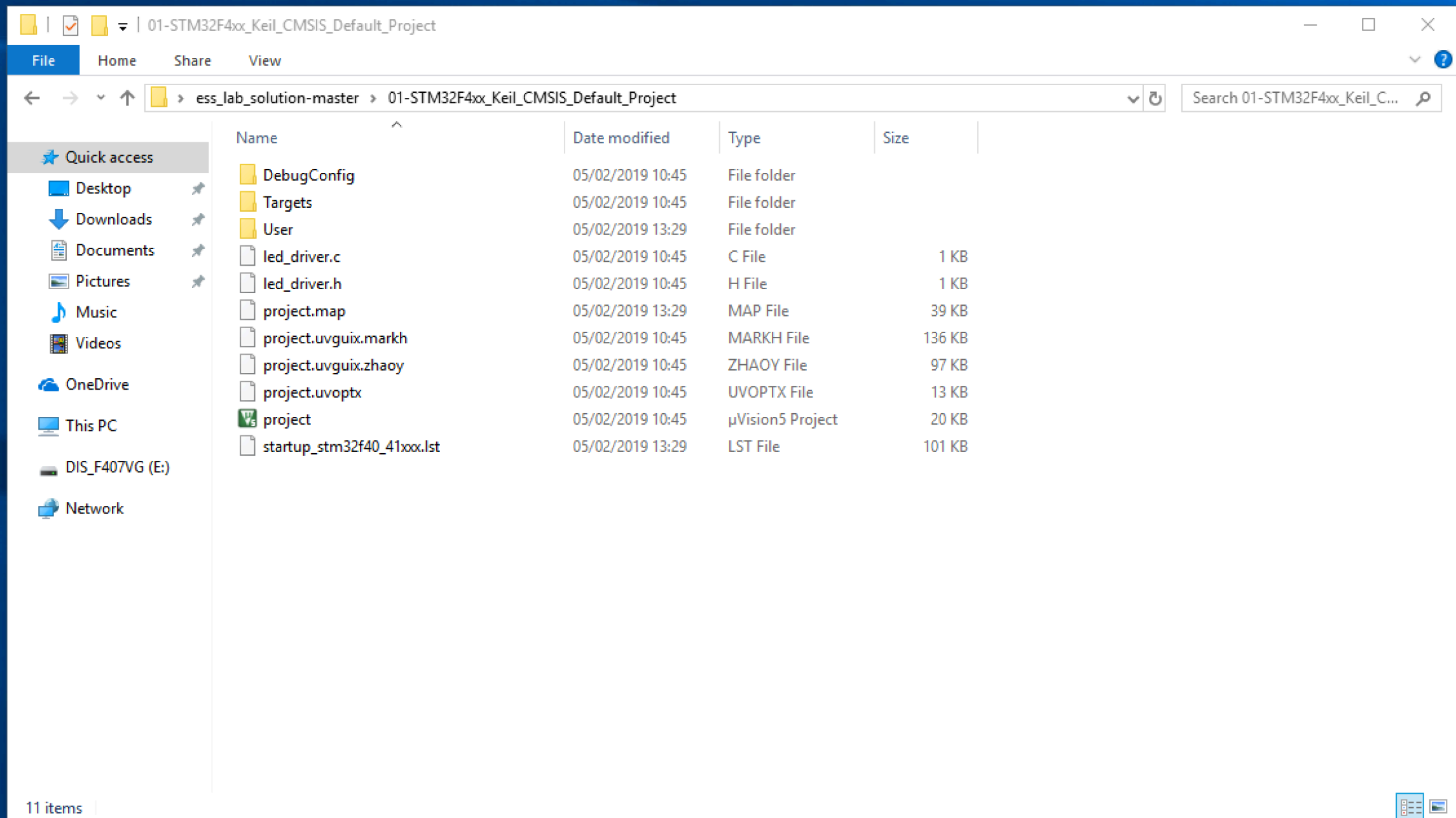Project

Project: project
- STM32F4-Discovery
  - CMSIS
    - stm32f4xx.h
    - system_stm32f4xx.h
  - Startup
    - startup_stm32f40_41xxx.s
  - STD_Periph_Drivers
    - misc.c
    - stm32f4xx_rcc.c
    - stm32f4xx_gpio.c
  - ESS
    - ess_helper.h
    - ess_helper.c
    - led_driver.h
    - led_driver.c
  - User
    - main.c
    - stm32f4xx_conf.h
    - stm32f4xx_it.c
    - stm32f4xx_it.h
    - system_stm32f4xx.c

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ess_lab_solution-master > 01-STM32F4xx_Keil_CMSIS_Default_Project

Search 01-STM32F4xx_Keil_C...

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DIS_F407VG (E:)

Network

Name	Date modified	Type	Size
DebugConfig	05/02/2019 10:45	File folder	
Targets	05/02/2019 10:45	File folder	
User	05/02/2019 13:29	File folder	
led_driver.c	05/02/2019 10:45	C File	1 KB
led_driver.h	05/02/2019 10:45	H File	1 KB
project.map	05/02/2019 13:29	MAP File	39 KB
project.uvguix.markh	05/02/2019 10:45	MARKH File	136 KB
project.uvguix.zhaoy	05/02/2019 10:45	ZHAOY File	97 KB
project.uvoptx	05/02/2019 10:45	UVOPTX File	13 KB
project	05/02/2019 10:45	µVision5 Project	20 KB
startup_stm32f40_41xxx.lst	05/02/2019 13:29	LST File	101 KB

11 items

Options for Target 'STM32F4-Discovery' ✕

Device | Target | Output | Listing | User | C/C++ | Asm | Linker | Debug | Utilities

Preprocessor Symbols

Define: STM32F40_41xxx,USE_STDPERIPH_DRIVER,STM32F4XX,KEIL_IDE,TM_DISCO_STM32F4_DISCOV

Undefine:

Language / Code Generation

☐ Execute-only Code

Optimization: `<default>` ▼

☐ Optimize for Time

☐ Split Load and Store Multiple

☐ One ELF Section per Function

☐ Strict ANSI C

☐ Enum Container always int

☐ Plain Char is Signed

☐ Read-Only Position Independent

☐ Read-Write Position Independent

Warnings: `<unspecified>` ▼

☐ Thumb Mode

☐ No Auto Includes

☐ C99 Mode

Include Paths: .\User;..\00-STM32F429_LIBRARIES;..\00-STM32F4xx_STANDARD_PERIPHERAL_DRIVERS\ST ...

Misc Controls:

Compiler control string: -c --cpu Cortex-M4.fp -D__EVAL -D__MICROLIB -g -O2 --apcs=interwork -I STM32F429_LIBRARIES -I ../00-

[OK] [Cancel] [Defaults]

Folder Setup ? ✕

Setup Compiler Include Paths: 🔆 ✕ ↑ ↓

```
.\User
..\00-STM32F429_LIBRARIES
..\00-STM32F4xx_STANDARD_PERIPHERAL_DRIVERS\STM32F4xx_StdPeriph_Driver\inc
..\00-STM32F4xx_STANDARD_PERIPHERAL_DRIVERS\STM32F4xx_StdPeriph_Driver\src
..\00-STM32F4xx_STANDARD_PERIPHERAL_DRIVERS\CMSIS\Device\ST\STM32F4xx\Ir
..\00-STM32F4xx_STANDARD_PERIPHERAL_DRIVERS\CMSIS\Device\ST\STM32F4xx\S
..\00-STM32F4xx_STANDARD_PERIPHERAL_DRIVERS\CMSIS\Include
..\ESS
.
```
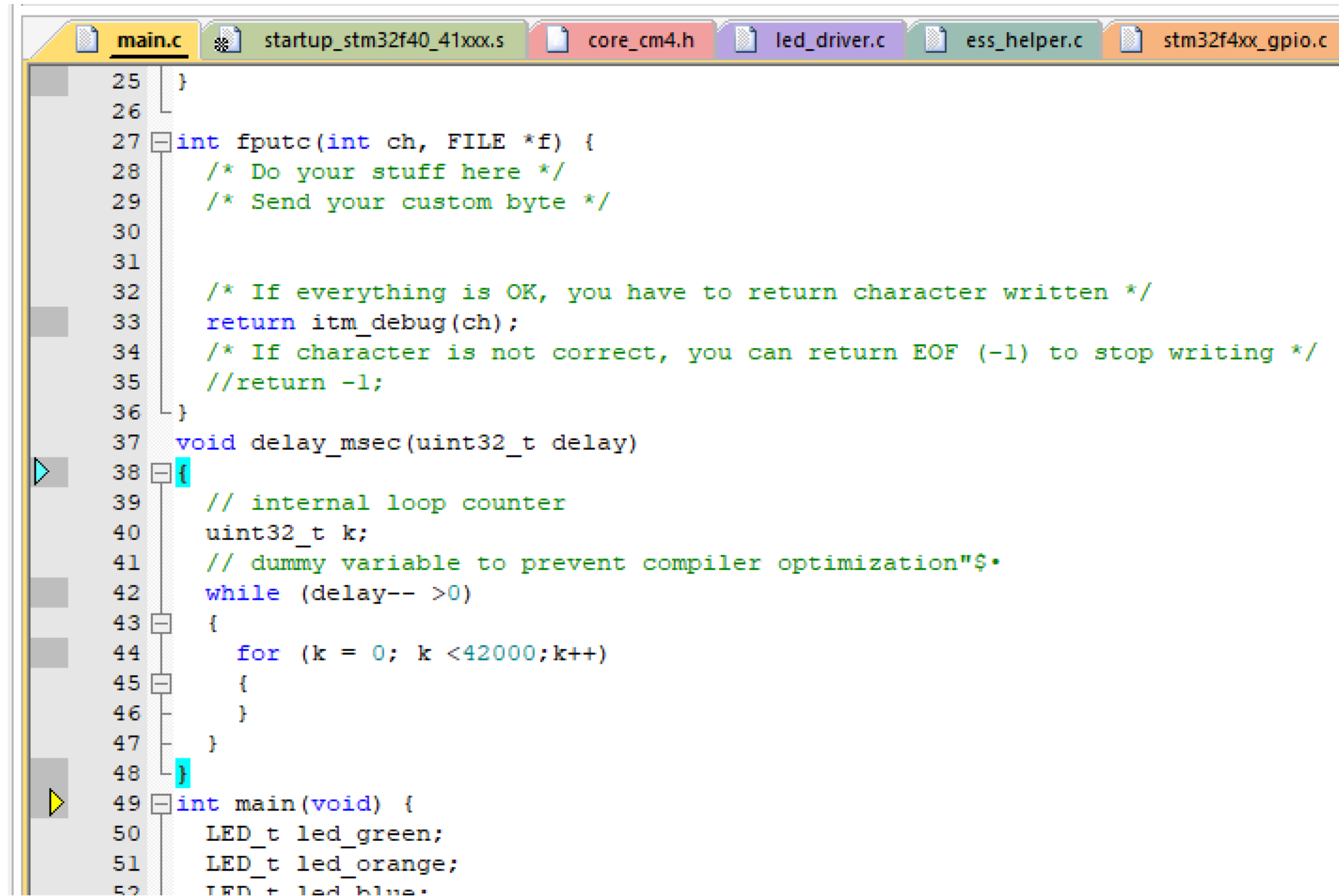
[OK] [Cancel]

Time Delay Function

```
main.c    startup_stm32f40_41xxx.s    core_cm4.h    led_driver.c    ess_helper.c    stm32f4xx_gpio.c

25    }
26
27    int fputc(int ch, FILE *f) {
28        /* Do your stuff here */
29        /* Send your custom byte */
30
31
32        /* If everything is OK, you have to return character written */
33        return itm_debug(ch);
34        /* If character is not correct, you can return EOF (-1) to stop writing */
35        //return -1;
36    }
37    void delay_msec(uint32_t delay)
38    {
39        // internal loop counter
40        uint32_t k;
41        // dummy variable to prevent compiler optimization"$•
42        while (delay-- >0)
43        {
44            for (k = 0; k <42000;k++)
45            {
46            }
47        }
48    }
49    int main(void) {
50        LED_t led_green;
51        LED_t led_orange;
52        LED_t led_blue;
```

Empirical Obs.

k = 10?
Too short!

k = 100,000?
Too long!

k= 50,000
close
k=…
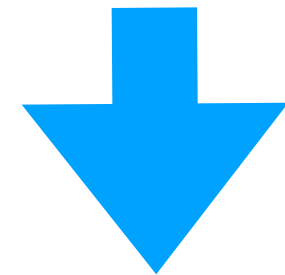
```
38: {
39:         // internal loop counter
40:         uint32_t k;
41:         // dummy variable to prevent compiler optimization"$•
0x0800090A E003      B          0x08000914
0x0800090C 2100      MOVS       r1,#0x00
0x0800090E 1C49      ADDS       r1,r1,#1
0x08000910 4291      CMP        r1,r2
0x08000912 D3FC      BCC        0x0800090E
0x08000914 1E40      SUBS       r0,r0,#1
42:         while (delay-- >0)
43:         {
44:                 for (k = 0; k <42000;k++)
45:                 {
46:                 }
47:         }
0x08000916 D2F9      BCS        0x0800090C
48: }
0x08000918 4770      BX         lr
49: int main(void) {
50:         LED_t led_green;
```
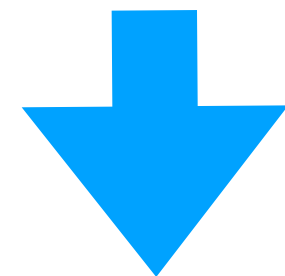
3 instructions
4 cycles
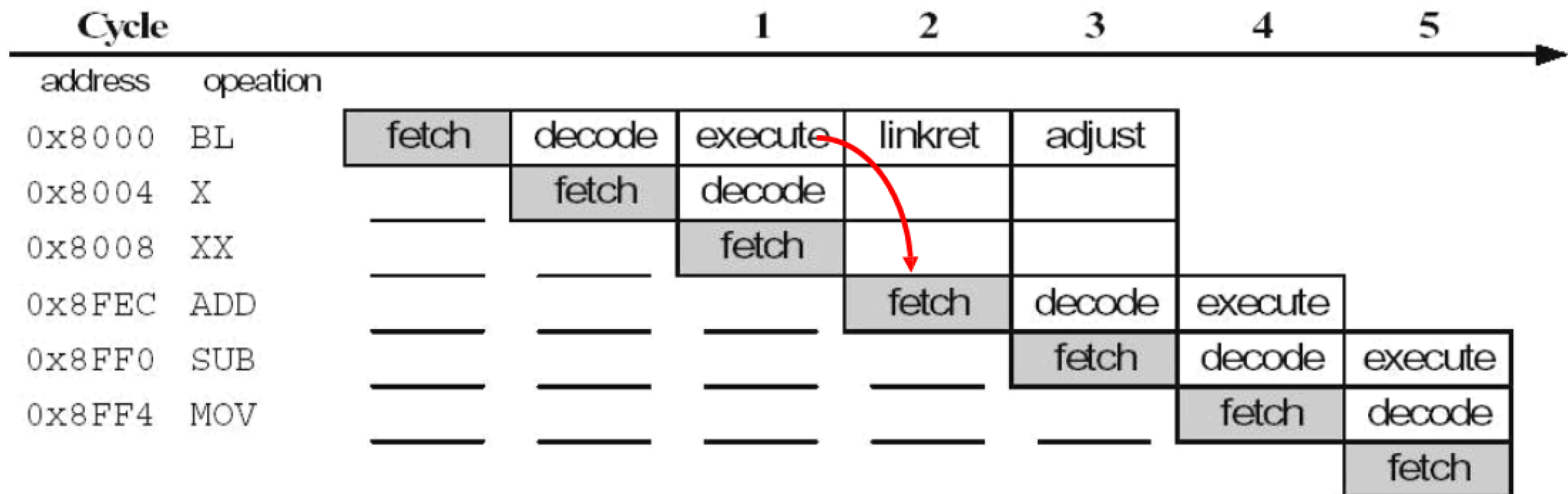
main.c   startup_stm32f40_41xxx.s   core_cm4.h   led_driver.c   ess_helper.c   stm32f4xx_gpio.c

```
25   }
26
27   int fputc(int ch, FILE *f) {
28       /* Do your stuff here */
29       /* Send your custom byte */
30
31
32       /* If everything is OK, you have to return character written */
33       return itm_debug(ch);
34       /* If character is not correct, you can return EOF (-1) to stop writing */
35       //return -1;
36   }
37   void delay_msec(uint32_t delay)
38   {
39       // internal loop counter
40       uint32_t k;
41       // dummy variable to prevent compiler optimization"$•
42       while (delay-- >0)
43       {
44           for (k = 0; k <42000;k++)
45           {
46           }
47       }
48   }
49   int main(void) {
50       LED_t led_green;
51       LED_t led_orange;
```

Cortex™-M4 core running at **168** MHz.

1 loop = 4 cycles

k = 168,000 / 4
= **42,000**

Branch Pipeline Example

Cycle			1	2	3	4	5
address	opeation						
0x8000	BL	fetch	decode	execute	linkret	adjust		
0x8004	X		fetch	decode				
0x8008	XX			fetch				
0x8FEC	ADD				fetch	decode	execute	
0x8FF0	SUB					fetch	decode	execute
0x8FF4	MOV						fetch	decode
							fetch

Solution On Github

https://github.com/zhaoymn/ess_lab