Supporting 200 different expansionboards

The ~~broken~~ promise of device tree

Devicetree

From devicetree.org:

> The Device Tree is a data structure for describing hardware. Rather than hard coding every detail of a device into an operating system, many aspect of the hardware can be described in a data structure that is passed to the operating system at boot time. The device tree is used both by Open Firmware, and in the standalone Flattened Device Tree (FDT) form.

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Devicetree

- Data only
- Only describes hardware (sorta)
  - compile by seperate compiler
  - no preprocessor
  - zero useful tools available

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Example

- Point browser to https://github.com/koenkooi/linux/blob/3.7-for-panto-rebase/arch/arm/boot/dts/am33xx.dtsi

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Beaglebone overview

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Beaglebone overview

- Small, cheap board with a cortex A8 CPU
- 104 pins exposed on 3 expansion connectors
- Runs linux
- Targeted at people moving up from microcontroller based boards like the arduino

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Capes

- Equivalent of ‘shields’ for arduino and ‘boosterpacks’ for msp430
- Standard allows up to 4 stacked capes
- EEPROM for ID and config info

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Capes

- A lot of different types:
  - Displays
  - Wifi/Bluetooth/NFC/Radar
  - Sensors
  - CNC
  - And a combination of the above

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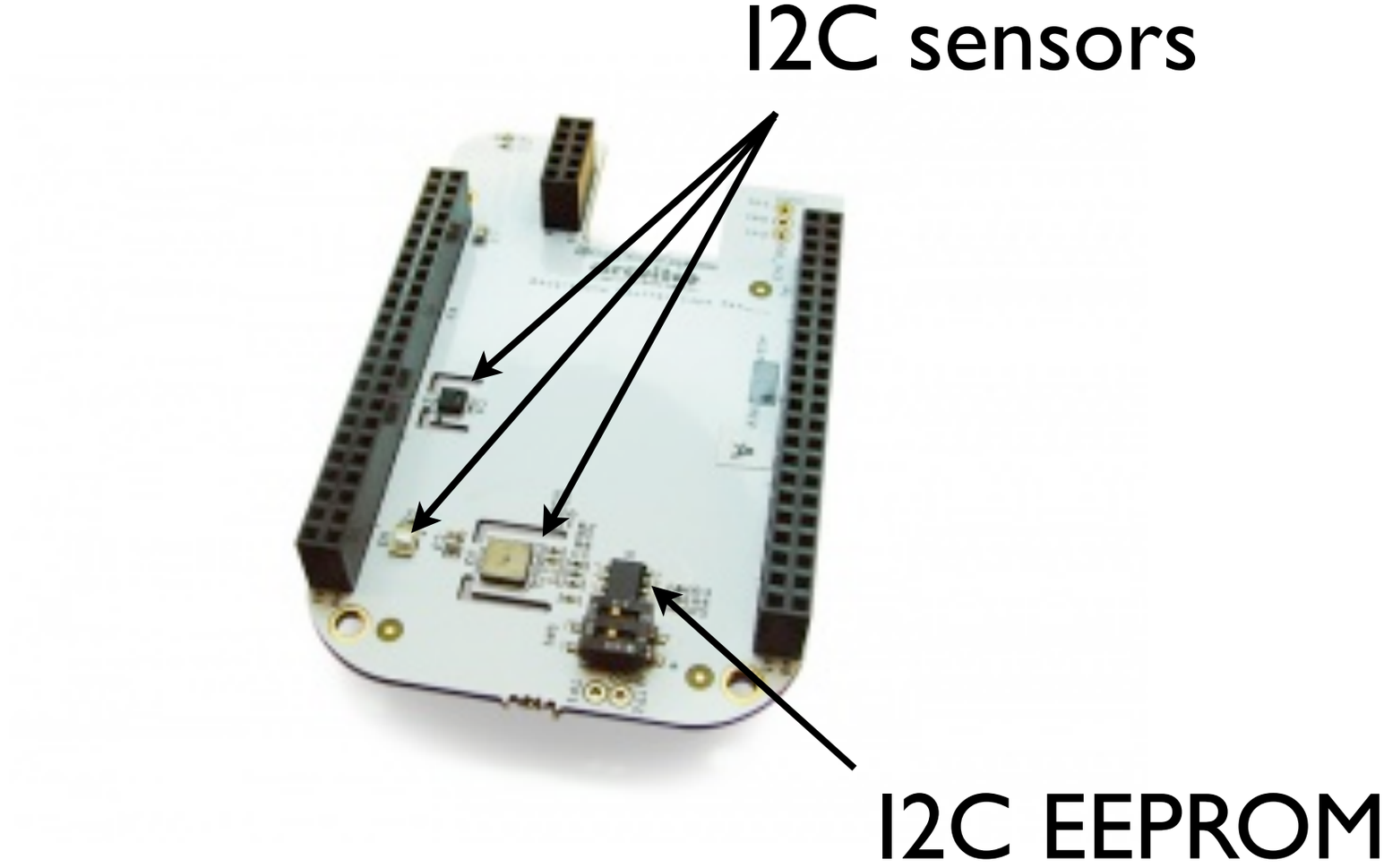
Weatherstation cape



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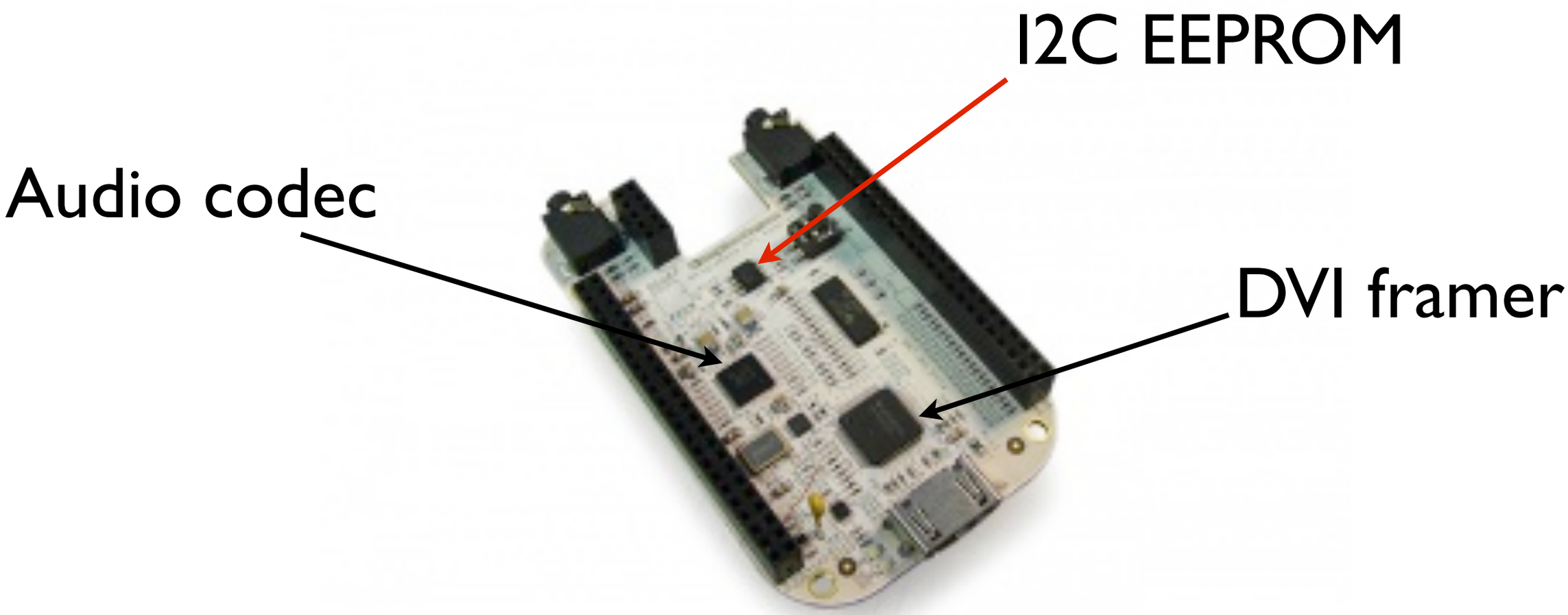
DVI+audio cape



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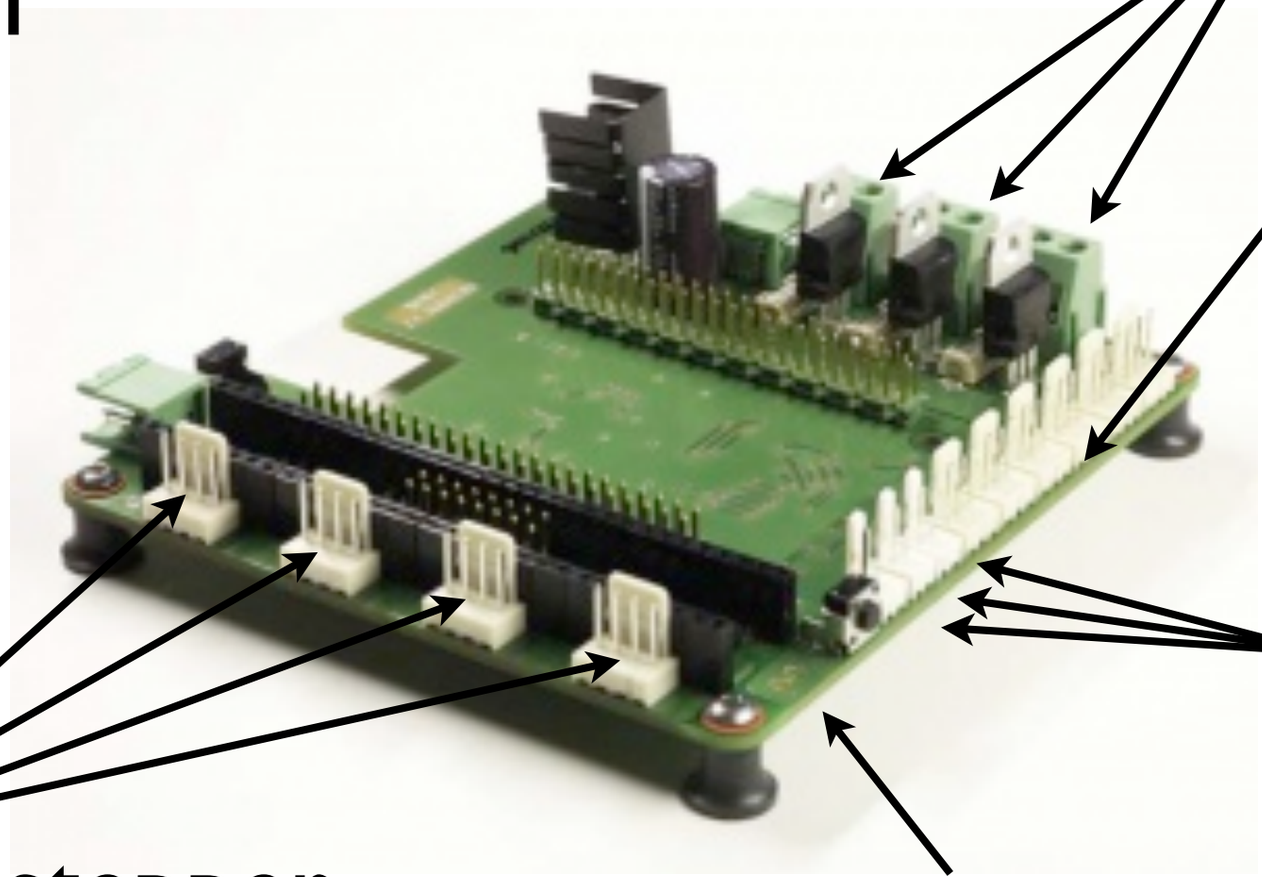
BeBoPr cape



PWM

I2C EEPROM
(bottom)

8 GPIO inputs

Analog input

PRUss driven stepper
motor drivers

LED

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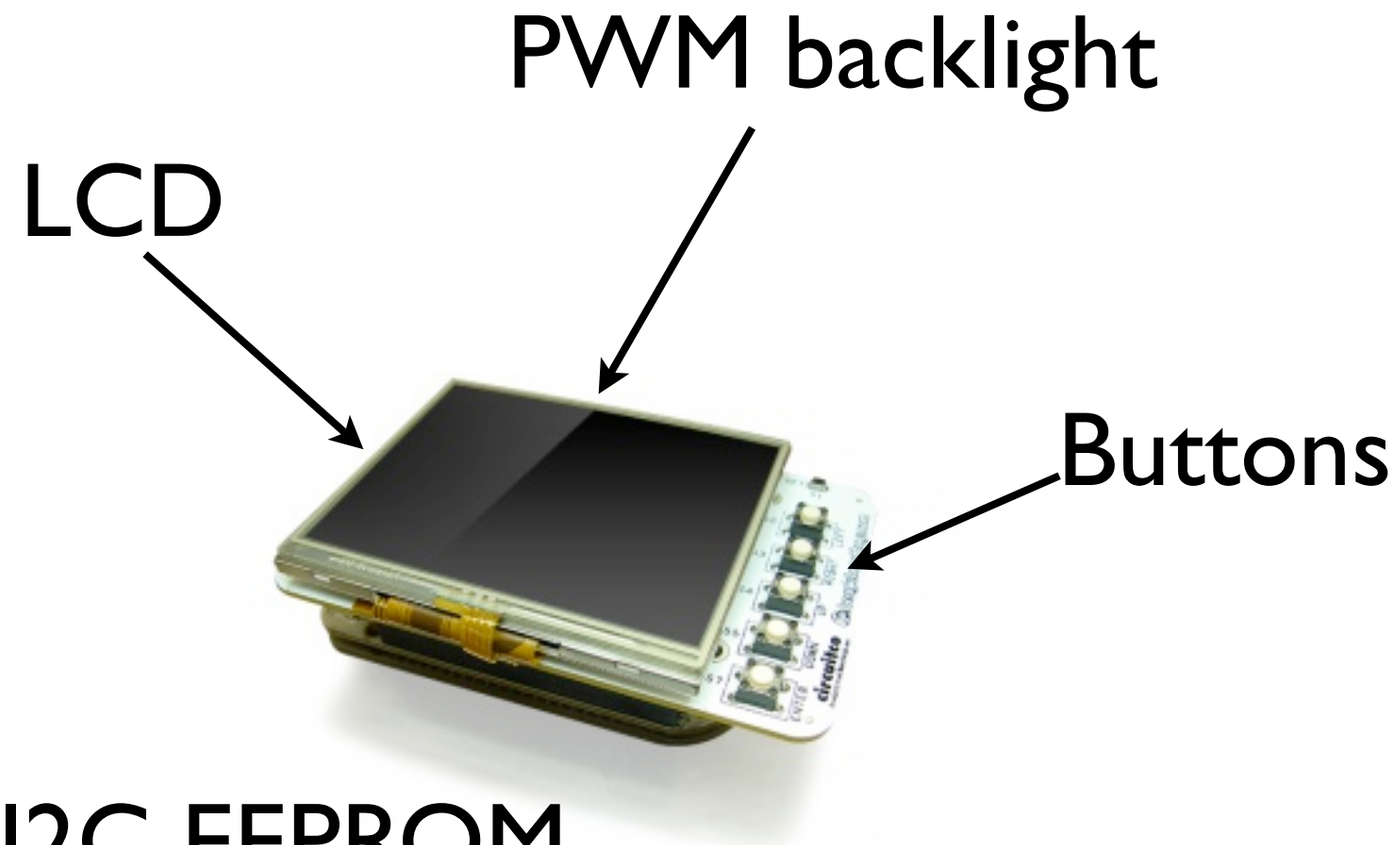
3” LCD cape



I2C EEPROM
(bottom)

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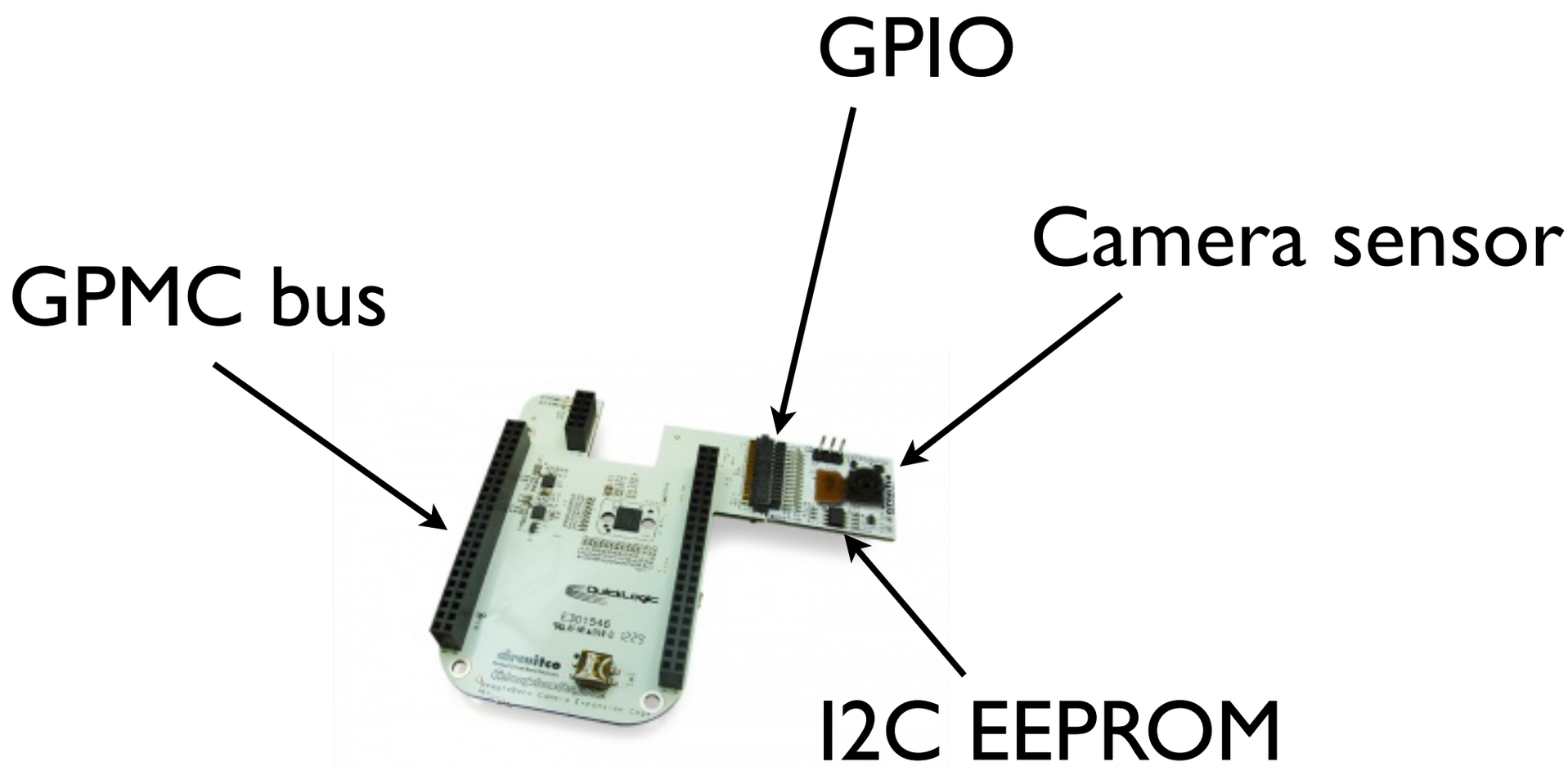
Camera cape



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GPIO-keys, old style

```
/* pinmux for lcd7 keys */
static struct pinmux_config lcd7_keys_pin_mux[] = {
     {"gpmc_a0.gpio1_16",  OMAP_MUX_MODE7 | AM33XX_PIN_INPUT}, //left
     {"gpmc_a1.gpio1_17",    OMAP_MUX_MODE7 | AM33XX_PIN_INPUT}, //right
     {"gpmc_a3.gpio1_19",  OMAP_MUX_MODE7 | AM33XX_PIN_INPUT}, //up
     {"mcasp0_axr0.gpio3_16",    OMAP_MUX_MODE7 | AM33XX_PIN_INPUT}, //down
     {"mcasp0_fsr.gpio3_19",    OMAP_MUX_MODE7 | AM33XX_PIN_INPUT}, //enter
     {NULL, 0},
};
static struct gpio_keys_platform_data beaglebone_lcd7_gpio_key_info = {
     .buttons        = beaglebone_lcd7_gpio_keys,
     .nbuttons       = ARRAY_SIZE(beaglebone_lcd7_gpio_keys),
};

static struct platform_device beaglebone_lcd7_keys = {
     .name   = "gpio-keys",
     .id     = -1,
     .dev    = {
          .platform_data  = &beaglebone_lcd7_gpio_key_info,
     },
};

static void beaglebone_lcd7_keys_init(int evm_id, int profile)
{
     int err;
     setup_pin_mux(lcd7_keys_pin_mux);
     err = platform_device_register(&beaglebone_lcd7_keys);
     if (err)
          pr_err("failed to register gpio keys for LCD7 cape\n");
}
```

```
/* Configure GPIOs for lcd7 keys */
static struct gpio_keys_button beaglebone_lcd7_gpio_keys[] = {
     {
          .code                = KEY_LEFT,
          .gpio                = GPIO_TO_PIN(1, 16),
          .active_low          = true,
          .desc                = "left",
          .type                = EV_KEY,
          .wakeup              = 1,
     },
     {
          .code                = KEY_RIGHT,
          .gpio                = GPIO_TO_PIN(1, 17),
          .active_low          = true,
          .desc                = "right",
          .type                = EV_KEY,
          .wakeup              = 1,
     },
     {
          .code                = KEY_UP,
          .gpio                = GPIO_TO_PIN(1, 19),
          .active_low          = true,
          .desc                = "up",
          .type                = EV_KEY,
          .wakeup              = 1,
     },
     {
          .code                = KEY_DOWN,
          .gpio                = GPIO_TO_PIN(3, 16),
          .active_low          = true,
          .desc                = "down",
          .type                = EV_KEY,
          .wakeup              = 1,
     },
     {
          .code                = KEY_ENTER,
          .gpio                = GPIO_TO_PIN(3, 19),
          .active_low          = true,
          .desc                = "enter",
          .type                = EV_KEY,
          .wakeup              = 1,
     },
};
```

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GPIO-keys, DT

```
bone_lcd3_cape_keys_00A0_pins: pinmux_bone_lcd3_cape_keys_00A0_pins {
     pinctrl-single,pins = <
          0x040 0x2f     /* gpmc_a0.gpio1_16, INPUT | PULLDIS | MODE7 */
          0x044 0x2f     /* gpmc_a1.gpio1_17, INPUT | PULLDIS | MODE7 */
          0x1a4 0x2f     /* mcasp0_fsr.gpio3_19, INPUT | PULLDIS | MODE7 */
          0x078 0x2f     /* gpmc_ben1.gpio1_28, INPUT | PULLDIS | MODE7 */
          0x164 0x2f     /* ecap0_in_pwm0_out.gpio0_7, INPUT | PULLDIS | MODE7 */
     >;
}
```

```
gpio_keys {
     compatible = "gpio-keys";
     pinctrl-names = "default";
     pinctrl-0 = <&bone_lcd3_cape_keys_00A0_pins>;

     #address-cells = <1>;
     #size-cells = <0>;

     button@1 {
          debounce_interval = <50>;
          linux,code = <105>;
          label = "left";
          gpios = <&gpio2 16 0x0>;
          gpio-key,wakeup;
          autorepeat;
     };
     button@2 {
          debounce_interval = <50>;
          linux,code = <106>;
          label = "right";
          gpios = <&gpio2 17 0x0>;
          gpio-key,wakeup;
          autorepeat;
     };
     button@3 {
          debounce_interval = <50>;
          linux,code = <103>;
          label = "up";
          gpios = <&gpio4 19 0x0>;
          gpio-key,wakeup;
          autorepeat;
     };
     button@4 {
          debounce_interval = <50>;
          linux,code = <108>;
          label = "down";
          gpios = <&gpio2 28 0x0>;
          gpio-key,wakeup;
          autorepeat;
     };
     button@5 {
          debounce_interval = <50>;
          linux,code = <28>;
          label = "enter";
          gpios = <&gpio1 7 0x0>;
          gpio-key,wakeup;
     };
};
```

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leds-gpio, old style

```
#define BEAGLEBONE_USR1_LED  GPIO_TO_PIN(1, 21)
#define BEAGLEBONE_USR2_LED  GPIO_TO_PIN(1, 22)
#define BEAGLEBONE_USR3_LED  GPIO_TO_PIN(1, 23)
#define BEAGLEBONE_USR4_LED  GPIO_TO_PIN(1, 24)

static struct gpio_led bone_gpio_leds[] = {
     {
          .name               = "beaglebone::usr0",
          .default_trigger    = "heartbeat",
          .gpio               = BEAGLEBONE_USR1_LED,
     },
     {
          .name               = "beaglebone::usr1",
          .default_trigger    = "mmc0",
          .gpio               = BEAGLEBONE_USR2_LED,
     },
     {
          .name               = "beaglebone::usr2",
          .gpio               = BEAGLEBONE_USR3_LED,
     },
     {
          .name               = "beaglebone::usr3",
          .gpio               = BEAGLEBONE_USR4_LED,
     },
};

static struct gpio_led_platform_data bone_gpio_led_info = {
     .leds          = bone_gpio_leds,
     .num_leds = ARRAY_SIZE(bone_gpio_leds),
};

static struct platform_device bone_leds_gpio = {
     .name     = "leds-gpio",
     .id  = -1,
     .dev = {
          .platform_data = &bone_gpio_led_info,
     },
};
```

```
static struct pinmux_config bone_pin_mux[] = {
     /* User LED gpios (gpio1_21 to gpio1_24) */
    {"gpmc_a5.rgmii2_td0", OMAP_MUX_MODE7 | AM33XX_PIN_OUTPUT}, // USR0
    {"gpmc_a6.rgmii2_tclk", OMAP_MUX_MODE7 | AM33XX_PIN_OUTPUT}, // USR1
    {"gpmc_a7.rgmii2_rclk", OMAP_MUX_MODE7 | AM33XX_PIN_OUTPUT}, // USR2
    {"gpmc_a8.rgmii2_rd3", OMAP_MUX_MODE7 | AM33XX_PIN_OUTPUT}, // USR3
    /* Grounding gpio1_6 (pin 3 Conn A) signals bone tester to start diag tests
    {"gpmc_ad6.gpio1_6", OMAP_MUX_MODE7 | AM33XX_PIN_INPUT_PULLUP},
     {NULL, 0},
};
static void boneleds_init(int evm_id, int profile )
{
     int err;
     setup_pin_mux(bone_pin_mux);
     err = platform_device_register(&bone_leds_gpio);
     if (err)
          pr_err("failed to register BeagleBone LEDS\n");
}
```

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leds-gpio, DT

```
userled_pins: pinmux_userled_pins {
     pinctrl-single,pins = <
          0x54 0x7  /* gpmc_a5.gpio1_21, OUTPUT | MODE7 */
          0x58 0x17 /* gpmc_a6.gpio1_22, OUTPUT_PULLUP | MODE7 */
          0x5c 0x7  /* gpmc_a7.gpio1_23, OUTPUT | MODE7 */
          0x60 0x17 /* gpmc_a8.gpio1_24, OUTPUT_PULLUP | MODE7 */
     >;
};
```

```
gpio-leds {
     compatible = "gpio-leds";
     pinctrl-names = "default";
     pinctrl-0 = <&userled_pins>;

     led0 {
          label = "beaglebone:green:usr0";
          gpios = <&gpio2 21 0>;
          linux,default-trigger = "heartbeat";
          default-state = "off";
     };

     led1 {
          label = "beaglebone:green:usr1";
          gpios = <&gpio2 22 0>;
          linux,default-trigger = "mmc0";
          default-state = "off";
     };

     led2 {
          label = "beaglebone:green:usr2";
          gpios = <&gpio2 23 0>;
          linux,default-trigger = "cpu0";
          default-state = "off";
     };

     led3 {
          label = "beaglebone:green:usr3";
          gpios = <&gpio2 24 0>;
          default-state = "off";
     };
};
```

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Talking points

- pinctrl
- resource tracking
- evm/bone split
- uboot/uimage/dtb lockstep
- pdata only
- keycodes and other non-hardware bits

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There's an if() in my boardfile, now what?

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