Unit3_Lesson(3)

write codes

main.c

```c
typedef volatile unsigned int  vuint32;

#define RCC_Base   0x40021000
#define GPIOPA_Base   0x40010800

#define RCC_APB2ENR    *(vuint32*)(RCC_Base+0x18)
#define GPIO_PA_CRH    *(vuint32*)(GPIOPA_Base+0x04)


#define SetClock   (1<<2)

typedef union{
    vuint32 all;
    struct{
        vuint32 reserved: 13;
        vuint32 pin13: 1;
    }pin;
}P_IN;

volatile P_IN* ptr = (volatile P_IN*)(GPIOPA_Base+0x0c);
int main(void)
{
    RCC_APB2ENR|=SetClock;
    GPIO_PA_CRH &= 0xff0fffff;
    GPIO_PA_CRH|=  0x00200000;
    while(1){
        ptr->pin.pin13=1;
        for(int i=0 ;i<50000;i++);
        ptr->pin.pin13=0;
        for(int i=0 ;i<50000;i++);
    }

}
```

startUp.c

```c
/* learn-in-depth
    Unit3_lesson3
    Eng\ Hazem Abd El-Halim
    */

#include <stdint.h>

extern uint32_t _stack_top ;
extern int main(void);

void reset_handler(void);

void default_handler(){
    reset_handler();
}

void NMI_handler(void)  __attribute__((weak,alias("default_handler")));;
void H_fault_handler(void)  __attribute__((weak,alias("default_handler")));;
void MM_fault_handler(void) __attribute__((weak,alias("default_handler")));;
void Bus_fault(void)    __attribute__((weak,alias("default_handler")));;
void Usage_fault_handler(void)  __attribute__((weak,alias("default_handler")));;

uint32_t vectors[]   __attribute__((section(".vectors"))) ={
        (uint32_t)  &_stack_top,
        (uint32_t) &reset_handler,
        (uint32_t) &NMI_handler,
        (uint32_t) &H_fault_handler,
        (uint32_t) &MM_fault_handler,
        (uint32_t) &Bus_fault,
        (uint32_t) &Usage_fault_handler
};

extern uint32_t _E_text ;
extern uint32_t _S_data ;
extern uint32_t _E_data ;
extern uint32_t _S_bss ;
extern uint32_t _E_bss ;

void reset_handler(){
    uint32_t Data_size = (unsigned char*)&_E_data - (unsigned char*)&_S_data ;
    unsigned char* p_src = (unsigned char*)&_E_text ;
    unsigned char* p_dest = (unsigned char*)&_S_data ;
    for(int i=0 ; i < Data_size ; i++){
        *((unsigned char*)p_dest++) =  *((unsigned char*)p_src++);
    }
    uint32_t Bss_size = (unsigned char*)&_E_data - (unsigned char*)&_S_data ;
    p_dest = (unsigned char*)&_S_bss ;
    for(int i=0 ; i < Bss_size ; i++){
        *((unsigned char*)p_dest++) =  (unsigned char)0 ;
    }


    main();

}
```

linker_script.ld

```
/* learn-in-depth
    Unit3_lesson3
    Eng\ Hazem Abd El-Halim
    */

MEMORY
{
flash (RX) : ORIGIN = 0x08000000, LENGTH = 128k
sram (RWX) : ORIGIN = 0x20000000, LENGTH = 20k
}

SECTIONS
{
    .text : {
            *(.vectors*)
            *(.text*)
            *(.rodata)
            _E_text = . ;
    } >flash

    .data : {
            _S_data = . ;
            *(.data)
            _E_data = . ;
    }> sram  AT> flash

    .bss : {
            _S_bss = . ;
            *(.bss*)
            _E_bss = . ;
            . = . + 0x1000 ;
            _stack_top = . ;
    } >sram
}
```

Makefile

```
CC=arm-none-eabi-
CFLAGS=-gdwarf-2 -mcpu=cortex-m3
INCS= -I .
LIBS=
SRC=$(wildcard *.c)
OBJ=$(SRC:.c=.o)
As_s=$(wildcard *.s)
As_o=$(As_s:.s=.o)
project_name= toggle_LED_cortexM3

all:$(project_name).bin

%.o: %.s
    $(CC)as.exe $(CFLAGS) $< -o $@

%.o: %.c
    $(CC)gcc.exe -c $(CFLAGS) $(INCS)  $< -o $@

$(project_name).elf: $(OBJ) $(As_o)
    $(CC)ld.exe -T linker_script.ld  $(LIBS) $(As_o)  $(OBJ)  -o  $@     -Map=Map_file.map

$(project_name).bin: $(project_name).elf
    $(CC)objcopy.exe -O binary $<  $@

clear_all:
    rm *.o *.elf *.bin
```

main.o

mingw32-make.exe main.o

startUp.o

mingw32-make.exe startUp.o

To show sections for object_file

main.o

```
$ arm-none-eabi-objdump.exe -h main.o

main.o:     file format elf32-littlearm

Sections:
Idx Name          Size      VMA       LMA       File off  Algn
  0 .text         0000007c  00000000  00000000  00000034  2**2
                  CONTENTS, ALLOC, LOAD, RELOC, READONLY, CODE
  1 .data         00000004  00000000  00000000  000000b0  2**2
                  CONTENTS, ALLOC, LOAD, DATA
  2 .bss          00000000  00000000  00000000  000000b4  2**0
                  ALLOC
  3 .debug_info   00000105  00000000  00000000  000000b4  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  4 .debug_abbrev 000000d3  00000000  00000000  000001b9  2**0
                  CONTENTS, READONLY, DEBUGGING
  5 .debug_loc    00000038  00000000  00000000  0000028c  2**0
                  CONTENTS, READONLY, DEBUGGING
  6 .debug_aranges 00000020  00000000  00000000  000002c4  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  7 .debug_line   00000056  00000000  00000000  000002e4  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  8 .debug_str    000000b1  00000000  00000000  0000033a  2**0
                  CONTENTS, READONLY, DEBUGGING
  9 .comment      0000007f  00000000  00000000  000003eb  2**0
                  CONTENTS, READONLY
 10 .debug_frame  0000002c  00000000  00000000  0000046c  2**2
                  CONTENTS, RELOC, READONLY, DEBUGGING
 11 .ARM.attributes 00000033  00000000  00000000  00000498  2**0
                  CONTENTS, READONLY
```

Startup.o

```
$ arm-none-eabi-objdump.exe -h startUp.o

startUp.o:     file format elf32-littlearm

Sections:
Idx Name          Size      VMA       LMA       File off  Algn
  0 .text         00000008  00000000  00000000  00000034  2**1
                  CONTENTS, ALLOC, LOAD, RELOC, READONLY, CODE
  1 .data         00000000  00000000  00000000  0000003c  2**0
                  CONTENTS, ALLOC, LOAD, DATA
  2 .bss          00000000  00000000  00000000  0000003c  2**0
                  ALLOC
  3 .vectors      00000050  00000000  00000000  0000003c  2**0
                  CONTENTS, RELOC, READONLY
  4 .debug_line   0000003b  00000000  00000000  0000008c  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  5 .debug_info   00000026  00000000  00000000  000000c7  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  6 .debug_abbrev 00000014  00000000  00000000  000000ed  2**0
                  CONTENTS, READONLY, DEBUGGING
  7 .debug_aranges 00000020  00000000  00000000  00000108  2**3
                  CONTENTS, RELOC, READONLY, DEBUGGING
  8 .debug_str    0000002a  00000000  00000000  00000128  2**0
                  CONTENTS, READONLY, DEBUGGING
  9 .ARM.attributes 00000021  00000000  00000000  00000152  2**0
                  CONTENTS, READONLY
```

To show symbol table for main.o and startUp.o

```
$ arm-none-eabi-nm.exe  main.o
00000000 T main
00000000 D ptr
```

```
$ arm-none-eabi-nm.exe  startUp.o
         U _E_data
         U _E_text
         U _S_bss
         U _S_data
         U _stack_top
00000000 W Bus_fault
00000000 T default_handler
00000000 W H_fault_handler
         U main
00000000 W MM_fault_handler
00000000 W NMI_handler
0000000c T reset_handler
00000000 W Usage_fault_handler
00000000 D vectors
```

use linker_script to get executable_file (toggle_LED_cortexM3.elf) and Map_file.map

mingw32-make-exe toggle_LED_cortexM3.elf

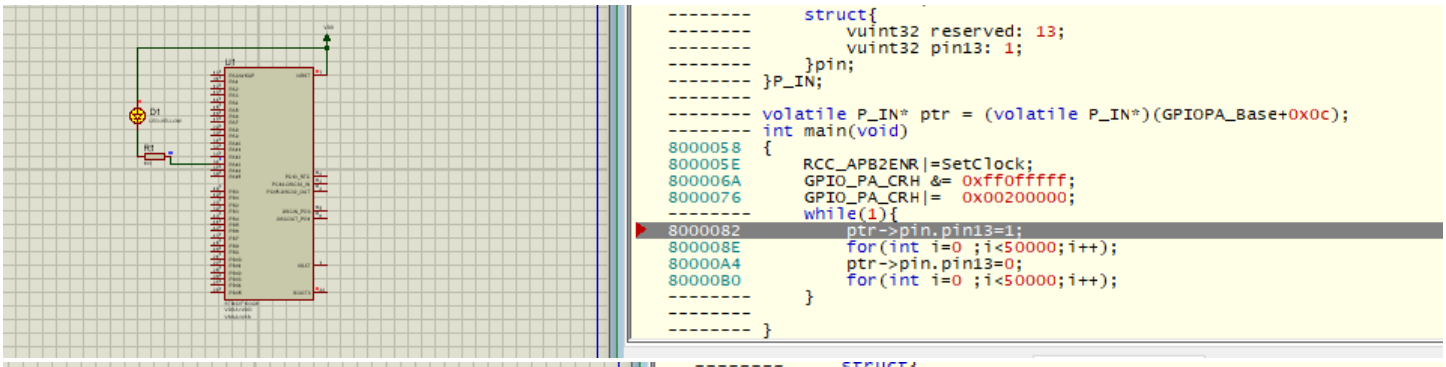
To show sections for toggle_LED_cortexM3.elf

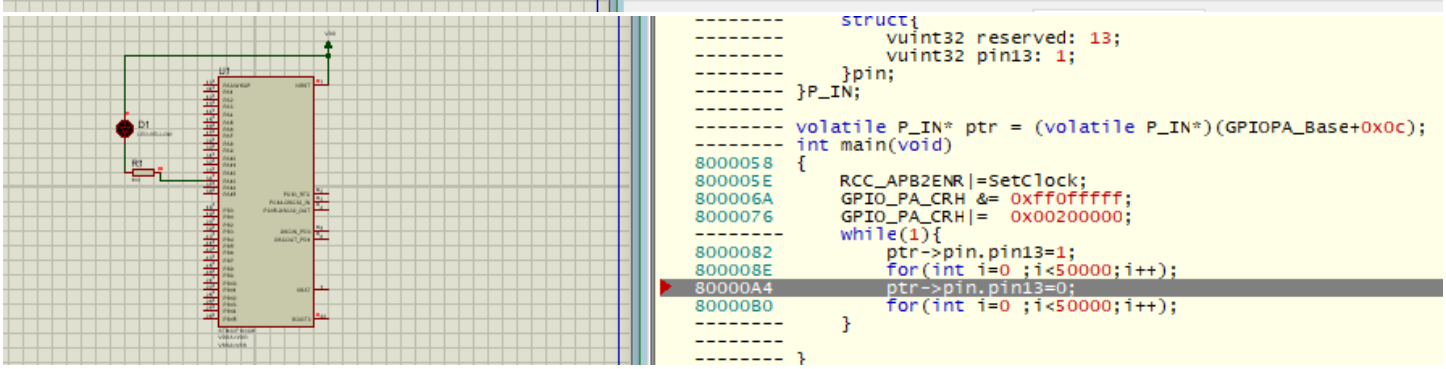
```
$ arm-none-eabi-objdump.exe -h toggle_LED_cortexM3.elf

toggle_LED_cortexM3.elf:     file format elf32-littlearm

Sections:
Idx Name          Size      VMA       LMA       File off  Algn
  0 .text         00000124  08000000  08000000  00010000  2**2
                  CONTENTS, ALLOC, LOAD, READONLY, CODE
  1 .data         00000004  20000000  08000124  00020000  2**2
                  CONTENTS, ALLOC, LOAD, DATA
  2 .bss          00001000  20000004  08000128  00020004  2**0
                  ALLOC
  3 .debug_info   00000295  00000000  00000000  00020004  2**0
                  CONTENTS, READONLY, DEBUGGING
  4 .debug_abbrev 000001a9  00000000  00000000  00020299  2**0
                  CONTENTS, READONLY, DEBUGGING
  5 .debug_loc    000000b4  00000000  00000000  00020442  2**0
                  CONTENTS, READONLY, DEBUGGING
  6 .debug_aranges 00000040  00000000  00000000  000204f6  2**0
                  CONTENTS, READONLY, DEBUGGING
  7 .debug_line   0000013e  00000000  00000000  00020536  2**0
                  CONTENTS, READONLY, DEBUGGING
  8 .debug_str    000001e2  00000000  00000000  00020674  2**0
                  CONTENTS, READONLY, DEBUGGING
  9 .comment      0000007e  00000000  00000000  00020856  2**0
                  CONTENTS, READONLY
 10 .ARM.attributes 00000033  00000000  00000000  000208d4  2**0
                  CONTENTS, READONLY
 11 .debug_frame  0000007c  00000000  00000000  00020908  2**2
                  CONTENTS, READONLY, DEBUGGING
```

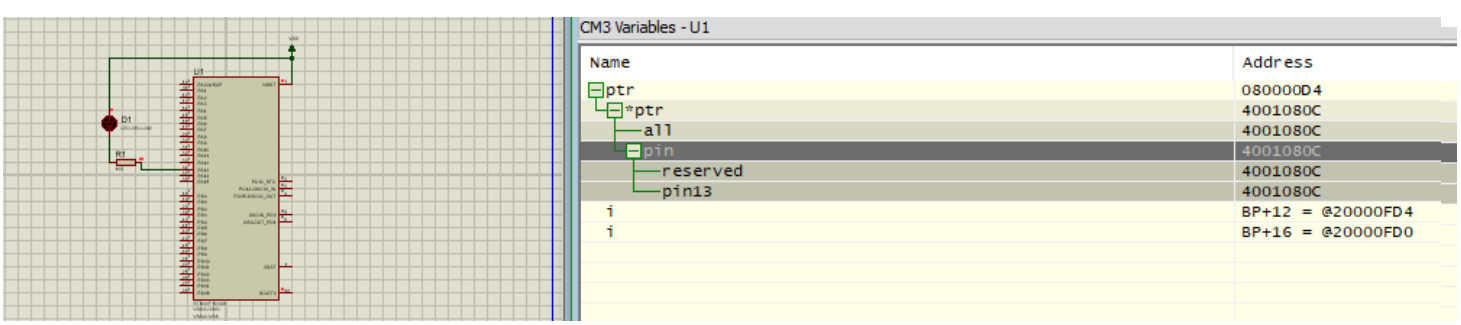
To show symbol table for toggle_LED_cortexM3.elf

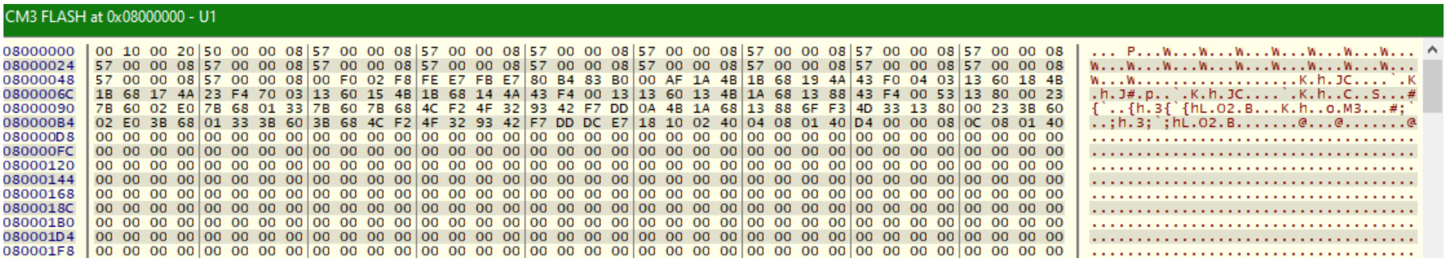
```
$ arm-none-eabi-nm.exe  toggle_LED_cortexM3.elf
20000004 B _E_bss
20000004 D _E_data
08000124 T _E_text
20000004 B _S_bss
20000000 D _S_data
20001004 B _stack_top
08000098 W Bus_fault
08000098 T default_handler
08000098 W H_fault_handler
0800001c T main
08000098 W MM_fault_handler
08000098 W NMI_handler
20000000 D ptr
080000a4 T reset_handler
08000098 W Usage_fault_handler
08000000 T vectors
```

Proteus simulation









```
CM3 FLASH at 0x08000000 - U1

08000000 | 00 10 00 20|50 00 00 08|57 00 00 08|57 00 00 08|57 00 00 08|57 00 00 08|57 00 00 08|57 00 00 08|57 00 00 08 | ... P...W...W...W...W...W...W...W...
08000024 | 57 00 00 08|57 00 00 08|57 00 00 08|57 00 00 08|57 00 00 08|57 00 00 08|57 00 00 08|57 00 00 08|57 00 00 08 | W...W...W...W...W...W...W...W...W...
08000048 | 57 00 00 08|57 00 00 08|00 F0 02 F8|FE E7 FB E7|80 B4 83 B0|00 AF 1A 4B|1B 68 19 4A|43 F0 04 03|13 60 18 4B | W...W...............K.h.JC....`.K
0800006C | 1B 68 17 4A|23 F4 70 03|13 60 15 4B|1B 68 14 4A|43 F4 00 13|13 60 13 4B|1A 68 13 88|43 F4 00 53|13 80 00 23 | .h.J#.p..`.K.h.JC....`.K.h..C..S...#
08000090 | 7B 60 02 E0|7B 68 01 33|7B 60 7B 68|4C F2 4F 32|93 42 F7 DD|0A 4B 1A 68|13 88 6F F3|4D 33 13 80|00 23 3B 60 | {`..{h.3{`{hL.O2.B...K.h..o.M3...#;`
080000B4 | 02 E0 3B 68|01 33 3B 60|3B 68 4C F2|4F 32 93 42|F7 DD DC E7|18 10 02 40|04 08 01 40|D4 00 00 08|0C 08 01 40 | ..;h.3;`;hL.O2.B.......@...@.......@
080000D8 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
080000FC | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
08000120 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
08000144 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
08000168 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
0800018C | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
080001B0 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
080001D4 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
080001F8 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
```

```
CM3 RAM at 0x20000000 - U1

20000BF4 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000C18 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000C3C | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000C60 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000C84 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000CA8 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000CCC | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000CF0 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000D14 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000D38 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000D5C | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000D80 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000DA4 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000DC8 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000DEC | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000E10 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000E34 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000E58 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000E7C | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000EA0 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000EC4 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000EE8 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000F0C | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000F30 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000F54 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000F78 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000F9C | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20000FC0 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|50 C3 00 00|50 C3 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ................P...P...............
20000FE4 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|FF FF FF FF|54 00 00 08|00 00 00 00|00 00 00 00|00 00 00 00 | ....................T...............
20001008 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
2000102C | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20001050 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20001074 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20001098 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
200010BC | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
200010E0 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20001104 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20001128 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
2000114C | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20001170 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20001194 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
200011B8 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
200011DC | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20001200 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20001224 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
20001248 | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
2000126C | 00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|00 00 00 00 | ....................................
```