Debugging Embedded Linux Systems: Locate Device Driver Source Code

Debugging Embedded Linux Training Series [Part 5]
Debugging Embedded Linux Training Series

- Part 1: Linux/Kernel Overview
- Part 2: Kernel Logging System Overview
- Part 3: printk and Variations
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Agenda

• Device Driver Architecture Overview
• How Does the Kernel Load a Driver?
• How to Locate a Device Driver?
• Case Study
Device driver architecture overview

- User Space
  - Application
- Kernel
  - Device Drivers
- Hardware
Device driver architecture overview

- User Space
  - Application

- Kernel
  - Device Drivers

- Hardware

- Application Drivers
  - Module Core Drivers
  - Controller Drivers

- User Space
  - Application

- Hardware
Example: UART

Application

TTY/Console Driver

Serial Core Driver

UART Device Driver

UART0  UART1  ...

(Texas Instruments logo)
Example: SDIO

```
Application

Kernel Virtual Filesystem

MMC Block Device Driver

SD Device Driver

SD Controller
```
Example: I2C

- Application
  - I2C-Dev Driver
    - I2C-Core Driver
      - I2C-Client Driver
      - I2C-Adapter Driver
        - I2C Adapter
          - I2C Device0
          - I2C Device1
          - ...
Problem

• Each driver module has a common application and core drivers.
• Kernel has many controller drivers to support multiple platforms.
• Only one controller device driver is used for a specific system.
• How do I find the controller device driver for my platform?
Problem

• Each driver module has a common application and core drivers.
• Kernel has many controller drivers to support multiple platforms.
• Only one controller device driver is used for a specific system.
• How do I find the controller device driver for my platform?

First, let’s see how the kernel finds it...
How does the kernel bind a driver to a device?

- The tie: *compatible*
- Both drivers and DT nodes define the *compatible* property.
- Kernel binds a driver to a device if their compatible string matches.
How does the kernel bind a driver to a device?

- The tie: *compatible*
- Both drivers and DT nodes define the *compatible* property.
- Kernel binds a driver to a device if their compatible string matches.

```
../dts/am33xx.dtsi
usb: usb@47400000 {
    compatible = "ti,am33xx-usb";
    ...
}
drivers/.../musb_am335x.c
static const struct of_device_id
am335x_child_of_match[] = {
    { .compatible = "ti,am33xx-usb" },
    { },
};
MODULE_DEVICE_TABLE(of, am335x_child_of_match)
```
How to locate a device driver?

Find the matching compatible string!
Case study: AM335x I2C subsystem (1)

$ ls -F drivers/i2c/

<table>
<thead>
<tr>
<th>Directory</th>
<th>Files and Subdirectories</th>
</tr>
</thead>
<tbody>
<tr>
<td>algos/</td>
<td>i2c-core.c, i2c-mux.c</td>
</tr>
<tr>
<td>busses/</td>
<td>i2c-core.h, i2c-slave-eeprom.c</td>
</tr>
<tr>
<td>i2c-boardinfo.c</td>
<td>i2c-dev.c, i2c-smbus.c</td>
</tr>
</tbody>
</table>
### Case study: AM335x I2C subsystem (1)

- $ ls -F drivers/i2c/

  ```
  algos/       i2c-core.c  i2c-mux.c       i2c-stub.c  muxes/
  busses/      i2c-core.h  i2c-slave-eeprom.c  Kconfig
  i2c-boardinfo.c  i2c-dev.c  i2c-smbus.c   Makefile
  ```

- $ ls -F drivers/i2c/busses/

  ```
  i2c-acorn.c       i2c-eg20t.c        i2c-octeon.c       i2c-sis5595.c
  i2c-ali1535.c      i2c-elektor.c      i2c-omap.c         i2c-sis630.c
  i2c-ali1563.c      i2c-emev2.c        i2c-opal.c         i2c-sis96x.c
  i2c-ali15x3.c      i2c-exynos5.c      i2c-piix4.c        i2c-st.c
  i2c-amd756.c       i2c-gpio.c         i2c-parport.c      i2c-stu300.c
  i2c-amd756-s4882.c  i2c-highlander.c   i2c-parport.h      i2c-tiny-usb.c
  i2c-amd8111.c      i2c-hix5hd2.c      i2c-parport-light.c i2c-taos-evm.c
  i2c-at91.c         i2c-hydra.c        i2c-pasemi.c       i2c-tegra.c
  i2c-au1550.c       i2c-i801.c         i2c-pca-isa.c      i2c-uniphier.c
  ```
Case study: AM335x I2C subsystem (2)

am33xx.dtsi

```dts
i2c0: i2c@44e0b000 {
    compatible = "ti,omap4-i2c";
    ...
};

i2c1: i2c@4802a000 {
    compatible = "ti,omap4-i2c";
    ...
};

i2c2: i2c@4819c000 {
    compatible = "ti,omap4-i2c";
    ...
};
```

am335x-evm.dts

```dts
&i2c1 {
    lis331dlh: lis331dlh@18 {
        compatible = "st,lis331dlh", "st,lis3lv02d";
        ...
    };

    tsl2550: tsl2550@39 {
        compatible = "taos,tsl2550";
        ...
    };

    tmp275: tmp275@48 {
        compatible = "ti,tmp275";
        ...
    };

    tlv320aic3106: tlv320aic3106@1b {
        compatible = "ti,tlv320aic3106";
        ...
    };
};
```
Case study: AM335x I2C subsystem adapter

```
am33xx.dtsi

i2c0: i2c@44e0b000 {
    compatible = "ti,omap4-i2c";
    ...
};
```
Case study: AM335x I2C subsystem adapter

am33xx.dtsi

i2c0: i2c@44e0b000 {
    compatible = "ti,omap4-i2c";
    ...
};

$ find . -name '*.c' -exec grep -H '\.compatible.*=.*omap4-i2c"' {} \;
Case study: AM335x I2C subsystem adapter

am33xx.dtsi

i2c0: i2c@44e0b000 {
    compatible = "ti,omap4-i2c";
    ...
};

$ find . -name '*.c' -exec grep -H \'.compatible.*=.*omap4-i2c'' {} \

./drivers/i2c/busses/i2c-omap.c: .compatible = "ti,omap4-i2c",

Case study: AM335x I2C subsystem - tlv320aic3106 codec

am335x-evm.dts

&i2c1 {
    tlv320aic3106: tlv320aic3106@1b {
        compatible = "ti,tlv320aic3106";
        ...
    };
};
Case study: AM335x I2C subsystem - tlv320aic3106 codec

```
am335x-evm.dts

&i2c1 {
  tlv320aic3106: tlv320aic3106@1b {
    compatible = "ti,tlv320aic3106";
    ...
  };

$ find . -name '*.c' -exec grep -H '\.compatible.*=.*tlv320aic3106' {} \;
```
Case study: AM335x I2C subsystem - tlv320aic3106 codec

am335x-evm.dts

```plaintext
&i2c1 {
   tlv320aic3106: tlv320aic3106@1b {
      compatible = "ti,tlv320aic3106";
      ...
   };
}
```

```plaintext
$ find . -name '*.c' -exec grep -H '\.compatible.*=.*tlv320aic3106'' {} \;
```

```plaintext
./sound/soc/codecs/tlv320aic3x.c:       { .compatible = "ti,tlv320aic3106" },
```
Case study: AM335x I2C subsystem - lis331dlh

am335x-evm.dts

&i2c1 {
    lis331dlh: lis331dlh@18 {
        compatible = "st,lis331dlh", "st,lis3lv02d";
        ...
    }
};
Case study: AM335x I2C subsystem - lis331dlh

am335x-evm.dts

```dts
&i2c1 {
  lis331dlh: lis331dlh@18 {
    compatible = "st,lis331dlh", "st,lis3lv02d";
    ...
  };
}
```

```bash
$ find . -name '*.c' -exec grep -H '\.compatible.*=.*lis3\(31dlh\|lv02d\)"' {} \;
```
Case study: AM335x I2C subsystem - lis331dlh

am335x-evm.dts

&i2c1 {
    lis331dlh: lis331dlh@18 {
        compatible = "st,lis331dlh", "st,lis3lv02d";
        ...
    };
}

$ find . -name '* . c' -exec grep -H '\.compatible.*=.*lis3\(31dlh|lv02d\)" ' {} \;

./drivers/misc/lis3lv02d/lis3lv02d_i2c.c: { .compatible = "st,lis3lv02d" },
Case study: AM335x I2C subsystem - tsl2550

am335x-evm.dts

&i2c1 {
tsl2550: tsl2550@39 {
  compatible = "taos,tsl2550";
  ...
};
Case study: AM335x I2C subsystem - tsl2550

```plaintext
am335x-evm.dts

#!/i2c {
    tsl2550: tsl2550@39 {
        compatible = "taos,tsl2550";
        ...
    }
};

$ find . -name '*.c' -exec grep -H '\.compatible.*=.tsl2550' {} \;
```
Case study: AM335x I2C subsystem - tsl2550

&i2c1 {
    tsl2550: tsl2550@39 {
        compatible = "taos,tsl2550";
        ...
    }
};

$ find . -name '*.c' -exec grep -H \'.compatible.*=.tsl2550' {} \;

<found nothing> ???
Case study: AM335x I2C subsystem - tsl2550

```plaintext
am335x-evm.dts

&i2c1 {
  tsl2550: tsl2550@39 {
    compatible = "taos,tsl2550";
    ...
  };
}

$ find . -name '*.c' -exec grep -H \."compatible.*=.*tsl2550"' {} \;
<found nothing> ???

$ find . -name '*.c' -exec grep -nH "tsl2550"' {} \;
```
Case study: AM335x I2C subsystem - tsl2550

am335x-evm.dts

```
&i2c1 {
    tsl2550: tsl2550@39 {
        compatible = "taos,tsl2550";
        ...
    };
}
```

```
$ find . -name '*.c' -exec grep -H '\.compatible.*=.*tsl2550' {} \;

<found nothing> ???
```

```
$ find . -name '*.c' -exec grep -nH '"tsl2550"' {} \;

drivers/misc/tsl2550.c:27:#define TSL2550_DRV_NAME   "tsl2550"
drivers/misc/tsl2550.c:441:    { "tsl2550", 0 },
```
Case study: AM335x I2C subsystem - tsl2550

&i2c1 {
  tsl2550: tsl2550@39 {
    compatible = "taos,tsl2550";
    ...
  };
}

$ find . -name '*.c' -exec grep -H '\.compatible.*=.*tsl2550' {} \
<found nothing> ???

$ find . -name '*.c' -exec grep -nH '"tsl2550"' {} \
drivers/misc/tsl2550.c:27:#define TSL2550_DRV_NAME      "tsl2550"
drivers/misc/tsl2550.c:441:  { "tsl2550", 0 },

$ grep -nC5 '"tsl2550"' drivers/misc/tsl2550.c
Case study: AM335x I2C subsystem - tsl2550

am335x-evm.dts

```dts
&i2c1 {
  tsl2550: tsl2550@39 {
    compatible = "taos tsl2550";
    ...
  };
}
```

```
$ find . -name '*.c' -exec grep -H \."compatible.*=.*tsl2550" {} \;

<found nothing> ???
```

```
$ find . -name '*.c' -exec grep -nH "tsl2550" {} \;

drivers/misc/tsl2550.c:27:#define TSL2550_DRV_NAME "tsl2550"
```

```
$ grep -nC5 "tsl2550" drivers/misc/tsl2550.c

... 440 static const struct i2c_device_id tsl2550_id[] = {
        { "tsl2550", 0 },
        { }
    };
    MODULE_DEVICE_TABLE(i2c, tsl2550_id);
```

```
```

```c
drivers/misc/tsl2550.c:441:     { "tsl2550", 0 },
```

```c
drivers/misc/tsl2550.c:443:
```

```c
drivers/misc/tsl2550.c:444:
```
Summary

• The link between device and driver: *compatible*

• Search in kernel source code for the compatible string, which is defined in the device node and DTS file.
For more information

- Debugging Embedded Linux Training Series: http://training.ti.com/debug-embedded-linux-training-series
- Download Processor SDK Linux for Embedded Processors: http://www.ti.com/processorsdk
- For questions about this training, refer to the E2E Embedded Linux Community Forum: http://e2e.ti.com/support/embedded/linux/f/354