

**GigaDevice Semiconductor Inc.**

**Arm<sup>®</sup> Cortex<sup>®</sup>-M3/4/23/33 32-bit MCU**

**应用笔记**

**AN033**

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## 1. Introduction

We usually use the IDE under windows to develop MCU project, This article describes how to manage a RTOS projects in a Linux environment with multiple Makefiles, develop an LED flashing feature in RTOS task. This scheme can specify modules or files to compile.

## 2. Development environment construction

The development environment prepare:

- Hardware development board: GD32F303-Test-V1.1
- Cmpile environment: ubuntu16.04
- Tool chain: gcc-arm-none-eabi, gcc-arm-none-objcopy
- Programing tools: SEGGR J-FlashVV6.50b

### 2.1. Install Ubuntu VM

VMware workstation download address:<https://www.vmware.com/cn/products/workstation-pro/workstation-pro-evaluation.html>.

Double-click the installation package and follow the installation wizard, shown in [Figure 2-1. Ubuntu vm installation wizard 1](#) click"next", Select the default settings.

Figure 2-1. Ubuntu vm installation wizard 1

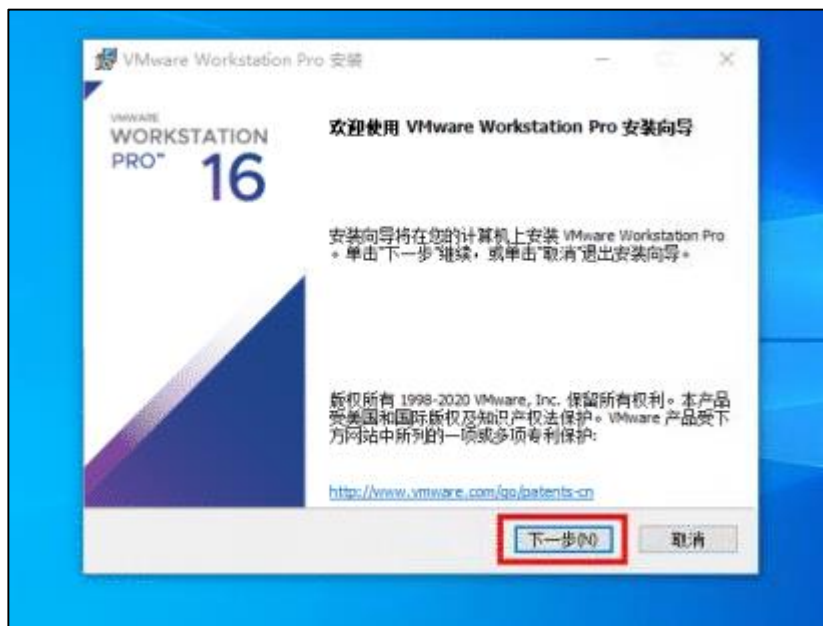
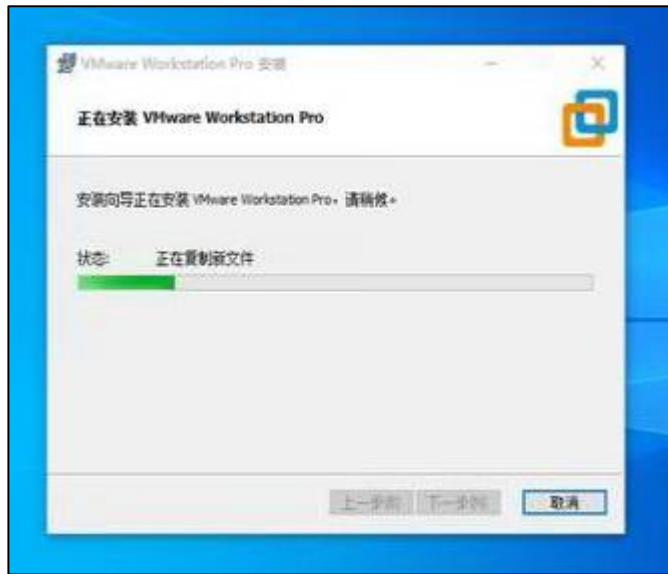


Figure 2-2. Ubuntu vm installation wizard 2



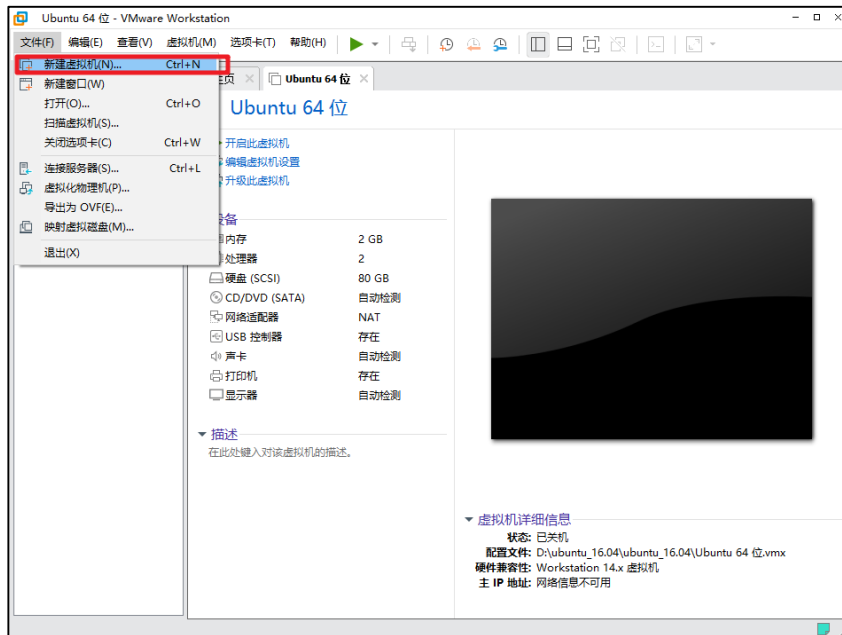
Click "finish", finish install.

Figure 2-3. Ubuntu vm installation wizard 3



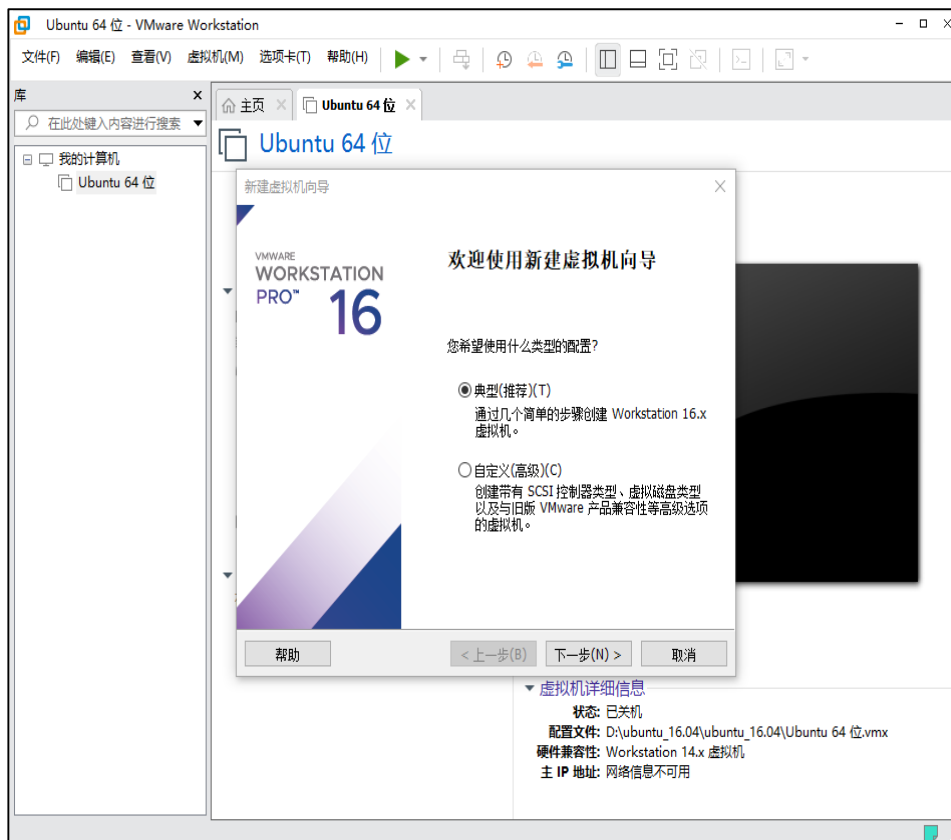
Download ubuntu iso file and install.download address:<http://mirrors.aliyun.com/ubuntu-releases/16.04/> After download Ubuntu iso,open VMware, click "file --> create new virtual machine".

Figure 2-4. Ubuntu vm installation wizard 4



Use default settings, click "next".

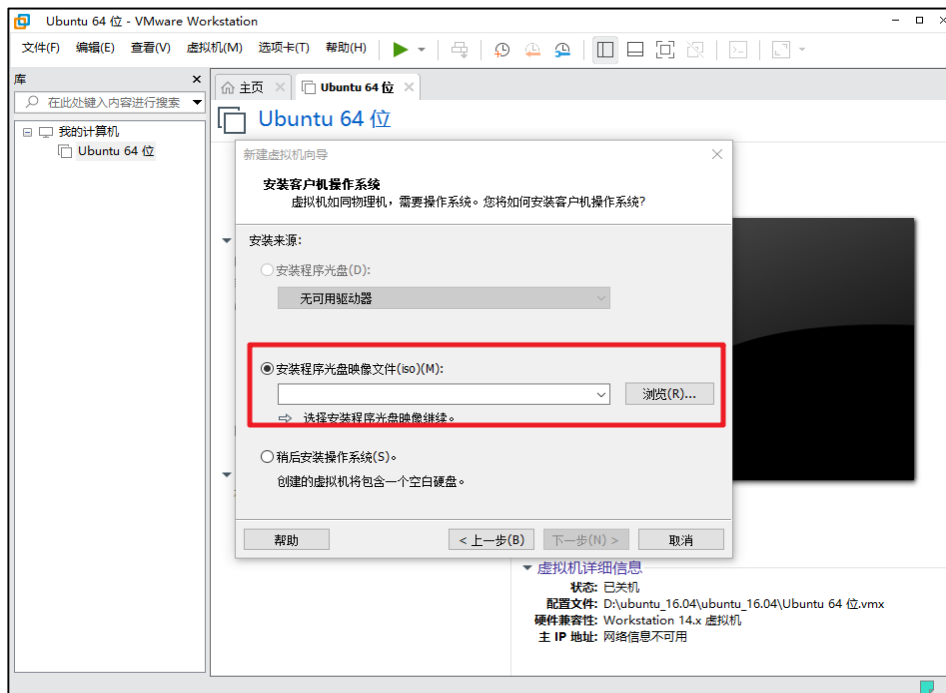
Figure 2-5. Ubuntu vm installation wizard 5



Select the Ubuntu iso file downloaded earlier, use default settings and click "next".

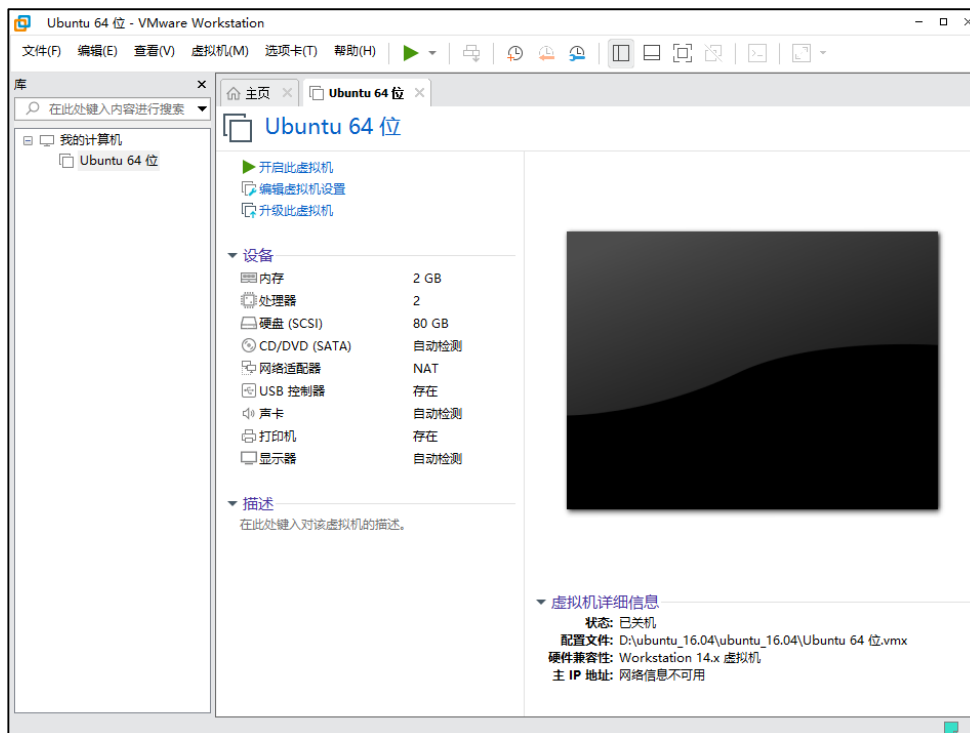


**Figure 2-6. Ubuntu vm installation wizard 6**



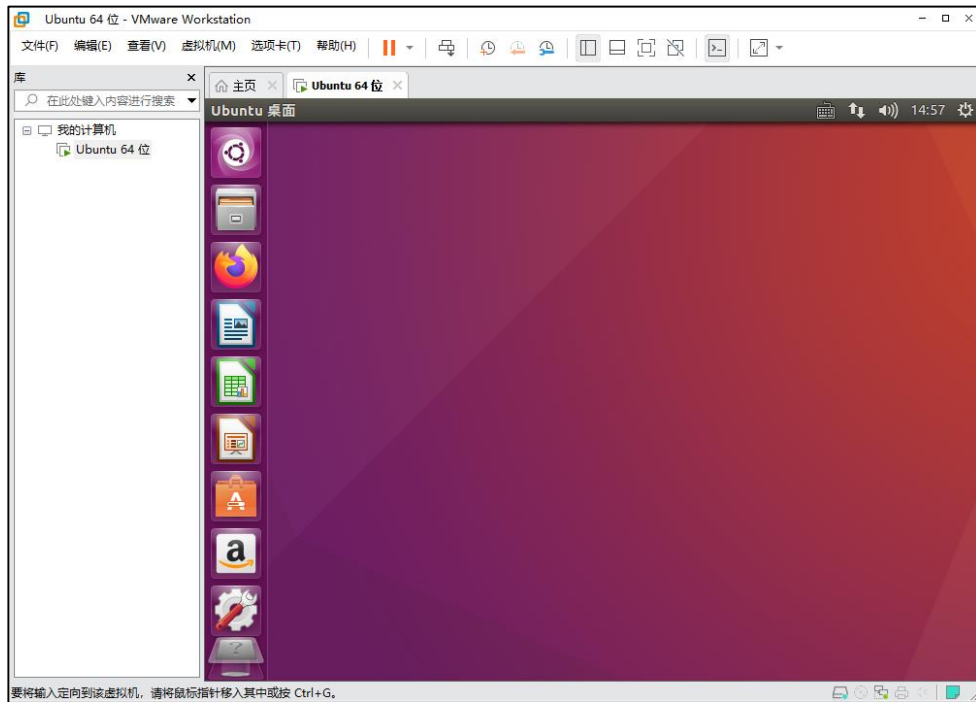
Click start this virtual machine, the first startup takes a long time, select the default settings until startup is complete.

**Figure 2-7. Ubuntu vm installation wizard 7**



**Figure 2-8. Ubuntu vm start done 8** show the page after the Ubuntu VM is started.

Figure 2-8. Ubuntu vm start done 8

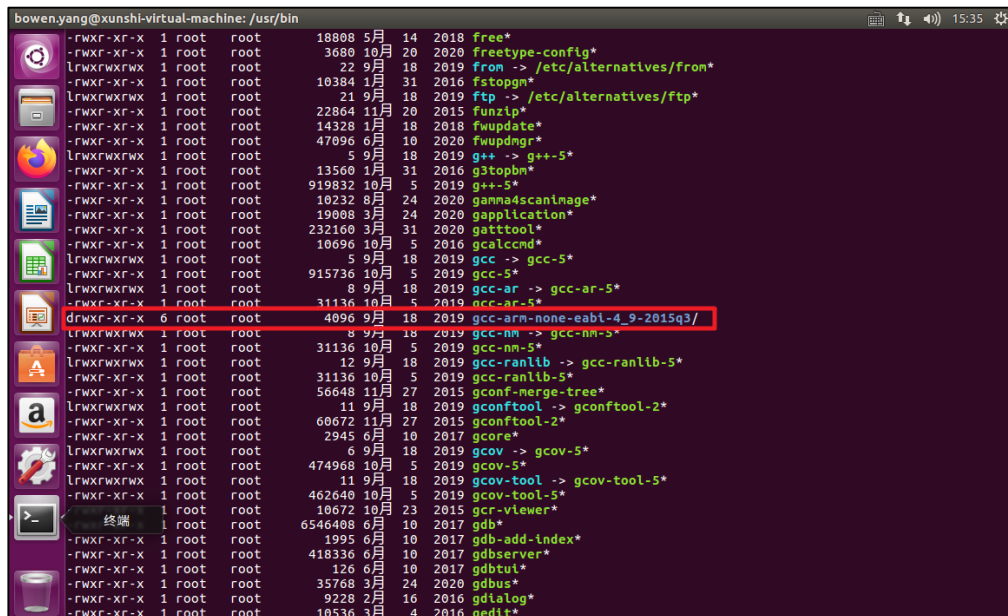


## 2.2. Install toolchain

Use the compiled toolchain, download address: <https://launchpad.net/gcc-arm-embedded/+download>.

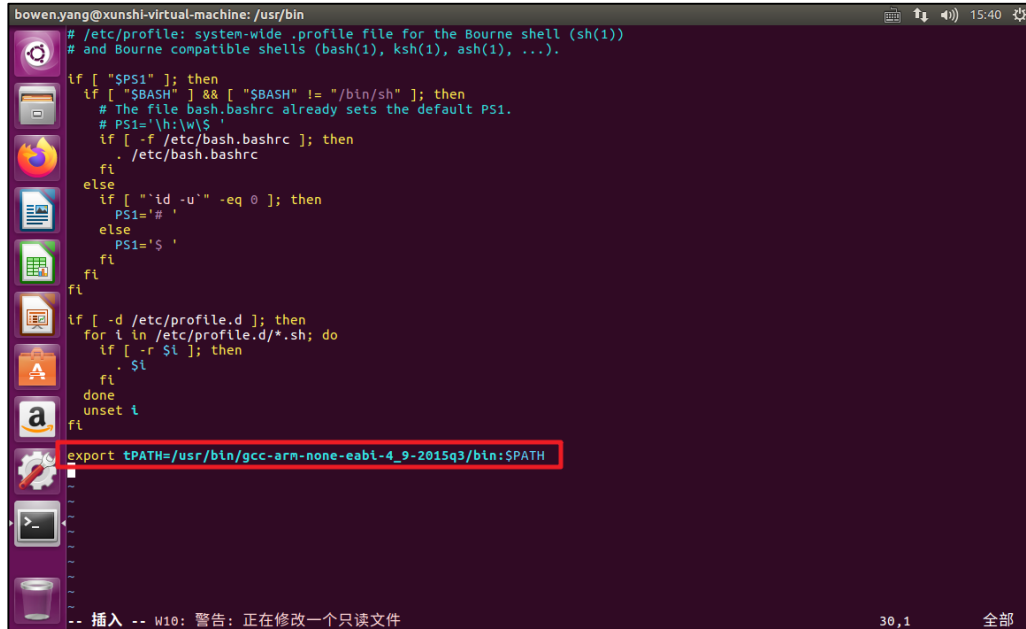
Decompress the downloaded toolchain to the /usr/bin directory of Ubuntu, get a directory gcc-arm-none-eabi-4\_9-2015q3/. shown in [Figure 2-9. directory of GCC toolchain](#).

Figure 2-9. directory of GCC toolchain



Configure the linux system environment variables. assign GCC toolchain directory in the last of /etc/profile.

**Figure 2-10. configuration environment variable**



```

bowen.yang@xunshi-virtual-machine: /usr/bin
# /etc/profile: system-wide .profile file for the Bourne shell (sh(1))
# and Bourne compatible shells (bash(1), ksh(1), ash(1), ...).

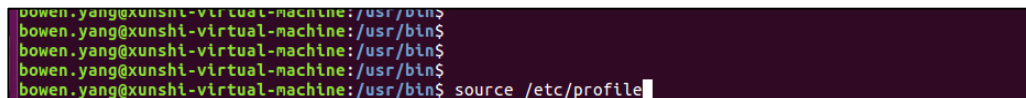
if [ "$PS1" ]; then
  if [ "$BASH" ] && [ "$BASH" != "/bin/sh" ]; then
    # The file bash.bashrc already sets the default PS1.
    # PS1='\h:\w\$ '
    if [ -f /etc/bash.bashrc ]; then
      . /etc/bash.bashrc
    fi
  else
    if [ "`id -u`" -eq 0 ]; then
      PS1='# '
    else
      PS1='$ '
    fi
  fi
fi

if [ -d /etc/profile.d ]; then
  for i in /etc/profile.d/*.sh; do
    if [ -r $i ]; then
      . $i
    fi
  done
unset i
fi

export TPATH=/usr/bin/gcc-arm-none-eabi-4_9-2015q3/bin:$PATH
  
```

Then input command "source /etc/profile" make the environment variable effective. The Ubuntu VM dose not need to be restarted.

**Figure 2-11. make the environment variable effective**

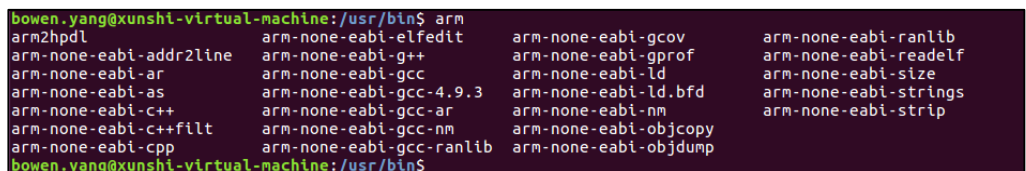


```

bowen.yang@xunshi-virtual-machine: /usr/bin$
bowen.yang@xunshi-virtual-machine: /usr/bin$
bowen.yang@xunshi-virtual-machine: /usr/bin$
bowen.yang@xunshi-virtual-machine: /usr/bin$
bowen.yang@xunshi-virtual-machine: /usr/bin$ source /etc/profile
  
```

After finishing, input command "arm" with the tab key, is successful if the tool chain list is display. shown in [Figure 2-12. toolchain list](#) here is arm-none-eabi-gcc and arm-none-eabi-objcopy we needed.

**Figure 2-12. toolchain list**



```

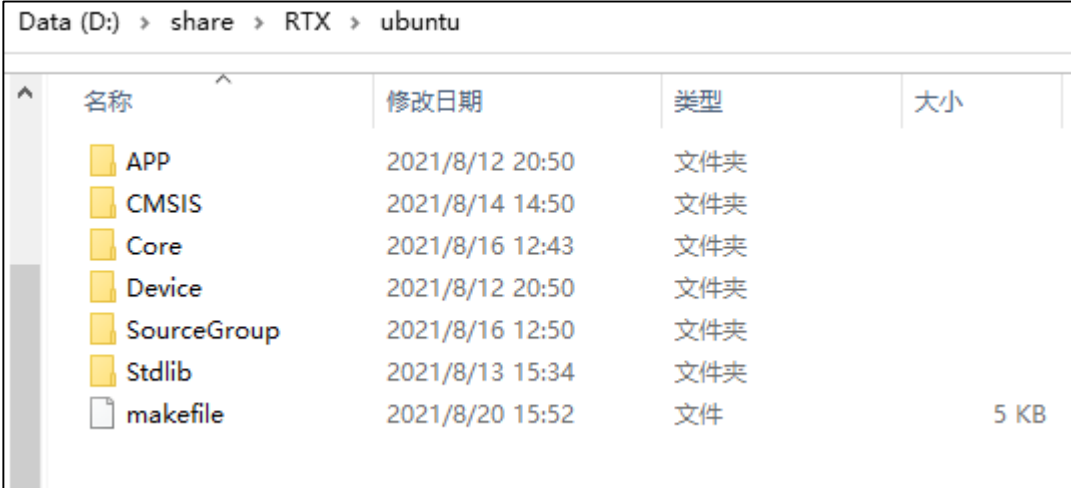
bowen.yang@xunshi-virtual-machine: /usr/bin$ arm
arm2hpd1          arm-none-eabi-elfedit      arm-none-eabi-gcov        arm-none-eabi-ranlib
arm-none-eabi-addr2line  arm-none-eabi-g++         arm-none-eabi-gprof      arm-none-eabi-readelf
arm-none-eabi-ar       arm-none-eabi-gcc         arm-none-eabi-ld         arm-none-eabi-size
arm-none-eabi-as       arm-none-eabi-gcc-4.9.3   arm-none-eabi-ld.bfd     arm-none-eabi-strings
arm-none-eabi-c++      arm-none-eabi-gcc-ar      arm-none-eabi-nm         arm-none-eabi-strip
arm-none-eabi-c++filt  arm-none-eabi-gcc-nm     arm-none-eabi-objcopy
arm-none-eabi-cpp      arm-none-eabi-gcc-ranlib  arm-none-eabi-objdump
bowen.yang@xunshi-virtual-machine: /usr/bin$
  
```

### 3. Create project

#### 3.1. Create project directory

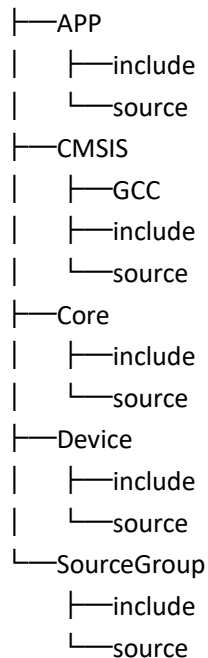
Place the code that needs to be compiled below the path D:\share\RTX\ubuntu, shown in [Figure 3-1. project code directory](#).

**Figure 3-1. project code directory**



名称	修改日期	类型	大小
APP	2021/8/12 20:50	文件夹	
CMSIS	2021/8/14 14:50	文件夹	
Core	2021/8/16 12:43	文件夹	
Device	2021/8/12 20:50	文件夹	
SourceGroup	2021/8/16 12:50	文件夹	
Stdlib	2021/8/13 15:34	文件夹	
makefile	2021/8/20 15:52	文件	5 KB

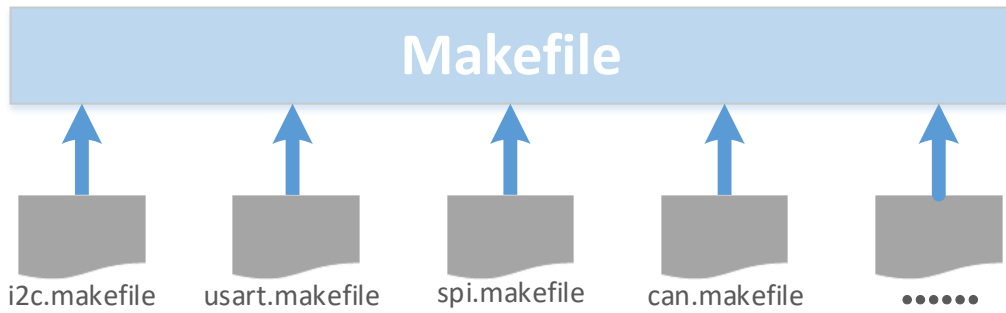
The directory structure is shown below, every directory needed a makefile.



#### 3.2. Makefile writing

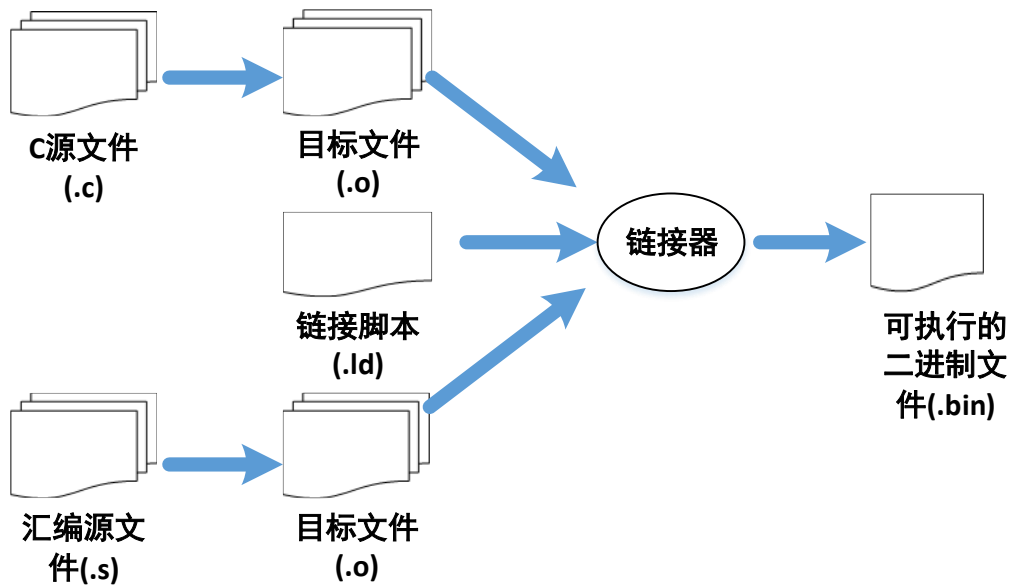
Use top-level makefile to manager makefile in subdirectories, shown in [Figure 3-2. makefile graphical](#).

Figure 3-2. makefile graphical



The compilation processs shown in [Figure 3-3. compilation flow chart.](#)

Figure 3-3. compilation flow chart



Top-level makefile edit an below:

Table 3-1. top-level makefile edit

CROSS_COMPILE	= arm-none-eabi-
CC	= \$(CROSS_COMPILE)gcc
OBJCOPY	= \$(CROSS_COMPILE)objcopy
TOP	=\$(shell pwd)
INC_FLAGS	= -I\$(TOP)/Device/include \ -I\$(TOP)/Core/include \ -I\$(TOP)/APP/include \ -I\$(TOP)/Stdlib/include \ -I\$(TOP)/CMSIS/include
CC_FLAGS	= -W -Wall -g -mcpu=cortex-m4 -mthumb -D GD32F30X_HD -D USE_STDPERIPH_DRIVER \$(INC_FLAGS) -O0 -std=gnu11

```

CC_ASM_FLAGS = -mthumb -mcpu=cortex-m4 -g -Wa,--warn

CC_LD_FLAGS += -mthumb -mcpu=cortex-m4
CC_LD_FLAGS += -Wl,--start-group -lc -lm -Wl,--end-group -specs=nosys.specs -static -Wl,-cref,-
u,Reset_Handler-Wl,-Map=RTX_Project.map-Wl,--gc-sections-Wl,--
defsym=malloc_getpagesize_P=0x80

LD_PATH = -TDevice/source/gd32f30x_flash.ld
#Indicates whether the module participates in compilation
SUPPORT_IIC = yes
SUPPORT_SPI = yes
SUPPORT_CAN = yes
SUPPORT_KEY = no
#Specify the source file to compile
include APP/source/sub.mak
include CMSIS/source/sub.mak
include Device/source/sub.mak
include SourceGroup/source/sub.mak

TARGET = RTX_Project

.PHONY: clean all
#replace with.o
C_OBJ = $(C_SRC:%.c=%o)
ASM_OBJ = $(ASM_SRC:%.s=%o)

all:$(C_OBJ) $(ASM_OBJ)
    $(CC) $(C_OBJ) $(ASM_OBJ) $(LD_PATH) -o $(TARGET).elf $(CC_LD_FLAGS)
    $(OBJCOPY) $(TARGET).elf $(TARGET).bin -Obinary

%.o:%.c
    $(CC) -c $(CC_FLAGS) -o $$@ $$<

%.o:%.s
    $(CC) -c $(CC_ASM_FLAGS) -o $$@ $$<

clean:
    rm -rf *.o $(C_OBJ) $(ASM_OBJ) $(TARGET) *.bin *.map *.elf

```

Create sub.mak file in each source directory of APP, CMSIS, Core, Device, SourceGroup directory, all sub.mak files are written an the same way, just introduce the sub.mak of directory CMSIS/source as below:

**Figure 3-4. sub.mak folder**

Data (D:) > share > RTX > ubuntu > CMSIS > source				
名称	修改日期	类型	大小	
os_systick.c	2021/8/13 20:42	C 文件	4 KB	
RTX_Config.c	2019/3/18 12:00	C 文件	2 KB	
rtx_delay.c	2019/3/18 15:50	C 文件	3 KB	
rtx_evflags.c	2019/3/18 15:50	C 文件	18 KB	
rtx_evr.c	2019/3/18 15:50	C 文件	79 KB	
rtx_kernel.c	2021/8/13 20:44	C 文件	20 KB	
rtx_lib.c	2019/3/18 15:50	C 文件	26 KB	
rtx_memory.c	2021/8/13 20:46	C 文件	7 KB	
rtx_mempool.c	2019/3/18 11:59	C 文件	23 KB	
rtx_msgqueue.c	2019/3/18 15:50	C 文件	32 KB	
rtx_mutex.c	2019/3/18 15:50	C 文件	17 KB	
rtx_semaphore.c	2019/3/18 11:59	C 文件	16 KB	
rtx_system.c	2019/3/18 15:50	C 文件	6 KB	
rtx_thread.c	2021/8/13 20:47	C 文件	58 KB	
rtx_timer.c	2021/8/13 20:48	C 文件	13 KB	
sub.mak	2021/8/19 17:46	MAK 文件	1 KB	

Specifies the file in this directory to compile in sub.mak. shown as below:

**Table 3-2. Subdirectory sub.mak**

```

CMSIS_PATH = CMSIS/source
C_SRC += $(CMSIS_PATH)/os_systick.c \
          $(CMSIS_PATH)/RTX_Config.c \
          $(CMSIS_PATH)/rtx_delay.c \
          $(CMSIS_PATH)/rtx_evflags.c \
          $(CMSIS_PATH)/rtx_evr.c \
          $(CMSIS_PATH)/rtx_kernel.c \
          $(CMSIS_PATH)/rtx_lib.c \
          $(CMSIS_PATH)/rtx_memory.c \
          $(CMSIS_PATH)/rtx_mempool.c \
          $(CMSIS_PATH)/rtx_msgqueue.c \
          $(CMSIS_PATH)/rtx_mutex.c \
          $(CMSIS_PATH)/rtx_semaphore.c \
          $(CMSIS_PATH)/rtx_system.c \
          $(CMSIS_PATH)/rtx_thread.c \
          $(CMSIS_PATH)/rtx_timer.c

ifeq ($(SUPPORT_KEY), yes)
C_SRC += $(AUDIO_PATH)/rtx_keymanager.c
endif

```

```
ASM_SRC += $(CMSIS_PATH)/../GCC/irq_cm3.s
```

### 3.3. Compile and test

input command “make” in the directory where the top-level makefile are.

**Figure 3-5. make result**

```
-o Device/source/system_gd32f30x.o Device/source/system_gd32f30x.c
In file included from /mnt/hgfs/share-2/RTX/ubuntu/Core/include/core_cm4.h:188:0,
    from /mnt/hgfs/share-2/RTX/ubuntu/Device/include/gd32f30x.h:258,
    from Device/source/system_gd32f30x.c:36:
/mnt/hgfs/share-2/RTX/ubuntu/Core/include/core_cmFunc.h: In function '__set_FPSCR':
/mnt/hgfs/share-2/RTX/ubuntu/Core/include/core_cmFunc.h:592:78: warning: unused parameter 'fpscr' [-Wunused-parameter]
__attribute__((always_inline)) __STATIC_INLINE void __set_FPSCR(uint32_t fpscr)
    ^
编译.o目标文件
arm-none-eabi-gcc -c -W -Wall -g -mcpu=cortex-m4 -mthumb -D GD32F30X_HD -D USE_STDPERIPH_DRIVER -I/mnt/hgfs/share-2/RTX/ubuntu/Device/include -I/mnt/hgfs/share-2/RTX/ubuntu/Core/include -I/mnt/hgfs/share-2/RTX/ubuntu/AP
P/include -I/mnt/hgfs/share-2/RTX/ubuntu/Stdlib/include -I/mnt/hgfs/share-2/RTX/ubuntu/CMSIS/include -O0 -std=gnu11
-o SourceGroup/source/main.o SourceGroup/source/main.c
In file included from /mnt/hgfs/share-2/RTX/ubuntu/Core/include/core_cm4.h:188:0,
    from /mnt/hgfs/share-2/RTX/ubuntu/Device/include/gd32f30x.h:258,
    from SourceGroup/source/main.c:6:
/mnt/hgfs/share-2/RTX/ubuntu/Core/include/core_cmFunc.h: In function '__set_FPSCR':
/mnt/hgfs/share-2/RTX/ubuntu/Core/include/core_cmFunc.h:592:78: warning: unused parameter 'fpscr' [-Wunused-parameter]
__attribute__((always_inline)) __STATIC_INLINE void __set_FPSCR(uint32_t fpscr)
    ^
SourceGroup/source/main.c: In function 'app_main':
SourceGroup/source/main.c:17:22: warning: unused parameter 'argument' [-Wunused-parameter]
void app_main(void *argument) {
    ^
arm-none-eabi-gcc -c -mthumb -mcpu=cortex-m4 -g -Wa,--warn -o CMSIS/source/./GCC/irq_cm3.o CMSIS/sourc
e/./GCC/irq_cm3.s
arm-none-eabi-gcc -c -mthumb -mcpu=cortex-m4 -g -Wa,--warn -o Device/source/startup_gd32f30x_hd.o Devic
e/source/startup_gd32f30x_hd.s
格式转换为bin文件
arm-none-eabi-gcc APP/source/gd32f307c_eval.o CMSIS/source/os_systick.o CMSIS/source/RTX_Config.o CMSIS/
source/rtx_delay.o CMSIS/source/rtx_evflags.o CMSIS/source/rtx_evr.o CMSIS/source/rtx_kernel.o CMSIS/source/rtx_lib
.o CMSIS/source/rtx_memory.o CMSIS/source/rtx_mempool.o CMSIS/source/rtx_msgqueue.o CMSIS/source/rtx_mutex.o CMSIS/
source/rtx_semaphore.o CMSIS/source/rtx_system.o CMSIS/source/rtx_thread.o CMSIS/source/rtx_timer.o Device/source/g
d32f30x_eval.o Device/source/gd32f30x_gpio.o Device/source/gd32f30x_rcu.o Device/source/system_gd32f30x.o SourceGro
up/source/main.o CMSIS/source/./GCC/irq_cm3.o Device/source/startup_gd32f30x_hd.o -TDevice/source/gd32f30x_flash.
ld -o RTX_Project.elf -mthumb -mcpu=cortex-m4 -WL,--start-group -lc -lm -WL,--end-group -specs=nosys.specs -static
-WL,-cref,-u,Reset_Handler -WL,-Map=RTX_Project.map -WL,--gc-sections -WL,--defsym=malloc_getpagesize_P=0x80
arm-none-eabi-objcopy RTX_Project.elf RTX_Project.bin -Obinary
root@xunshi-virtual-machine: /mnt/hgfs/share-2/RTX/ubuntu#
```

The top-level makefile folder will generate .bin file, .elf file and .map file.

**Figure 3-6. top-level makefile folder**

名称	修改日期	类型	大小
APP	2021/8/12 20:50	文件夹	
CMSIS	2021/8/14 14:50	文件夹	
Core	2021/8/16 12:43	文件夹	
Device	2021/8/12 20:50	文件夹	
SourceGroup	2021/8/16 12:50	文件夹	
makefile	2021/8/20 16:55	文件	5 KB
RTX_Project.bin	2021/8/20 18:40	BIN 文件	42 KB
RTX_Project.elf	2021/8/20 18:40	ELF 文件	330 KB
RTX_Project.map	2021/8/20 18:40	MAP 文件	216 KB

Input command “make clean” in top-level makefile folder, the .bin file, .elf file and .map file is deleted.



**Figure 3-7. make clean result**

```
root@xunshi-virtual-machine:/mnt/hgfs/share-2/RTX/ubuntu# make clean
rm -rf *.o APP/source/gd32f307c_eval.o CMSIS/source/os_systick.o CMSIS/source/RTX_Config.o CMSIS/source/rtx_delay.o
CMSIS/source/rtx_evflags.o CMSIS/source/rtx_evr.o CMSIS/source/rtx_kernel.o CMSIS/source/rtx_lib.o CMSIS/source/rt
x_memory.o CMSIS/source/rtx_mempool.o CMSIS/source/rtx_msgqueue.o CMSIS/source/rtx_mutex.o CMSIS/source/rtx_semaphore.o CMSIS/source/rtx_system.o CMSIS/source/rtx_thread.o CMSIS/source/rtx_timer.o Device/source/gd32f30x_eval.o Device/source/gd32f30x_gpio.o Device/source/gd32f30x_rcu.o Device/source/system_gd32f30x.o SourceGroup/source/main.o CMSIS/source/./GCC/irq_cm3.o Device/source/startup_gd32f30x_hd.o RTX_Project *.bin *.map *.elf
root@xunshi-virtual-machine:/mnt/hgfs/share-2/RTX/ubuntu#
```

Finally, we can use SEGGER J-Flash download the firmware to mcu for test. The LED is working.

## 4. Revision history

Table 4-1. Revision history

Revision No.	Description	Date
1.0	Initial Release	Aug.26, 2021

## Important Notice

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