El toolchain de GNU

Programació a Baix Nivell – *i*TIC

Sebastià Vila-Marta

Escola Politècnica Superior d'Enginyeria de Manresa
Universitat Politècnica de Catalunya

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led.c

```
#include <avr/io.h>
#include <util/delay.h>

int main (void) {
  uint8_t counter;
  DDRB = 0xFF; /* port B en mode output */

  while (1) {
    PORTB = 0xFF;
    for (counter = 0; counter != 5; counter++)
      _delay_loop_2(30000);

    PORTB = 0x00;
    for (counter = 0; counter != 50; counter++)
      _delay_loop_2(30000);
  }
  return 1;
}
```

led.c preprocessat

```
int main (void) {
  uint8_t counter;

  (*(volatile uint8_t *)((0x04) + 0x20)) = 0xFF;

  while (1) {
    (*(volatile uint8_t *)((0x05) + 0x20)) = 0xFF;
    for (counter = 0; counter != 5; counter++)
      _delay_loop_2(30000);

    (*(volatile uint8_t *)((0x05) + 0x20)) = 0x00;
    for (counter = 0; counter != 50; counter++)
      _delay_loop_2(30000);
  }
  return 1;
}
```

led.c traduït

```
        .file "led.c"
         __zero_reg__ = 1
        .text
        .global main
        .type main, @function
main:
        ldi r24,lo8(-1)
        out 36-32,r24
        ldi r19,lo8(-1)
        ldi r20,lo8(30000)
        ldi r21,hi8(30000)
.L3: out 37-32,r19
        movw r24,r20
1: sbiw r24,1
        brne 1b
        movw r24,r20
1: sbiw r24,1
        brne 1b
        movw r24,r20
1: sbiw r24,1
        brne 1b
        movw r24,r20
1: sbiw r24,1
        brne 1b
        movw r24,r20
1: sbiw r24,1
        brne 1b
        out 37-32,__zero_reg__
        ldi r18,lo8(0)
.L2: movw r24,r20
1: sbiw r24,1
        brne 1b
        subi r18,lo8(-(1))
        cpi r18,lo8(50)
        brne .L2
        rjmp .L3
        .size main, .-main
```

Makefile del projecte

```
.PHONY: implanta

led.hex: led
	avr-objcopy -Oihex led led.hex

led.o: led.c
	avr-gcc -Os -mmcu=atmega328p -DF_CPU=16000000UL -c led.c

led: led.o
	avr-gcc -mmcu=atmega328p -o led led.o

implanta:
	sudo avrdude -c arduino -p atmega328p -P /dev/ttyACM0 -U led.hex
```