vf103的变化 git diff 0.4.1..0.5.0 SoC/gd32vf103/\*\*/npk.yml
- evalsoc的变化: git diff 0.4.1..0.5.0 SoC/evalsoc/\*\*/npk.yml
- NMSIS的变化: git diff 0.4.1..0.5.0 NMSIS/\*\*/npk.yml
- application的变化: git diff 0.4.1..0.5.0 application/\*\*/npk.yml
- RTOS的变化: git diff 0.4.1..0.5.0 OS/\*\*/npk.yml

执行查看代码变更命令方法如下

```
git clone https://github.com/Nuclei-Software/nuclei-sdk/
cd nuclei-sdk
git fetch --all
git diff 0.4.1..0.5.0 SoC/gd32vf103/***npk.yml
git diff 0.4.1..0.5.0 SoC/evalsoc/***npk.yml
git diff 0.4.1..0.5.0 NMSIS/***npk.yml
git diff 0.4.1..0.5.0 application/***npk.yml
git diff 0.4.1..0.5.0 OS/***npk.yml
```

# GCC13 auto generated RVV instructions when RVV enabled¶

If you are using Nuclei SDK 0.5.0 with Nuclei RISC-V Toolchain 2023.10, and when compile some examples with RVV enabled, it may generate rvv instructions which called auto-vectorization.

Take application/baremetal/benchmark/dhrystone for example:

```
cd application/baremetal/benchmark/dhrystone
# enable extra vector extension, which means the -march=rv64imafdcv
make CORE=nx900fd ARCH_EXT=v clean
make CORE=nx900fd ARCH_EXT=v dasm
```

Then if you check the dhrystone.dasm, you will be able to see rvv instructions:

This auto generated instructions may affect your hardware performance, so if you want to disable it, you don't need to pass rvv extension when compile application.

```
$ cat dhrystone.dasm |grep vs
 800003e2: cc3ff057          vsetivli      zero,31,e8,m8,ta,ma
 800003f8: 02038427          vse8.v       v8,(t2)
 8000040c: 020b8027          vse8.v       v0,(s7)
 800004a2: cc3ff057          vsetivli      zero,31,e8,m8,ta,ma
 800004b2: 02098827          vse8.v       v16,(s3)
 80000524: cc3ff057          vsetivli      zero,31,e8,m8,ta,ma
 80000530: 02098c27          vse8.v       v24,(s3)
 80000df2: cdb3f057          vsetivli      zero,7,e64,m8,ta,ma
 80000dfa: 0204f427          vse64.v      v8,(s1)
 80000e20: cdb3f057          vsetivli      zero,7,e64,m8,ta,ma
 80000e28: 02047027          vse64.v      v0,(s0)
```

You can check [https://gcc.gnu.org/bugzilla/show\\_bug.cgi?id=112537](https://gcc.gnu.org/bugzilla/show_bug.cgi?id=112537) for more details.

# 更新 Nuclei Studio 2023.10 到最新修正版本¶

2023.11.06上传的Nuclei Studio 2023.10版本存在一些问题，我们进行了修正，并于2023.11.17 13:30替换线上2023.10版本。

## 问题描述¶

2023年11月06日发布的Nuclei Studio 2023.10版本中存在一些问题,影响用户使用:

- build tools的busybox存在问题导致make 带 pre- post- steps时编译出问题
- Nuclei Settings中corner cases在特定场景下会出错
- Nuclei Settings的打开方式影响工程中其他文件的打开方式
- 在QEMU中使用V扩展时, 没有传入RVV length
- 修复打开一个全新的workspace, 创建新的工程的时候, 能够创建同名项目的问题, 重开workspace即可解决这个问题

我们重新做了一些变更, 以修复以上问题 :

- 修改并发布Nuclei Studio Plugins 2.1.0, 上传到插件更新网站
- 修改并发布Windows build-tools 1.2, 替换了线上的Windows Build Tools 2023.10
- 发布了新的Nuclei Studio 2023.10, 替换了线上的Nuclei Studio 2023.10

## 升级Nuclei Studio 2023.10 到最新版本的方法¶

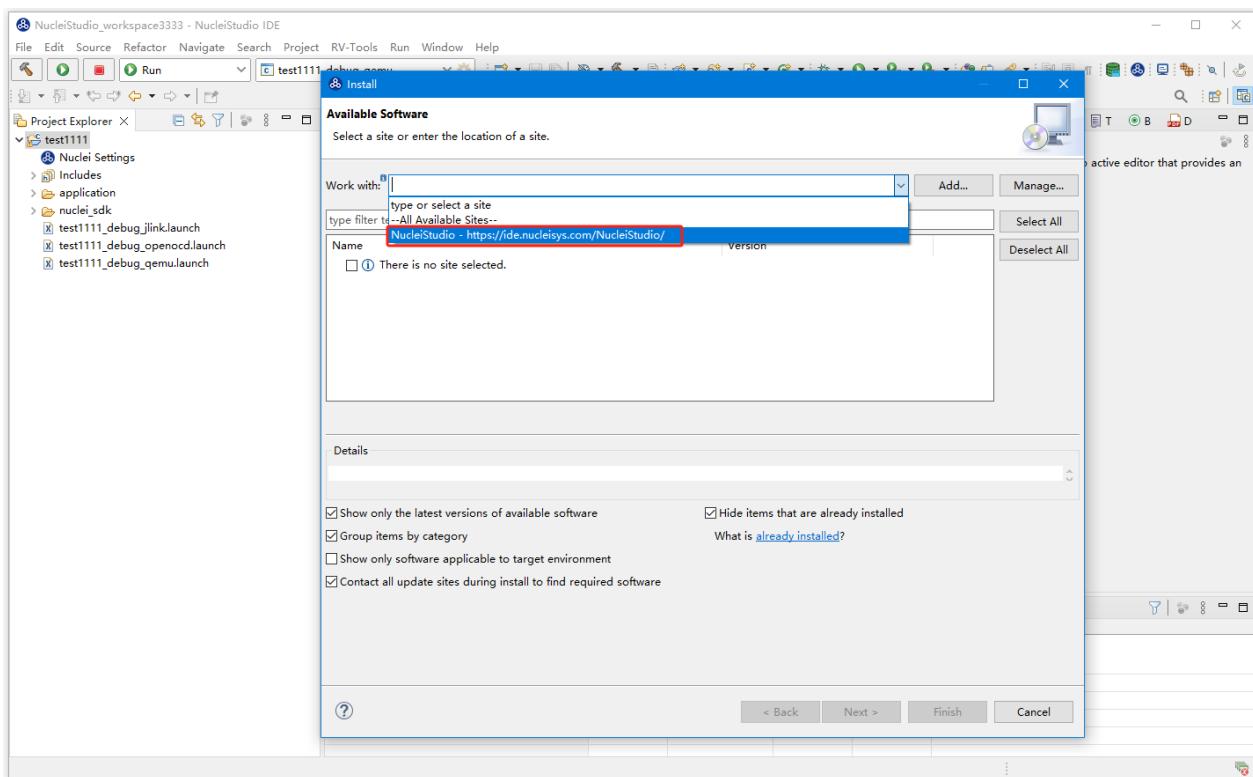
如果您的Nuclei Studio 2023.10, 是在2023年11月18日之前下载, 版本中存在的上述问题可能会引响您的使用体验, 您可以选择手动进行升级, 也可以选择重官网上下载我们最新发布的版本。

### 对2023年11月18日之前下载了Nuclei Studio 2023.10进行升级¶

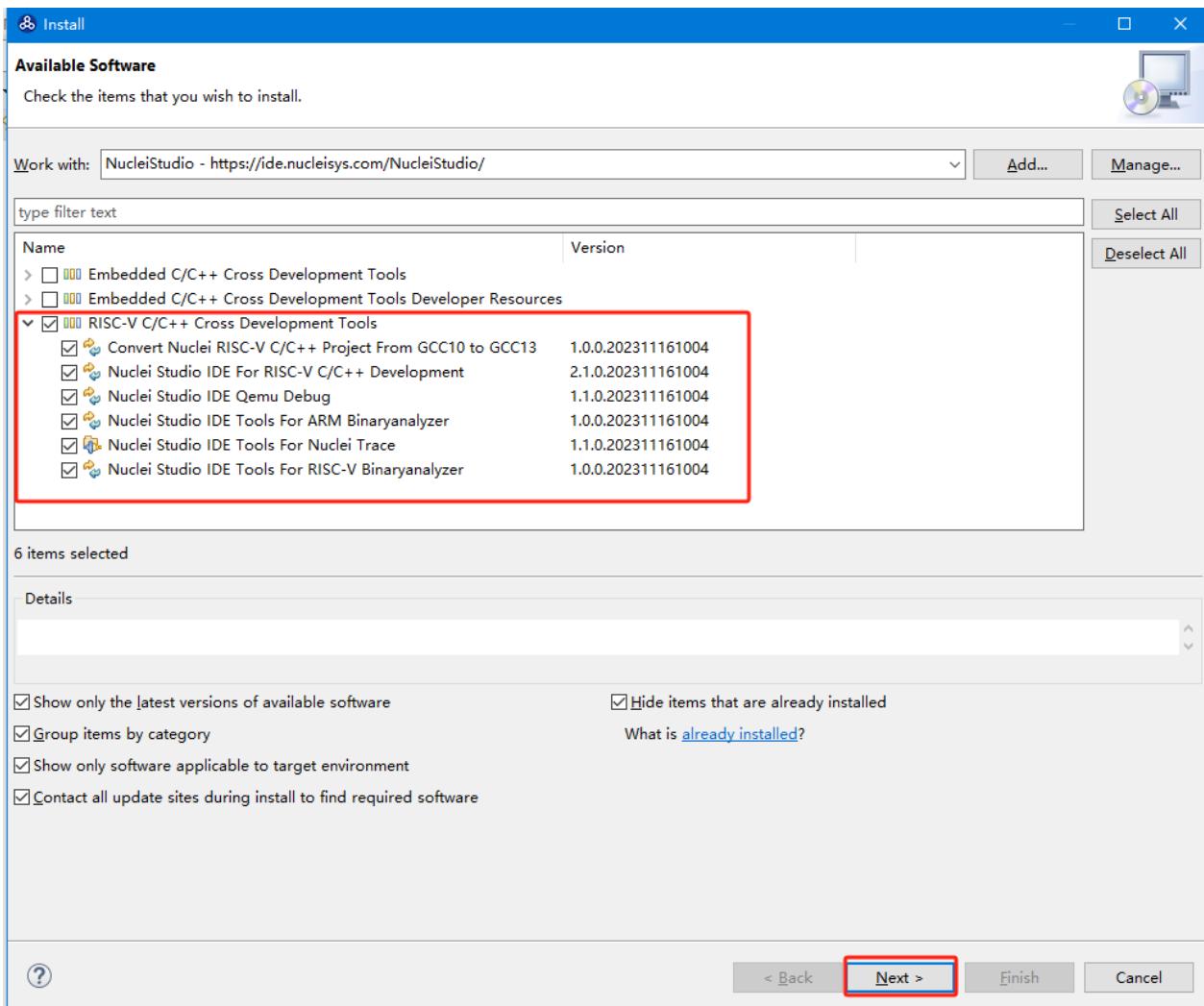
如果您是在2023年11月18日之前下载了Nuclei Studio 2023.10, 可以通过以下方式更新您的Nuclei Studio 2023.10 到最新版本

#### 1. 升级Nuclei Studio Plugins

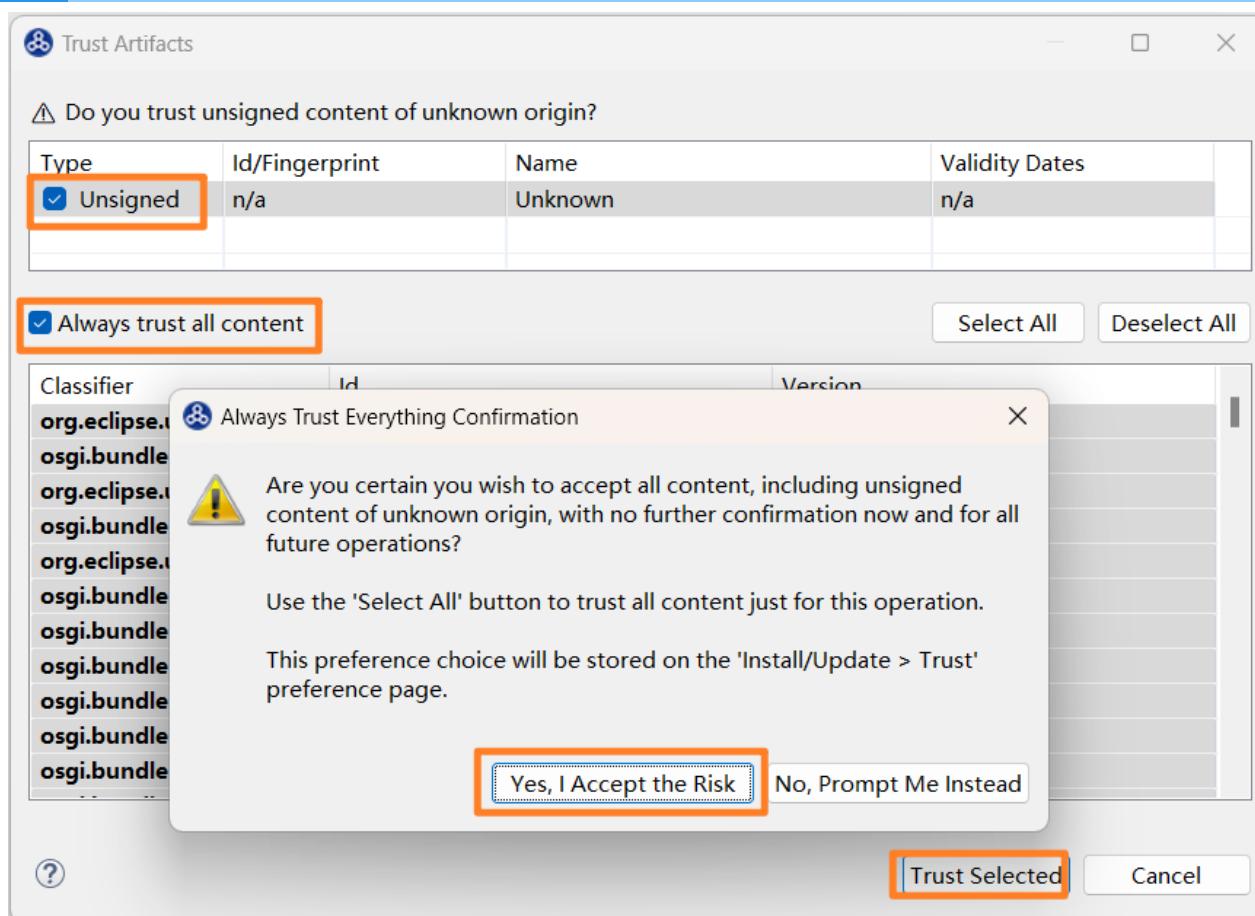
在Nuclei Studio菜单中找到Help->Install New Software, 然后在Install工具的Work with 选中NucleiStudio - <https://ide.nucleisys.com/NucleiStudio/>,下面会列出所有待更新的插件。



在弹出的插件列表中选中需要升级的插件，我们选中RISC-V C/C++ Cross Development Tools，然后Next。



在升级过程中，Nuclei Studio会询问Trust Artifacts时，操作如下图，选择Trust Selected，然后升级完成，Nuclei Studio会重启。至此Nuclei Studio Plugins升级完成。



## 2. 升级build-tools

Linux版本不需要执行此步骤，只需要确保系统中装了make工具就行。

下载build-tools-1.2，并替换Nuclei Studio 2023.10中的  
NucleiStudio\toolchain\build-tools中内容。

关于这部分，可以查阅[编译工程时，使用了Pre-build Command/Post-build Command时报错](#)中的详细说明。

- [build-tools-1.2下载](#)

经此两步，完成了对Nuclei Studio 2023.10的升级。

从官网下载最新的版本¶

如果不想做手动升级工作，可以直接从我们的网站上下载最新的Nuclei Studio 2023.10。

- [Windows版下载](#)
- [Linux版下载](#)

## 参考资料¶

- [Nuclei Studio FAQs](#)
- [Nuclei Studio/Tools 不断更新的补充文档](#)
- [Nuclei Studio Issues](#)

# OpenOCD在操作容量大于16M-Byte的nor-flash时的问题¶

操作0 ~ 16M地址区间spi控制器需要发送三个字节的地址信息，称为3byte地址模式；操作16M ~ 2G地址区间spi控制器则需要发送四个字节的地址信息，称为4byte地址模式；

nuspi控制器的普通spi和xip默认都是3byte地址模式

我们在OpenOCD里开发了两组spi驱动分别是nuspi和custom，都可以支持3byte模式和4byte模式，其中nuspi可通过判断操作地址，自动切换模式

在OpenOCD里有很多种方式可以read/verify flash内的数据，可以归结为两大类，一类是直接通过xip的方式读取flash数据，另一类则是通过调用驱动使用普通spi的方式读取flash数据。

因此，直接通过xip的方式读取flash数据时，就会有只能读到前面16M地址范围的限制，这样的命令有

- flash verify\_image filename [offset] [type]
- dump\_image filename address size
- gdb的x命令
- 等等 直接读取memory的命令

当然OpenOCD里面也存在一些读取flash的命令，会直接调用cfg文件注册的spi驱动，这样的命令有

- flash read\_bank num filename [offset [length]]
- flash verify\_bank num filename [offset]

# 通过修改.cproject文件，升级工程工具链到GCC 13¶

Nuclei Studio 2023.10的IDE进行了一次大版本的升级，其中自带的工具链从gcc10升级到了gcc13，并且工具链的前缀也发生了变化。参见 <https://github.com/Nuclei-Software/nuclei-studio/releases/tag/2023.10>

虽然我们在2023.10的IDE中提供了右键选中工程一键升级的工具（参见IDE的手册第8章节），但是这个只能一个工程一个工程的转换，对于有大量工程需要批量转换的项目而言不太友好，因此我们这里列出来如果写脚本进行工程的转换升级，则可以参考如下的思路进行转换。

以下变更仅针对Nuclei Studio 2023.10之前版本创建的gcc10的工程，进行升级变更，如果需要批量变更，编写脚本的时候应先检查工程是否是riscv gcc10的工程。

## 修改toolchain相关配置

在Nuclei Studio 2023.10之前的版本中使用的gcc是做了许多个性化的变更，需要Nuclei Studio 2023.10版中使用的gcc,继承了官方版本的特性和一些命名方式，在工程中的.cproject文件中，主要是要修改以下几个值。其中

ilg.gnumcueclipse.managedbuild.cross.riscv.option.toolchain.name的值是  
RISC-V Nuclei GCC 、

ilg.gnumcueclipse.managedbuild.cross.riscv.option.toolchain.id的值是  
3901352267

`ilg.gnumcueclipse.managedbuild.cross.riscv.option.command.prefix`的值是  
`riscv-nuclei-elf-`,则说明工程在创建时所使用的是GCC 10。如果需要使工程支持GCC 13,  
需要进行如下变更：

- toolchain.name的值从RISC-V Nuclei GCC变更为RISC-V GCC/Newlib
  - toolchain.id的值从3901352267变更为2262347901
  - command.prefix的值从riscv-nuclei-elf-变更为riscv64-unknown-elf-

## 变更前.cproject文件的内容

```
<option id="ilg.gnumcueclipse.managedbuild.cross.riscv.option.command.size.208535
<option id="ilg.gnumcueclipse.managedbuild.cross.riscv.option.command.make.135588
<option id="ilg.gnumcueclipse.managedbuild.cross.riscv.option.command.rm.13306659
```

变更后.cproject文件的内容

```
<option id="ilg.gnumcueclipse.managedbuild.cross.riscv.option.toolchain.name.1297
<option id="ilg.gnumcueclipse.managedbuild.cross.riscv.option.toolchain.id.114390
<option id="ilg.gnumcueclipse.managedbuild.cross.riscv.option.command.prefix.1270
<option id="ilg.gnumcueclipse.managedbuild.cross.riscv.option.command.c.718590769
<option id="ilg.gnumcueclipse.managedbuild.cross.riscv.option.command.cpp.2436609
<option id="ilg.gnumcueclipse.managedbuild.cross.riscv.option.command.ar.41625009
<option id="ilg.gnumcueclipse.managedbuild.cross.riscv.option.command.objcopy.741
<option id="ilg.gnumcueclipse.managedbuild.cross.riscv.option.command.objdump.147
<option id="ilg.gnumcueclipse.managedbuild.cross.riscv.option.command.size.208535
<option id="ilg.gnumcueclipse.managedbuild.cross.riscv.option.command.make.135588
<option id="ilg.gnumcueclipse.managedbuild.cross.riscv.option.command.rm.13306659
```

## 修改RISC-V扩展相关配置¶

在Nuclei Studio 2023.10之前的版创建的工程中，RISC-V扩展是存放在四个单独的boolean类型的值中，而在Nuclei Studio 2023.10创建的工程中，改为一个string类型的值中,所以在要在工程的.cproject文件中找到四个旧的值，并按规则转换成为新的RISC-V扩展的字符串，存放到 `ilg.gnumcueclipse.managedbuild.cross.riscv.option.target.isa.extensions` 中，同时将旧的四个单独的boolean类型的值置空或者删除。

```
# 四个单独的boolean类型的值
ilg.gnumcueclipse.managedbuild.cross.riscv.option.target.isa.extension.rvb
ilg.gnumcueclipse.managedbuild.cross.riscv.option.target.isa.extension.rvk
ilg.gnumcueclipse.managedbuild.cross.riscv.option.target.isa.extension.dsp
ilg.gnumcueclipse.managedbuild.cross.riscv.option.target.isa.extension.vector
```

```
# 一个string类型的值
ilg.gnumcueclipse.managedbuild.cross.riscv.option.target.isa.extensions
```

1. 首先，根据

`ilg.gnumcueclipse.managedbuild.cross.riscv.option.target.isa.base`

确认工程对应的arch是rv32/rv64

2. 其次，根据

`ilg.gnumcueclipse.managedbuild.cross.riscv.option.target.isa.fp`确认是否带f/d

3. 最后，根据对应转换规则转换出正确的RISC-V扩展字符串

转换规则(特别说明， p的值需要接在RISC-V扩展字符串的最后)：

- b -> \_zba\_zbb\_zbc\_zbs
- k -> \_zk\_zks
- v -> rv32f/d : \_zve32f, rv64f: \_zve64f, rv64fd: v
- p -> rv64: \_xxldsp, rv32: \_xxldspn1x

例如，现在有一个N307FD的工程，它的arch=rv32imafdcbpv(gcc10)，可以知道它是一个rv32,带fd并且使用了bpv扩展，那么根据转换规则，转换出来的RISC-V扩展字符串为  
\_zba\_zbb\_zbc\_zbs\_zve32f\_xxldspn1x。

变更前.cproject文件的内容

```
<option id="ilg.gnumcueclipse.managedbuild.cross.riscv.option.target.isa.base.489">
<option id="ilg.gnumcueclipse.managedbuild.cross.riscv.option.target.isa.fp.19369">
<option id="ilg.gnumcueclipse.managedbuild.cross.riscv.option.target.isa.extensions.1">
<option id="ilg.gnumcueclipse.managedbuild.cross.riscv.option.target.isa.extensions.2">
<option id="ilg.gnumcueclipse.managedbuild.cross.riscv.option.target.isa.extensions.3">
```

变更后.cproject文件的内容

```
<option id="ilg.gnumcueclipse.managedbuild.cross.riscv.option.target.isa.extensions.1">
```

## 修改libncrt C库相关配置¶

在Nuclei Studio 2023.10之前的版创建的工程中,使用libncrt C库时，会在工程中包含一个--specs=libncrt\_xxx.specs或者链接库 里面包含 -lncrt\_xxx，而在Nuclei Studio 2023.10 创建的工程中，如果使用了libncrt C库，需要将--specs=libncrt\_xxx.specs的方式变更为-lncrt\_xxx，然后额外需要链接的时候补上 -lncrt\_small -lheapops\_basic -lfileops\_uart，通用的target编译选项需要补上 -isystem=/include/libncrt

举例如下： \* -lncrt\_small -> -lncrt\_small -lheapops\_basic -lfileops\_uart \* --specs=libncrt\_small.specs -> -lncrt\_small -lheapops\_basic -lfileops\_uart

1. 在.cproject文件中确认否存在--specs=libncrt\_xxx.specs，如果存在，则表示这个是一个使用了libncrt的工程，则可以进行后续的步骤
2. 如果--specs=libncrt\_xxx.specs存在，先将其删除
3. 如果-lm存在，则先将其删除
4. 查找ilg.gnumcueclipse.managedbuild.cross.riscv.option.c.linker.libs 或者  
ilg.gnumcueclipse.managedbuild.cross.riscv.option.cpp.linker.libs 中是否存m，如果存在则先将删除
5. 查找ilg.gnumcueclipse.managedbuild.cross.riscv.option.c.linker.libs 或者

ilg.gnuclipse.managedbuild.cross.riscv.option.cpp.linker.libs  
中是否存ncrt\_xxx

6. 根据上面的结果，在

ilg.gnuclipse.managedbuild.cross.riscv.option.c.linker.libs或者  
ilg.gnuclipse.managedbuild.cross.riscv.option.cpp.linker.libs  
中补充对应的值

- --specs=libncrt\_xxx.specs存在，添加ncrt\_xxx；或者ncrt\_xxx存在。需要额外添加heapops\_basic和fileops\_uart

7. 在ilg.gnuclipse.managedbuild.cross.riscv.option.target.other中  
补上 -isystem=/include/libcrt

# --specs=libncrt\_xxx1.specs可能存在于以下string类型的值

```
ilg.gnuclipse.managedbuild.cross.riscv.option.target.other
ilg.gnuclipse.managedbuild.cross.riscv.option.optimization.other
ilg.gnuclipse.managedbuild.cross.riscv.option.warnings.other
ilg.gnuclipse.managedbuild.cross.riscv.option.debugging.other
ilg.gnuclipse.managedbuild.cross.riscv.option.assembler.otherwarnings
ilg.gnuclipse.managedbuild.cross.riscv.option.assembler.other
ilg.gnuclipse.managedbuild.cross.riscv.option.c.compiler.otheroptimizations
ilg.gnuclipse.managedbuild.cross.riscv.option.c.compiler.otherwarnings
ilg.gnuclipse.managedbuild.cross.riscv.option.c.compiler.other
ilg.gnuclipse.managedbuild.cross.riscv.option.c.linker.other
ilg.gnuclipse.managedbuild.cross.riscv.option.cpp.compiler.otheroptimizations
ilg.gnuclipse.managedbuild.cross.riscv.option.cpp.compiler.otherwarnings
ilg.gnuclipse.managedbuild.cross.riscv.option.cpp.compiler.other
ilg.gnuclipse.managedbuild.cross.riscv.option.cpp.linker.other
ilg.gnuclipse.managedbuild.cross.riscv.option.createflash.other
ilg.gnuclipse.managedbuild.cross.riscv.option.createlisting.other
ilg.gnuclipse.managedbuild.cross.riscv.option.printsize.other
```

举例，工程中用到了--specs=libncrt\_balanced.specs

变更前.cproject文件的内容

```
<option id="ilg.gnuclipse.managedbuild.cross.riscv.option.target.other.173556"
<option id="ilg.gnuclipse.managedbuild.cross.riscv.option.optimization.other"
```

变更后.cproject文件的内容

```
<option id="ilg.gnuclipse.managedbuild.cross.riscv.option.target.other.173556"
<option IS_BUILTIN_EMPTY="false" IS_VALUE_EMPTY="false" id="ilg.gnuclipse.ma
    <listOptionValue builtIn="false" value="ncrt_balanced"/>
    <listOptionValue builtIn="false" value="fileops_uart"/>
    <listOptionValue builtIn="false" value="heapops_basic"/>
</option>
```

## 增加link warning消除的配置¶

在GCC 13使用过程中会产生很多的warning信息，可以在链接选项中额外增加-Wl,--no-warn-rwx-segments参数，用以关闭这些warning信息。

具体参见

[https://sourceware.org/binutils/docs/ld/Options.html#index\\_002d\\_002dwarn\\_002drwx\\_002dsegments](https://sourceware.org/binutils/docs/ld/Options.html#index_002d_002dwarn_002drwx_002dsegments)

变更前.cproject文件的内容

```
<option id="ilg.gnumcueclipse.managedbuild.cross.riscv.option.cpp.linker.other.1000">
```

变更后.cproject文件的内容

```
<option id="ilg.gnumcueclipse.managedbuild.cross.riscv.option.cpp.linker.other.1000">
```

完成以上变更后，reload一下工程，工程就可以在Nuclei Studio 2023.10下正常编译、调试、运行了。

说明：

本文档中，所有引用的例子中关于.cproject文件，出现的类似  
id="ilg.gnumcueclipse.managedbuild.cross.riscv.option.target.other.  
1735566114"中，1735566114是一个Nuclei Studio生成的hash值，不同时间不同  
工程各不相同，且其不影响配置，如果能保持与原值相同的情况下，尽量保持相同。

# 在Nuclei Studio下用命令行编译工程

以下文档是在2024.06版本的IDE中实测，作为补充说明。

因NucleiStudio 2024.06版运行在java 21的环境上，实际应用中很多用户的本地没有java 21环境，故在运行命令时发现在执行该命令时，因找不到对应的jre而报错。为解决上述问题，可以在本地机器上安装java 21的环境（如何安装用户可以自行搜索相关教程），也可以在命令行中通过 -vm 参数指定NucleiStudio 2024.06中自带的jre的路径。

NucleiStudio.exe -vm "<user\_nucleistudio\_path>/plugins/org.eclipse.justj.openjdk..

提供一组批量导入工程并批量编译工程的命令

创建workspace并批量导入工程

NucleiStudio.exe -vm "<user\_nucleistudio\_path>/plugins/org.eclipse.justj.openjdk..

编译这组导入的工程

NucleiStudio.exe -vm "<user\_nucleistudio\_path>/plugins/org.eclipse.justj.openjdk..

以下文档是在2023.10版本的IDE中实测，其他版本可能需要做一些调整适配才可以正常工作。

Nuclei Studio是图形化（GUI）的代码编写工具，但是在某些特定的场景下，用户需要通过命令行来快速编译工程，在Nuclei Studio中，只需要一行命令就可以实现。下载好Nuclei Studio后，在Nuclei Studio的workspace已经创建好了需要编译的工程test，同时Nuclei Studio已退出运行，执行以下命令就可以完成工程的编译。

提醒：请确保 NucleiStudio的PATH已经设置到系统中，这样 NucleiStudio.exe/NucleiStudio 才可以被执行。

下面以Windows系统举例

NucleiStudio.exe --launcher.suppressErrors -nosplash -application org.eclipse.cdt..

--launcher.suppressErrors 用来屏蔽构建出错时，Eclipse会出错弹窗。

如果需要在2022.12版本的IDE上进行使用，则需要先设置好toolchain目录下gcc/bin和build-tools/bin的路径到系统PATH中，然后将NucleiStudio.exe换成eclipsec.exe

针对2022.12版本，命令举例如下：

```
# 这里请修改成自己的IDE路径  
set NSIDE=D:\NucleiStudio_IDE_202212-win64\NucleiStudio  
# 必须设置好系统PATH
```

```
set PATH=%NSIDE%\toolchain\gcc\bin;%NSIDE%\toolchain\build-tools\bin;%PATH%
# 注意NucleiStudio.exe换成了eclipsec.exe
%NSIDE%\eclipsec.exe --launcher.suppressErrors -nosplash -application org.eclipse.cdt.managedbuilder.core.headlessbuild -data C:\Users\11653\NucleiStudio_workspace2023 -cleanBuild test2222\Debug -Debug
```

这个2023.10版本的举例的命令会弹出一个额外的命令行窗口进行输出。

The screenshot shows a command-line interface with the following text output:

```
>E\NucleiStudio_IDE_202310-win64\NucleiStudio>NucleiStudio.exe --launcher.suppressErrors -nosplash -application org.eclipse.cdt.managedbuilder.core.headlessbuild -data C:\Users\11653\NucleiStudio_workspace2023 -cleanBuild test2222\Debug -Debug

& NucleiStudio.exe --launcher.suppressErrors -nosplash -application org.eclipse.cdt.managedbuilder.core.headlessbu... -  □ ×

sdk/SoC/hbirdv2/Common/Source/Stubs/lseek.o ./hbird_sdk/SoC/hbirdv2/Common/Source/Stubs/open.o ./hbird_sdk/SoC/hbirdv2/C
ommon/Source/Stubs/read.o ./hbird_sdk/SoC/hbirdv2/Common/Source/Stubs/sbrk.o ./hbird_sdk/SoC/hbirdv2/Common/Source/Stubs
/stat.o ./hbird_sdk/SoC/hbirdv2/Common/Source/Stubs/times.o ./hbird_sdk/SoC/hbirdv2/Common/Source/Stubs/unlink.o ./hbird
_sdk/SoC/hbirdv2/Common/Source/Stubs/wait.o ./hbird_sdk/SoC/hbirdv2/Common/Source/Stubs/write.o ./hbird_sdk/SoC/hbirdv2
/Common/Source/GCC/intexc_hbirdv2.o ./hbird_sdk/SoC/hbirdv2/Common/Source/GCC/startup_hbirdv2.o ./hbird_sdk/SoC/hbirdv2
/Common/Source/Drivers/hbirdv2_gpio.o ./hbird_sdk/SoC/hbirdv2/Common/Source/Drivers/hbirdv2_i2c.o ./hbird_sdk/SoC/hbirdv
2/Common/Source/Drivers/hbirdv2_pwm.o ./hbird_sdk/SoC/hbirdv2/Common/Source/Drivers/hbirdv2_spi.o ./hbird_sdk/SoC/hbirdv
2/Common/Source/Drivers/hbirdv2_uart.o ./hbird_sdk/SoC/hbirdv2/Common/Source/Drivers/htif.o ./hbird_sdk/SoC/hbirdv2/Com
mon/Source/hbirdv2_common.o ./hbird_sdk/SoC/hbirdv2/Common/Source/system_hbirdv2.o ./application/main.o test2222.hex te
st2222.lst test2222.size ./hbird_sdk/SoC/hbirdv2/Common/Source/GCC/intexc_hbirdv2.o ./hbird_sdk/SoC/hbirdv2/Common/Source
/GCC/startup_hbirdv2.o ./hbird_sdk/SoC/hbirdv2/Common/Source/Stubs/clock_getres.d ./hbird_sdk/SoC/hbirdv2/Common/Source/
Stubs/clock_gettime.d ./hbird_sdk/SoC/hbirdv2/Common/Source/Stubs/clock_settime.d ./hbird_sdk/SoC/hbirdv2/Common/Source/
Stubs/close.d ./hbird_sdk/SoC/hbirdv2/Common/Source/Stubs/execve.d ./hbird_sdk/SoC/hbirdv2/Common/Source/Stubs/exit.d ./h
bird_sdk/SoC/hbirdv2/Common/Source/Stubs/fork.d ./hbird_sdk/SoC/hbirdv2/Common/Source/Stubs/fstat.d ./hbird_sdk/SoC/hbi
rdv2/Common/Source/Stubs/getpid.d ./hbird_sdk/SoC/hbirdv2/Common/Source/Stubs/gettimeofday.d ./hbird_sdk/SoC/hbirdv2/Com
mon/Source/Stubs/isatty.d ./hbird_sdk/SoC/hbirdv2/Common/Source/Stubs/kill.d ./hbird_sdk/SoC/hbirdv2/Common/Source/Stubs
/link.d ./hbird_sdk/SoC/hbirdv2/Common/Source/Stubs/lseek.d ./hbird_sdk/SoC/hbirdv2/Common/Source/Stubs/open.d ./hbird_s
dk/SoC/hbirdv2/Common/Source/Stubs/read.d ./hbird_sdk/SoC/hbirdv2/Common/Source/Stubs/sbrk.d ./hbird_sdk/SoC/hbirdv2/Com
mon/Source/Stubs/stat.d ./hbird_sdk/SoC/hbirdv2/Common/Source/Stubs/times.d ./hbird_sdk/SoC/hbirdv2/Common/Source/Stubs/
unlink.d ./hbird_sdk/SoC/hbirdv2/Common/Source/Stubs/wait.d ./hbird_sdk/SoC/hbirdv2/Common/Source/Stubs/write.d ./hbird
_sdk/SoC/hbirdv2/Common/Source/Drivers/hbirdv2_gpio.o ./hbird_sdk/SoC/hbirdv2/Common/Source/Drivers/hbirdv2_i2c.d ./hbir
d_sdk/SoC/hbirdv2/Common/Source/Drivers/hbirdv2_pwm.o ./hbird_sdk/SoC/hbirdv2/Common/Source/Drivers/hbirdv2_spi.d ./hbir
d_sdk/SoC/hbirdv2/Common/Source/Drivers/hbirdv2_uart.d ./hbird_sdk/SoC/hbirdv2/Common/Source/Drivers/htif.d ./hbird_sdk
/SoC/hbirdv2/Common/Source/hbirdv2_common.o ./hbird_sdk/SoC/hbirdv2/Common/Source/system_hbirdv2.o ./application/main.o
test2222.elf

15:34:36 Build Finished. 0 errors, 0 warnings. (took 326ms)
```

- **NucleiStudio.exe**：该参数是Nuclei Studio的启动应用，在Nuclei Studio的安装目录下。
- **--launcher.suppressErrors**：该参数是用于抑制Nuclei Studio启动时的错误信息。
- **-nosplash**：该参数用于关闭启动时的 Splash 屏幕。这意味着在启动 Eclipse 时不会显示一个短暂的加载屏幕。
- **-application**：该参数用于指定要运行的应用程序。在这里，**org.eclipse.cdt.managedbuilder.core.headlessbuild** 是指 Headless 构建应用程序。该应用程序用于执行构建操作，而不需要图形用户界面（GUI）。
- **-data**：该参数用于指定工作区路径。它告诉 Nuclei Studio 将数据存储在哪里，例如工作空间、项目和文件。
- **-build**：该参数用于指定需要编译的工程，**test/Debug**，表示的是编译**test**工程中的 Debug 配置；一般Nuclei Studio创建的工程有Debug、Release两套配置，如果不指定配置，这个默认会编译出Debug、Release，可以看到编译后工程目录下有Debug、Release两个目录。

```
|-.settings
|application
|Debug
| |application
| |nuclei_sdk
|-nuclei_sdk
```

```
└─Release
    ├─application
    └─nuclei_sdk
```

- **-cleanBuild**：该参数与**-build**类似，只是在编译之前，会清空清理工作空间。建议使用**-cleanBuild**。
  - **-Debug**：该参数用于指定编译过程是**Debug**模式，在编译时会输出详细的编译过程日志。如果不带此参数，命令将静默执行，没有任何输出。

以下为上面举例命令的输出内容，以供参考

```
17:00:17 **** Clean-only build of configuration Debug for project test ****  
make -j8 clean  
rm -rf ./nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/chown.o ./nuclei_sdk/S
```

17:00:17 Build Finished. 0 errors, 0 warnings. (took 371ms)

```
17:00:18 **** Build of configuration Debug for project test ****
make -j8 all
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/chown.c
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/clock_getres.c
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/clock_gettime.c
Invoking: GNU RISC-V Cross C Compiler
Invoking: GNU RISC-V Cross C Compiler
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/clock_settime.c
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series
Invoking: GNU RISC-V Cross C Compiler
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series
Invoking: GNU RISC-V Cross C Compiler
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/close.c
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/environ.c
Invoking: GNU RISC-V Cross C Compiler
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/errno.c
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/execve.c
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series
Invoking: GNU RISC-V Cross C Compiler
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series
Invoking: GNU RISC-V Cross C Compiler
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series
Invoking: GNU RISC-V Cross C Compiler
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series
```

```
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/environ.c
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/chown.c
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/clock_gettime.c
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/clock_settime.c
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/close.c

Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/clock_gettime.c
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/clock_settime.c
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/exit.c
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/fork.c

Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/fstat.c
Invoking: GNU RISC-V Cross C Compiler
Invoking: GNU RISC-V Cross C Compiler
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series -
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/getpid.c
Invoking: GNU RISC-V Cross C Compiler
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series -
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/execve.c
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series -
Invoking: GNU RISC-V Cross C Compiler

riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series -
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/gettimeofday.c
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/isatty.c
Invoking: GNU RISC-V Cross C Compiler
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/kill.c
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series -
Invoking: GNU RISC-V Cross C Compiler
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series -
Invoking: GNU RISC-V Cross C Compiler
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series -
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/exit.c

Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/errno.c
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/fork.c
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/link.c

Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/lseek.c
Invoking: GNU RISC-V Cross C Compiler
```

```
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/gettimeof  
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series  
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/open.c  
Invoking: GNU RISC-V Cross C Compiler  
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series
```

```
Invoking: GNU RISC-V Cross C Compiler  
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series  
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/read.c  
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/kill.c  
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/getpid.c  
Invoking: GNU RISC-V Cross C Compiler  
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series
```

```
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/readlink.c  
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/sbrk.c  
Invoking: GNU RISC-V Cross C Compiler  
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series  
Invoking: GNU RISC-V Cross C Compiler  
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series  
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/isatty.c
```

```
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/fstat.c  
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/link.c  
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/lseek.c  
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/read.c
```

```
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/stat.c  
  
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/symlink.c  
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/times.c  
Invoking: GNU RISC-V Cross C Compiler  
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/unlink.c  
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series  
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/readlink.c  
Invoking: GNU RISC-V Cross C Compiler  
Invoking: GNU RISC-V Cross C Compiler  
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series  
Invoking: GNU RISC-V Cross C Compiler  
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series  
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series
```

```
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/wait.c
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/write.c
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/sbrk.c
Invoking: GNU RISC-V Cross C Compiler
Invoking: GNU RISC-V Cross C Compiler

riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/GCC/intexc_evalsoc.S
Invoking: GNU RISC-V Cross Assembler
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/unlink.c

Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/symlink.c
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/GCC/intexc_evalsoc_s.S

Invoking: GNU RISC-V Cross Assembler
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/GCC/startup_evalsoc.S
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/GCC/intexc_evalsoc.S
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/open.c
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/wait.c
Invoking: GNU RISC-V Cross Assembler

riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/Drivers/evalsoc_uart.c
Invoking: GNU RISC-V Cross C Compiler
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/evalsoc_common.c
Building file: ../nuclei_sdk/SoC/evalsoc/Common/Source/system_evalsoc.c
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series
Invoking: GNU RISC-V Cross C Compiler
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series
Invoking: GNU RISC-V Cross C Compiler
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/stat.c
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/write.c

Building file: ../application/main.c
Invoking: GNU RISC-V Cross C Compiler
riscv64-unknown-elf-gcc -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series
```

```
Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/GCC/startup_evalsoc.S

Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Stubs/newlib/times.c

Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/GCC/intexc_evalsoc_s.S

Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/Drivers/evalsoc_uart.c

Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/evalsoc_common.c

Finished building: ../nuclei_sdk/SoC/evalsoc/Common/Source/system_evalsoc.c

Finished building: ../application/main.c

Building target: test.elf
Invoking: GNU RISC-V Cross C++ Linker
riscv64-unknown-elf-g++ -march=rv32imafdc -mabi=ilp32d -mtune=nuclei-300-series -
Finished building target: test.elf

Invoking: GNU RISC-V Cross Create Flash Image
riscv64-unknown-elf-objcopy -O ihex "test.elf" "test.hex"
Invoking: GNU RISC-V Cross Create Listing
riscv64-unknown-elf-objdump --source --all-headers --demangle --line-numbers --wide
Invoking: GNU RISC-V Cross Print Size
riscv64-unknown-elf-size --format=berkeley "test.elf"
    text      data      bss      dec      hex filename
    8824      1272     4592    14688     3960 test.elf
Finished building: test.size
Finished building: test.hex

Finished building: test.lst
```

17:00:23 Build Finished. 0 errors, 0 warnings. (took 5s.75ms)

以下为org.eclipse.cdt.managedbuilder.core.headlessbuild所提供的参数，以供参考。

```
-data      {/path/to/workspace}
-remove   {[uri:/]/path/to/project}
-removeAll {[uri:/]/path/to/projectTreeURI} Remove all projects under URI
-import   {[uri:/]/path/to/project}
-importAll {[uri:/]/path/to/projectTreeURI} Import all projects under URI
```

```
-build      {project_name_reg_ex{/config_reg_ex} | all}
-cleanBuild {project_name_reg_ex{/config_reg_ex} | all}
-markerType Marker types to fail build on {all | cdt | marker_id}
-no-indexer Disable indexer
-verbose    Verbose progress monitor updates
-printErrorMarkers Print all error markers
-I          {include_path} additional include_path to add to tools
-include    {include_file} additional include_file to pass to tools
-D          {preproc_define} addition preprocessor defines to pass to the tools
-E          {var=value} replace/add value to environment variable when running
-Ea         {var=value} append value to environment variable when running all
-EP         {var=value} prepend value to environment variable when running all
-ER         {var} remove/unset the given environment variable
-T          {toolid} {optionid=value} replace a tool option value in each config
-Ta         {toolid} {optionid=value} append to a tool option value in each config
-Tp         {toolid} {optionid=value} prepend to a tool option value in each config
-Tr         {toolid} {optionid=value} remove a tool option value in each config
Tool option values are parsed as a string, comma separated list of strings
```

# OpenOCD烧写程序时报错Error:Device ID 8xle2g8a6d is not known as FESPI capable¶

Nuclei Studio 2023.10版中烧写程序时有报以下错误：

参见这个 <https://github.com/riscv-mcu/hbird-sdk/issues/8>

```
Info : Using libusb driver
Info : clock speed 1000 kHz
Info : JTAG tap: riscv.cpu tap/device found: 0x1e200a6d (mfg: 0x536 (Nuclei System))
Info : [riscv.cpu] Found 0 triggers
halted at 0x200000b2 due to debug interrupt
Info : Examined RISCV core; XLEN=32, misa=0x40001105
[riscv.cpu] Target successfully examined.
Info : starting gdb server for riscv.cpu on 3333
Info : Listening on port 3333 for gdb connections
Error: Device ID 0x1e200a6d is not known as FESPI capable
Error: auto_probe failed
```

因为在openocd 2023.10中，将flash bank \$\_FLASHNAME从fespi修改为了nuspi，需要工程中的openocd配置文件中的fespi修改为了nuspi，以蜂鸟工程为例，将 hbird\_sdk/SoC/hbirdv2/Board/mcu200t/openocd\_hbirdv2.cfg修改为如下配置，工程即可正常使用。

```
adapter_khz      1000

interface ftdi
ftdi_vid_pid 0x0403 0x6010
ftdi_oscanc1_mode off

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

set _CHIPNAME riscv
jtag newtap $_CHIPNAME cpu -irlen 5
```

```
set _TARGETNAME $_CHIPNAME.cpu
target create $_TARGETNAME riscv -chain-position $_TARGETNAME
$_TARGETNAME configure -work-area-phys 0x80000000 -work-area-size 10000 -work-area-step 1000
$_TARGETNAME select

set _FLASHNAME $_CHIPNAME.flash
flash bank $_FLASHNAME nuspi 0x20000000 0 0 0 $_TARGETNAME
# Set the ILM space also as flash, to make sure it can be add breakpoint with hardware
#flash bank onboard_ilm nuspi 0x80000000 0 0 0 $_TARGETNAME

# Expose Nuclei self-defined CSRS range 770-800,835-850,1984-2032,2064-2070
# See https://github.com/riscv/riscv-gnu-toolchain/issues/319#issuecomment-358397340
# Then user can view the csr register value in gdb using: info reg csr775 for CSR775
riscv expose_csrs 770-800,835-850,1984-2032,2064-2070

init
#reset
if {[ info exists pulse_srst]} {
    ftdi_set_signal nSRST 0
    ftdi_set_signal nSRST z
}
halt
# We must turn on this because otherwise the IDE version debug cannot download the image
flash protect 0 0 last off
```

# 关于dhrystone在IDE上跑分和NSDK 0.5.0命令行跑分不一致的问题¶

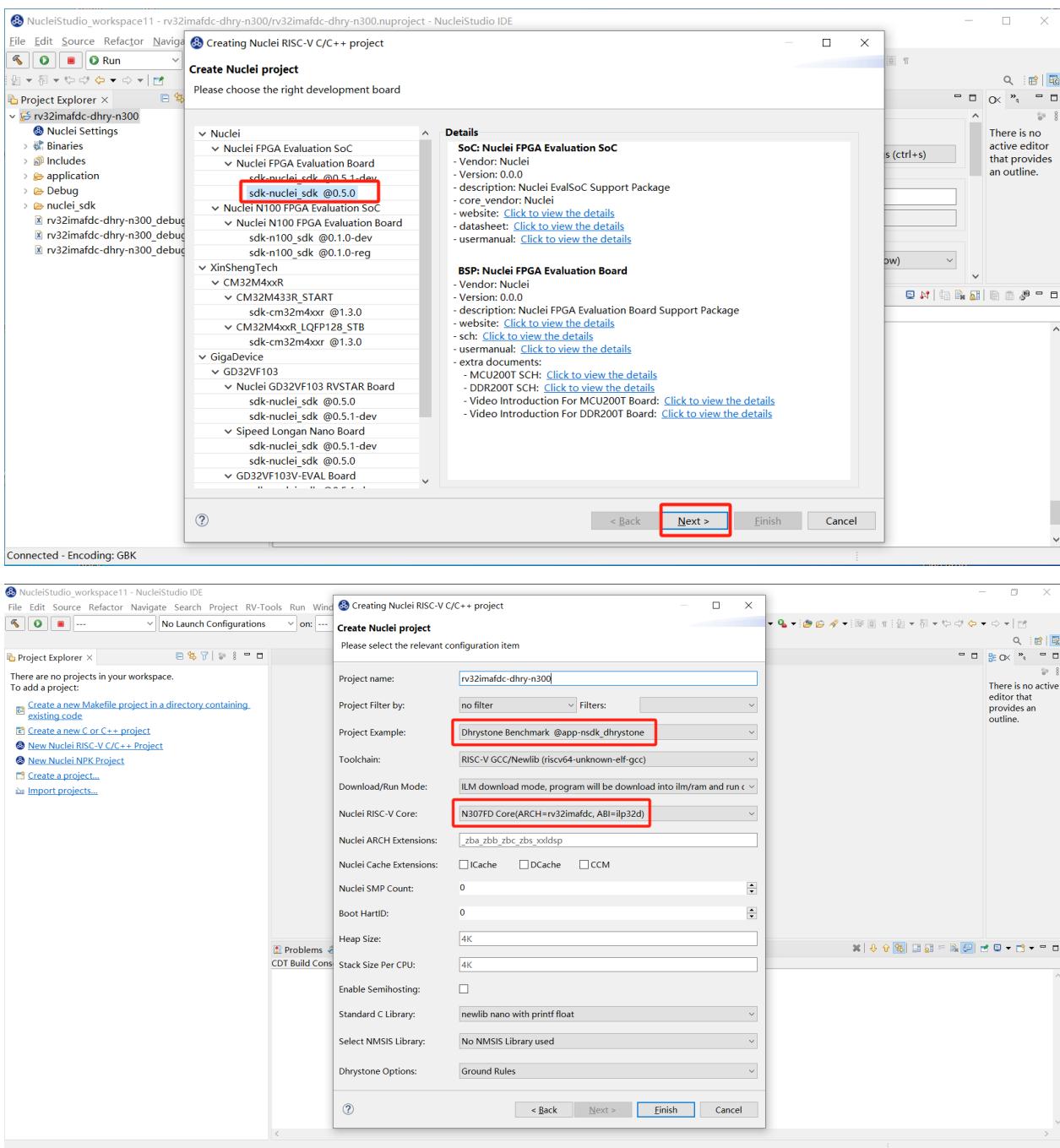
## 问题说明¶

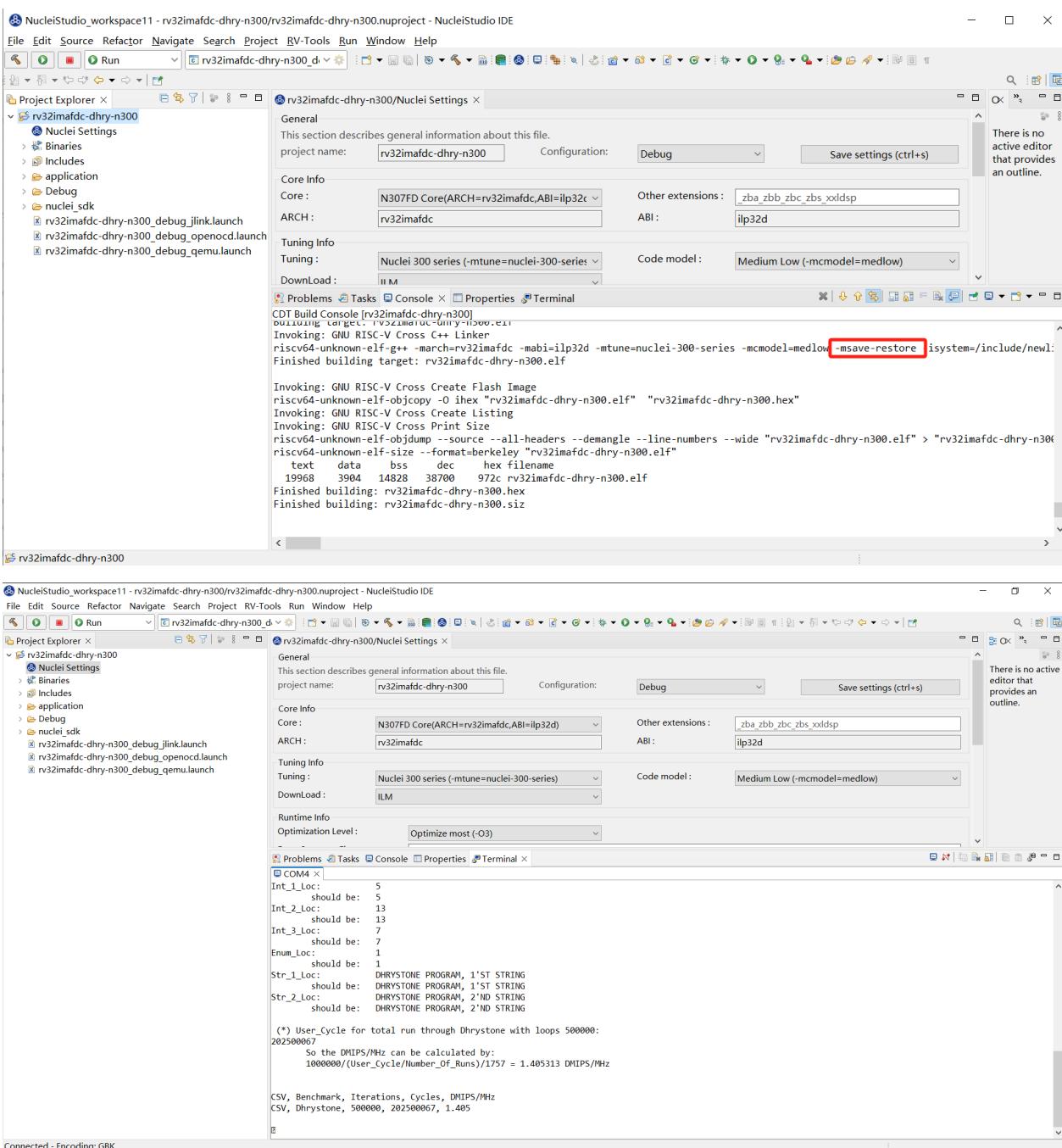
在0.5.0版本的sdk-nuclei\_sdk中，为了IDE上使用libncrt库的时候编译有些程序不报错，设置了会默认带上`-msave-restore`。但在创建dhrystone用例工程时，选择使用newlib库后，该选项会导致跑分降低，不符合CPU的真实跑分。

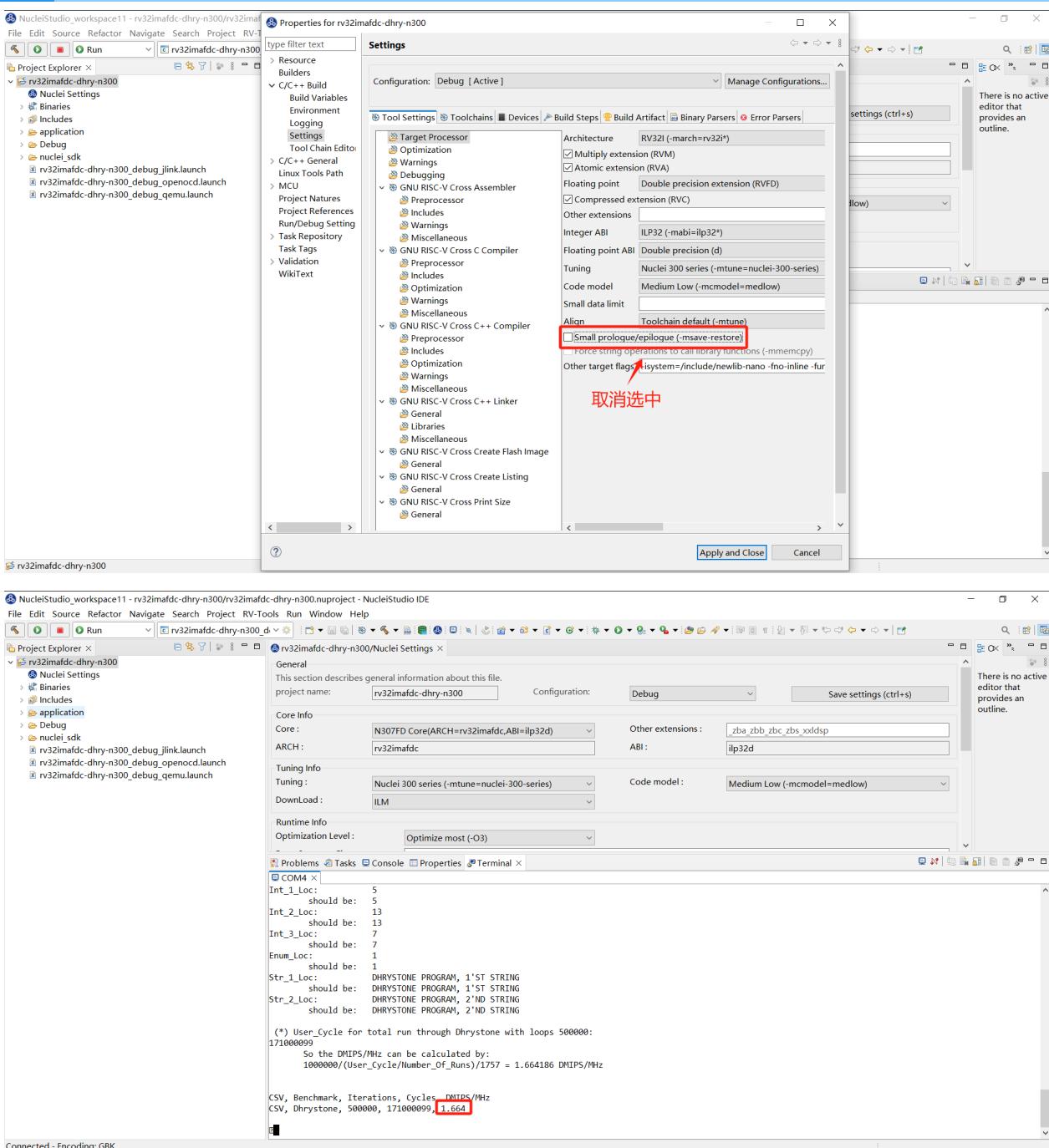
## 解决方案¶

在跑分的时候，需要在对应项目的Properties -> C/C++ Build -> Settings中，取消对Small prologue/epilogue(`-msave-restore`)的选中。具体流程和示例图如下：

1. 下载sdk-nuclei\_sdk 0.5.0 NPK组件包。
2. 新建一个Nuclei RISCV-V C/C++ project。
3. 在新建项目的过程中，选中Dhrystone Benchmark和N307FD Core,其他选项默认设置即可。此时直接编译运行，跑分为1.405。
4. 但实际需要跑分时，要先取消选中`-msave-restore`选项，该跑分结果为1.664。







# Error: Couldn't find an available hardware trigger / Error: can't add breakpoint: resource not available¶

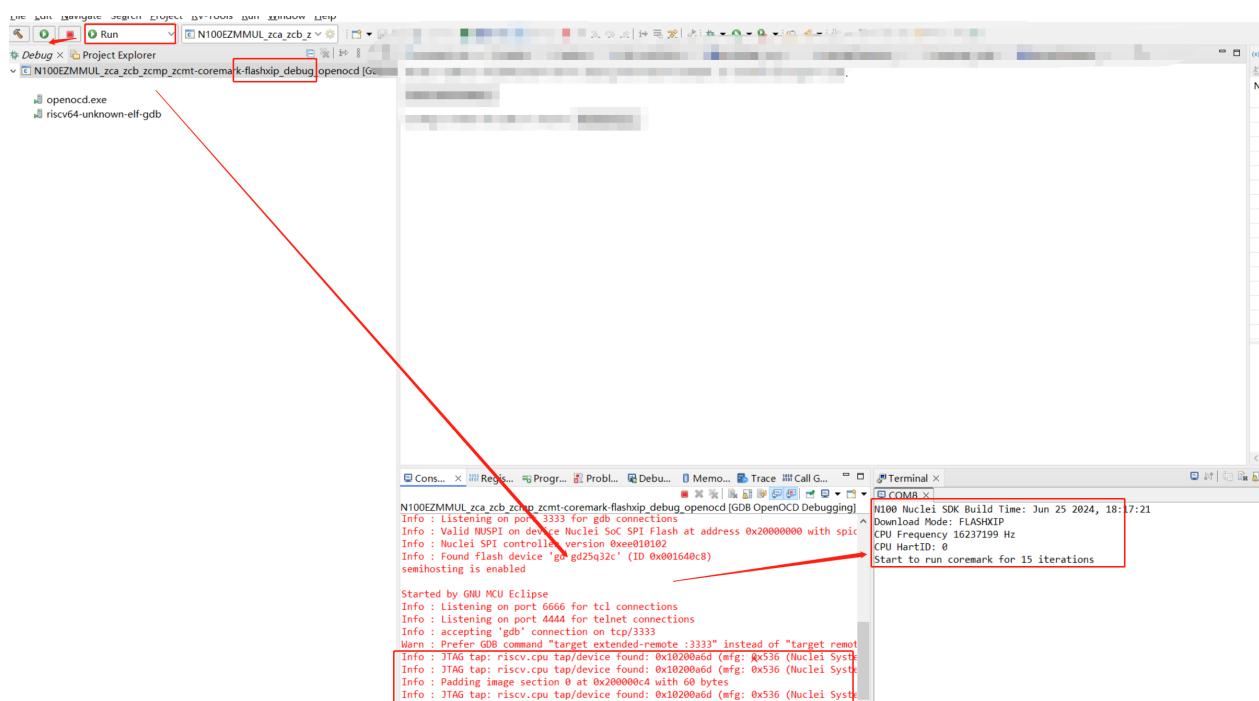
## 问题说明¶

在NucleiStudio中使用OpenOCD调试hbird/hbirdv2处理器（不支持硬件断点）或者Nuclei 100系列的处理器时，当程序运行在Flash/FlashXip下时，会报Error。

Error: Couldn't find an available hardware trigger.  
Error: can't add breakpoint: resource not available

```
Info : coreid=0, 10 : 0x0
Info : coreid=0, 32 : 0x0
Info : Examined RISC-V core; found 1 harts
Info : hart 0: XLEN=32, misa=0x0001104
[riscv.cpu] Target successfully examined.
Info : starting gdb server for riscv.cpu on 3333
Info : Listening on port 3333 for gdb connections
Info : Valid NUSPI on device Nuclei SoC SPI Flash at address 0x20000000 with spictrl regbase at 0x10014000
Info : Nuclei SPI controller version 0xee010102
Info : Found flash device 'gd gd25q32c' (ID 0x001640c8)
semihosting is enabled

Started by GNU MCU Eclipse
Info : Listening on port 6666 for tcl connections
Info : Listening on port 4444 for telnet connections
Info : accepting 'gdb' connection on tcp/3333
Warn : Prefer GDB command "target extended-remote :3333" instead of "target remote :3333"
Info : JTAG tap: riscv.cpu tap/device found: 0x10200a6d (mfg: 0x536 (Nuclei System Technology Co Ltd), part: 0x0200, ver: 0x1)
Info : JTAG tap: riscv.cpu tap/device found: 0x10200a6d (mfg: 0x536 (Nuclei System Technology Co Ltd), part: 0x0200, ver: 0x1)
Info : Padding image section 0 at 0x200000c4 with 60 bytes
Info : JTAG tap: riscv.cpu tap/device found: 0x10200a6d (mfg: 0x536 (Nuclei System Technology Co Ltd), part: 0x0200, ver: 0x1)
Info : [riscv cpu] Found 0 triggers
Error: Couldn't find an available hardware trigger.
Error: can't add breakpoint: resource not available
```



是因为所运行的CPU不支持硬件断点，导致程序运行在Flash上的时候，IDE调试功能无法正常工作，这个是IDE会需要打一个临时断点的缘故导致的。如果需要下载并运行程序，切换到Run运行模式可以正常运行程序。

## 解决方案¶

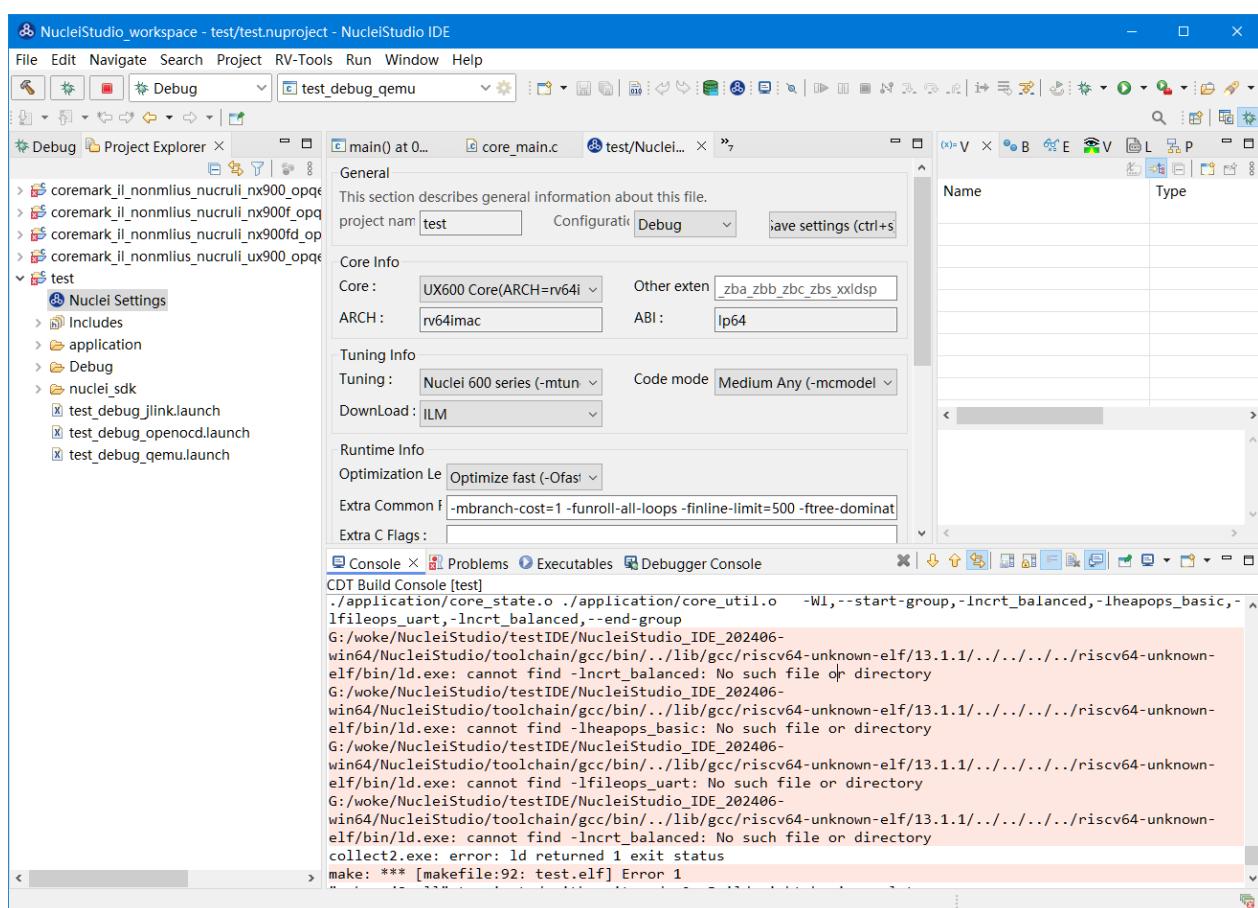
当在调试此类型处理器时，如果需要调试的话，就需要将程序编译运行在RAM上。

# cannot find -lncrt\_balanced: No such file or directory¶

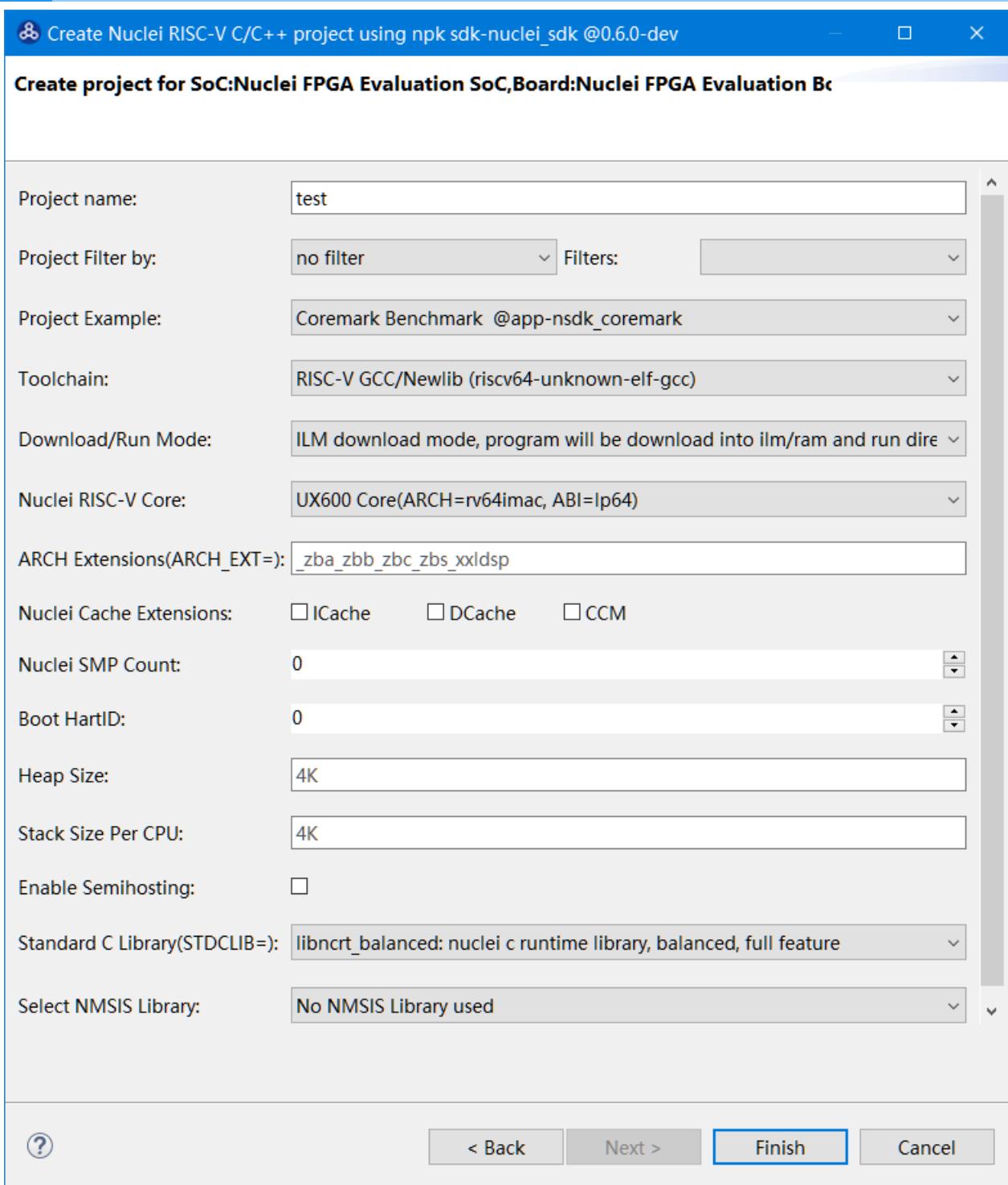
## 问题说明¶

在NucleiStudio中使用编译工程时有报错信息如下：

```
G:/NucleiStudio/toolchain/gcc/bin/.../lib/gcc/riscv64-unknown-elf/13.1.1/.../...
G:/NucleiStudio/toolchain/gcc/bin/.../lib/gcc/riscv64-unknown-elf/13.1.1/.../...
G:/NucleiStudio/toolchain/gcc/bin/.../lib/gcc/riscv64-unknown-elf/13.1.1/.../...
G:/NucleiStudio/toolchain/gcc/bin/.../lib/gcc/riscv64-unknown-elf/13.1.1/.../...
```



是因为在创建工程时，我们创建了一个64位的工程，同时在Standard C Library时，选择了带-lncrt\_balanced、-lfileops\_uart的扩展，而此类扩展又不支持64位，导致编译不通过。



## 解决方案¶

-lncrt\_balanced、-lfileops\_uart不支持64位处理器，在创建此类处理器工程时，避免使用此类扩展。

# UnsatisfiedLinkError of swt-win32-4965r8.dll on Windows 7¶

## 问题说明¶

用户在Windows 7、Windows 8下使用NucleiStudio 2024.06时，发现启动不了，在NucleiStudio\configuration目录的日志中可以看到以下报错内容：

```
!ENTRY org.eclipse.osgi 4 0 2024-07-16 10:41:57.010
!MESSAGE Application error
!STACK 1
java.lang.UnsatisfiedLinkError: Could not load SWT library. Reasons:
C:\NucleiStudio\configuration\org.eclipse.osgi\492\0\.cp\swt-win32-4965r11.dll
no swt-win32 in java.library.path: C:\NucleiStudio;C:\Windows\Sun\Java\bin;C:
no swt in java.library.path: C:\NucleiStudio;C:\Windows\Sun\Java\bin;C:\Wind
C:\Users\username\.swt\lib\win32\x86_64\swt-win32-4965r11.dll: 找不到指定的程序。
Can't load library: C:\Users\username\.swt\lib\win32\x86_64\swt-win32.dll
Can't load library: C:\Users\username\.swt\lib\win32\x86_64\swt.dll
C:\Users\username\.swt\lib\win32\x86_64\swt-win32-4965r11.dll: 找不到指定的程序。

at org.eclipse.swt.internal.Library.loadLibrary(Library.java:345)
at org.eclipse.swt.internal.Library.loadLibrary(Library.java:254)
at org.eclipse.swt.internal.C.<clinit>(C.java:19)
at org.eclipse.swt.internal.win32.STARTUPINFO.<clinit>(STARTUPINFO.java:42)
at org.eclipse.swt.widgets.Display.<clinit>(Display.java:149)
at org.eclipse.ui.internal.Workbench.createDisplay(Workbench.java:721)
at org.eclipse.ui.PlatformUI.createDisplay(PlatformUI.java:185)
at org.eclipse.ui.internal.ide.application.IDEApplication.createDisplay(IDEAp
at org.eclipse.ui.internal.ide.application.IDEApplication.start(IDEApplicati
at org.eclipse.equinox.internal.app.EclipseAppHandle.run(EclipseAppHandle.ja
at org.eclipse.core.runtime.internal.adaptor.EclipseAppLauncher.runApplication
at org.eclipse.core.runtime.internal.adaptor.EclipseAppLauncher.start(EclipseA
at org.eclipse.core.runtime.adaptor.EclipseStarter.run(EclipseStarter.java:43
at org.eclipse.core.runtime.adaptor.EclipseStarter.run(EclipseStarter.java:27
at java.base/jdk.internal.reflect.DirectMethodHandleAccessor.invoke(DirectMet
at java.base/java.lang.reflect.Method.invoke(Method.java:580)
at org.eclipse.equinox.launcher.Main.invokeFramework(Main.java:668)
at org.eclipse.equinox.launcher.Main.basicRun(Main.java:605)
at org.eclipse.equinox.launcher.Main.run(Main.java:1481)
```

是因为在eclipse 2024.06版本中，有使用到一些特性，而该特性对操作系统有要求，可以参考<https://github.com/eclipse-platform/eclipse.platform.swt/issues/1252>

That commit references `SystemParametersInfoForDpi`. See <https://learn.microsoft.com/en-us/windows/win32/api/winuser/nf-winuser-systemparametersinfofordpi>

And `f809372` references `GetSystemMetricsForDpi`. See <https://learn.microsoft.com/en-us/windows/win32/api/winuser/nf-winuser-getsystemmetricsfordpi>

Both of these functions require a minimum version of Windows 10:

Minimum supported client	Windows 10, version 1607 [desktop apps only]
Minimum supported server	Windows Server 2016 [desktop apps only]



But this does still not explain problems with MacOS.

并且在eclipse的官方文档中，针对eclipse测试的操作系统中也做了说明，对某些版本的操作系统不再做兼容。可以参考

[https://eclipse.dev/eclipse/development/plans/eclipse\\_project\\_plan\\_4\\_32.xml#target\\_environments](https://eclipse.dev/eclipse/development/plans/eclipse_project_plan_4_32.xml#target_environments)

Operating System	Version	Hardware	JRE	Windowing System
Windows	10 11	x86 64-bit	OpenJDK 17.0.8 (LTS) OpenJDK 21 (LTS) Oracle Java 17.0.8 (LTS) Oracle Java 21 (LTS)	Win32
Red Hat Enterprise Linux	9.0	x86 64-bit aarch64	OpenJDK 17.0.8 (LTS) OpenJDK 21 (LTS) Oracle Java 17.0.8 (LTS) Oracle Java 21 (LTS)	GTK 3
		Power 64-bit LE	OpenJDK 17.0.8 (LTS)	
SUSE Linux Enterprise Server	15 SP4	x86 64-bit	OpenJDK 17.0.8 (LTS) OpenJDK 21 (LTS)	GTK 3
		Power 64-bit LE	OpenJDK 17.0.8 (LTS)	
Ubuntu Long Term Support	22.04	x86 64-bit aarch64	OpenJDK 17.0.8 (LTS) OpenJDK 21 (LTS)	GTK 3
Apple macOS	12	x86 64-bit	OpenJDK 17.0.8 (LTS) OpenJDK 21 (LTS) Oracle Java 17.0.8 (LTS) Oracle Java 21 (LTS)	Cocoa
	13	M1 (arm64)	OpenJDK 17.0.8 (LTS) OpenJDK 21 (LTS)	

而NucleiStudio 2024.06是基于eclipse 2024.06，所以也会有同类型的问题。

## 解决方案

请在windows 10或以上的版本操作系统上使用 NucleiStudio 2024.06。

如果想在Windows 7、Windows 8等低版本的操作系统上使用NucleiStudio，可以考虑使用NucleiStudio 2024.02及以下版本。

## 使用 Profiling 功能时可能遇到的一些问题¶

目前使用 Profiling 功能可能遇到一些问题，记录如下：

- 问题1：日志打印中报片上内存不足，没有充足内存来存放 gprof/gcov 数据
  - 问题2：采用串口输出的方式收集数据，打印被冲掉，Console 或 Terminal 收集的数据不全，导致数据解析失败，弹出 No files have been generated 错误弹框
  - 问题3：删掉 gmon.out 文件，再次解析时，弹出 No files have been generated 错误弹框

问题1：日志打印中报片上内存不足，没有充足内存来存放 gprof/gcov 数据

**gprof/gcov data** 需要存到片上内存上，占用内存的大小与用例规模有关(几十到几百KB不等)，需要确保片上内存足够大。

解决方案

首先需要确认软件配置的内存大小与硬件实际大小相匹配（ilm/sram/flash/ddr），否则需要适配软件链接脚本内存布局：

比如，如果是 DOWNLOAD=ilm 模式下载，可以按硬件的 ilm 与 dlm 大小适配。对于 nuclei sdk 0.6.0 版本，修改的文件为nuclei-sdk/SoC/evalsoc/Board/nuclei\_fpga\_eval/Source/GCC/gcc evalsoc ilm.ld

INCLUDE evalsoc.memory

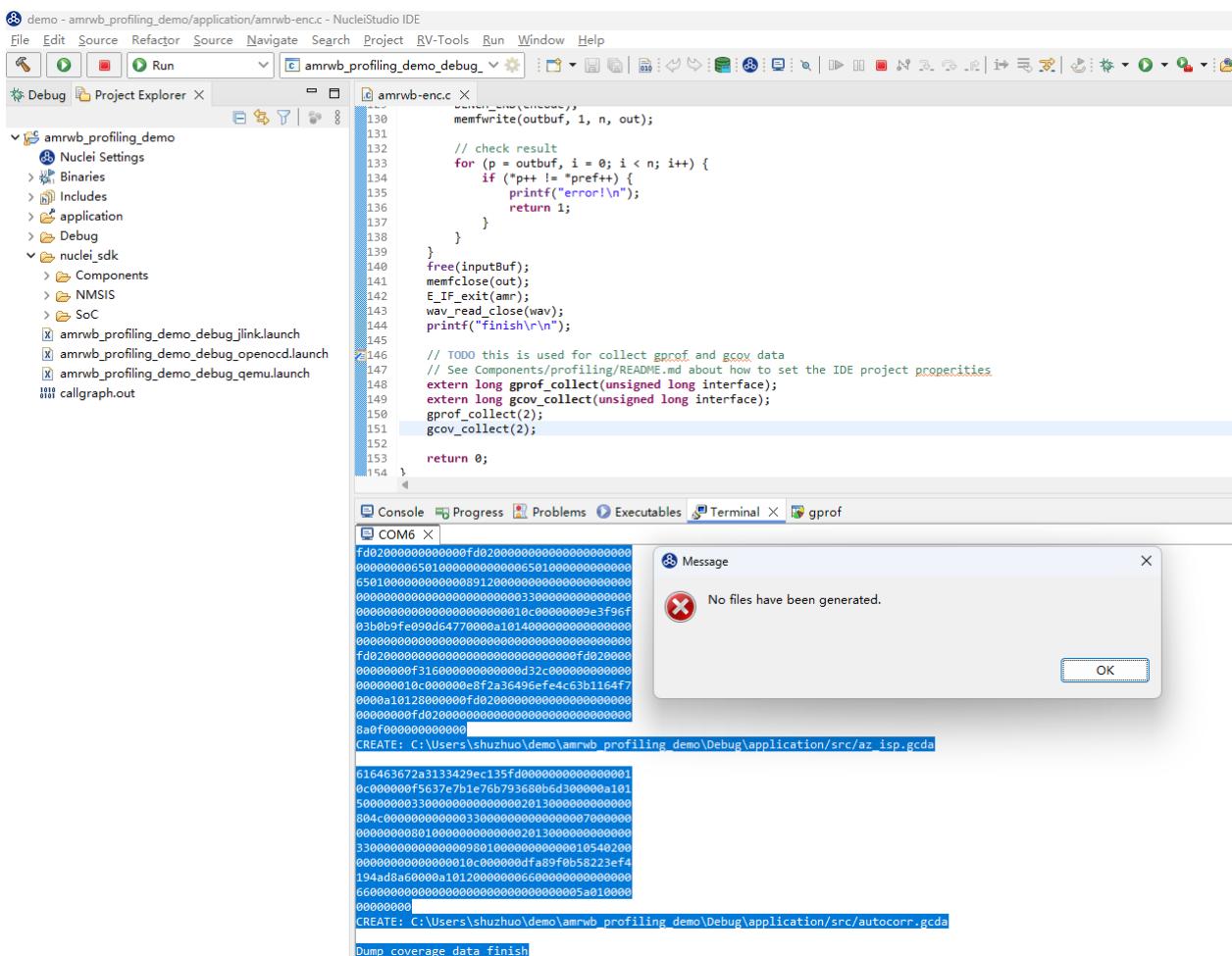
## MEMORY

```
{
    ilm (rxa!w) : ORIGIN = ILM_MEMORY_BASE, LENGTH = ILM_MEMORY_SIZE
    ram (wxa!r) : ORIGIN = DLM_MEMORY_BASE, LENGTH = DLM_MEMORY_SIZE
}
```

如果 DOWNLOAD=ilm 模式内存不足，可以使用内存大一点的下载方式（如 DOWNLOAD=ddr）。

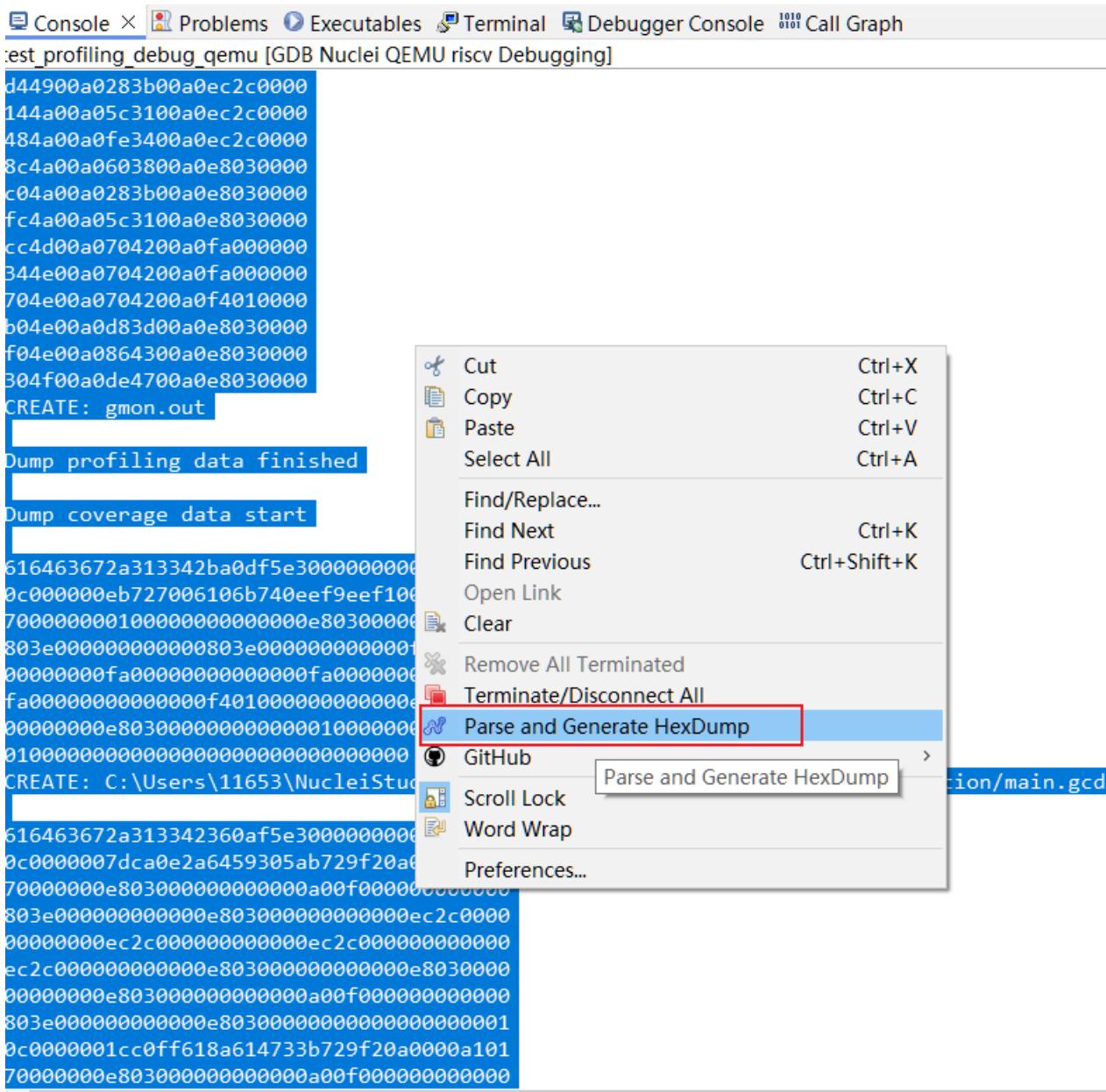
## 问题2：Console 或 Terminal 收集的数据不全导致数据解析时失败¶

在 NucleiStudio 2024.06 中，当选择使用串口输出的方式使用 Profiling 功能时，可能使用 Parse and Generate Hexdump 解析数据时弹出 No files have been generated 错误弹框，最后没有生成对应的 gmon.out 文件或者 \*.gcno 文件。这可能是因为串口数据被冲掉，导致数据不完整从而解析失败



确认方法：

需确保串口开始时的打印没有被冲掉，参考[Nuclei Studio 使用 Profiling 功能进行性能调优举例](#)



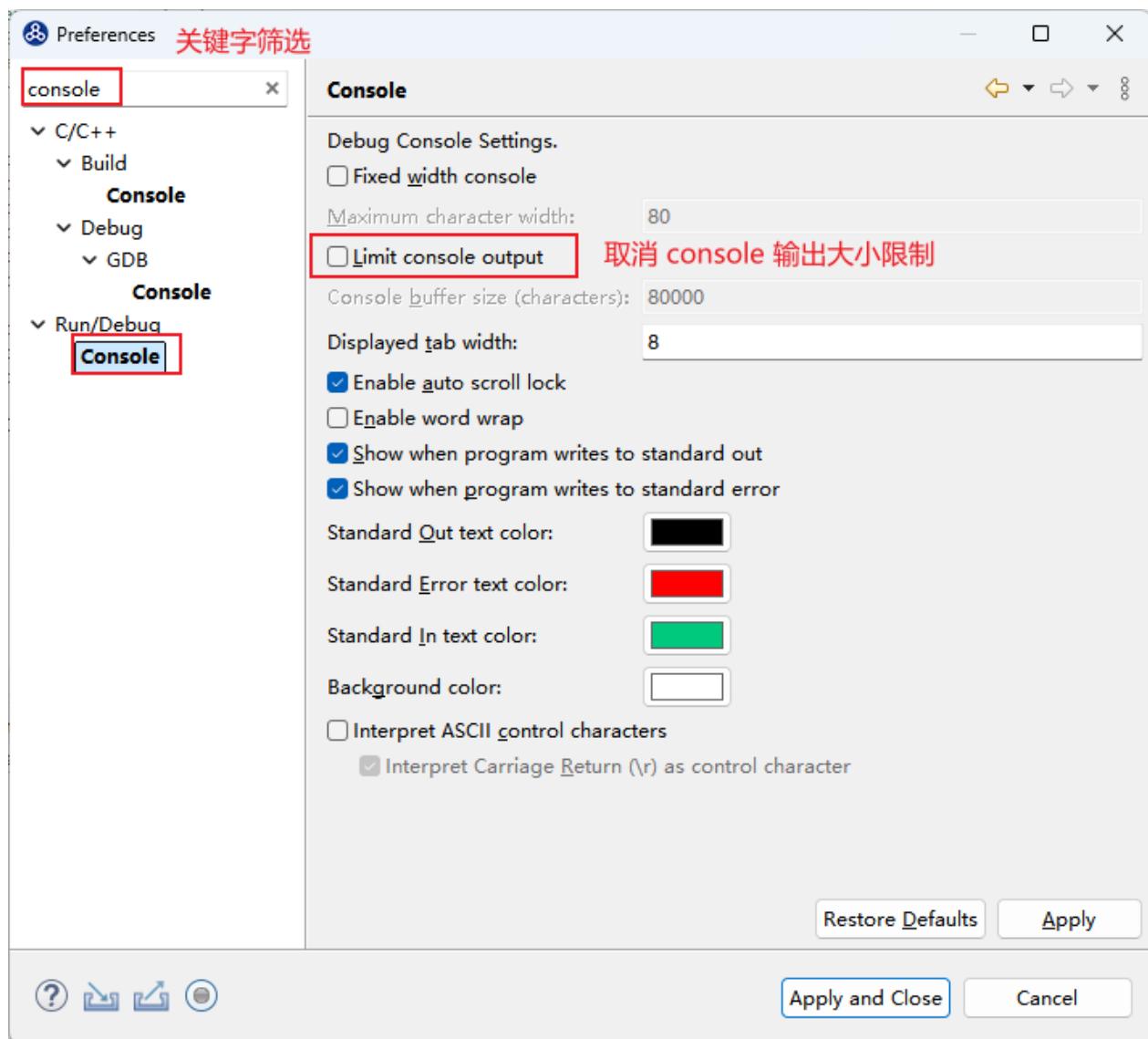
## 解决方案

因为在Console或者Terminal中，对输出的内容条数有限制，当输出的内容长度超过限制时，前面的内容会被冲掉，导致内容不完整，这样会解析失败。

需要调节 Console 或 Terminal 输出大小限制，确保数据没有被冲掉。

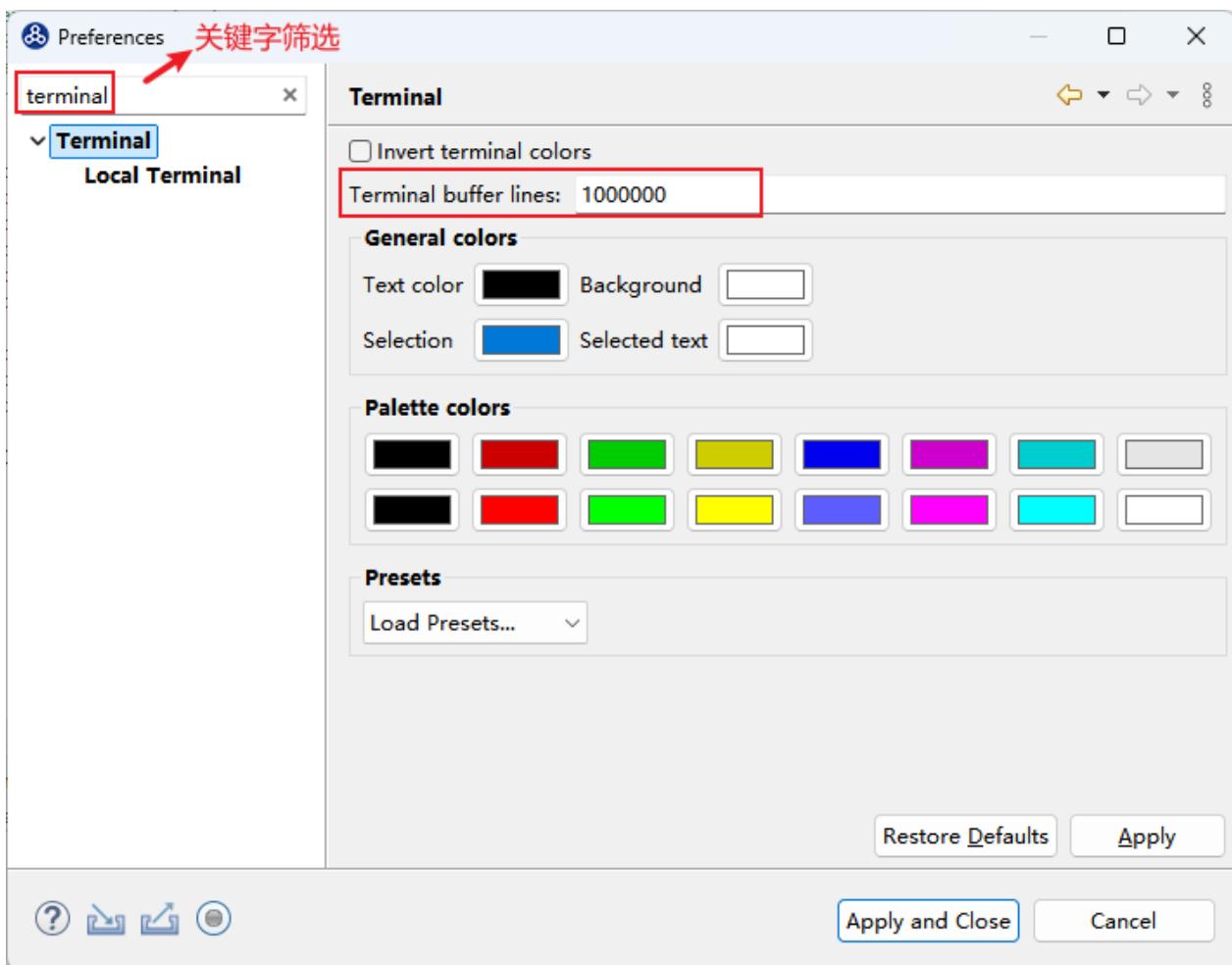
- 建议将Console中输出内容条限修改为不受限制。

Window->Preference 进入如下界面：



- 建议将Terminal中输出内容条限修改为一个较大的值。

Window->Preference 进入如下界面：



### 问题3：删掉 gmon.out 文件，再次解析，弹出 No files have been generated 错误弹框¶

手动删掉工程文件夹下的 gmon.out 文件，再次解析时出现 No files have been generated 的错误弹框

```

demo - amrwb_profiling_demo\application\amrwb-enc.c - NucleiStudio IDE
File Edit Source Refactor Source Navigate Search Project RV-Tools Run Window Help
Debug Project Explorer amrwb-enc.c
amrwb_profiling_demo
  Nuclei Settings
  Binaries
  Includes
  application
  Debug
  nuclei_sdk
    Components
    NMSIS
    SoC
  amrwb_profiling_demo_debug_jlink.launch
  amrwb_profiling_demo_debug_openocd.launch
  amrwb_profiling_demo_debug_qemu.launch
  callgraph.out

130     memfwrite(outbuf, 1, n, out);
131
132     // check result
133     for (p = outbuf, i = 0; i < n; i++) {
134         if (*p++ != *pref++) {
135             printf("error!\n");
136             return 1;
137         }
138     }
139 }
140 free(inputBuf);
141 memfclose(out);
142 E_IF_exit(0);
143 wav_read_close(wav);
144 printf("finish!\n");
145
146 // TODO this is used for collect gprof and gcov data
147 // See Components/profiling/README.md about how to set the IDE project properties.
148 extern long gprof_collect(unsigned long interface);
149 extern long gcov_collect(unsigned long interface);
150 gprof_collect(2);
151 gcov_collect(2);
152
153
154 }

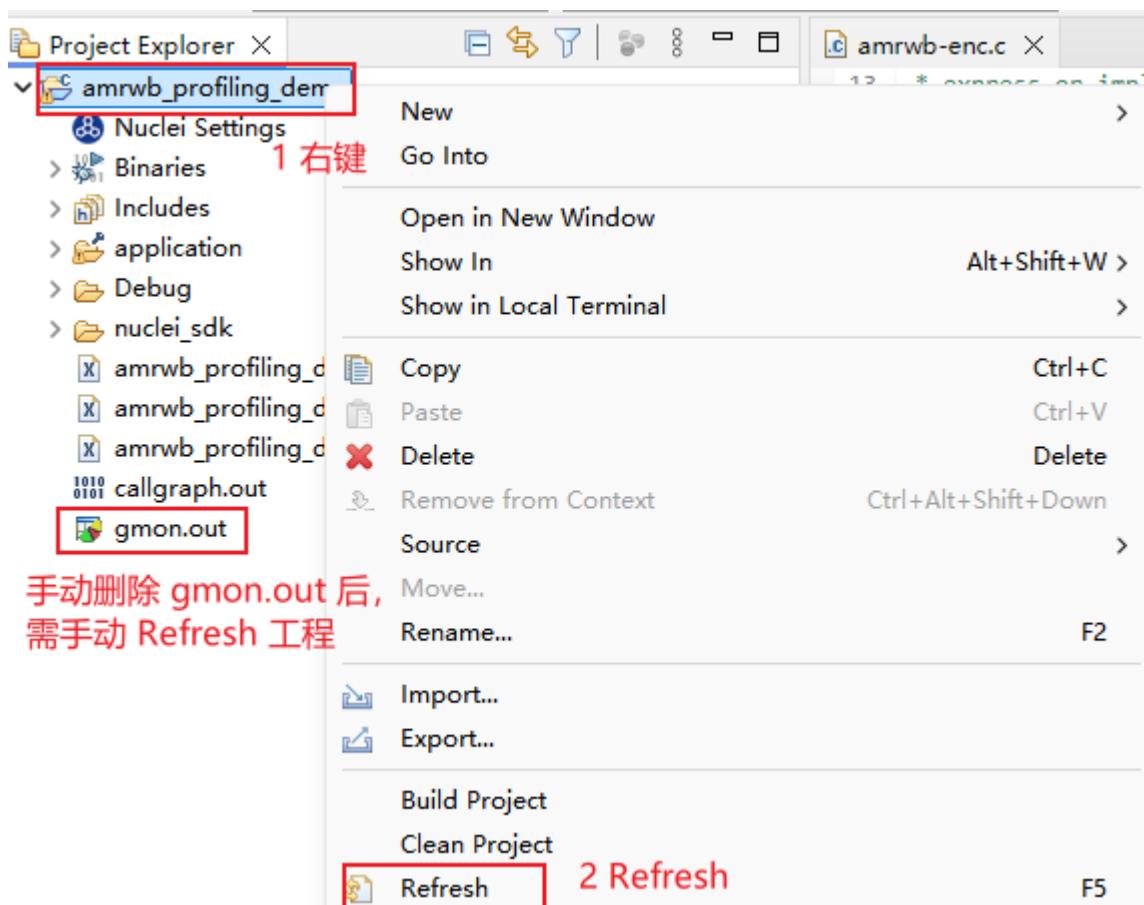
Console Progress Problems Executables Terminal gprof
COM6 ×
Message ×
No files have been generated.
OK

```

CREATE: C:\Users\shuzhuo\demo\amrwb\_profiling\_demo\Debug\application\src\az\_isp.gcda  
CREATE: C:\Users\shuzhuo\demo\amrwb\_profiling\_demo\Debug\application\src\autocorr.gcda  
Dump coverage data finish

## 解决方案¶

手动删掉 gmon.out 文件后，需要手动刷新一下工程。



# Nuclei Studio使用Profiling功能进行性能调优 举例¶

文档是基于 Nuclei Studio 的 2024.06 Windows 版本实测。

## 问题说明¶

Nuclei Studio 2024.06 提供 Profiling 功能、Call Graph 功能以及 Code coverage 功能，方便用户使用。简单描述如下：

- Profiling 功能：基于 binutils gprof 工具，可用于分析函数调用关系、调用次数、以及运行时间；通过 Profiling 抓取热点函数可以用来分析程序的瓶颈，以便进行性能优化。
- Call Graph 功能：基于 Profiling 功能，将函数调用关系、调用次数、以及运行时间用图展示出来，方便开发人员分析。
- Code coverage 功能：基于 gcc 编译器提供 gcov 工具，可用来查看源码文件的代码覆盖率，帮助开发人员确定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 [NucleiStudio\\_User\\_Guide.pdf](#) 相关章节对这几个功能已经有较详细的描述，这篇文档以一个例子来展示它们的实际应用。

## 解决方案¶

### 1 环境准备¶

所需材料：

- Nuclei Studio：[NucleiStudio 2024.06](#)，以 Windows 版本为例
- 用例：以 [AMR-WB-enc](#) 即自适应多速率宽带编码音频算法为例，用户可以移植自己的用例

基于 nuclei-sdk v0.6.0 移植 amrwbenc 裸机用例：

打开 Nuclei Studio 建立 amrwbenc 工程，然后移植 amrwbenc 源码，最终用例可正常运行。用户可以移植自己的用例，不同用例移植的细节各不相同，这一步不是这篇文档的重点，略过。

### 2 Profiling 功能¶

Nuclei studio 中 Profiling 功能基于 binutils gprof 工具。编译时需带特定的编译选项 -pg 来编译指定源码文件，编译成功后得到 ELF 文件，然后在实际开发板上运行并收集需要的 gmon.out 文

件，最终在 IDE 上以图形化的方式展示。所以还需要在用例末尾添加 gprof 数据收集代码，有两种方式：

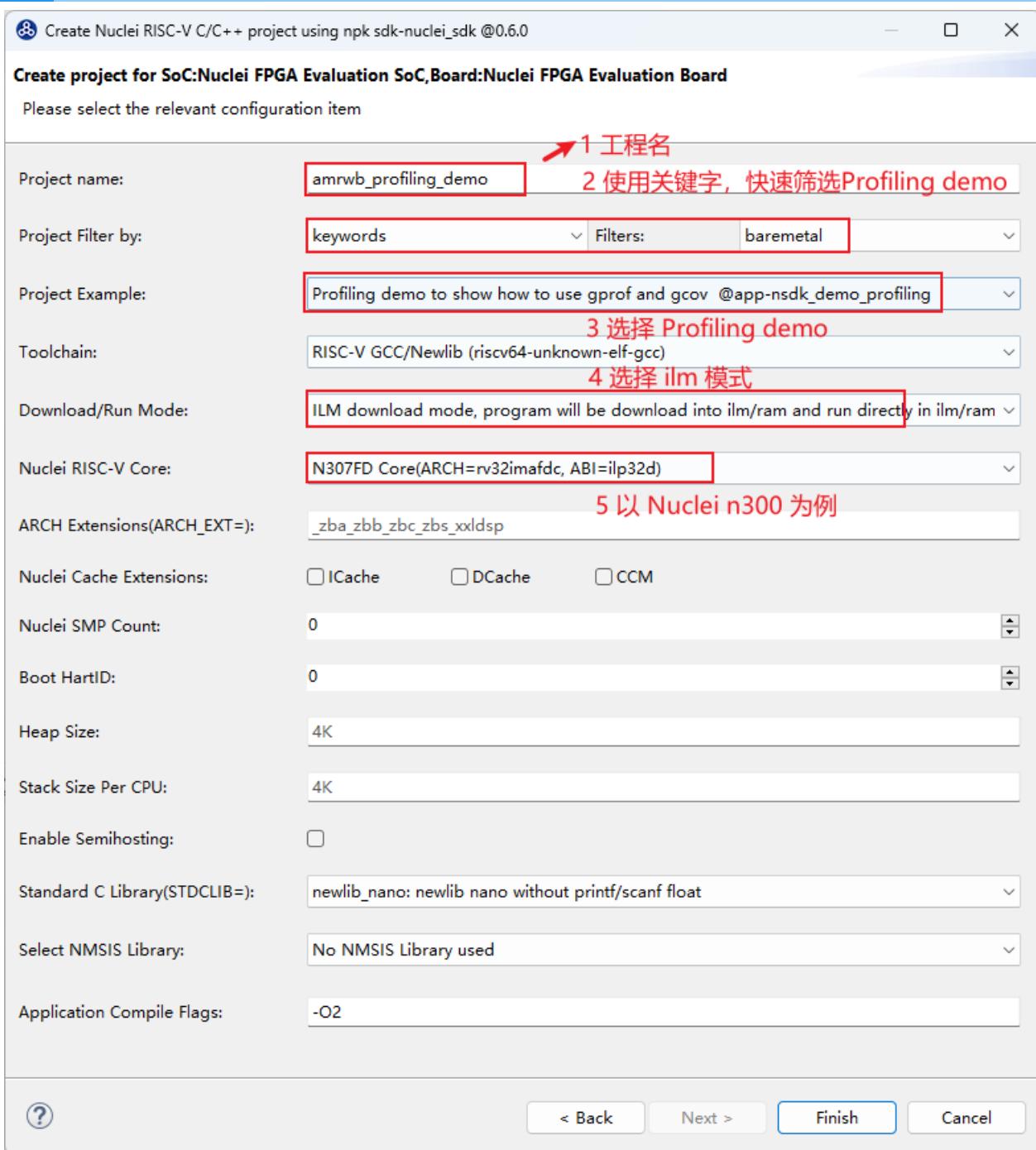
- 方式1：移植 gprof 数据收集代码到自己的工程中，代码可以参考 [Profiling README](#)
- 方式2：基于 Nuclei Studio 中的 Profiling demo 进行改造，即用自己的用例替换掉 Profiling demo 工程的的用例部分

下面示例采用后一种方法进行演示：

step1：新建 Profiling demo 工程

File->New->New Nuclei RISC-V C/C++ Project, 选择 Nuclei FPGA Evalution Board->sdk-nuclei\_sdk @0.6.0

注意：Nuclei SDK 需选择 0.6.0 及以后版本才支持 Profiling 与 Code coverage 功能



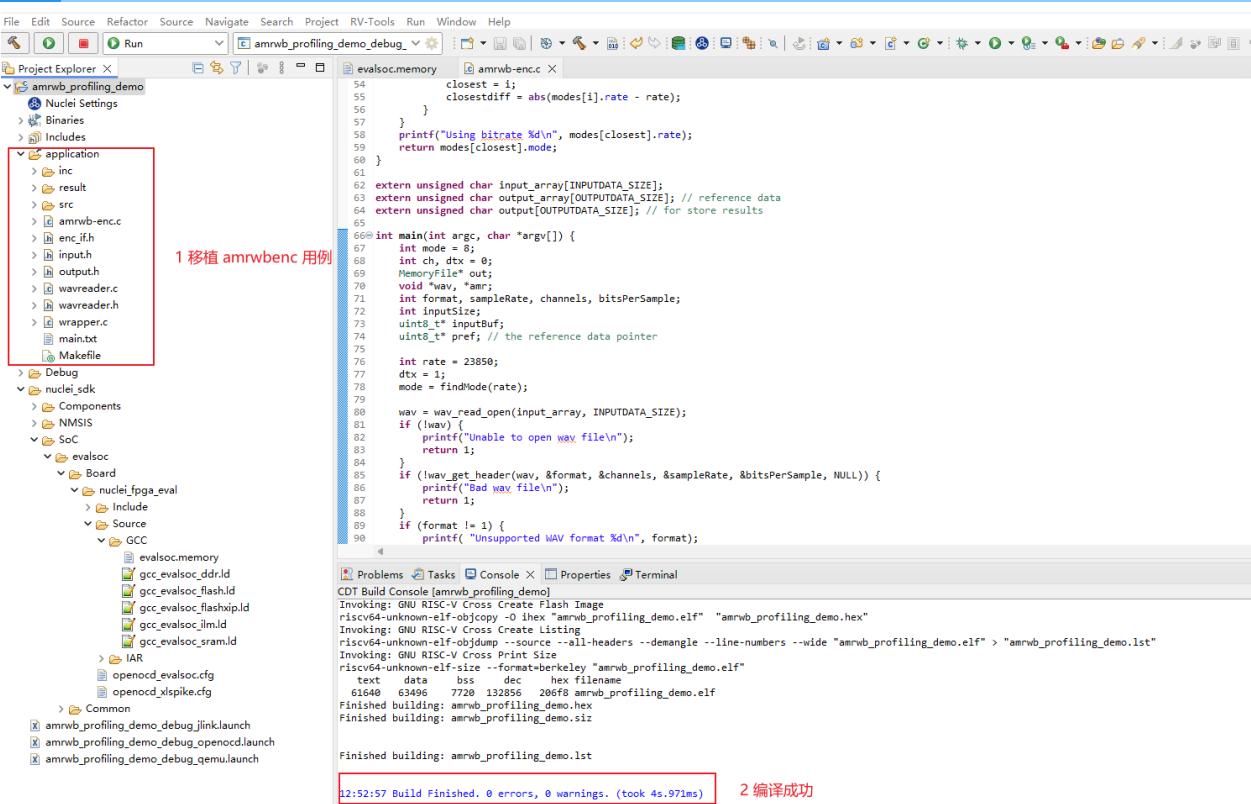
## step2：基于 Profiling demo 工程移植 amrwbenc 裸机用例

删掉 Profiling demo 工程中 application 中的原始用例，替换成 amrwbenc 用例，形成如下目录结构，并确保能编译成功。

这里提供本示例使用的工程，有兴趣可以下载使用：

[优化前的工程下载链接](#)

下载 zip 包后，可以直接导入到 Nuclei Studio 中运行(导入步骤：File->Import->Existing Projects into Workspace->Next->Select archive file->选择zip压缩包->next即可)



step3：在用例结尾处添加 gprof 数据收集代码，并添加 -pg 编译选项，重新编译代码

在 main 函数的结尾处添加 gprof 数据收集代码：

```
int main(int argc, char *argv[]) {
    /*
     * 代码省略
     */

    /*
     * 在main函数的结尾处添加gprof数据收集代码
     */
    // TODO this is used for collect gprof and gcov data
    // See Components/profiling/README.md about how to set the IDE project properties
    extern long gprof_collect(unsigned long interface);
    gprof_collect(2);

    return 0;
}
```

收集 gprof data 有三种方式，通过入参不同进行区分：

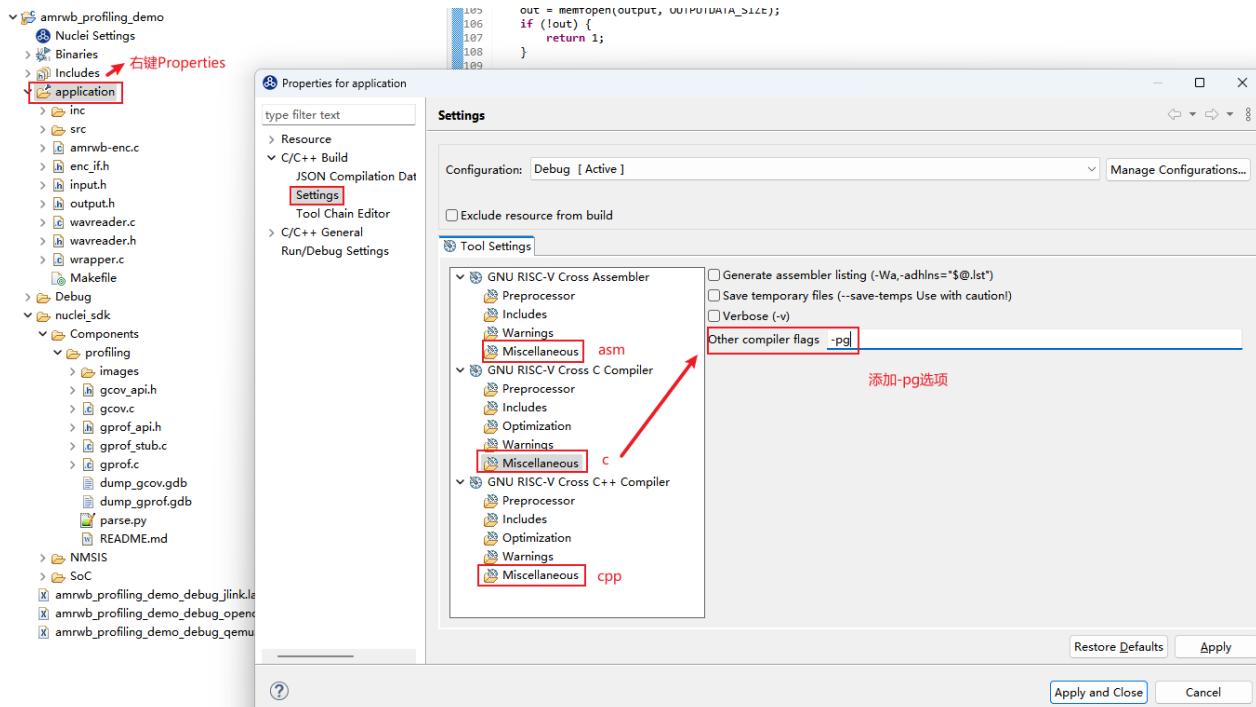
- gprof\_collect(0)：在缓冲区中收集 gprof 或 gcov 数据，在调试程序时可以使用 GDB 脚本转储 gcov 或 gprof 二进制文件
- gprof\_collect(1)：使用 semihost 直接将 gprof 或 gcov 数据写入文件中

- gprof\_collect(2)：直接在 Console 或 Serial Terminal 中打印 gcov 或 gprof 数据，然后可以通过IDE中 Parse and Generate HexDump 功能进行解析数据并保存到PC上

详情可参考 [Profiling README](#)，这里以将 gprof data 打印到串口（Console 或 Serial Terminal）为例。

对需要进行profiling的代码添加 -pg 编译选项，重新编译代码：

注意：选择 application, 对关键代码添加 -pg 编译选项，这个用例只有 C 代码，只对 C 代码添加 -pg 编译选项即可



#### step4：运行程序

有几种方式可以运行程序：

- qemu 模拟器（不需要硬件，简单跑一下流程，测试结果不准确）
- 上板测试（基于定时器采集数据）
- 基于 xl\_cpumodel (Nuclei Near Cycle Model)，参考：[通过Profiling展示Nuclei Model NICE/VNICE指令加速](#)

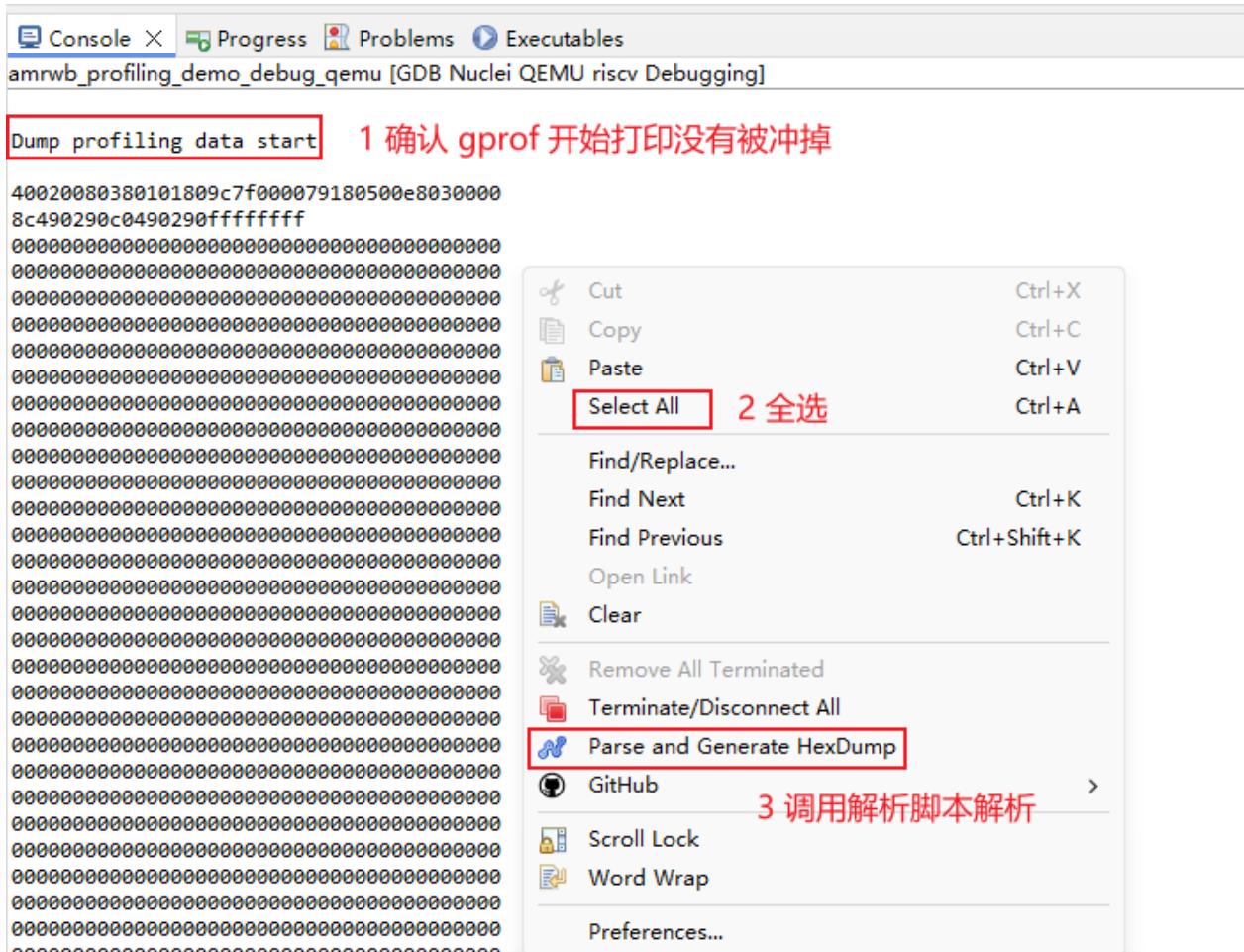
这一篇文章只介绍 qemu 仿真与上板测试两种方式，qemu 收集的数据打印到 Console 口，上板实际运行输出到 Nuclei Studio 的 Serial Terminal 口。

#### step5：解析 gprof 数据

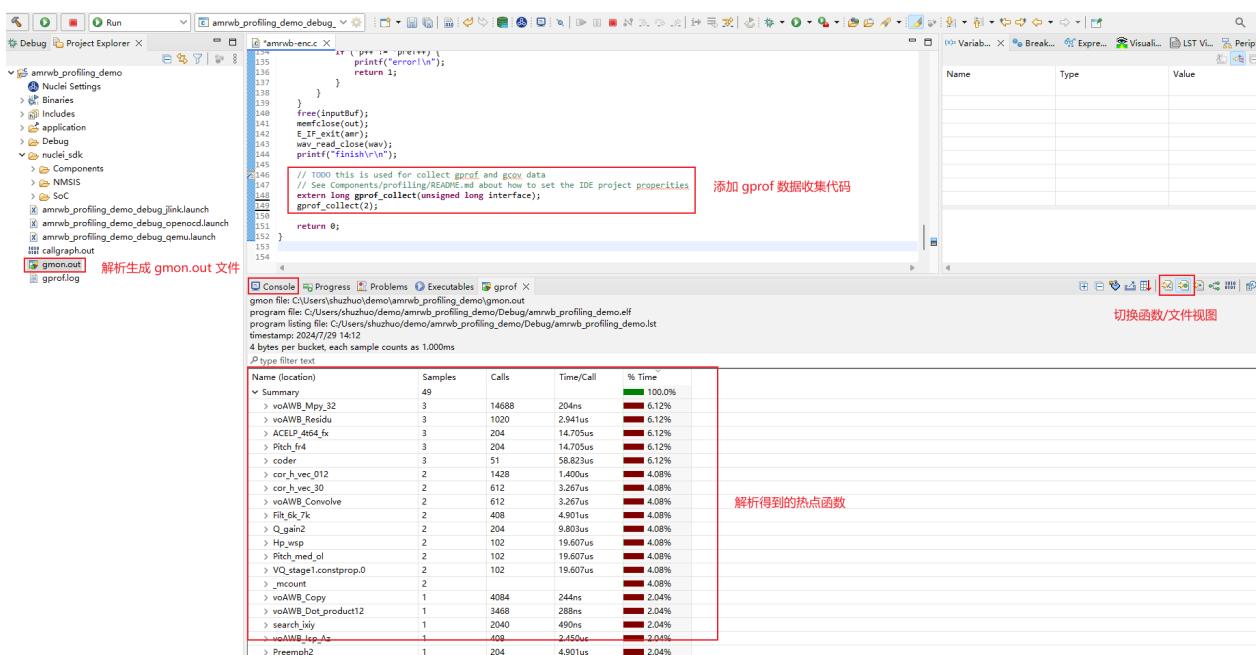
开始解析 gprof 数据。注意：这一步可能遇到一些问题，解决方法可参考 [Profiling与Code coverage 功能可能遇到的问题](#)

- 在 qemu 上测试，log 打印到 Console 口

注意: qemu 仅用来模拟展示, 如果希望得到准确的热点函数, 需要上板测试。



解析完成后, 会在当前工程目录下生成 gmon.out, 双击打开展示:

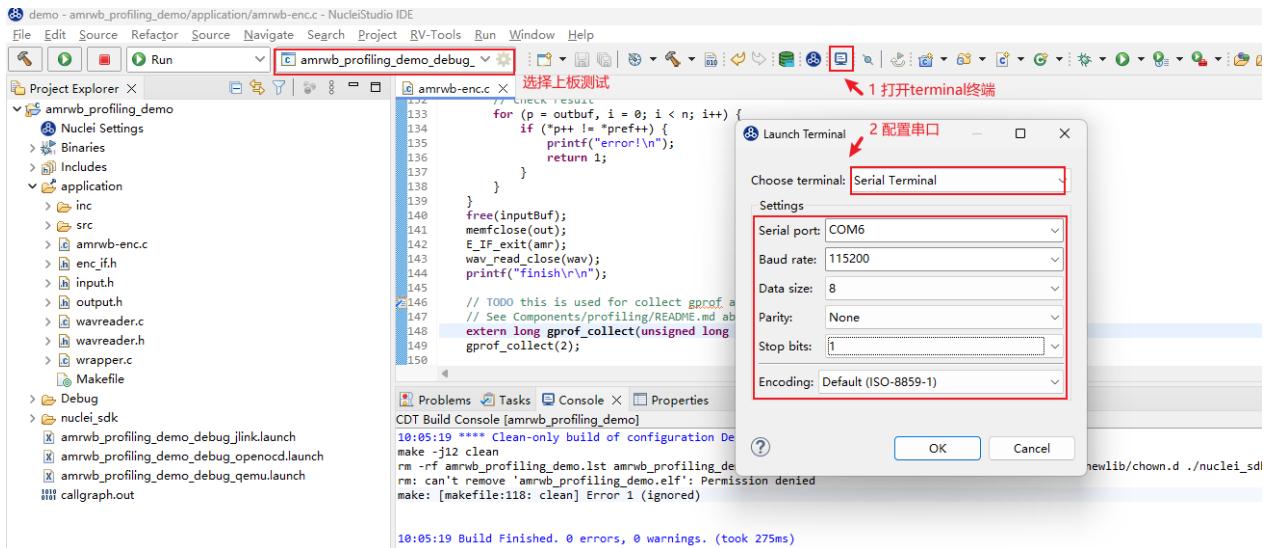


### • 上板测试

上板测试的步骤与 qemu 类似, 唯一不同的是 gprof 数据输出到 Serial Terminal 上。

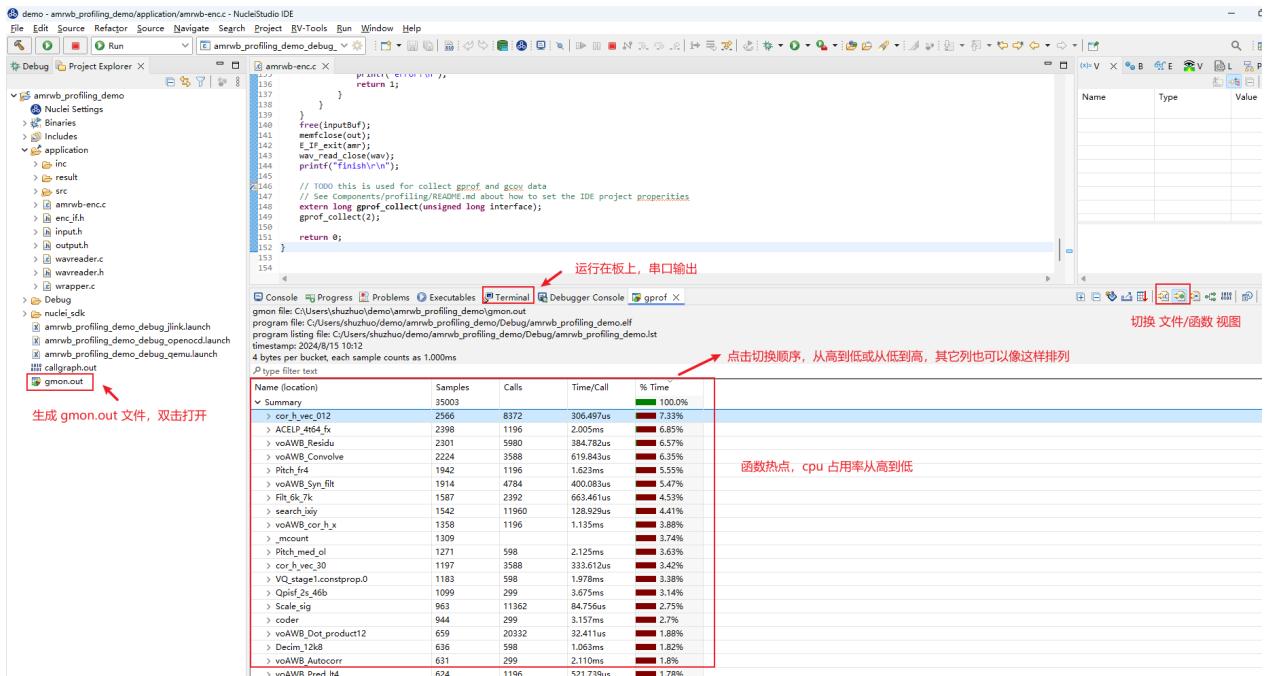
## 配置 Serial Terminal:

注意:如果串口工具已经打开,确保每次运行 gprof 前,清除掉串口打印(鼠标右键-> Clear Terminal),避免对数据解析产生影响。



同样,全选 log,右键选择Parse and Generate HexDump功能,就会在工程文件夹下生成gmon.out文件,刷新工程后,就可以双击打开这个gmon.out文件。

如下图是在板子上实际运行得到的gprof数据:



从而得到TOP5热点函数为(实际上板测试):

cor\_h\_vec\_012  
ACELP\_4t64\_fx  
voAWB\_Residu

```
voAWB_Convolve
voAWB_Syn_filt
```

获得热点函数后，可以从热点函数入手开始优化，优化 TOP 函数往往可以事半功倍。

### step6：优化热点函数

有如下几种方法优化热点函数：

- 调节编译器参数，针对整个工程或单独算子使用 O2/O3/Ofast 等优化等级，开启 `-finline-functions -funroll-all-loops` 等优化选项
- 针对算法进行优化，使用更好的算法实现热点函数
- 使用 RISC-V 扩展指令（RVP/RVV 扩展等）优化

这里以 RVP 扩展为例，按照热点函数从高到低，用 RVP 扩展来优化。需要确定所用硬件支持 RVP 扩展。

举例如下：

TOP1 热点函数为 `cor_h_vec_012`，分析函数，尝试使用 RVP 扩展优化：

如下以 `#if defined __riscv_xxldspn3x` 隔开的代码表示使用 Nuclei N3 P 扩展指令优化的代码。其中 `_RV_DSMALDA` 是一条 Nuclei N3 P 扩展指令，实现了 一次完成 4 笔 int16 相乘，最后累加，结果存放到 int64 变量中。

这些指令 Intrinsic API 可参考 [Nuclei P 扩展指令 Intrinsic API](#)

具体的 RVP 指令手册，请联系芯来科技获取。

优化后的工程如下，可以与优化之前的工程做对比，只优化了 `cor_h_vec_012` 算子：

[优化后的工程下载链接](#)

使用 Nuclei N3 P 扩展指令优化的代码片段如下：

```
void cor_h_vec_012(
    Word16 h[],                      /* (i) scaled impulse response
    Word16 vec[],                     /* (i) scaled vector (/8) to correlate
    Word16 track,                     /* (i) track to use
    Word16 sign[],                    /* (i) sign vector
    Word16 rrixix[][NB_POS],          /* (i) correlation of h[x] with h[0:NB_POS]
    Word16 cor_1[],                  /* (o) result of correlation (NB_POS)
    Word16 cor_2[]                   /* (o) result of correlation (NB_POS)
)
{
    Word32 i, j, pos, corr;
    Word16 *p0, *p1, *p2, *p3, *cor_x, *cor_y;
```

```
Word32 L_sum1,L_sum2;
cor_x = cor_1;
cor_y = cor_2;
p0 = rrixix[track];
p3 = rrixix[track+1];
pos = track;

for (i = 0; i < NB_POS; i+=2)
{
    p1 = h;
    p2 = &vec[pos];
#if defined __riscv_xxldspn3x
    Word32 tmp1, tmp2;
    int64_t sum64_1, sum64_2;
    int64_t p64_1, p64_2;
    sum64_1 = 0;
    sum64_2 = 0;
    for (j=62-pos ;(j - 4) >= 0; j -= 4)
    {
        p64_1 = *_SIMD64(p1)++;
        tmp1 = __RV_PKBB16(*(p2 + 1), *p2);
        tmp2 = __RV_PKBB16(*(p2 + 3), *(p2 + 2));
        p64_2 = __RV_DPACK32(tmp2, tmp1);
        sum64_1 = __RV_DSMALDA(sum64_1, p64_1, p64_2);

        tmp1 = __RV_PKBB16(*(p2 + 2), *(p2 + 1));
        tmp2 = __RV_PKBB16(*(p2 + 4), *(p2 + 3));
        p64_2 = __RV_DPACK32(tmp2, tmp1);
        sum64_2 = __RV_DSMALDA(sum64_2, p64_1, p64_2);
        p2 += 4;
    }
    L_sum1 = (Word32)sum64_1;
    L_sum2 = (Word32)sum64_2;
    for ( ;j >= 0; j--)
    {
        L_sum1 += *p1 * *p2++;
        L_sum2 += *p1++ * *p2;
    }
#endif
    L_sum1 += *p1 * *p2;
    L_sum1 = (L_sum1 << 2);
    L_sum2 = (L_sum2 << 2);

    corr = (L_sum1 + 0x8000) >> 16;
```

```
    cor_x[i] = vo_mult(corr, sign[pos]) + (*p0++);
    corr = (L_sum2 + 0x8000) >> 16;
    cor_y[i] = vo_mult(corr, sign[pos + 1]) + (*p3++);
    pos += STEP;

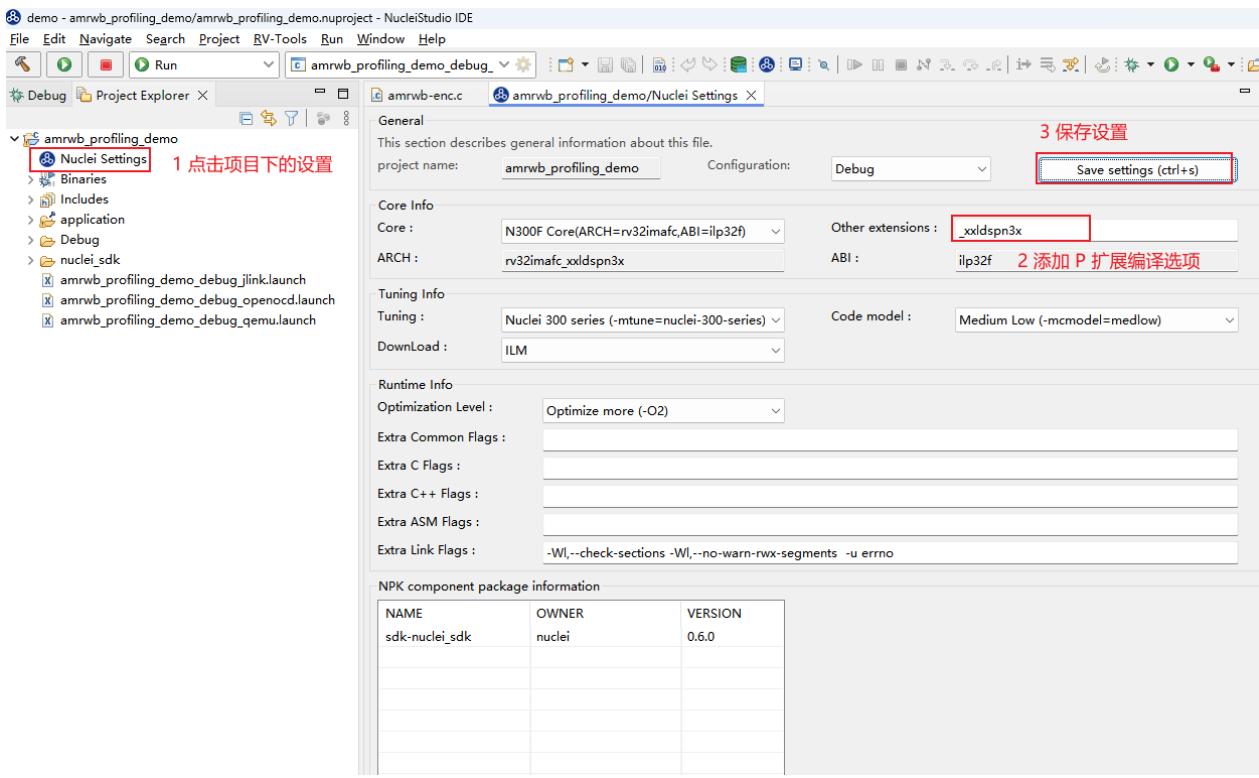
    p1 = h;
    p2 = &vec[pos];
#endif defined __riscv_xxldspn3x
    sum64_1 = 0;
    sum64_2 = 0;
    for (j=62-pos ;(j - 4) >= 0; j -= 4)
    {
        p64_1 = __SIMD64(p1)++;
        tmp1 = __RV_PKBB16(*(p2 + 1), *p2);
        tmp2 = __RV_PKBB16(*(p2 + 3), *(p2 + 2));
        p64_2 = __RV_DPACK32(tmp2, tmp1);
        sum64_1 = __RV_DSMALDA(sum64_1, p64_1, p64_2);

        tmp1 = __RV_PKBB16(*(p2 + 2), *(p2 + 1));
        tmp2 = __RV_PKBB16(*(p2 + 4), *(p2 + 3));
        p64_2 = __RV_DPACK32(tmp2, tmp1);
        sum64_2 = __RV_DSMALDA(sum64_2, p64_1, p64_2);
        p2 += 4;
    }
    L_sum1 = (Word32)sum64_1;
    L_sum2 = (Word32)sum64_2;
    for ( ;j >= 0; j--)
    {
        L_sum1 += *p1 * *p2++;
        L_sum2 += *p1++ * *p2;
    }
#endif
    L_sum1 += *p1 * *p2;
    L_sum1 = (L_sum1 << 2);
    L_sum2 = (L_sum2 << 2);

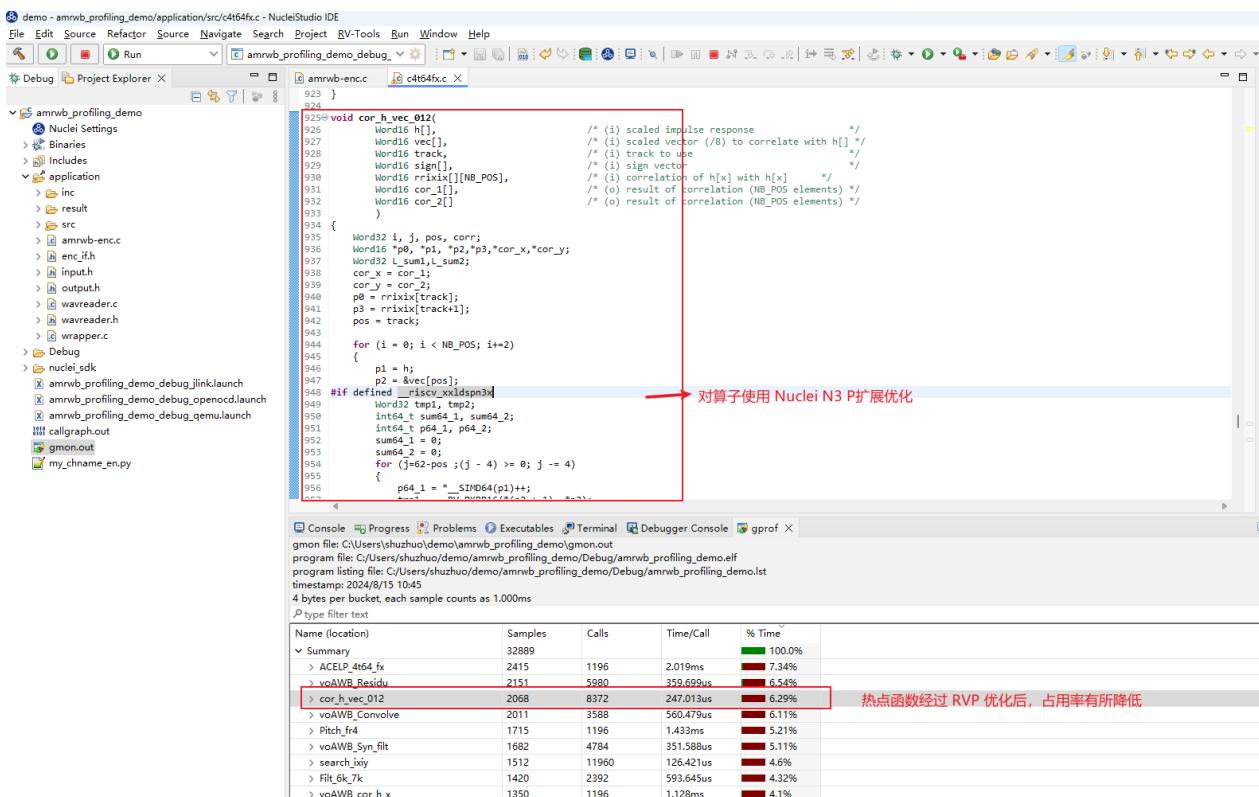
    corr = (L_sum1 + 0x8000) >> 16;
    cor_x[i+1] = vo_mult(corr, sign[pos]) + (*p0++);
    corr = (L_sum2 + 0x8000) >> 16;
    cor_y[i+1] = vo_mult(corr, sign[pos + 1]) + (*p3++);
    pos += STEP;
}
return;
```

}

这个算子进行 P 扩展优化后，编译时务必带上 dsp 扩展选项进行编译，如下图所示：



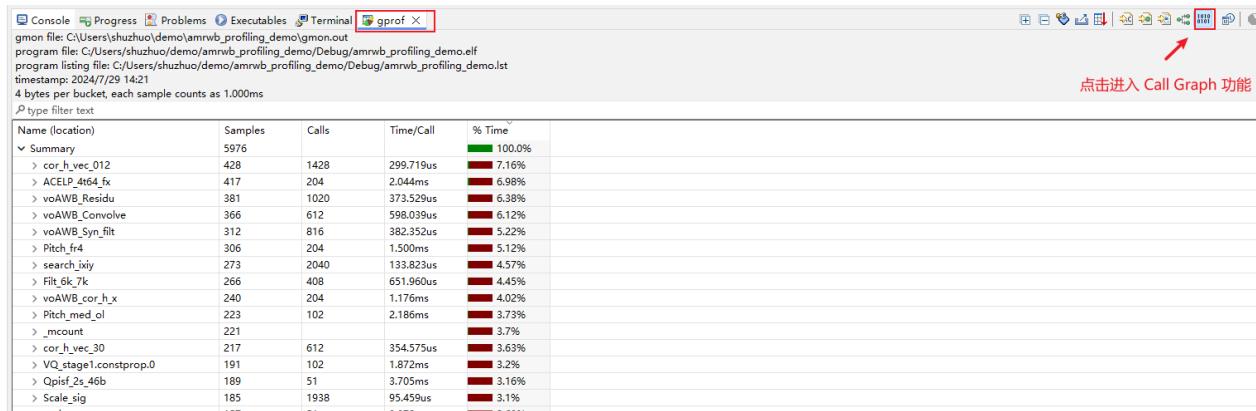
CLean Project 并重新编译，重新跑一次profiling，可以看到优化效果，`cor_h_vec_012` 函数占用率有所下降，函数调用时间也有所减少。



注意： 上述仅提供简单的示例，用户可以依次对热点函数进行分析并优化，运行过程中由于采样等原因，导致 TOP 函数分布有所波动，这是正常的，最终精确的分析需要统计最终的总 cycle 数，然后计算提升比。

## 2 Call Graph 功能

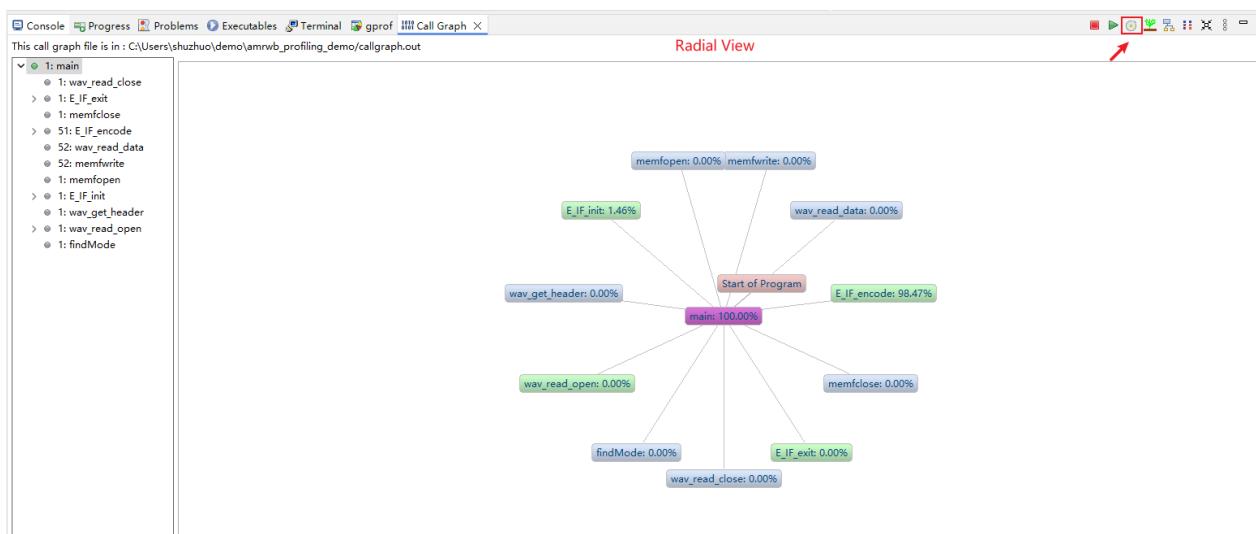
Nuclei Studio 中 Call Graph 主要是通过分析 Profiling 的数据来获取到程序中函数的调用关系。



Call Graph 功能包括如下几种视图：

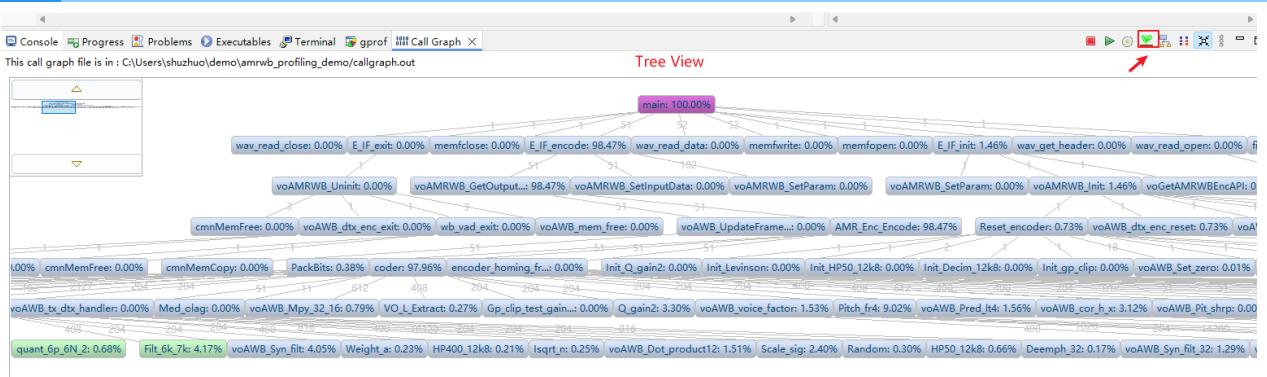
- Radial View

本视图中展示了程序的调用关系。



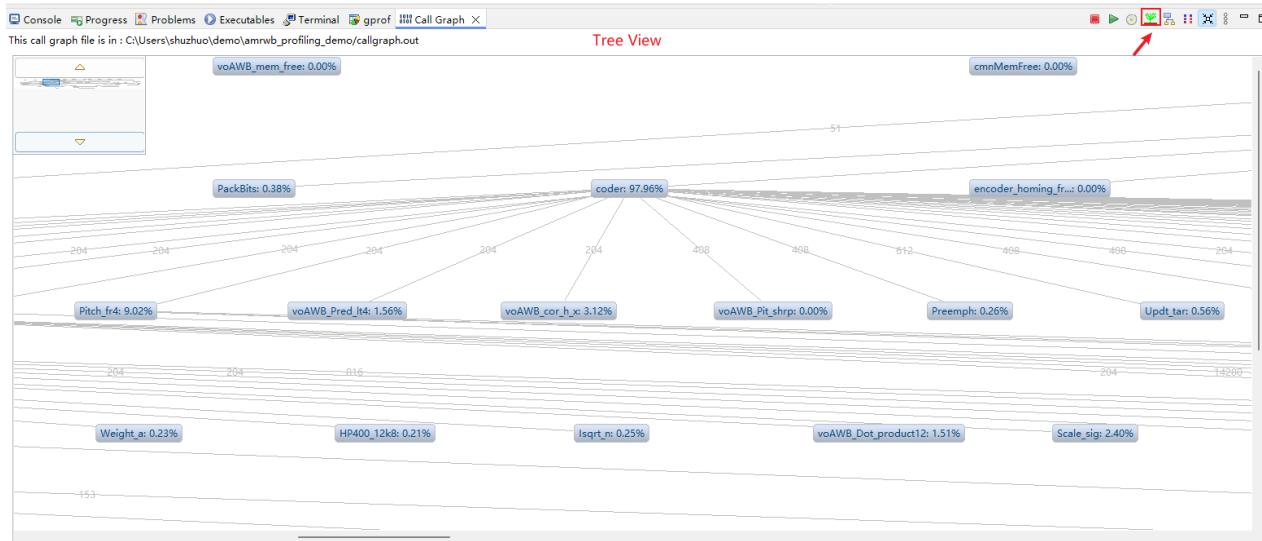
- Tree View

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。



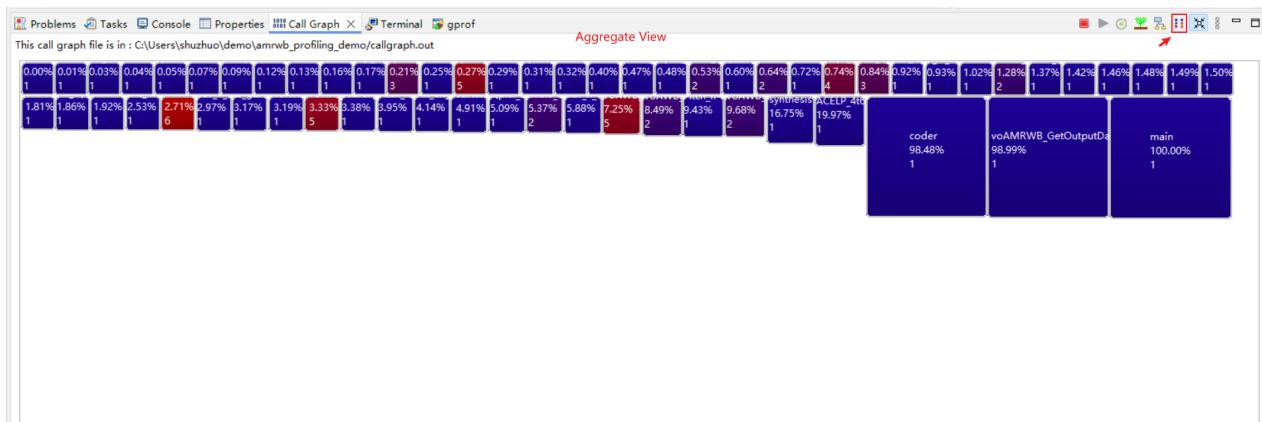
- Level View

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

以方图的方式，非常直观的展示了程序的耗时关系。



### 3 Code coverage 功能

Nuclei studio 中 Code coverage 功能基于 gcc 编译器提供的 gcov 工具，编译时需带特定的编译选项 -coverage 来编译指定源码文件，编译成功后得到 ELF 文件，然后在实际开发板上运行并收集需要的 coverage 文件(gcda/gcno 文件)，最终在 IDE 上以图形化的方式展示。

使用方法与 Profiling 功能类似，这里仅对不同的地方进行说明：

step1：新建 Profiling demo 工程

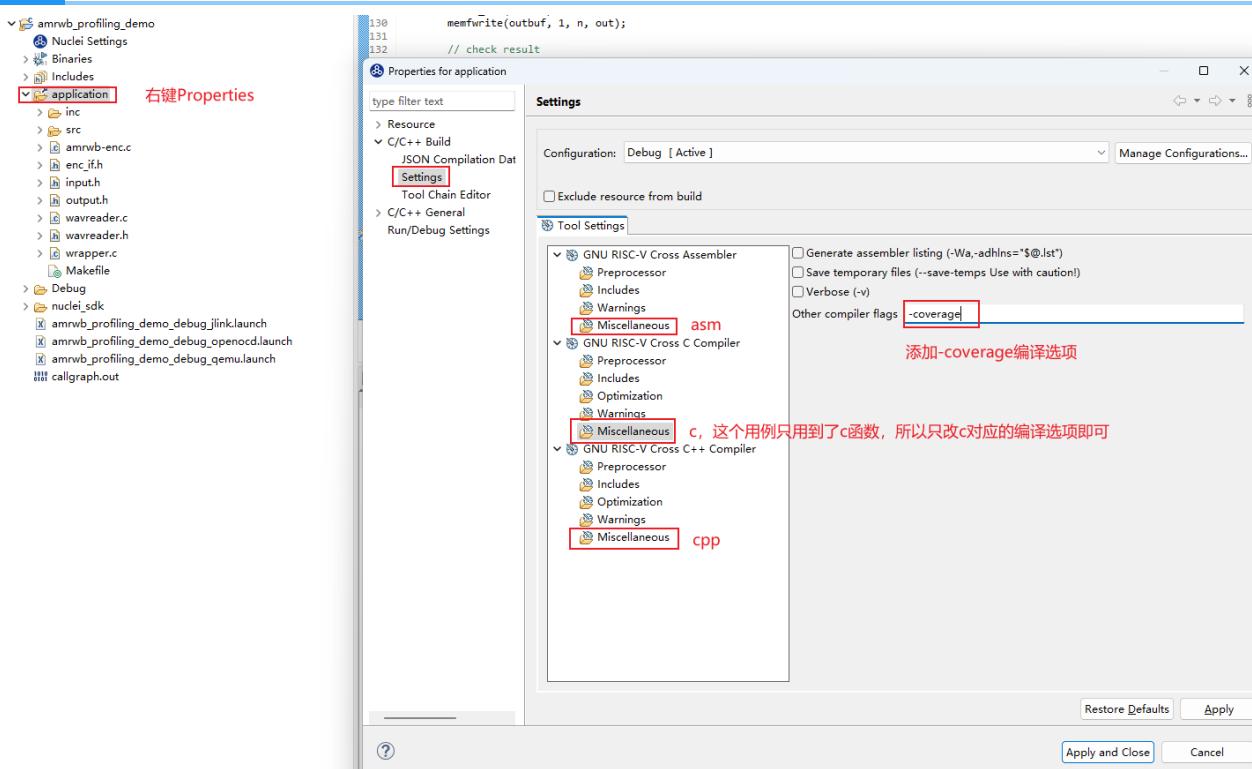
step2：基于 Profiling demo 工程移植 amrwbenc 裸机用例

step3：添加 gcov 数据收集代码，并添加 -coverage 编译选项，重新编译代码

在main函数的结尾处添加gprof数据收集代码：

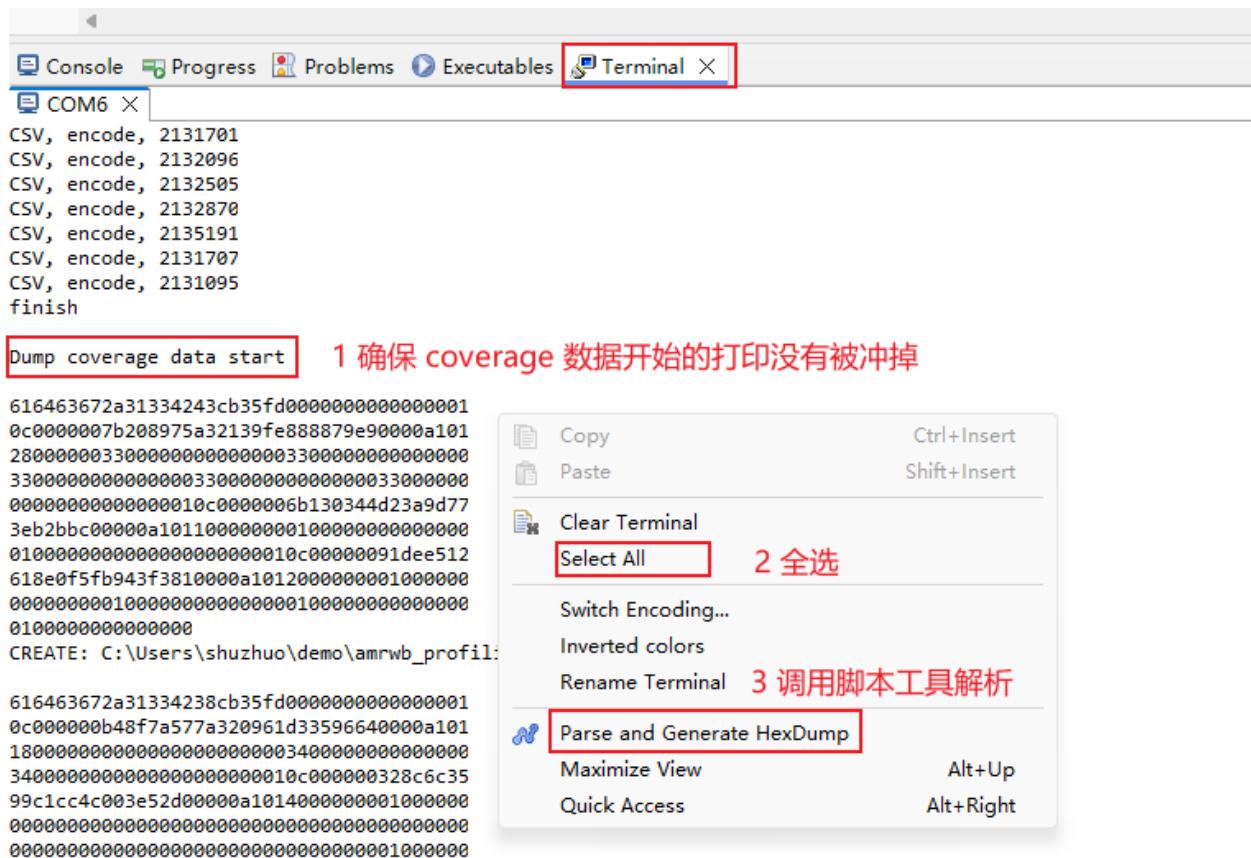
```
int main(int argc, char *argv[]) {  
    /*  
     * 代码省略  
     */  
  
    /*  
     * 在main函数的结尾处添加 gcov 数据收集代码  
     */  
    // TODO this is used for collect gprof and gcov data  
    // See Components/profiling/README.md about how to set the IDE project proper  
    extern long gcov_collect(unsigned long interface);  
    gcov_collect(2);  
  
    return 0;  
}
```

添加-coverage编译选项，重新编译代码：

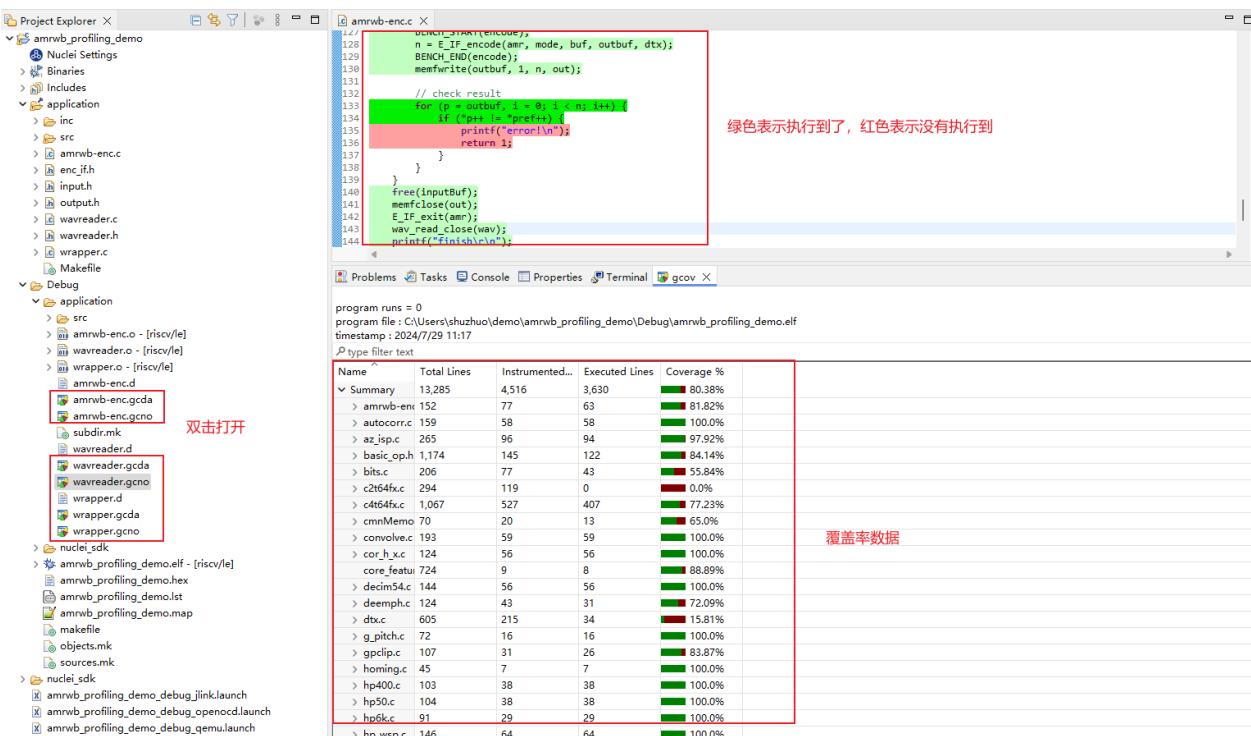


#### step4：运行程序

可以在qemu中模拟运行，或者上板实际运行都可以（统计覆盖率，不涉及到性能分析，所以使用qemu或者上板测试都可以）。



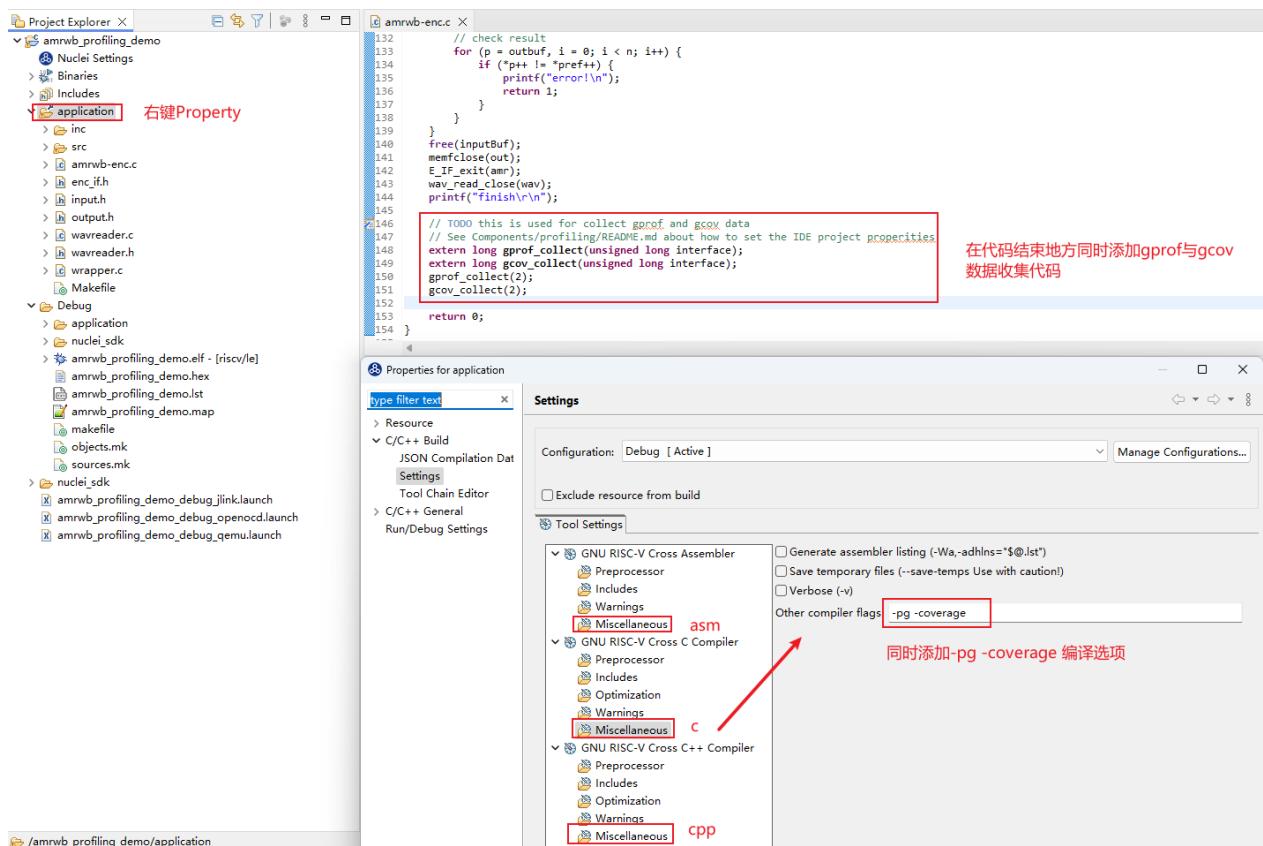
解析之后，在Debug->application文件夹下生成了 gcda 与 gcno 文件，双击打开即可



## 4 补充

1. Profiling 与 Code coverage 功能可以同时打开，只需添加一起收集 Profiling 数据与 Code coverage 数据的代码，并在编译时添加 -pg -coverage 编译选项。

```
// TODO this is used for collect gprof and gcov data
// See Components/profiling/README.md about how to set the IDE project properties
extern long gprof_collect(unsigned long interface);
extern long gcov_collect(unsigned long interface);
gprof_collect(2);
gcov_collect(2);
```



1. 使用Profiling可能遇见的问题：
2. 片上内存不足，打印日志中有错误打印，gprof/gcov data 需要占用一定大小空间
3. Console 或 Terminal 收集的数据不全导致解析数据不正确，需确认数据没有被冲掉，需要调节 Console 或 Terminal 输出大小限制
4. 手动删掉 gmon.out 文件，再次解析，弹出 No files have been generated 错误弹框

上述具体解决方法可参考 [Profiling与Code coverage功能可能遇到的问题](#)

# 通过Profiling展示Nuclei Model NICE/VNICE指令加速¶

由于 Nuclei Model 仅支持Linux版本，所以此文档的测试都是基于 Nuclei Studio 的 Linux 版本 ( $\geq 2024.06$ ) 完成的。

## 背景描述¶

### Nuclei Model Profiling¶

在[Nuclei Studio 使用 Profiling 功能进行性能调优举例](#)中已经通过 qemu 以及上板测试两种运行方式展示了如何在 IDE 中导入特定程序进行 Profiling，此文档中的一部分将介绍如何针对 Nuclei Model 完成 Profiling。

Nuclei Model Profiling 的优势：

- 无需使用开发板等硬件
- model 中内建了 gprof 功能，无需 Profiling 库和 gcc -pg 选项就可以产生 Profiling 文件
- 采取了指令级别的采样，可以进行指令级别的 Profiling 分析

在[NucleiStudio\\_User\\_Guide.pdf](#)相关章节对 Nuclei Model 如何仿真性能分析配置已经有较详细的描述，此文档以一个例子来展示其实际应用。

### NICE/VNICE 自定义指令加速¶

NICE/VNICE使得用户可以结合自己的应用扩展自定义指令，将芯来的标准处理器核扩展成为面向领域专用的处理器，NICE 具体编码规则可以参考 [Nuclei\\_RISC-V\\_ISA\\_Spec.pdf](#) 中的 NICE Introduction。NICE 适用于无需使用 RISCV Vector 的自定义指令，VNICE 适用于需要使用 RISCV Vector 的自定义指令。

[demo\\_nice/demo\\_vnlice](#)介绍了 Nuclei 针对 NICE/VNICE 的 demo 应用是如何编译运行的，此文档将通过改造一个更为常见的 AES 加解密的例子，重点说明该如何使用 NICE/VNICE 指令替换热点函数以及如何在 model 里实现 NICE/VNICE 指令，然后通过 Nuclei Studio 的 Profiling 功能分析替换前后的程序性能。

# 解决方案¶

## 环境准备¶

Nuclei Studio：[NucleiStudio 2024.06 Linux](#)

## Model Profiling¶

工程创建方式有两种：

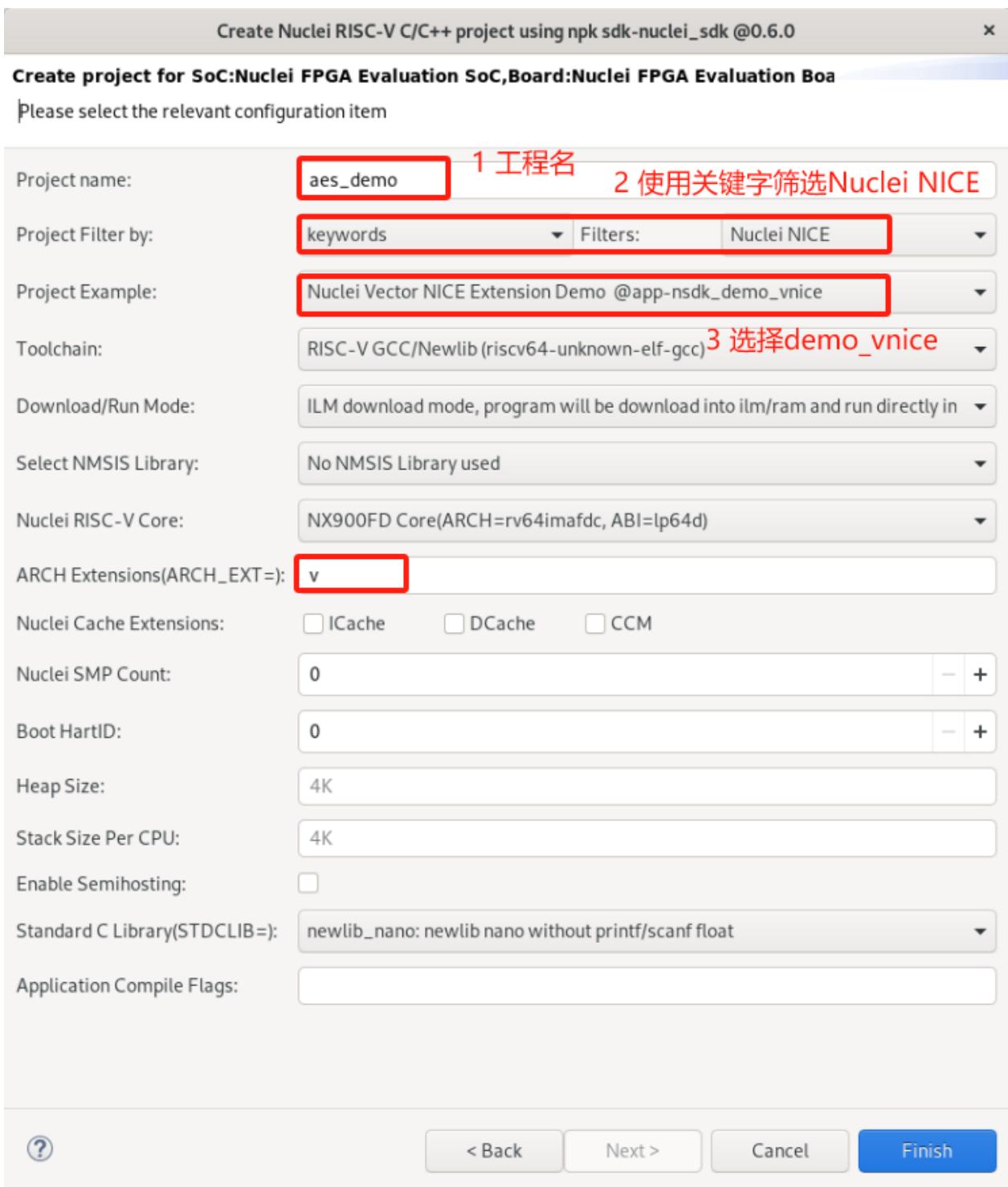
- 方式1：用户可以使用 Nuclei Studio 中的 demo\_nice 或 demo\_vniced 模板来移植改造自己的 NICE/VNICE 程序
- 方式2：用户导入自己的工程到 Nuclei Studio 中，然后再添加 NICE 内嵌汇编头文件、NICE CSR 使能等代码

此文档将采取前一种方式创建工作，由于此 demo 会用到 VNICE 指令，故创建 demo\_vniced 工程，然后将 AES 加解密程序移植替换到其中。

### step1：新建 demo\_vniced 工程¶

File->New->New Nuclei RISC-V C/C++ Project，选择Nuclei FPGA Evalution Board->sdk-nuclei\_sdk @0.6.0

注意：Nuclei SDK 需选择 0.6.0 及以后版本



## step2：基于 demo\_vnice 工程移植 aes\_demo 裸机用例¶

移植 aes\_demo 时，需要保留 demo\_vnice 中的 insn.h 内嵌汇编头文件框架，方便后续添加自定义的 NICE/VNICE 指令，在 main.c 中需要保留 NICE/VNICE 指令执行前的 CSR 使能代码：

```
__RV_CSR_SET(CSR_MSTATUS, MSTATUS_XS);
```

其余 demo\_vnice 工程中 application 原始用例可删除，替换成 aes\_demo 用例，形成如下目录结构，并确保能够编译通过。

The screenshot shows the Eclipse IDE interface with the following details:

- Project Explorer:** Shows the project structure for "aes\_demo". A red box highlights the source files: aes\_debug.h, aes\_dec.c, aes\_enc.c, aes\_test.c, api\_aes.h, insn.h, and main.c.
- Editor:** Displays the content of the file "aes\_test.c". The code implements AES test cases, including key scheduling and encryption/decryption of known inputs. A specific line of code is highlighted in blue: "0xE9,0x3D,0x7E,0x11, 0x73,0x93,0x17,0x2A," which corresponds to the first roundkey.
- Terminal:** Shows the build logs for "aes\_demo". It includes the command "cdtBuildConsole[aes\_demo]" and the output of the build process, which involves several RISC-V tools like riscv64-unknown-elf-g++ and riscv64-unknown-elf-objcopy.
- Bottom Status Bar:** Shows the message "22:59:34 Build Finished. 0 errors, 0 warnings. (took 879ms)".

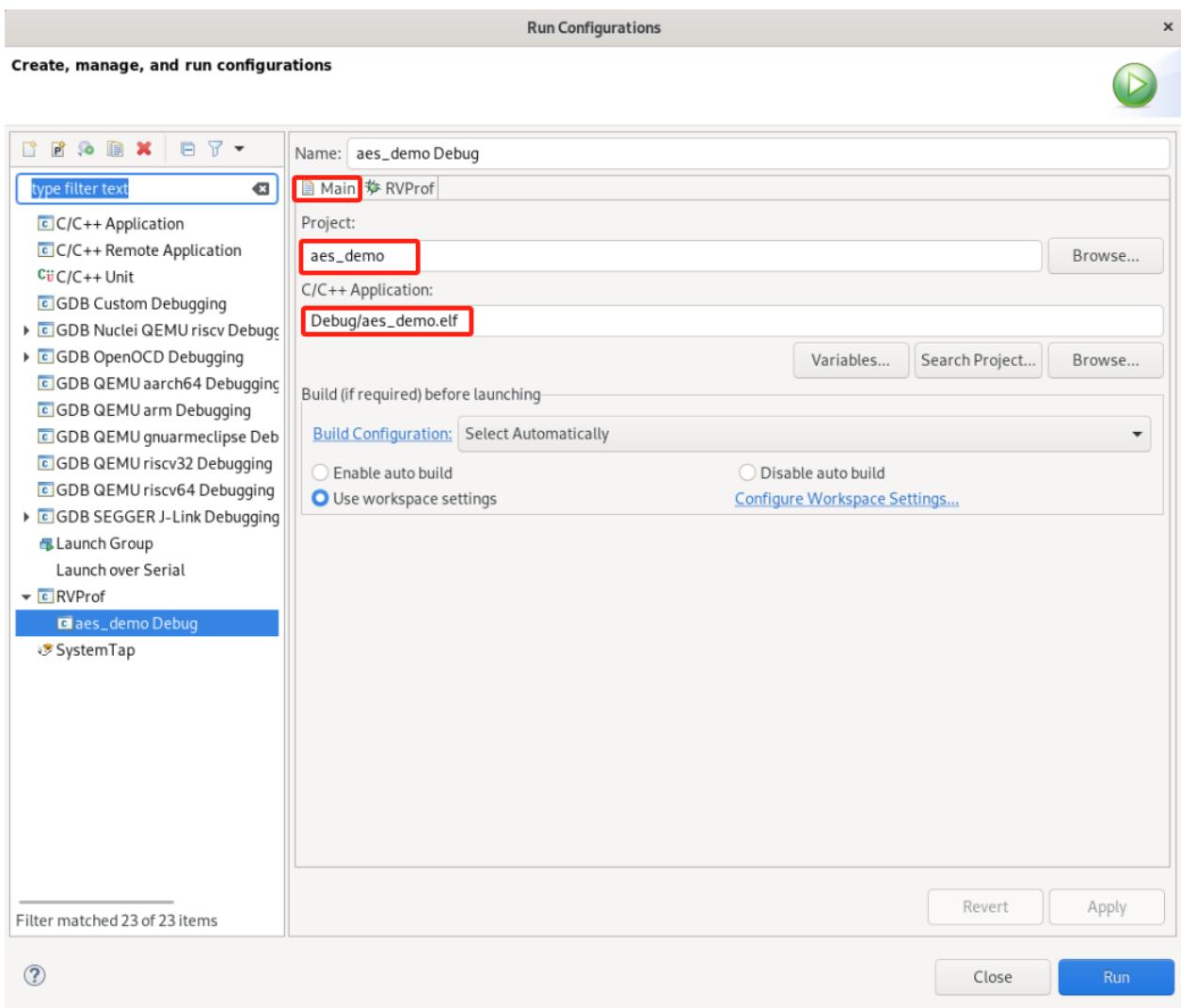
用户可以下载我们移植好的 AES 加解密 demo：优化前AES工程链接下载

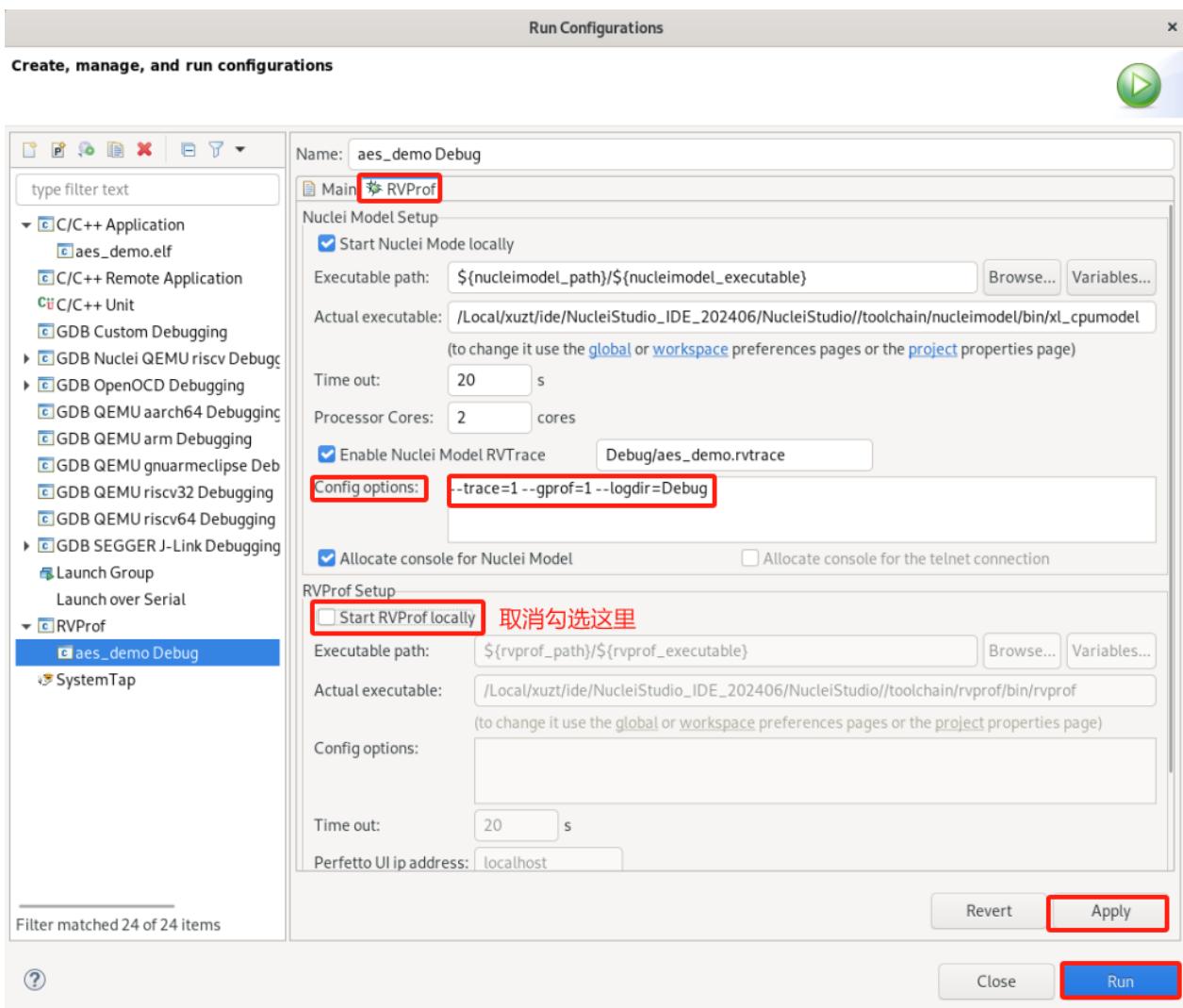
下载 zip 包后，可以直接导入到 Nuclei Studio 中运行(导入步骤：File->Import->Existing Projects into Workspace->Next->Select archive file->选择zip压缩包->next即可)

### step3 : model 仿真程序

首先将 aes\_debug.h 中的 LOCAL\_DEBUG 打开，准备测试 AES 算法的整体 cycle 数。

Nuclei Model 仿真程序需要配置 Nuclei Studio 中的 RVProf 运行配置，打开 Nuclei Studio 主菜单栏的 Run 选项的 Run Configurations 后，先在 Main 选项卡中选择编译好的 elf 文件路径，然后在 RVProf 选项卡的 Config options 中完成 model 运行配置 --trace=1 --gprof=1 --logdir=Debug，--trace=1 表示开启 rvtrace，--gprof=1 表示开启 gprof 功能生成 \*.gmon 文件，--logdir=Debug 则表示最终生成的 \*.rvtrace 文件、\*.gmon 文件存放的路径为当前工程下的 Debug 目录，取消勾选 Start RVProf locally，然后点击 Apply 和 Run，model 就开始运行程序了。





在 Console 中会看到 Total elapsed time 说明 model 已经完成仿真了，得到 AES 算法整体消耗 154988 cycle。

```

File Edit Source Refactor Source Navigate Search Project RV-Tools Run Window Help
Project Explorer X aes_demo Debug
  aes_demo
    Nuclei Settings
    Binaries
    Includes
    application
      aes_debug.h
      aes_dec.c
      aes_test.c
      aes_debug.h
      aes_dec.c
      aes_enc.c
      aes_aes.h
      api_aes.h
      insns.h
      main.c
    Debug
    application
    nuclei_sdk
    aes_demoElf-[riscv]
      aes_demo.hex
      aes_demo.lst
      aes_demo.map
      aes_demo.rvtrace
      gprof0.gmon
      gprof0.log
      makefile
      objects.mk
      sources.mk
    nuclei_sdk
      aes_demo_debug_llink.launch
      aes_demo_debug_openoc.launch
      aes_demo_debug_qemu.launch
      callgraph.out
      xmodel_nice

Problems Tasks Console Properties gprof
<terminated>:aes_demo Debug [RVProf]x_lcpu model (Terminated Aug 30, 2024, 9:50:39 AM)
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]: /Local/xuzt/ide/ide_workspace/aes_demo/Debug/aes_demo.elf
[XLMODEL-INFO] found the following .elf files:
[XLMODEL-INFO] /Local/xuzt/ide/ide_workspace/aes_demo/Debug/aes_demo.elf
[XLMODEL-INFO] Created Cluster0
[XLMODEL-INFO] start address: 0xb00000200
[XLMODEL-INFO] rv64 file
[XLMODEL-INFO] argv[0]: -
[XLMODEL-INFO] argv[1]: -t
[XLMODEL-INFO] argv[2]: -permissive-off
[XLMODEL-INFO] argv[3]: /Local/xuzt/ide/ide_workspace/aes_demo/Debug/aes_demo.elf
Nuclei SDK Build Time: Aug 30 2024, 09:50:33
Download Mode: ILM
CPU Frequency: 692387 Hz
CPU HartID: 0
Benchmark name: aes
Benchmark initialized
#
# AES 256 test 1/1
[CSV_aes_256_ecb_154988] AES 算法整体消耗 cycle 数
test completed
[XLMODEL-INFO] total run 157366 instruction
Info: /SOC/system: Simulation stopped by user.
[XLMODEL-INFO] Total elapsed time: 1.691684s
[XLMODEL-INFO] Press Enter to finish

```

将 aes\_debug.h 中的 LOCAL\_DEBUG 关掉去掉程序打印，为了准确测试 Profiling 数据，确保 Nuclei Studio 的 launch bar 为 aes\_demo Debug, 重新 Run model：

```

File Edit Source Refactor Source Navigate Search Project RV-Tools Run Window Help
Project Explorer X aes_demo Debug
  aes_demo
    Nuclei Settings
    Binaries
    Includes
    application
    Debug
    nuclei_sdk
    aes_demoElf-[riscv]
      aes_demo.hex
      aes_demo.lst
      aes_demo.map
      aes_demo.rvtrace
      gprof0.gmon
      gprof0.log
      makefile
      objects.mk
      sources.mk
    nuclei_sdk
      aes_demo_debug_llink.launch
      aes_demo_debug_openoc.launch
      aes_demo_debug_qemu.launch
      callgraph.out
      xmodel_nice

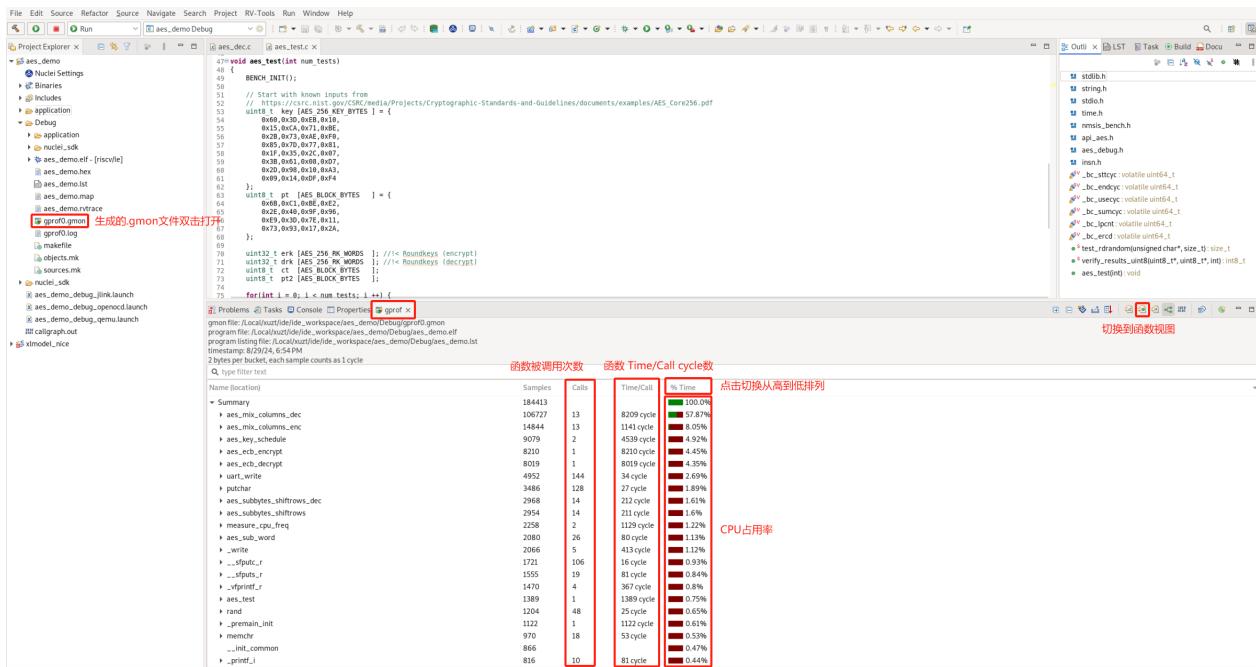
Problems Tasks Console Properties gprof
<terminated>:aes_demo Debug [RVProf]x_lcpu model (Terminated Aug 30, 2024, 10:07:09 AM)
SystemC 2.3.4-Accellera ... May 16 2024 16:02:03
Copyright (c) 1996-2022 by all Contributors.
ALL RIGHTS RESERVED
[XLMODEL-INFO] filename[0]: /Local/xuzt/ide/ide_workspace/aes_demo/Debug/aes_demo.elf
[XLMODEL-INFO] found the following .elf files:
[XLMODEL-INFO] /Local/xuzt/ide/ide_workspace/aes_demo/Debug/aes_demo.elf
[XLMODEL-INFO] Created Cluster0
[XLMODEL-INFO] start address: 0xb00000200
[XLMODEL-INFO] rv64 file
[XLMODEL-INFO] argv[0]: -
[XLMODEL-INFO] argv[1]: -t
[XLMODEL-INFO] argv[2]: -permissive-off
[XLMODEL-INFO] argv[3]: /Local/xuzt/ide/ide_workspace/aes_demo/Debug/aes_demo.elf
Nuclei SDK Build Time: Aug 30 2024, 10:07:04
Download Mode: ILM
CPU Frequency: 692387 Hz
CPU HartID: 0
Benchmark initialized
#
[XLMODEL-INFO] total run 147342 instruction
Info: /SOC/system: Simulation stopped by user.
[XLMODEL-INFO] Total elapsed time: 1.738168s
[XLMODEL-INFO] Press Enter to finish

```

## step4：解析 gprof 数据

model 仿真程序完成后，双击打开生成的 `gprof*.gmon` 文件，切换到函数视图，点击 % Time 从高到低排列函数 CPU 占用率。

注意：Time/Call 显示的是每个函数的函数体 text 段的 cycle 数，并不是整个函数的 cycle 数，是不计入其中子函数占用的 cycle 数的。



从而得到 CPU 占用率最高的 TOP5 热点函数为：

aes\_mix\_columns\_dec  
aes\_mix\_columns\_enc  
aes\_key\_schedule  
aes\_ecb\_decrypt  
aes\_ecb\_encrypt

注意：此时需要备份当前的 `aes_demo` 工程，改名为 `aes_demo_nice` 工程，这样可以在 Nuclei Studio 中同时打开两个工程，方便添加 NICE/VNICE 指令优化后的工程和原 `aes_demo` 工程进行 Profiling 比较。

## step5：NICE/VNICE 指令替换

用户需要在备份的 `aes_demo_nice` 工程下，研究热点函数算法特点，将其替换为 NICE/VNICE 指令，从而提升整体程序性能。

在包含 AES 加解密的 TOP5 热点函数的 `aes_dec.c` 和 `aes_dec.c` 两个C文件中 `#include "insn.h"` 以便添加 NICE/VNICE 指令替换。

TOP1 热点函数为 `aes_mix_columns_dec`, 实现了 AES 算法解密的逆混合列, 输入一个状态矩阵, 经过计算后原地址输出一个计算后的状态矩阵, 实现了 Load 数据、逆混合运算以及 Store 数据, 代码如下:

```
static void aes_mix_columns_dec(
    uint8_t      pt[16]      //!< Current block state
){  
    // Col 0  
    for(int i = 0; i < 4; i++) {  
        uint8_t b0,b1,b2,b3;  
        uint8_t s0,s1,s2,s3;  
  
        s0 = pt[4*i+0];  
        s1 = pt[4*i+1];  
        s2 = pt[4*i+2];  
        s3 = pt[4*i+3];  
  
        b0 = XTE(s0) ^ XTB(s1) ^ XTD(s2) ^ XT9(s3);  
        b1 = XT9(s0) ^ XTE(s1) ^ XTB(s2) ^ XTD(s3);  
        b2 = XTD(s0) ^ XT9(s1) ^ XTE(s2) ^ XTB(s3);  
        b3 = XTB(s0) ^ XTD(s1) ^ XT9(s2) ^ XTE(s3);  
  
        pt[4*i+0] = b0;  
        pt[4*i+1] = b1;  
        pt[4*i+2] = b2;  
        pt[4*i+3] = b3;  
    }  
}
```

由于输入输出地址一样, 可以考虑用一条 NICE 指令替换, 指令的 `opcode`、`funct3` 和 `funct7` 都可以在编码位域中自定义, 该指令设置 `opcode` 为 Custom-0, `funct3` 设置为0, `funct7` 设置为0x10, 寄存器只使用到 `rs1` 描述入参地址, 不需要使用 `rd` 和 `rs2`, 指令写到 `insn.h` 中, 内嵌汇编如下:

```
_STATIC_FORCEINLINE void custom_aes_mix_columns_dec(uint8_t* addr)
{
    int zero = 0;
    asm volatile(".insn r 0xb, 0, 0x10, x0, %1, x0" : "=r"(zero) : "r"(addr));
```

用户可以在 `insn.h` 中定义一个 `USE_NICE` 的宏选择是否使用 NICE , 在 `aes_dec.c` 改写 `aes_mix_columns_dec` 如下 :

```
static void aes_mix_columns_dec(
    uint8_t      pt[16]      //!< Current block state
```

```

) {

#endif USE_NICE
    custom_aes_mix_columns_dec(pt);
#else
    // Col 0
    for(int i = 0; i < 4; i++) {
        uint8_t b0,b1,b2,b3;
        uint8_t s0,s1,s2,s3;

        s0 = pt[4*i+0];
        s1 = pt[4*i+1];
        s2 = pt[4*i+2];
        s3 = pt[4*i+3];

        b0 = XTE(s0) ^ XTB(s1) ^ XTD(s2) ^ XT9(s3);
        b1 = XT9(s0) ^ XTE(s1) ^ XTB(s2) ^ XTD(s3);
        b2 = XTD(s0) ^ XT9(s1) ^ XTE(s2) ^ XTB(s3);
        b3 = XTB(s0) ^ XTD(s1) ^ XT9(s2) ^ XTE(s3);

        pt[4*i+0] = b0;
        pt[4*i+1] = b1;
        pt[4*i+2] = b2;
        pt[4*i+3] = b3;
    }
#endif
}

```

TOP2 热点函数为 `aes_mix_columns_enc`, 和 TOP1 类似, 实现的是 AES 加密的逆混合列, 同样也是输入一个状态矩阵, 经过计算后原地址输出一个计算后的状态矩阵 :

```

static void aes_mix_columns_enc(
    uint8_t      ct [16]       //!< Current block state
){
    for(int i = 0; i < 4; i++) {
        uint8_t b0,b1,b2,b3;
        uint8_t s0,s1,s2,s3;

        s0 = ct[4*i+0];
        s1 = ct[4*i+1];
        s2 = ct[4*i+2];
        s3 = ct[4*i+3];

        b0 = XT2(s0) ^ XT3(s1) ^ (s2) ^ (s3);

```

```

    b1 =      (s0) ^ XT2(s1) ^ XT3(s2) ^      (s3);
    b2 =      (s0) ^      (s1) ^ XT2(s2) ^ XT3(s3);
    b3 = XT3(s0) ^      (s1) ^      (s2) ^ XT2(s3);

    ct[4*i+0] = b0;
    ct[4*i+1] = b1;
    ct[4*i+2] = b2;
    ct[4*i+3] = b3;
}

}

```

考虑到指令实现可能无法只用1条指令完成，可使用2条 VNICE 指令替换此算法，第一条 load 16 byte 数据到 Vector 寄存器，第二条再完成计算以及 store。

指令的 `opcode`、`funct3` 和 `funct7` 仍然可以在编码位域中自定义，第一条指令使用 `rd` 描述 Vector 寄存器，`rs1` 描述入参地址，第二条指令使用 `rs1` 描述入参地址，`rs1` 描述入参 Vector 寄存器，两条 VNICE 指令的内嵌汇编写到 `insn.h` 中，定义如下：

```

__STATIC_FORCEINLINE vint8m1_t __custom_vnice_load_v_i8m1 (uint8_t* addr)
{
    vint8m1_t rdata ;
    asm volatile(".insn r 0xb,4,0,%0,%1,x0"
               : "=vr"(rdata)
               : "r"(addr)
               );
    return rdata;
}

__STATIC_FORCEINLINE void __custom_vnice_aes_mix_columns_enc_i8m1 (uint8_t *addr,
{
    int zero = 0;
    asm volatile(".insn r 0xb,4,1,x0,%1,%2"
               : "=r"(zero)
               : "r"(addr)
               , "vr"(data)
               );
}

```

用户通过定义 Vector 寄存器以及使用上定义好的 VNICE 指令内嵌汇编改写 `aes_enc.c` 中的 `aes_mix_columns_enc` 如下：

```

static void aes_mix_columns_enc(
    uint8_t      ct [16]        //!< Current block state
){
#endif USE_NICE

```

```
uint32_t blkCnt = 16;
size_t l;
vint8m1_t vin;
for (; (l = __riscv_vsetvl_e8m1(blkCnt)) > 0; blkCnt -= l) {
    vin = __custom_vnice_load_v_i8m1(ct);
    __custom_vnice_aes_mix_columns_enc_i8m1(ct, vin);
}
#else
for(int i = 0; i < 4; i++) {
    uint8_t b0,b1,b2,b3;
    uint8_t s0,s1,s2,s3;

    s0 = ct[4*i+0];
    s1 = ct[4*i+1];
    s2 = ct[4*i+2];
    s3 = ct[4*i+3];

    b0 = XT2(s0) ^ XT3(s1) ^ (s2) ^ (s3);
    b1 = (s0) ^ XT2(s1) ^ XT3(s2) ^ (s3);
    b2 = (s0) ^ (s1) ^ XT2(s2) ^ XT3(s3);
    b3 = XT3(s0) ^ (s1) ^ (s2) ^ XT2(s3);

    ct[4*i+0] = b0;
    ct[4*i+1] = b1;
    ct[4*i+2] = b2;
    ct[4*i+3] = b3;
}
#endif
}
```

修改后的程序代码编译通过：(aes\_demo\_nice 工程)

```

File Edit Source Refactor Source Navigate Search Project RV-Tools Run Window Help
Project Explorer X aes_demo aes_demo_nice
  aes_demo_nice
    Nuclei Settings
    Binaries
    Includes
    application
    Debug
    application
    nuclei_sdk
      aes_demo_nice.elf - [riscv64] 编译生成elf
        aes_demo_nice.hex
        aes_demo_nice.lst
        aes_demo_nice.map
        makefile
        objects.mk
        sources.mk
  nuclei_sdk
    aes_demo_nice_debug.jlink.launch
    aes_demo_nice_debug.openocd.launch
    aes_demo_nice_debug.gemu.launch
  xlmodel_nice
    xlmodel_nice
aes_debug.h aes_demo_nice.c insn.h
70 }
71
72 #define XT2(x) ((x << 1) ^ (x & 0x80 ? 0x1b : 0x00))
73 #define XT3(x) ((XT2(x) ^ x)
74 #define XT4(x) ((XT2(XT3(x)) ^ x)
75 #define XT5(x) ((XT4(XT3(x)) ^ x)
76 #define XT6(x) ((XT5(XT3(x)) ^ x)
77 #define XT7(x) ((XT6(XT3(x)) ^ XT2(x) ^ x)
78 #define XT8(x) ((XT7(XT3(x)) ^ XT4(x) ^ x)
79 #define XT9(x) ((XT8(XT3(x)) ^ XT4(x) ^ XT2(x))
80
81 // Inverse mix columns transformation.
82 static void aes_mix_columns_dec(
83     uint8_t * pt[16] //< Current block state
84 ) {
85 #ifdef USE_NICE
86     custom_aes_mix_columns_dec(pt);
87 #else
88     // Col_0
89     for(int i = 0; i < 4; i++) {
90         uint8_t s0, b0, b1, b2, b3;
91         uint8_t t_0, s1, s2, s3;
92
93         s0 = pt[i*4+0];
94         s1 = pt[i*4+1];
95         s2 = pt[i*4+2];
96         s3 = pt[i*4+3];
97
98         b0 = XT6(s0) ^ XT8(s1) ^ XT0(s2) ^ XT9(s3);
99         b1 = XT9(s0) ^ XT6(s1) ^ XT2(s2) ^ XT8(s3);
100        b2 = XT0(s0) ^ XT9(s1) ^ XT4(s2) ^ XT5(s3);
101        b3 = XT5(s0) ^ XT0(s1) ^ XT9(s2) ^ XT6(s3);
102
103        pt[i*4+0] = b0;
104        pt[i*4+1] = b1;
105        pt[i*4+2] = b2;
106        pt[i*4+3] = b3;
107    }
108 #endif
109 }
110

```

Problems Tasks Console Properties Call Graph  
CDT Build Console [aes\_demo\_nice]  
Finished building: ..application/aes\_enc.c  
Finished building: ..application/aes\_dec.c  
Building target: aes\_demo\_nice.elf  
Invoking: GNU RISC-V Cross C++ Linker  
riscv64-unknown-elf-g++ -march=rv64imafdcv -mabi=lp64 -mtune=nuclei-900-series -mcmodel=medany -mno-save-restore -O0 -ffunction-sections -fdata-sections -fno-common -g -T "/Loc  
Finished building target: aes\_demo\_nice.elf  
Invoking: GNU RISC-V Cross Create Flash Image  
riscv64-unknown-elf-objcopy -O ihex "aes\_demo\_nice.elf" "aes\_demo\_nice.hex"  
Invoking: GNU RISC-V Cross Create Listing  
riscv64-unknown-elf-objdump -S -M riscv -f -d3 -C -z .text,.data,.bss,.rodata,.data1,.bss1,.rodata1,.text1,.data2,.bss2,.rodata2,.text2,.data3,.bss3,.rodata3,.text3,.data4,.bss4,.rodata4,.text4,.data5,.bss5,.rodata5,.text5,.data6,.bss6,.rodata6,.text6,.data7,.bss7,.rodata7,.text7,.data8,.bss8,.rodata8,.text8,.data9,.bss9,.rodata9,.text9,.data10,.bss10,.rodata10,.text10,.data11,.bss11,.rodata11,.text11,.data12,.bss12,.rodata12,.text12,.data13,.bss13,.rodata13,.text13,.data14,.bss14,.rodata14,.text14,.data15,.bss15,.rodata15,.text15,.data16,.bss16,.rodata16,.text16,.data17,.bss17,.rodata17,.text17,.data18,.bss18,.rodata18,.text18,.data19,.bss19,.rodata19,.text19,.data20,.bss20,.rodata20,.text20,.data21,.bss21,.rodata20,.text21,.data22,.bss22,.rodata22,.text22,.data23,.bss23,.rodata23,.text23,.data24,.bss24,.rodata24,.text24,.data25,.bss25,.rodata25,.text25,.data26,.bss26,.rodata26,.text26,.data27,.bss27,.rodata27,.text27,.data28,.bss28,.rodata28,.text28,.data29,.bss29,.rodata29,.text29,.data30,.bss30,.rodata29,.text30,.data31,.bss31,.rodata29,.text31,.data32,.bss32,.rodata29,.text32,.data33,.bss33,.rodata29,.text33,.data34,.bss34,.rodata29,.text34,.data35,.bss35,.rodata29,.text35,.data36,.bss36,.rodata29,.text36,.data37,.bss37,.rodata29,.text37,.data38,.bss38,.rodata29,.text38,.data39,.bss39,.rodata29,.text39,.data40,.bss40,.rodata29,.text40,.data41,.bss41,.rodata29,.text41,.data42,.bss42,.rodata29,.text42,.data43,.bss43,.rodata29,.text43,.data44,.bss44,.rodata29,.text44,.data45,.bss45,.rodata29,.text45,.data46,.bss46,.rodata29,.text46,.data47,.bss47,.rodata29,.text47,.data48,.bss48,.rodata29,.text48,.data49,.bss49,.rodata29,.text49,.data50,.bss50,.rodata29,.text50,.data51,.bss51,.rodata29,.text51,.data52,.bss52,.rodata29,.text52,.data53,.bss53,.rodata29,.text53,.data54,.bss54,.rodata29,.text54,.data55,.bss55,.rodata29,.text55,.data56,.bss56,.rodata29,.text56,.data57,.bss57,.rodata29,.text57,.data58,.bss58,.rodata29,.text58,.data59,.bss59,.rodata29,.text59,.data60,.bss60,.rodata29,.text60,.data61,.bss61,.rodata29,.text61,.data62,.bss62,.rodata29,.text62,.data63,.bss63,.rodata29,.text63,.data64,.bss64,.rodata29,.text64,.data65,.bss65,.rodata29,.text65,.data66,.bss66,.rodata29,.text66,.data67,.bss67,.rodata29,.text67,.data68,.bss68,.rodata29,.text68,.data69,.bss69,.rodata29,.text69,.data70,.bss70,.rodata29,.text70,.data71,.bss71,.rodata29,.text71,.data72,.bss72,.rodata29,.text72,.data73,.bss73,.rodata29,.text73,.data74,.bss74,.rodata29,.text74,.data75,.bss75,.rodata29,.text75,.data76,.bss76,.rodata29,.text76,.data77,.bss77,.rodata29,.text77,.data78,.bss78,.rodata29,.text78,.data79,.bss79,.rodata29,.text79,.data80,.bss80,.rodata29,.text80,.data81,.bss81,.rodata29,.text81,.data82,.bss82,.rodata29,.text82,.data83,.bss83,.rodata29,.text83,.data84,.bss84,.rodata29,.text84,.data85,.bss85,.rodata29,.text85,.data86,.bss86,.rodata29,.text86,.data87,.bss87,.rodata29,.text87,.data88,.bss88,.rodata29,.text88,.data89,.bss89,.rodata29,.text89,.data90,.bss90,.rodata29,.text90,.data91,.bss91,.rodata29,.text91,.data92,.bss92,.rodata29,.text92,.data93,.bss93,.rodata29,.text93,.data94,.bss94,.rodata29,.text94,.data95,.bss95,.rodata29,.text95,.data96,.bss96,.rodata29,.text96,.data97,.bss97,.rodata29,.text97,.data98,.bss98,.rodata29,.text98,.data99,.bss99,.rodata29,.text99,.data100,.bss100,.rodata29,.text100,.data101,.bss101,.rodata29,.text101,.data102,.bss102,.rodata29,.text102,.data103,.bss103,.rodata29,.text103,.data104,.bss104,.rodata29,.text104,.data105,.bss105,.rodata29,.text105,.data106,.bss106,.rodata29,.text106,.data107,.bss107,.rodata29,.text107,.data108,.bss108,.rodata29,.text108,.data109,.bss109,.rodata29,.text109,.data110,.bss110,.rodata29,.text110,.data111,.bss111,.rodata29,.text111,.data112,.bss112,.rodata29,.text112,.data113,.bss113,.rodata29,.text113,.data114,.bss114,.rodata29,.text114,.data115,.bss115,.rodata29,.text115,.data116,.bss116,.rodata29,.text116,.data117,.bss117,.rodata29,.text117,.data118,.bss118,.rodata29,.text118,.data119,.bss119,.rodata29,.text119,.data120,.bss120,.rodata29,.text120,.data121,.bss121,.rodata29,.text121,.data122,.bss122,.rodata29,.text122,.data123,.bss123,.rodata29,.text123,.data124,.bss124,.rodata29,.text124,.data125,.bss125,.rodata29,.text125,.data126,.bss126,.rodata29,.text126,.data127,.bss127,.rodata29,.text127,.data128,.bss128,.rodata29,.text128,.data129,.bss129,.rodata29,.text129,.data130,.bss130,.rodata29,.text130,.data131,.bss131,.rodata29,.text131,.data132,.bss132,.rodata29,.text132,.data133,.bss133,.rodata29,.text133,.data134,.bss134,.rodata29,.text134,.data135,.bss135,.rodata29,.text135,.data136,.bss136,.rodata29,.text136,.data137,.bss137,.rodata29,.text137,.data138,.bss138,.rodata29,.text138,.data139,.bss139,.rodata29,.text139,.data140,.bss140,.rodata29,.text140,.data141,.bss141,.rodata29,.text141,.data142,.bss142,.rodata29,.text142,.data143,.bss143,.rodata29,.text143,.data144,.bss144,.rodata29,.text144,.data145,.bss145,.rodata29,.text145,.data146,.bss146,.rodata29,.text146,.data147,.bss147,.rodata29,.text147,.data148,.bss148,.rodata29,.text148,.data149,.bss149,.rodata29,.text149,.data150,.bss150,.rodata29,.text150,.data151,.bss151,.rodata29,.text151,.data152,.bss152,.rodata29,.text152,.data153,.bss153,.rodata29,.text153,.data154,.bss154,.rodata29,.text154,.data155,.bss155,.rodata29,.text155,.data156,.bss156,.rodata29,.text156,.data157,.bss157,.rodata29,.text157,.data158,.bss158,.rodata29,.text158,.data159,.bss159,.rodata29,.text159,.data160,.bss160,.rodata29,.text160,.data161,.bss161,.rodata29,.text161,.data162,.bss162,.rodata29,.text162,.data163,.bss163,.rodata29,.text163,.data164,.bss164,.rodata29,.text164,.data165,.bss165,.rodata29,.text165,.data166,.bss166,.rodata29,.text166,.data167,.bss167,.rodata29,.text167,.data168,.bss168,.rodata29,.text168,.data169,.bss169,.rodata29,.text169,.data170,.bss170,.rodata29,.text170,.data171,.bss171,.rodata29,.text171,.data172,.bss172,.rodata29,.text172,.data173,.bss173,.rodata29,.text173,.data174,.bss174,.rodata29,.text174,.data175,.bss175,.rodata29,.text175,.data176,.bss176,.rodata29,.text176,.data177,.bss177,.rodata29,.text177,.data178,.bss178,.rodata29,.text178,.data179,.bss179,.rodata29,.text179,.data180,.bss180,.rodata29,.text180,.data181,.bss181,.rodata29,.text181,.data182,.bss182,.rodata29,.text182,.data183,.bss183,.rodata29,.text183,.data184,.bss184,.rodata29,.text184,.data185,.bss185,.rodata29,.text185,.data186,.bss186,.rodata29,.text186,.data187,.bss187,.rodata29,.text187,.data188,.bss188,.rodata29,.text188,.data189,.bss189,.rodata29,.text189,.data190,.bss190,.rodata29,.text190,.data191,.bss191,.rodata29,.text191,.data192,.bss192,.rodata29,.text192,.data193,.bss193,.rodata29,.text193,.data194,.bss194,.rodata29,.text194,.data195,.bss195,.rodata29,.text195,.data196,.bss196,.rodata29,.text196,.data197,.bss197,.rodata29,.text197,.data198,.bss198,.rodata29,.text198,.data199,.bss199,.rodata29,.text199,.data200,.bss200,.rodata29,.text200,.data201,.bss201,.rodata29,.text201,.data202,.bss202,.rodata29,.text202,.data203,.bss203,.rodata29,.text203,.data204,.bss204,.rodata29,.text204,.data205,.bss205,.rodata29,.text205,.data206,.bss206,.rodata29,.text206,.data207,.bss207,.rodata29,.text207,.data208,.bss208,.rodata29,.text208,.data209,.bss209,.rodata29,.text209,.data210,.bss210,.rodata29,.text210,.data211,.bss211,.rodata29,.text211,.data212,.bss212,.rodata29,.text212,.data213,.bss213,.rodata29,.text213,.data214,.bss214,.rodata29,.text214,.data215,.bss215,.rodata29,.text215,.data216,.bss216,.rodata29,.text216,.data217,.bss217,.rodata29,.text217,.data218,.bss218,.rodata29,.text218,.data219,.bss219,.rodata29,.text219,.data220,.bss220,.rodata29,.text220,.data221,.bss221,.rodata29,.text221,.data222,.bss222,.rodata29,.text222,.data223,.bss223,.rodata29,.text223,.data224,.bss224,.rodata29,.text224,.data225,.bss225,.rodata29,.text225,.data226,.bss226,.rodata29,.text226,.data227,.bss227,.rodata29,.text227,.data228,.bss228,.rodata29,.text228,.data229,.bss229,.rodata29,.text229,.data230,.bss230,.rodata29,.text230,.data231,.bss231,.rodata29,.text231,.data232,.bss232,.rodata29,.text232,.data233,.bss233,.rodata29,.text233,.data234,.bss234,.rodata29,.text234,.data235,.bss235,.rodata29,.text235,.data236,.bss236,.rodata29,.text236,.data237,.bss237,.rodata29,.text237,.data238,.bss238,.rodata29,.text238,.data239,.bss239,.rodata29,.text239,.data240,.bss240,.rodata29,.text240,.data241,.bss241,.rodata29,.text241,.data242,.bss242,.rodata29,.text242,.data243,.bss243,.rodata29,.text243,.data244,.bss244,.rodata29,.text244,.data245,.bss245,.rodata29,.text245,.data246,.bss246,.rodata29,.text246,.data247,.bss247,.rodata29,.text247,.data248,.bss248,.rodata29,.text248,.data249,.bss249,.rodata29,.text249,.data250,.bss250,.rodata29,.text250,.data251,.bss251,.rodata29,.text251,.data252,.bss252,.rodata29,.text252,.data253,.bss253,.rodata29,.text253,.data254,.bss254,.rodata29,.text254,.data255,.bss255,.rodata29,.text255,.data256,.bss256,.rodata29,.text256,.data257,.bss257,.rodata29,.text257,.data258,.bss258,.rodata29,.text258,.data259,.bss259,.rodata29,.text259,.data260,.bss260,.rodata29,.text260,.data261,.bss261,.rodata29,.text261,.data262,.bss262,.rodata29,.text262,.data263,.bss263,.rodata29,.text263,.data264,.bss264,.rodata29,.text264,.data265,.bss265,.rodata29,.text265,.data266,.bss266,.rodata29,.text266,.data267,.bss267,.rodata29,.text267,.data268,.bss268,.rodata29,.text268,.data269,.bss269,.rodata29,.text269,.data270,.bss270,.rodata29,.text270,.data271,.bss271,.rodata29,.text271,.data272,.bss272,.rodata29,.text272,.data273,.bss273,.rodata29,.text273,.data274,.bss274,.rodata29,.text274,.data275,.bss275,.rodata29,.text275,.data276,.bss276,.rodata29,.text276,.data277,.bss277,.rodata29,.text277,.data278,.bss278,.rodata29,.text278,.data279,.bss279,.rodata29,.text279,.data280,.bss280,.rodata29,.text280,.data281,.bss281,.rodata29,.text281,.data282,.bss282,.rodata29,.text282,.data283,.bss283,.rodata29,.text283,.data284,.bss284,.rodata29,.text284,.data285,.bss285,.rodata29,.text285,.data286,.bss286,.rodata29,.text286,.data287,.bs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```
1 make minimum required(VERSION 3.1)
2 project(xl_cpumodel)
3
4 # specify the C++ standard
5 set(CMAKE_CXX_STANDARD 17)
6 set(CMAKE_CXX_STANDARD_REQUIRED True)
7 set(CMAKE_CXX_EXTENSIONS OFF)
8 set(CMAKE_EXPORT_COMPILE_COMMANDS ON)
9
10 set(CMAKE_PREFIX_PATH ${ENV{SYSTEMC_HOME}})
11
12 add_compile_options(-O3 -g -Wall -Wextra -Wunused-function -Wno-pedantic)
13
14 if(CLUSTER_NUM LESS 1)
15   message(FATAL_ERROR "CLUSTER_NUM must be greater than or equal to 1")
16 endif()
17 add_compile_options(-DCLUSTER_NUM=${CLUSTER_NUM})
18
19 include_directories(. ${nice}/inc/
20                     .${systemc}/include/
21                     .${xl_node}/include/
22                     .${xl_spike}/include/xl_spike/
23                     .${XLSPIKE}/include/softfloat/
24                     .${XLSPIKE}/include/device/
25                     .${XLSPIKE}/include/riscv/
26                     .${XLSPIKE}/include/fdt/
27                     .${XLSPIKE}/include/fesvr/
28
29 list(APPEND SRC_NICE ".${nice}/src/nice.cc")
30
31 # Link to libxl_model.a
32 add_library(xl_model STATIC STATIC IMPORTED)
33 set_target_properties(xl_model STATIC PROPERTIES IMPORTED_LOCATION ${PROJECT_SOURCE_DIR}/xl_model/library/libxl_model.a)
34
35 # Link to libsystemc.a
36 add_library(systemc STATIC STATIC IMPORTED)
37 set_target_properties(systemc STATIC PROPERTIES IMPORTED_LOCATION ${PROJECT_SOURCE_DIR}/systemc/library/libsystemc.a)
38
39 # Link to libxl_node.a
40 set(XLNODE ${PROJECT_SOURCE_DIR}/xl_node/library/libxl_node.a)
41
42 # Link to libspike.a
43 set(XLSPIKE ${PROJECT_SOURCE_DIR}/xl_spike/library/libxl_spike.a)
44
45 add_executable(xl_cpumodel ${SRC_NICE})
46
47 target_link_libraries(xl_cpumodel
48   -Wl,-start-group
49   ${XLNODE}
50   ${XLSPIKE}
51   ${XLCPUMODEL}
52   ${XLSPITK}
53   ${XLSPITKE}
54   -Wl,--end-group
55   -d)
```

Problems Tasks Console Properties Call Graph gprof

CDT Build Console [xModel\_nice]

Building in: /local/uxit/ide/ide workspace/xModel\_nice/build/default

make -j1 -B -t -target xl\_cpumodel

Scanning dependencies of target xl\_cpumodel

[ 50%] Building CXX object CMakeFiles/xl\_cpumodel.dir/src/nice.cc.o

In file included from /local/uxit/ide/ide workspace/xModel\_nice/src/nice.h:29,

from /local/uxit/ide/ide workspace/xModel\_nice/include/riscv/processor.h:29,

from /local/uxit/ide/ide workspace/xModel\_nice/include/riscv/mmu.h:11,

from /local/uxit/ide/ide workspace/xModel\_nice/include/nice.h:7,

from /local/uxit/ide/ide workspace/xModel\_nice/include/nice\_cc:1;

/local/uxit/ide/ide workspace/xModel\_nice/src/nice.cc:348: warning: type qualifiers ignored on function return type [-Wignored-qualifiers]

348 const reg\_t dependencycons( reg\_val, const char feature, const char depends\_on) const noexcept;

[100%] Linking CXX executable xl\_cpumodel

[100%] Built target xl\_cpumodel

Build complete (0 errors, 1 warnings): /local/uxit/ide/ide workspace/xModel\_nice/build/default

打开 `nice.cc` 文件，用户需要用该文件的 `do_nice` 函数实现所有自定义的 NICE/VNICE 指令，当前 `do_nice` 里包含了针对 `demo_nice` 或 `demo_vniced` 的 Nuclei 定义的 NICE/VNICE 指令，用户可以参考其中注释完成自己的自定义指令。

注意：当用户编写自定义 NICE/VNICE 指令时，需要关掉和 Nuclei demo\_nice/demo\_vnice 对应的 NUCLEI\_NICE\_SCALAR/NUCLEI\_NICE\_VECTOR 宏，以免和用户自定义的指令编码相冲突。

```

129 //...
130 /* brief specific operation for NICE instruction.
131 * @param[in] p           The class represents one processor in a RISC-V machine, including all the states, registers, memory, and other relevant components.
132 * @param[in] insn         You can access and modify the content of the class processor_t through p.
133 * @param[in] pc           Program Counter corresponding to the instruction.
134 * @param[in] func7        Remarks You need to add the instruction cycle to the implementation of each instruction in the format of STATE.mcycle->bump(x).
135 * @param[in] funct3       where x is the expected cycle count of this instruction minus 1.
136 * @param[in] reg          For example, if the expected cycle count of the instruction is 2, then x would be 1.
137 */
138 void do_nice(processor_t* p, insn_t insn, reg_t pc) {
139     (void)pc;
140     uint32_t instr = insn.bits();
141     uint32_t customId = (instr >> 2) & 0x7f;
142     uint32_t func7 = (instr >> 25) & 0x7f;
143     uint32_t funct3 = (instr >> 12) & 0x7f;
144
145     if (customId == CUSTOM0) {
146         #ifdef NUCLEI_NICE_SCALAR
147             /* Implementation of the Nuclei-specific NICE instruction CLW: Load 12-byte data from memory to row buffer. */
148             if (func7 == 0) {
149                 /* MMU access to the memory component encapsulated in p, RS1, RS2, and RD represent the values of
150                  specific XPR encoded in the insn. For specific definitions, please refer to decode_macros.h.*/
151                 row_buffer[0] = MMU.load.uint32(RS1);
152                 row_buffer[1] = MMU.load.uint32(RS1 + 4);
153                 row_buffer[2] = MMU.load.uint32(RS1 + 8);
154                 row_buffer[3] = MMU.load.uint32(RS1 + 8);
155                 STATE.mcycle->bump(CLW_CYCLE_ADD);
156             }
157             /* Implementation of the Nuclei-specific NICE instruction CSW: Store 12-byte data from row buffer to memory. */
158             else if (func7 == 4) {
159                 MMU.store.uint32(RS1, row_buffer[0]);
160                 MMU.store.uint32(RS1 + 4, row_buffer[1]);
161                 MMU.store.uint32(RS1 + 8, row_buffer[2]);
162                 STATE.mcycle->bump(CSW_CYCLE_ADD);
163             }
164             /* Implementation of the Nuclei-specific NICE instruction CACC: Sums a row of the matrix, and columns are accumulated automatically. */
165             else if (func7 == 6) {
166                 row_buffer[0] += MMU.load.uint32(RS1);
167                 row_buffer[1] += MMU.load.uint32(RS1);
168                 row_buffer[2] += MMU.load.uint32(RS1 + 4);
169                 row_buffer[2] += MMU.load.uint32(RS1 + 8);
170                 WRITE_RD(MMU.load.uint32(RS1) + MMU.load.uint32(RS1 + 4) + MMU.load.uint32(RS1 + 8));
171                 STATE.mcycle->bump(CACC_CYCLE_ADD);
172             }
173         #endif
174     }
175     /* You can refer to the encapsulation of vector instructions in xlspike/include/riscv/v_ext_macros.h for the specific writing style of Vector-NICE. */
176     #ifdef NUCLEI_NICE_VECTOR
177         /* Implementation of the Nuclei-specific Vector NICE load instruction: Memory load to a vint32m8_t vector register. */
178         if (func7 == 0x7f) {
179             /* If (func3 == 1) {
180                 VL_LD_NICL0, [l * nf + fn], int32, false);
181                 STATE.mcycle->bump(VNICE_LOAD);
182             }
183         */
184     #endif
185 }

```

CDT Build Console [xmodel\_nice]  
Building in: /Local/xuzt/ide/xmodel\_nice/build/default  
make -C /Local/xuzt/ide/xmodel\_nice/ -j1  
[ 50%] Building CMakeFiles/xl\_cpmodef.dir/nice/src/nice.cc.o  
In file included from /Local/xuzt/ide/xmodel\_nice/.xl\_spike/include/riscv/processor.h:29,  
from /Local/xuzt/ide/xmodel\_nice/.xl\_spike/include/riscv/mm.h:11,  
from /Local/xuzt/ide/xmodel\_nice/nice/nice.h:  
from /Local/xuzt/ide/xmodel\_nice/nice/nice\_vnike.c:  
/Local/xuzt/ide/xmodel\_nice/.xl\_spike/include/riscv/csr.h:348: warning: type qualifiers ignored on function return type [-Wignored-qualifiers]  
348 | const reg\_t dependency(Constr reg\_t val, const char texture, const char depends\_on) const noexcept;  
[100%] Linking CXX executable xl\_cpmodef  
[100%] Built target xl\_cpmodef  
Build complete (0 errors, 1 warnings): /Local/xuzt/ide/xmodel\_nice/build/default

AES demo 中定义的 NICE/VNICE 指令实现如下图，通过指令的 `opcode`、`funct3` 和 `funct7` 编写条件判断语句指定该条指令，然后在其中实现指令行为以及指令 `cycle` 数添加。

NICE 指令实现中，MMU 宏表示 memory 访问，load memory 使用 `MMU.load_uint<n>`，store memory 使用 `MMU.store_uint<n>`，RD、RS1、RS2、RS3 宏表示其对应标量寄存器中的值，FRS1、FRS2、FRS3 宏表示其对应浮点寄存器中的值，这些宏的使用可以参考 `nice/inc/decode_macros.h`。

VNICE 指令实现中仍然是用 MMU 宏访问 memory，只不过 Vector 寄存器数据会存储在 `P.VU_elt` 类中，用户可以参考 `xlspike/include/riscv/v_ext_macros.h` 完成相关代码编写。

在指令实现完后，将自定义指令需要的 `cycle` 数 `n` 直接标定：`STATE.mcycle->bump(n)`；即可，这里根据硬件通过 `NICE/VNICE` 实现此算法的理论值，标定 `custom_aes_mix_columns_dec` 为 7 cycle，`__custom_vnike_load_v_i8m1` 为 1 cycle，`__custom_vnike_aes_mix_columns_enc_i8m1` 为 2 cycle。

The screenshot shows the Nuclei Studio interface with the following details:

- Project Explorer:** Shows the project structure with files like `aes_demo`, `nice_aes`, `xlmodel_nice`, and `xl_cpumodel-[x86_64][0]`.
- Code Editor:** Displays the `nice.cc` file containing C++ code for the `do_nice` function. The code implements NICE/VNICE instructions for AES operations. Two specific sections are highlighted with red boxes:
  - AES demo NICE指令实现和cycle标定:** Lines 201-323 show the implementation of the `NICE(XTE)` instruction for AES. It involves multiple memory loads and stores using `MMU.load` and `MMU.store` functions.
  - AES demo VNICE指令实现和cycle标定:** Lines 324-336 show the implementation of the `VNICE(XTE)` instruction for AES, which is similar to the NICE version but with different memory addresses.
- Build Console:** Shows the build process for `xl_cpumodel`. The output includes compiler warnings and notes about macro decoding.
- Status Bar:** Shows the message "编译通过" (Compile Passed).

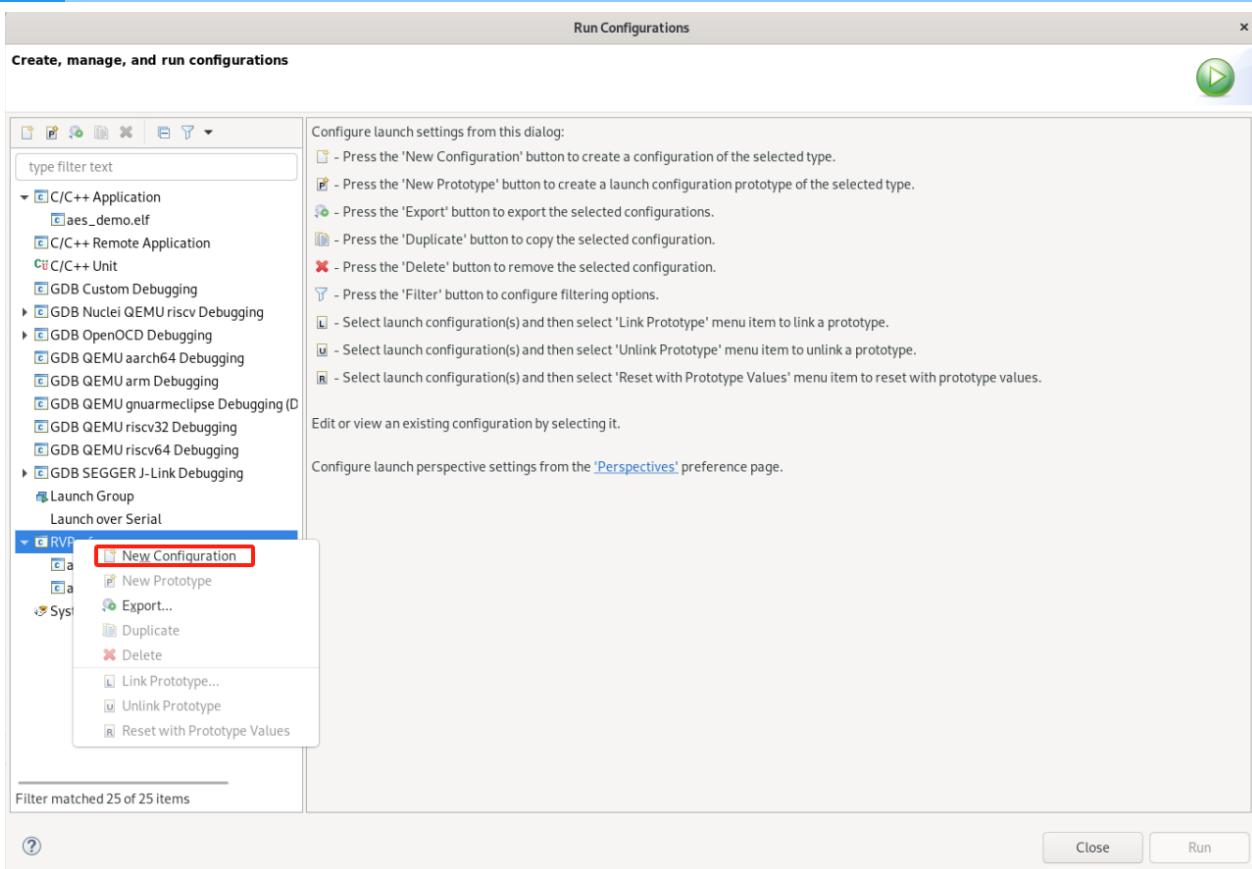
以上介绍了用户如何从原始 Nuclei Model 软件包添加自定义 NICE/VNICE 指令，接下来需要将新编译出的 model 可执行程序导入到 Nuclei Studio 中，为了不和 Nuclei Studio 原始 model 名称混淆，可以将 model 导入到 `NucleiStudio/toolchain/nucleimodel/bin_aes/` 的创建路径下，我们提供了两种 model 可执行程序获取方式：

1. 实现 AES demo NICE/VNICE 指令的 Nuclei model 软件包[添加AES NICE指令model软件包](#)，编译后将 `xl_cpumodel` 可执行程序导入上述路径。
2. 编译好的 model 的可执行程序 `xl_cpumodel`，直接导入上述路径。

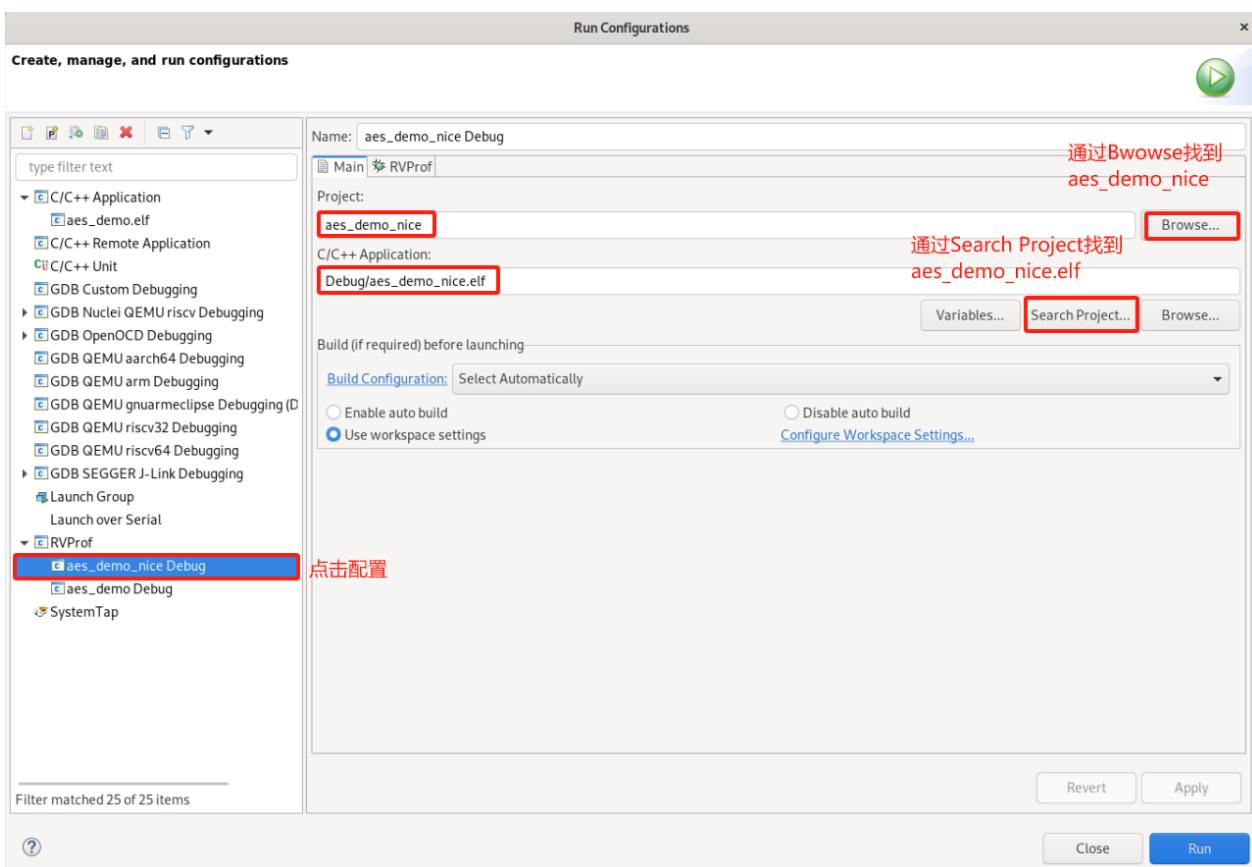
## step7：热点函数再分析¶

注意：请务必完成 step6 中介绍的实现了 NICE/VNICE 指令的 model 导入 Nuclei Studio 中才能用 model Run `aes_demo_nice` 工程。

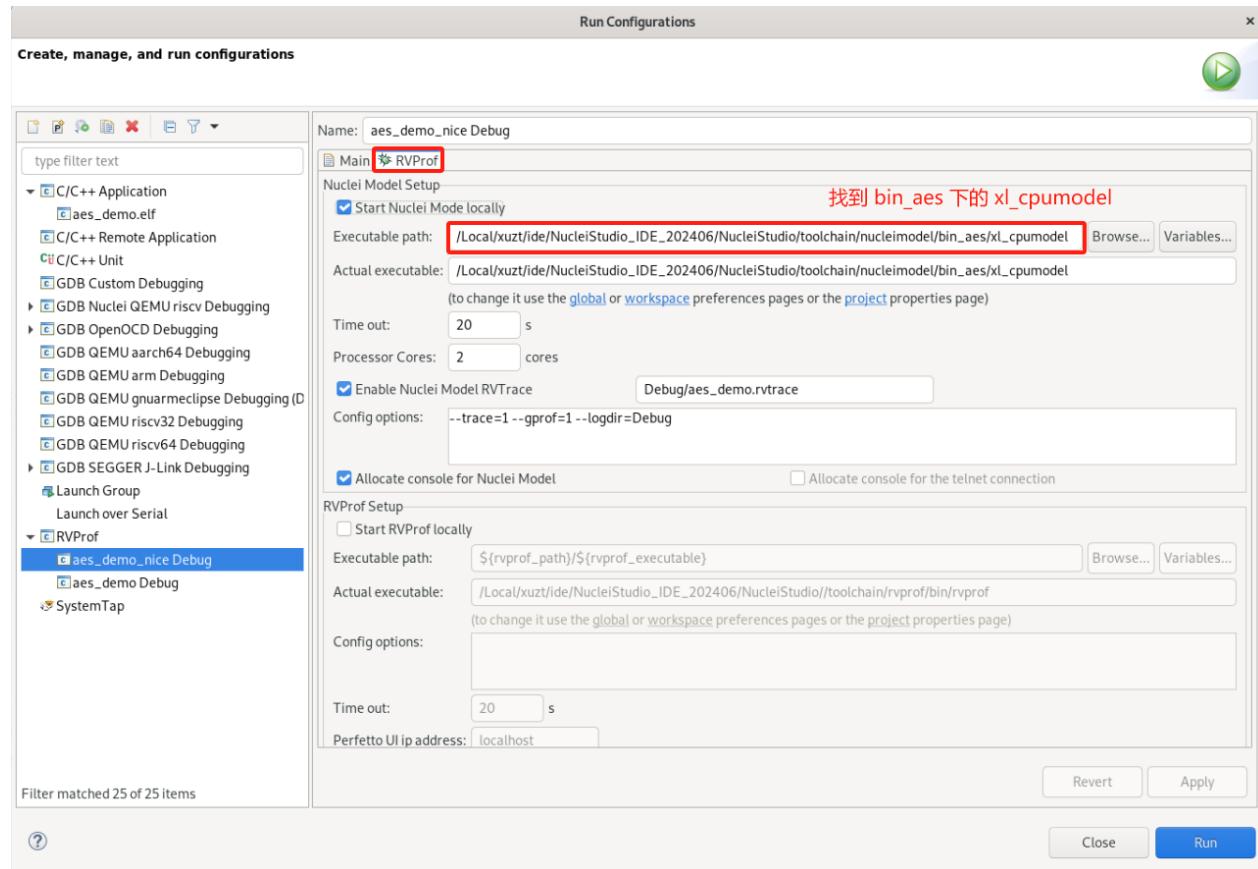
首先打开 Nuclei Studio 主菜单栏的 Run 选项的 Run Configurations，model 配置需要重新添加一份 Nuclei Studio 中的 RVProf 运行配置 `aes_demo_nice Debug`：



将 Main 选项卡的 Project 通过 Browse 改为 aes\_demo\_nice, C/C++ Application 通过 Search Project 改为 aes\_demo\_nice.elf:



然后将 RVProf 选项卡中的 model 执行路径 Executable path 改为 step6 中新修改 model 的执行路径：.../NucleiStudio/toolchain/nucleimodel/bin\_aes/xl\_cpumodel:

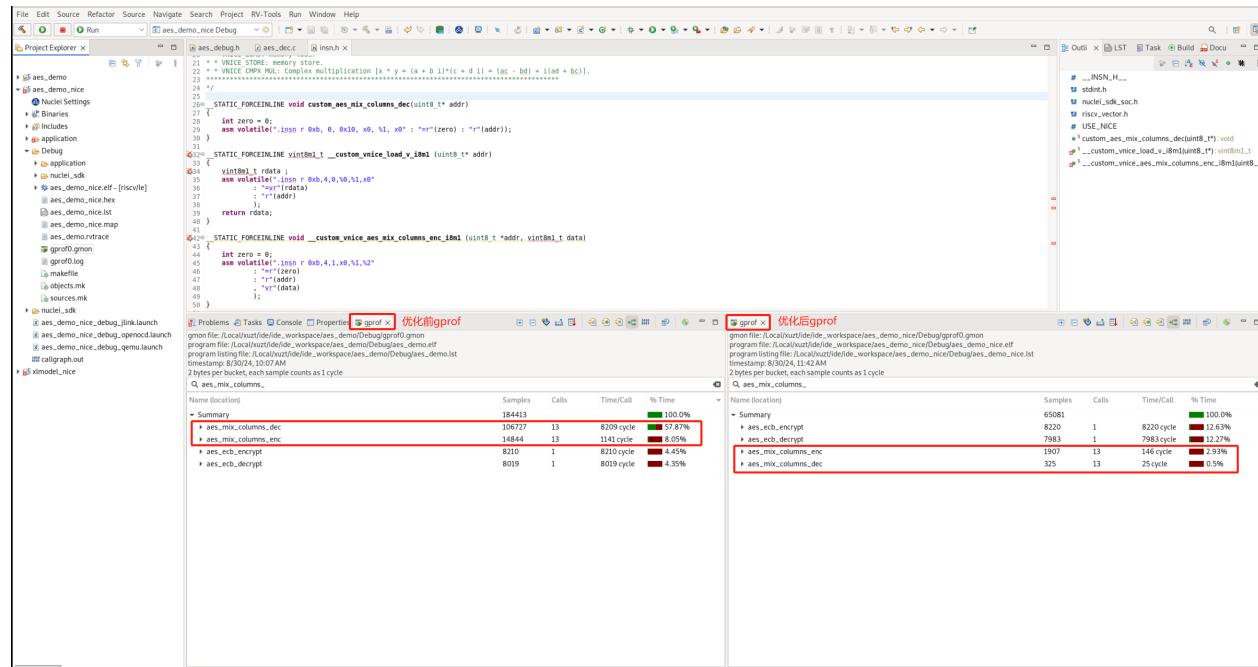


运行前将 aes\_debug.h 中的 LOCAL\_DEBUG 打开，测试优化后 AES 算法的整体 cycle 数，选择 Nuclei Studio 的 launch bar 的 aes\_demo\_nice Debug 后 Run model，得到 AES 算法优化后整体消耗 cycle 数从优化前的 154988 降到了 35619 cycle。

将 `aes_debug.h` 中的 `LOCAL_DEBUG` 关掉测试重新 Run model 测试 Profiling 数据，双击 `gprof0.gmon` 可以看到 CPU 占用率较高的热点函数已经没有 `aes_mix_columns_enc` 和 `aes_mix_columns_dec` 了：

搜索 aes\_mix\_columns\_enc 和 aes\_mix\_columns\_dec，CPU 占用率 aes\_mix\_columns\_enc 从 8.05% 降到了 2.93%，aes\_mix\_columns\_dec 从 57.87% 降到了 0.5%，函数 Time per Call 消耗 cycle 数 aes\_mix\_columns\_enc 从 1141 cycle 降到了 146

cycle, aes\_mix\_columns\_dec 从 8209 cycle 降到了 25 cycle, 说明了通过 NICE/VNICE 指令替换热点函数可以大幅提高程序算法性能。



数据统计如下 : (enc: aes\_mix\_columns\_enc, dec: aes\_mix\_columns\_dec)

Function	Before Optimization NICE/VNICE Optimization		
CPU Usage % (enc)	8.05	2.93	
CPU Usage % (dec)	57.87	0.5	
Time per Call Cycles (enc)	1,141	146	
Time per Call Cycles (dec)	8,209	25	
AES Program Total Before Optimization NICE/VNICE Optimization			
Cycles	154,988	35,619	

AES加解密 NICE/VNICE demo : [优化后AES工程链接下载](#)