Blinking an LED

….The hard way.

In Linux, everything is a file

Learning about Linux through SYSFS

Thanks to Bill Gatliff

What is SYSFS?

- Virtual file system that exposes drivers to userspace
- **`/sys/devices`** ← driver hierarchy
- **`/sys/class`** ← common interfaces

- Let's go thru some examples…

What is SYSFS?

- Virtual file system that exposes drivers to userspace
- bone$ **`cd /sys/class`**
- bone$ **`ls`**

```
backlight  firmware     lcd       net           scsi_device   tty
bdi        gpio         leds      power_supply  scsi_disk     udc
block      graphics     mbox      pwm           scsi_generic  usb_device
bluetooth  hwmon        mdio_bus  regulator     scsi_host     vc
bsg        i2c-adapter  mem       rfkill        sound         video4linux
devfreq    i2c-dev      misc      rtc           spi_master    vtconsole
display    input        mmc_host  scsi_changer  spidev
```

- Let’s go through some examples…

Blinking an LED

- Everything is a file in Linux

```
$ cd /sys/class/leds
$ ls -F
beaglebone:green:usr0/
beaglebone:green:usr1/
beaglebone:green:usr2/
beaglebone:green:usr3/
$ cd beaglebone\:green\:usr0
$ ls
brightness device max_brightness power
subsystem trigger uevent
```

Blinking an LED

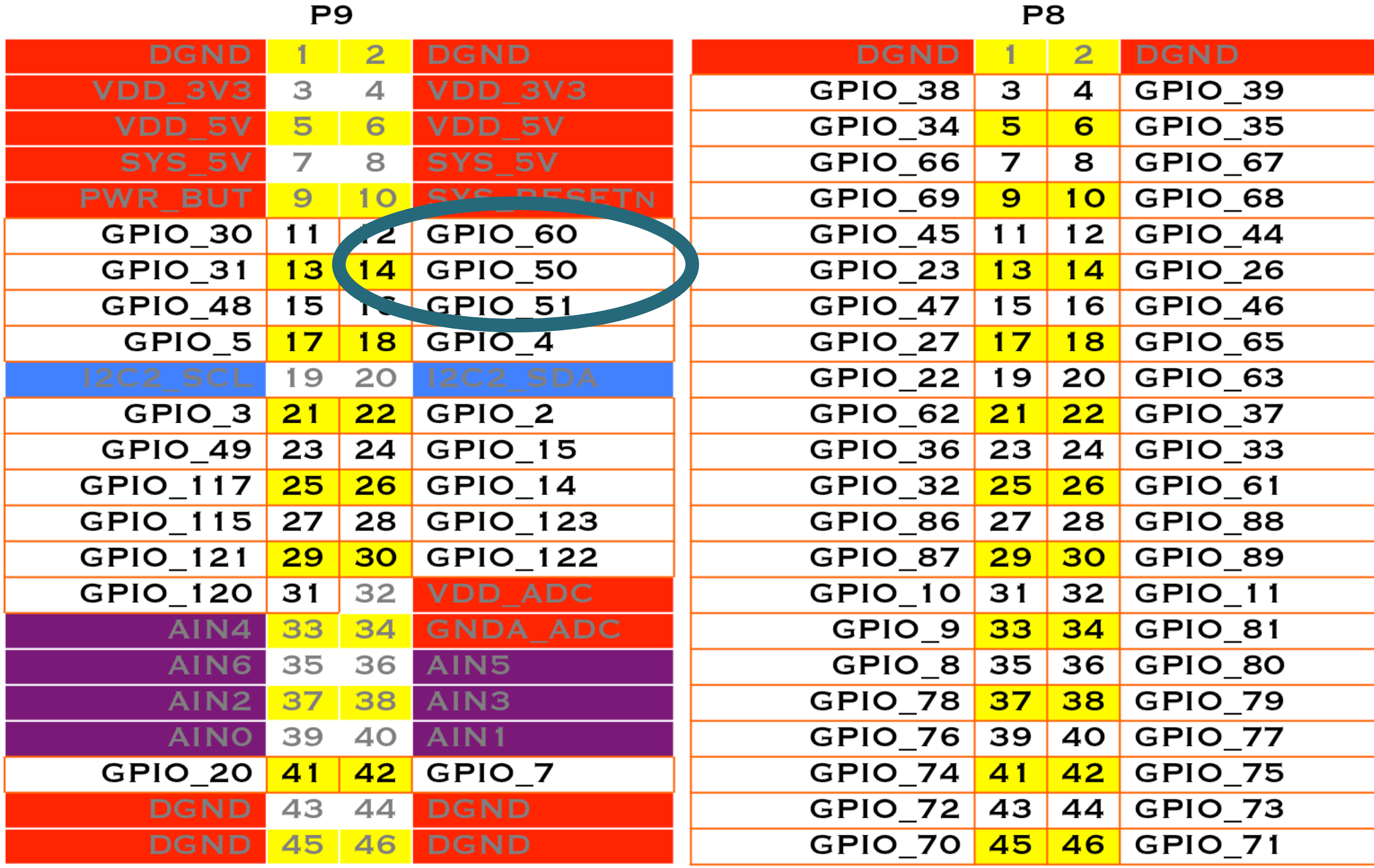
```
$ cat trigger
none nand-disk mmc0 timer oneshot [heartbeat]
     backlight gpio cpu0 default-on transient
$ echo none > trigger
$ echo 1 > brightness
$ echo 0 > brightness
```

Blinking an External LED

- The gpio pins are accessed through

`/sys/class/gpio`

- Earlier we used gpio **`P9_14`**
- The table shows which gpio pin it's assigned to



P9

DGND	1	2	DGND
VDD_3V3	3	4	VDD_3V3
VDD_5V	5	6	VDD_5V
SYS_5V	7	8	SYS_5V
PWR_BUT	9	10	SYS_RESETN
GPIO_30	11	12	GPIO_60
GPIO_31	13	14	GPIO_50
GPIO_48	15	16	GPIO_51
GPIO_5	17	18	GPIO_4
I2C2_SCL	19	20	I2C2_SDA
GPIO_3	21	22	GPIO_2
GPIO_49	23	24	GPIO_15
GPIO_117	25	26	GPIO_14
GPIO_115	27	28	GPIO_123
GPIO_121	29	30	GPIO_122
GPIO_120	31	32	VDD_ADC
AIN4	33	34	GNDA_ADC
AIN6	35	36	AIN5
AIN2	37	38	AIN3
AIN0	39	40	AIN1
GPIO_20	41	42	GPIO_7
DGND	43	44	DGND
DGND	45	46	DGND

P8

DGND	1	2	DGND
GPIO_38	3	4	GPIO_39
GPIO_34	5	6	GPIO_35
GPIO_66	7	8	GPIO_67
GPIO_69	9	10	GPIO_68
GPIO_45	11	12	GPIO_44
GPIO_23	13	14	GPIO_26
GPIO_47	15	16	GPIO_46
GPIO_27	17	18	GPIO_65
GPIO_22	19	20	GPIO_63
GPIO_62	21	22	GPIO_37
GPIO_36	23	24	GPIO_33
GPIO_32	25	26	GPIO_61
GPIO_86	27	28	GPIO_88
GPIO_87	29	30	GPIO_89
GPIO_10	31	32	GPIO_11
GPIO_9	33	34	GPIO_81
GPIO_8	35	36	GPIO_80
GPIO_78	37	38	GPIO_79
GPIO_76	39	40	GPIO_77
GPIO_74	41	42	GPIO_75
GPIO_72	43	44	GPIO_73
GPIO_70	45	46	GPIO_71

Blinking an External LED

- Here's how you turn it on

```
$ cd /sys/class/gpio
$ ls
export gpiochip0 gpiochip32 gpiochip64 gpiochip96
unexport
```

- No gpio pins are visible

```
$ echo 50 > export
$ ls
export gpio50 gpiochip0 gpiochip32 gpiochip64 …
```

- Notice **`gpio50`** has appeared

Blinking an External LED

- Go in a take control

```
bone$ cd gpio50
bone$ ls
active_low  direction  edge  power  subsystem  uevent
value
bone$ echo out > direction
bone$ echo 1 > value
```

- Your LED should be on

Reading a switch

- Once you know how to control an LED, reading a switch is easy
- A switch is wired to **P9_42**. Which gpio is this?

```
$ cd /sys/class/gpio
$ echo 7 > export
$ cd gpio7
$ echo in > direction
```

Reading a Switch

- Button not pushed

```
$ cat value
0
```

- Button pushed

```
$ cat value
1
```

Read in a Loop

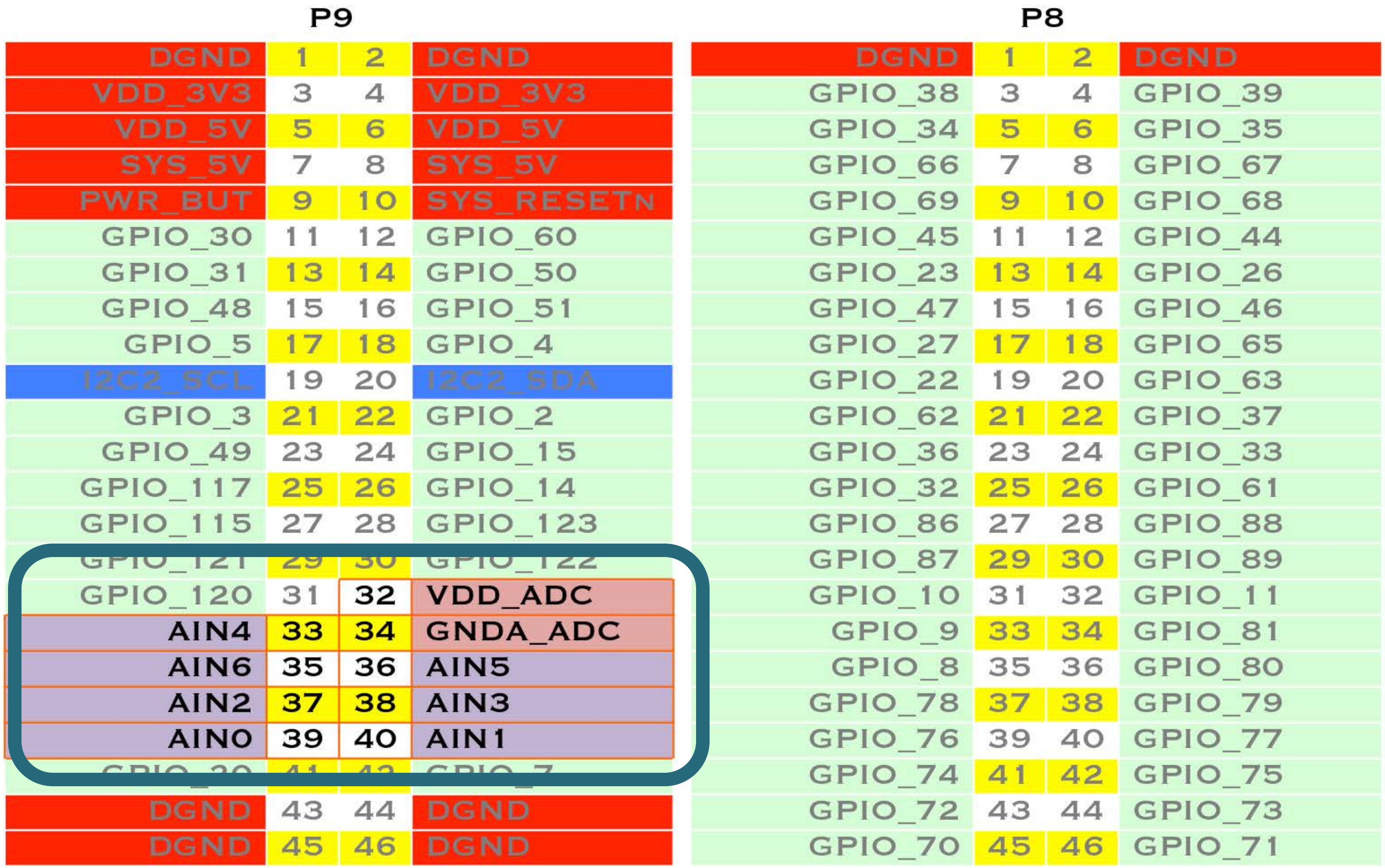
Spaces are important

- You ca over and over

```
#!/bin/ba
cd /sys/class/gpio
while [ 1 ]
do
    cat gpio7/value
    sleep 0.25
done
```

```
tr '\n' '\r' < gpio7/value
```

Analog In



P9				P8			
DGND	1	2	DGND	DGND	1	2	DGND
VDD_3V3	3	4	VDD_3V3	GPIO_38	3	4	GPIO_39
VDD_5V	5	6	VDD_5V	GPIO_34	5	6	GPIO_35
SYS_5V	7	8	SYS_5V	GPIO_66	7	8	GPIO_67
PWR_BUT	9	10	SYS_RESETN	GPIO_69	9	10	GPIO_68
GPIO_30	11	12	GPIO_60	GPIO_45	11	12	GPIO_44
GPIO_31	13	14	GPIO_50	GPIO_23	13	14	GPIO_26
GPIO_48	15	16	GPIO_51	GPIO_47	15	16	GPIO_46
GPIO_5	17	18	GPIO_4	GPIO_27	17	18	GPIO_65
I2C2_SCL	19	20	I2C2_SDA	GPIO_22	19	20	GPIO_63
GPIO_3	21	22	GPIO_2	GPIO_62	21	22	GPIO_37
GPIO_49	23	24	GPIO_15	GPIO_36	23	24	GPIO_33
GPIO_117	25	26	GPIO_14	GPIO_32	25	26	GPIO_61
GPIO_115	27	28	GPIO_123	GPIO_86	27	28	GPIO_88
GPIO_121	29	30	GPIO_122	GPIO_87	29	30	GPIO_89
GPIO_120	31	32	VDD_ADC	GPIO_10	31	32	GPIO_11
AIN4	33	34	GNDA_ADC	GPIO_9	33	34	GPIO_81
AIN6	35	36	AIN5	GPIO_8	35	36	GPIO_80
AIN2	37	38	AIN3	GPIO_78	37	38	GPIO_79
AIN0	39	40	AIN1	GPIO_76	39	40	GPIO_77
GPIO_20	41	42	GPIO_7	GPIO_74	41	42	GPIO_75
DGND	43	44	DGND	GPIO_72	43	44	GPIO_73
DGND	45	46	DGND	GPIO_70	45	46	GPIO_71

Analog In

- Input voltage range is 0 to 1.8V.
- These are accessed much link the gpio

```
$ cd /sys/devices/ocp.3/helper.16
$ ls
AIN0 AIN2 AIN4 AIN6 driver power uevent
AIN1 AIN3 AIN5 AIN7 modalias subsystem
$ cat AIN6
1185
```

Analog In

- You can keep reading the input using

```
while [ 1 ]
do
    tr '\n' '\r' < AIN6
done
```