GigaDevice Semiconductor Inc.

Arm® Cortex®-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
- Compile environment: ubuntu16.04
- Tool chain: gcc-arm-none-eabi, gcc-arm-none-objcopy
- Programming 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. 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".
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**

![Ubuntu vm installation wizard 7](image)

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

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

After finishing, input command "arm" with the tab key, is successful if the tool chain list is displaye. 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
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**

<table>
<thead>
<tr>
<th>名称</th>
<th>修改日期</th>
<th>类型</th>
<th>大小</th>
</tr>
</thead>
<tbody>
<tr>
<td>APP</td>
<td>2021/8/12 20:50</td>
<td>文件夹</td>
<td></td>
</tr>
<tr>
<td>CMSIS</td>
<td>2021/8/14 14:50</td>
<td>文件夹</td>
<td></td>
</tr>
<tr>
<td>Core</td>
<td>2021/8/16 12:43</td>
<td>文件夹</td>
<td></td>
</tr>
<tr>
<td>Device</td>
<td>2021/8/12 20:50</td>
<td>文件夹</td>
<td></td>
</tr>
<tr>
<td>SourceGroup</td>
<td>2021/8/16 12:50</td>
<td>文件夹</td>
<td></td>
</tr>
<tr>
<td>Stdlib</td>
<td>2021/8/13 15:34</td>
<td>文件夹</td>
<td></td>
</tr>
<tr>
<td><strong>makefile</strong></td>
<td>2021/8/20 15:52</td>
<td>文件</td>
<td>5 KB</td>
</tr>
</tbody>
</table>

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

```
├── APP
│   ├── include
│   └── source
├── CMSIS
│   ├── GCC
│   │   ├── include
│   │   └── source
│   └── Core
│       ├── include
│       └── source
├── Device
│   ├── include
│   └── source
└── SourceGroup
    ├── include
    └── source
```

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

Makefile

i2c.makefile  usart.makefile  spi.makefile  can.makefile  

The compilation processes shown in Figure 3-3. compilation flow chart.

Figure 3-3. compilation flow chart

C source files (.c) → target files (.o) → linker → executable binary (.bin)

Linker

C source files (.c)

Assemble source files (.s) → target files (.o)

Top-level makefile edit an below:

Table 3-1. top-level makefile edit

<table>
<thead>
<tr>
<th>CROSS_COMPILE</th>
<th>arm-none-eabi-</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC</td>
<td>$(CROSS_COMPILE)gcc</td>
</tr>
<tr>
<td>OBJCOPY</td>
<td>$(CROSS_COMPILE)objcopy</td>
</tr>
<tr>
<td>TOP</td>
<td>$(shell pwd)</td>
</tr>
</tbody>
</table>
| INC_FLAGS           | -I$(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 -lIm -lWl,--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 in the same way, just introduce the sub.mak of directory CMSIS/source as below:
Figure 3-4. sub.mak folder

<table>
<thead>
<tr>
<th>名称</th>
<th>修改日期</th>
<th>类型</th>
<th>大小</th>
</tr>
</thead>
<tbody>
<tr>
<td>os_systick.c</td>
<td>2021/8/13 20:42</td>
<td>C文件</td>
<td>4 KB</td>
</tr>
<tr>
<td>RTX_Config.c</td>
<td>2019/3/18 12:00</td>
<td>C文件</td>
<td>2 KB</td>
</tr>
<tr>
<td>rtx_delay.c</td>
<td>2019/3/18 15:50</td>
<td>C文件</td>
<td>3 KB</td>
</tr>
<tr>
<td>rtx_evflags.c</td>
<td>2019/3/18 15:50</td>
<td>C文件</td>
<td>18 KB</td>
</tr>
<tr>
<td>rtx_evrc.c</td>
<td>2019/3/18 15:50</td>
<td>C文件</td>
<td>79 KB</td>
</tr>
<tr>
<td>rtx_kernel.c</td>
<td>2021/8/13 20:44</td>
<td>C文件</td>
<td>20 KB</td>
</tr>
<tr>
<td>rtx_lib.c</td>
<td>2019/3/18 15:50</td>
<td>C文件</td>
<td>26 KB</td>
</tr>
<tr>
<td>rtx_memory.c</td>
<td>2021/8/13 20:46</td>
<td>C文件</td>
<td>7 KB</td>
</tr>
<tr>
<td>rtx_mempool.c</td>
<td>2019/3/18 11:59</td>
<td>C文件</td>
<td>23 KB</td>
</tr>
<tr>
<td>rtx_msgqueue.c</td>
<td>2019/3/18 15:50</td>
<td>C文件</td>
<td>32 KB</td>
</tr>
<tr>
<td>rtx_mutex.c</td>
<td>2019/3/18 15:50</td>
<td>C文件</td>
<td>17 KB</td>
</tr>
<tr>
<td>rtx_semaphore.c</td>
<td>2019/3/18 11:59</td>
<td>C文件</td>
<td>16 KB</td>
</tr>
<tr>
<td>rtx_system.c</td>
<td>2019/3/18 15:50</td>
<td>C文件</td>
<td>6 KB</td>
</tr>
<tr>
<td>rtx_thread.c</td>
<td>2021/8/13 20:47</td>
<td>C文件</td>
<td>58 KB</td>
</tr>
<tr>
<td>rtx_timer.c</td>
<td>2021/8/19 17:46</td>
<td>MAK文件</td>
<td>1 KB</td>
</tr>
</tbody>
</table>

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

Table 3-2. Subdirectory sub.mak

```make
CMSIS_PATH = CMSIS/source
C_SRC += $(CMSIS_PATH)/os_systick.c \$(CMSIS_PATH)/RTX_Config.c \$(CMSIS_PATH)/rtx_delay.c \$(CMSIS_PATH)/rtx_evflags.c \$(CMSIS_PATH)/rtx_evrc.c \$(CMSIS_PATH)/rtx_kernel.c \$(CMSIS_PATH)/rtx_lib.c \$(CMSIS_PATH)/rtx_memory.c \$(CMSIS_PATH)/rtx_mempool.c \$(CMSIS_PATH)/rtx_msgqueue.c \$(CMSIS_PATH)/rtx_mutex.c \$(CMSIS_PATH)/rtx_semaphore.c \$(CMSIS_PATH)/rtx_system.c \$(CMSIS_PATH)/rtx_thread.c \$(CMSIS_PATH)/rtx_timer.c
ifdef ($(SUPPORT_KEY), yes)
C_SRC += $(AUDIO_PATH)/rtx_keymanager.c
eendif
```
3.3. Compile and test

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

Figure 3-5. make result

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

Figure 3-6. top-level makefile folder

Input command “make clean” in top-level makefile folder, the .bin file, .elf file and .map file is deleted.
Finally, we can use SEGGR J-Flash download the firmware to mcu for test. The LED is working.
4. Revision history

Table 4-1. Revision history

<table>
<thead>
<tr>
<th>Revision No.</th>
<th>Description</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Initial Release</td>
<td>Aug.26, 2021</td>
</tr>
</tbody>
</table>
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