Raspberry Pi

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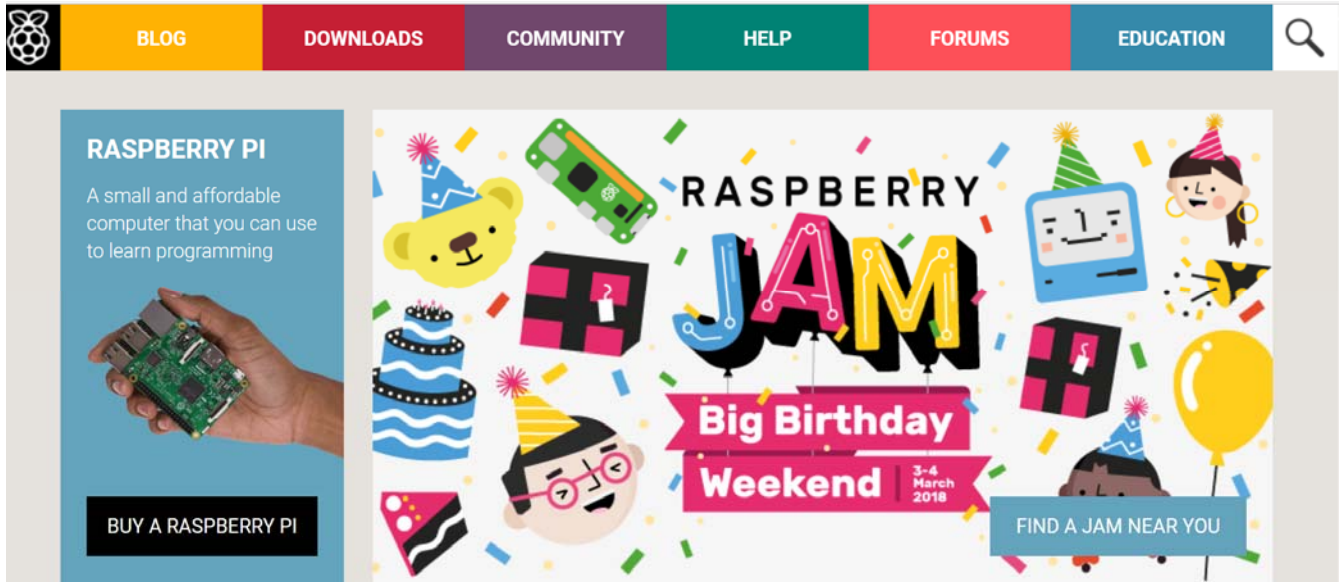
Raspberry Pi

- Physical Computing을 위한 오픈소스 HW & SW
  - 영국 라즈베리 파이 재단이 학교의 컴퓨터 교육 목적으로 만든 싱글 보드 컴퓨터
  - 모니터나 TV에 연결하고 표준 키보드와 마우스 사용
  - 인터넷 검색 및 고화질 비디오의 재생, 스프레드 시트, 워드 프로세싱, 게임 등 데스크톱 컴퓨터에서 작업할 수 있다고 기대되는 모든 일이 가능
  - 뛰어난 성능(특히, 그래픽)과 저렴한 가격(35달러 이하)
  - 2016년 3월 라즈베리 파이 3 모델 B 출시
    - 쿼드코어 CPU, 증가된 RAM 용량, Wi-Fi와 Bluetooth 내장



Raspberry Pi Open Source Hardware

- Spec.

	Pi 1 Model A	Pi 1 Model A+	Pi 1 Model B	Pi 1 Model B+	Pi 2 Model B	Pi 3 Model B
판매금액	US$25	US$20	US$35			
Processor chipset	Broadcom BCM2835 700MHz Single-Core 32Bit ARM1176JZF-S				Broadcom BCM2836 900MHz Quad-Core 32Bit ARM Cortex-A7	Broadcom BCM2837 1.2GHz Quad-Core 64Bit ARM Cortex-A53
Ethernet	No		10/100 BaseT Ethernet socket			
Wi-Fi	No					BCM43143 (802.11 b/g/n Wireless LAN)
Bluetooth	No					Bluetooth 4.1 (Bluetooth Classic and LE)
GPU	Dual Core VideoCore IV® Multimedia Co-Processor, Provides Open GL ES 2.0, hardware-accelerated OpenVG, and 1080p30, H.264 high-profile decode, Capable of 1Gpixel/s, 1.5Gtexel/s or 24GFLOPs with texture filtering and DMA infrastructure					
Memory(SDRAM)	256 MB (GPU와 공유)		512 MB (GPU와 공유)		1GB LPDDR2	
USB 2.0	1 Port (direct from BCM2835 chip)		2 Ports (보드에서 3포트 USB 허브 지원)	4 Ports (보드에서 5포트 USB 허브 지원)		
Camera Connector	라즈베리 파이 카메라와 라즈베리파이 NoIR 카메라를 연결하기 위한 15-pin MIPI Camera Serial Interface (CSI-2)					
Video Output	HDMI (rev 1.3 & 1.4), PAL과 NTSC 기준에 맞는 640×350 부터 1920×1200 이상의 14개의 해상도, Composite RCA (PAL & NTSC)	HDMI (rev 1.3 & 1.4), PAL과 NTSC 기준에 맞는 640×350 부터 1920×1200 이상의 14개의 해상도, Composite RCA (PAL & NTSC, 오디오 출력도 겸함)				
Display Connector	Display Serial Interface (DSI) 15 way flat flex cable connector					
Audio Output	3.5mm jack를 통한 오디오, HDMI를 통한 디지털 오디오, I²S					
Storage	SD / MMC / SDIO 카드 슬롯 (카드에 3.3 V가 공급될때)	Micro SD	SD / MMC / SDIO 카드 슬롯	Micro SD		
GPIO Connector (Low-Level Peripherals)	26-pin (GPIO, UART, I²C, SPI, +3.3V, +5V, GND)	40-pin (GPIO, UART, I²C, SPI, +3.3V, +5V, GND)	26-pin (GPIO, UART, I²C, SPI, +3.3V, +5V, GND)	40-pin 2.54 mm (100 mil) expansion header: 2x20 strip (GPIO, UART, I²C, SPI, +3.3V, +5V, GND)		
Power	5V 1.8A					5V 2.5A(2.4A)
Power Supply	Micro USB Socket 혹은 GPIO Header를 통해					
Dimensions	85×56×17mm (돌출 제외)	66 x 56 x 14mm (HAT 보드와 동일)	85×56×17mm (돌출 제외)			
Weight	45g	23g	45g			

Raspberry Pi Open Source Hardware

기본 액세서리

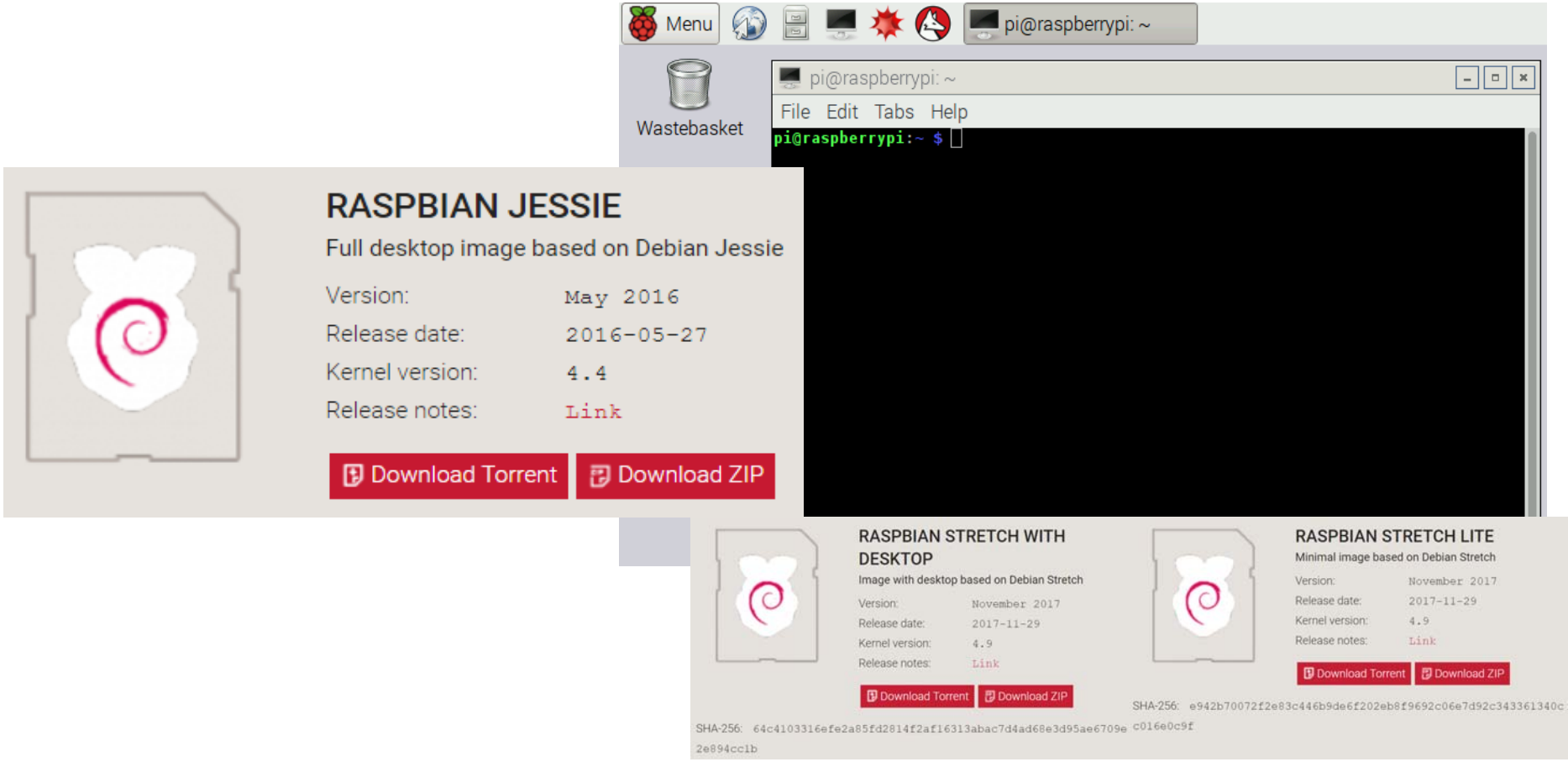
- 디스플레이 장치 – 모니터 또는 TV
- 모니터 연결 케이블
- 입력 장치 – 키보드와 마우스
- 저장 장치 – Micro SD 메모리 카드
- Micro SD 메모리 카드 리더
- 전원 케이블(5V, 2500mA)

추가 액세서리

- 랜 케이블
- USB 무선 인터넷 어댑터
- 독립전원 USB 허브
- 라즈베리 파이 보호 케이스
- GPIO 확장 어댑터 보드

Raspberry Pi Open Source Software

- Raspbian
  - **라즈베리 파이 재단 공식 지원 운영체제**
  - http://www.raspberrypi.org

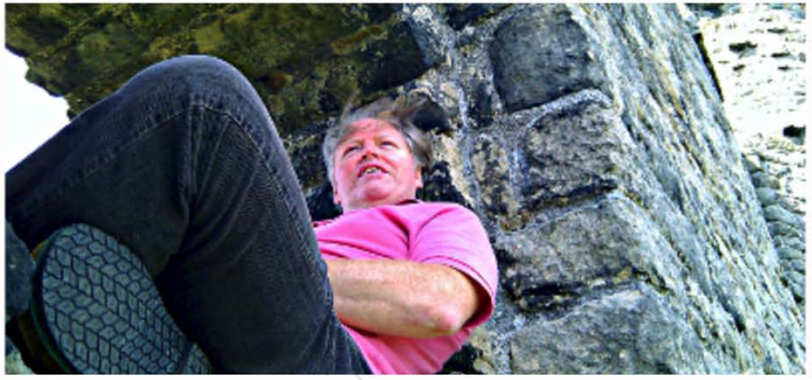


Raspberry Pi Open Source Software

- Wiring Pi (http://www.wiringpi.com)

Wiring Pi

GPIO Interface library for the Raspberry Pi



About

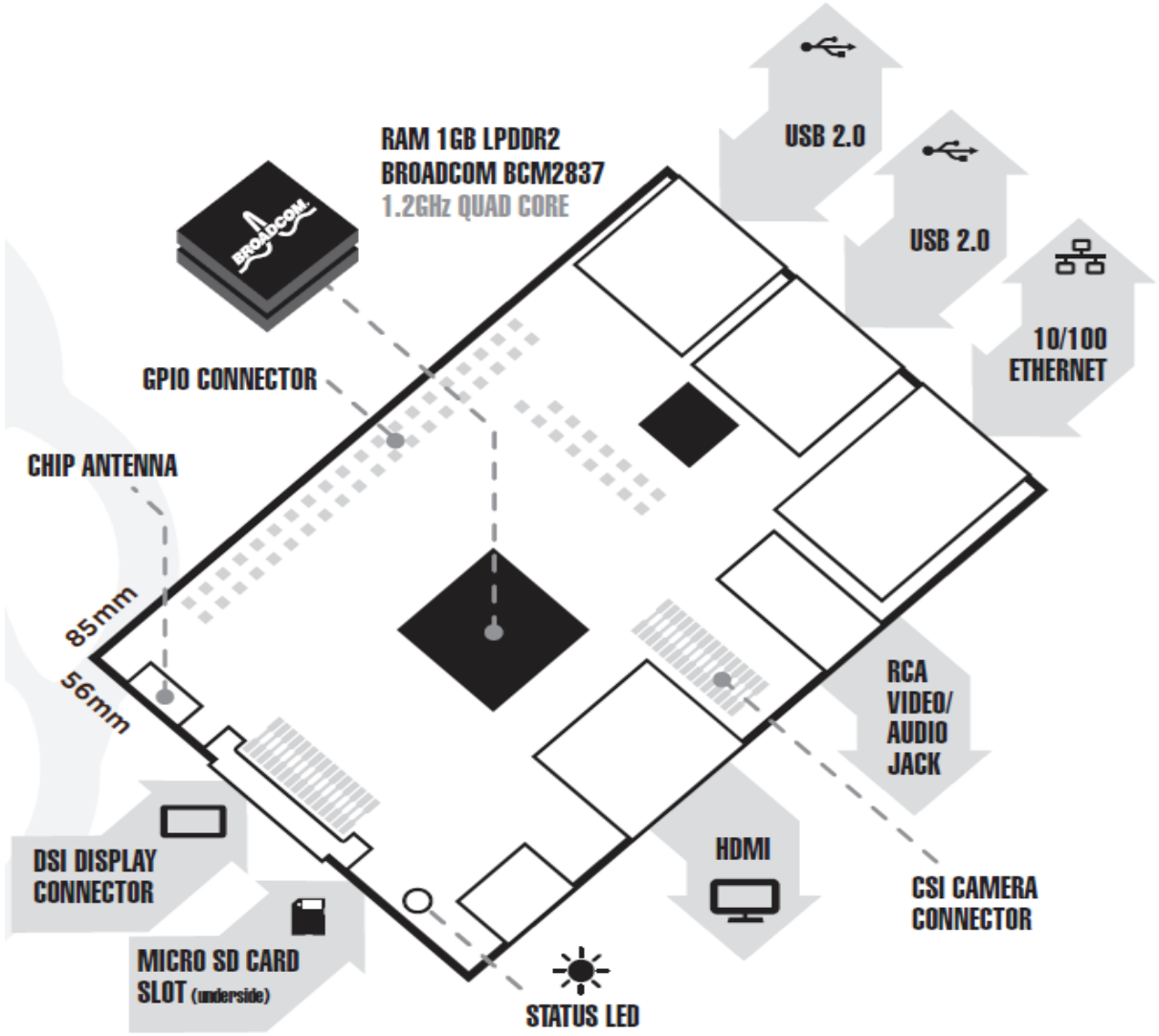
WiringPi is a ***PIN*** based GPIO access library written in C for the BCM2835, BCM2836 and BCM2837 SoC devices used in all **Raspberry Pi.** versions. It's released under the GNU LGPLv3 license and is usable from C, C++ and RTB (BASIC) as well as many other languages with suitable wrappers (See below) It's designed to be familiar to people who have used the Arduino "*wiring*" system[1] and is intended for use by experienced C/C++ programmers. It is not a newbie learning tool.

Search Site

Recent Posts

- wiringPi updated to 2.36
- wiringPi update to 2.29
- wiringPi updated for the new Pi v2
- wiringPi and the Raspberry Pi Compute board
- PiGlow added to the devLib

Raspberry Pi 3 Model B

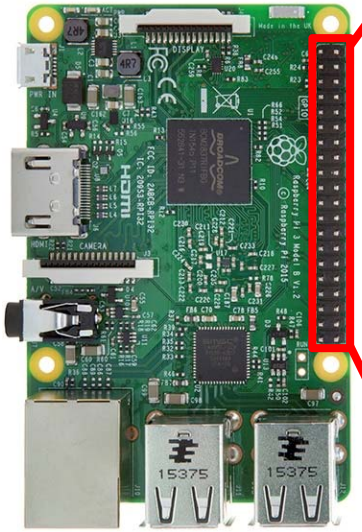


Raspberry Pi 3 Model B

- Raspberry Pi 3 Model B Spec.
  - Quad Core 1.2GHz Broadcom BCM2837 64bit CPU
  - 1GB RAM
  - BCM43438 wireless LAN and Bluetooth Low Energy (BLE) on board
  - 40-pin extended GPIO
  - 4 USB 2 ports
  - 4 Pole stereo output and composite video port
  - Full size HDMI
  - CSI camera port for connecting a Raspberry Pi camera
  - DSI display port for connecting a Raspberry Pi touchscreen display
  - Micro SD port for loading your operating system and storing data
  - Upgraded switched Micro USB power source up to 2.5A

Raspberry Pi 3 Model B GPIO

- Raspberry Pi 3 GPIO
  - Pin Map



Raspberry Pi 3 GPIO Header

Pin#	NAME	NAME	Pin#
01	3.3v DC Power	DC Power 5v	02
03	GPIO02 (SDA1 , I²C)	DC Power 5v	04
05	GPIO03 (SCL1 , I²C)	Ground	06
07	GPIO04 (GPIO_GCLK)	(TXD0) GPIO14	08
09	Ground	(RXD0) GPIO15	10
11	GPIO17 (GPIO_GEN0)	(GPIO_GEN1) GPIO18	12
13	GPIO27 (GPIO_GEN2)	Ground	14
15	GPIO22 (GPIO_GEN3)	(GPIO_GEN4) GPIO23	16
17	3.3v DC Power	(GPIO_GEN5) GPIO24	18
19	GPIO10 (SPI_MOSI)	Ground	20
21	GPIO09 (SPI_MISO)	(GPIO_GEN6) GPIO25	22
23	GPIO11 (SPI_CLK)	(SPI_CE0_N) GPIO08	24
25	Ground	(SPI_CE1_N) GPIO07	26
27	ID_SD (I²C ID EEPROM)	(I²C ID EEPROM) ID_SC	28
29	GPIO05	Ground	30
31	GPIO06	GPIO12	32
33	GPIO13	Ground	34
35	GPIO19	GPIO16	36
37	GPIO26	GPIO20	38
39	Ground	GPIO21	40

Rev. 2
29/02/2016

www.element14.com/RaspberryPi

Raspberry Pi 3 Model B GPIO

- BCM2835 ARM GPIO
  - 54개의 GPIO를 지원
  - 다음과 같은 register(32bits)로 GPIO 제어
    - GPFSELn : GPIO Function Select Registers
      - 000: input / 001: output, 기타: alternate function
    - GPSETn : GPIO Pin Output Set Registers
    - GPCLRn : GPIO Pin Output Clear Registers
    - GPLEVn : GPIO Pin Level Registers
    - GPEDSn : GPIO Event Detect Status Registers
    - GPRENn : GPIO Rising Edge Detect Enable Registers
    - GPFENn : GPIO Falling Edge Detect Enable Registers

- BCM2835 ARM GPIO == Raspberry Pi 3 GPIO
  - https://www.raspberrypi.org/app/uploads/2012/02/BCM2835-ARM-Peripherals.pdf

Raspberry Pi 3 Model B GPIO

▣ Raspberry Pi 3 GPIO Register

⊙ GPFSELn / GPSETn / GPCLRn

	Address	Field Name	Description	Size	Read/ Write
GPIO 0~9를 선택	0x 3F20 0000	GPFSEL0	GPIO Function Select 0	32	R/W
GPIO 10~19를 선택	0x 3F20 0004	GPFSEL1	GPIO Function Select 1	32	R/W
GPIO 20~29를 선택	0x 3F20 0008	GPFSEL2	GPIO Function Select 2	32	R/W
GPIO 30~39를 선택	0x 3F20 000C	GPFSEL3	GPIO Function Select 3	32	R/W
GPIO 40~49를 선택	0x 3F20 0010	GPFSEL4	GPIO Function Select 4	32	R/W
GPIO 50~53를 선택	0x 3F20 0014	GPFSEL5	GPIO Function Select 5	32	R/W
	0x 3F20 0018	-	Reserved	-	-
GPIO 0~31를 설정	0x 3F20 001C	GPSET0	GPIO Pin Output Set 0	32	W
GPIO 32~53를 설정	0x 3F20 0020	GPSET1	GPIO Pin Output Set 1	32	W
	0x 3F20 0024	-	Reserved	-	-
GPIO 0~31를 설정	0x 3F20 0028	GPCLR0	GPIO Pin Output Clear 0	32	W
GPIO 32~53를 설정	0x 3F20 002C	GPCLR1	GPIO Pin Output Clear 1	32	W

Raspberry Pi 3 Model B GPIO

- Raspberry Pi GPIO Register
  - 제어 예시) GPIO 18 사용
    - GPFSEL1:24-26bits
    - GPSET0:18bit
    - GPCLR0:18bit

```
#include <stdlib.h>
#include <stdio.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>
#include <sys/mman.h>

#define GPIO_BASE 0x3F200000
#define GPFSEL1   0x04
#define GPSET0    0x1C
#define GPCLR0    0x28
```

Bit(s)	Field Name	Description	Type	Reset
26-24	FSEL18	FSEL18 - Function Select 18	R/W	0
23-21	FSEL17	FSEL17 - Function Select 17	R/W	0
20-18	FSEL16	FSEL16 - Function Select 16	R/W	0

Table 6-3 – GPIO Alternate function select register 1

Address	Field Name	Description	Size	Read/ Write
0x 3F20 0000	GPFSEL0	GPIO Function Select 0	32	R/W
0x 3F20 0004	GPFSEL1	GPIO Function Select 1	32	R/W
0x 3F20 0008	GPFSEL2	GPIO Function Select 2	32	R/W
0x 3F20 001C	GPSET0	GPIO Pin Output Set 0	32	W
0x 3F20 0020	GPSET1	GPIO Pin Output Set 1	32	W
0x 3F20 0028	GPCLR0	GPIO Pin Output Clear 0	32	W
0x 3F20 002C	GPCLR1	GPIO Pin Output Clear 1	32	W

Raspberry Pi GPIO Register

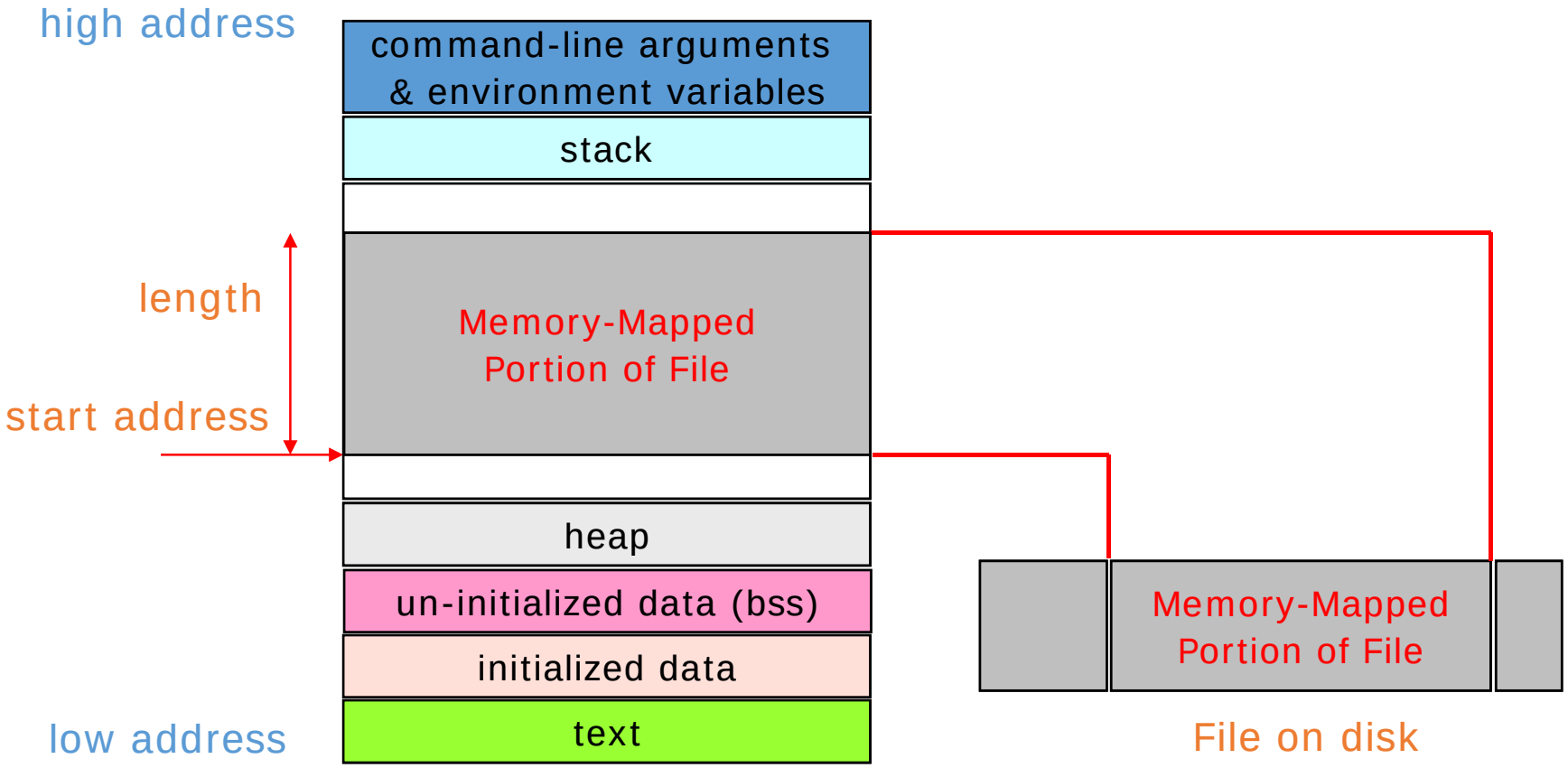
제어 예시) GPIO 18 사용

```
int main()
{
    int fd = open( "/dev/mem", O_RDWR|O_SYNC );
    if ( fd < 0 ){
        printf( "can't open /dev/mem \n" );
        exit(-1);
    }

    char *gpio_memory_map
      = (char *)mmap(0, 4096, PROT_READ|PROT_WRITE,
                                  MAP_SHARED, fd, GPIO_BASE );

    if ( gpio_memory_map == MAP_FAILED )
    {
        printf( " Error : mmap \n" );
        exit(-1);
    }
```

```
    volatile unsigned int* gpio
            = (volatile unsigned int*)gpio_memory_map;

    gpio[GPFSEL1/4] = (1<<24);
//  *(gpio + (GPFSEL1 / 4)) = (1<<24);

    int i;
    for ( i=0; i<5; i++ ) {
        gpio[GPCLR0/4] = (1<<18);
        sleep(1);

        gpio[GPSET0/4] = (1<<18);
        sleep(1);
}

    munmap( gpio_memory_map, 4096);

    return 0;
}
```

Memory-Mapped File

- Map a file on disk into a buffer in memory
  - perform I/O without using **read** or **write**



System Calls for Memory-Mapped File

- Map pages of memory
  - `#include <sys/types.h>`
  - `#include <sys/mman.h>`
  - `caddr_t mmap(caddr_t addr, size_t len, int prot, int flag, int fd, off_t off);`
  - return: starting address of mapped region if OK, –1 on error
  - The first argument, **`addr`**
    - 0 (recommended) : system choose the starting address
    - can be a specific value
  - The third argument, **`prot`**
    - **`PROT_READ`** : region can be read
    - **`PROT_WRITE`** : region can be written
    - **`PROT_EXEC`** : region can be executed
    - **`PROT_NONE`** : region cannot be accessed
  - The fourth argument, **`flag`**
    - **`MAP_FIXED`** : return value must equal addr
    - **`MAP_SHARED`** : store operations modify the mapped file
    - **`MAP_PRIVATE`** : store operations modify a copy of mapped file

Q & A

http://mesl.khu.ac.kr