Device Drivers

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COMP2215: Computer Systems II
Operating System (OS)

Uniform Interface
- ...for users
- ...for programs

Management of Resources
- CPU time
- Memory
- Access to devices

Management of Interactions
- Desired: networking, comms. among users/processes
- Undesired: protection, security
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Uniform Interface

Uniform for device class or system:

<table>
<thead>
<tr>
<th>PC</th>
<th>Embedded</th>
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<tbody>
<tr>
<td>◾ Terminal</td>
<td>◾ Serial port?</td>
</tr>
<tr>
<td>◾ Keyboard</td>
<td>◾ Memory card?</td>
</tr>
<tr>
<td>◾ Hard Disk</td>
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</table>

In contrast to a PC where a minimum of I/O hardware is guaranteed, for an embedded systems the hardware configuration varies widely. Nevertheless if a type of I/O exist, a standardized form of access can be provided.
Application I/O

Device Independent parts of OS

Device Drivers

Interrupt Handlers (ISRs)

Hardware

after Tanenbaum, 2008
OS Application Interface I

- Isolates Software from
  - device details
  - device technology
  - communication protocol (bus type)
- May be stable over decades
- Bridge to user space
OS Application Interface II

- Abstraction of Device
  - Character devices
  - Block devices
- Buffering
- Error Handling
- Allocation
  - Naming
  - Protection
Role of the Driver

 Aside from read/write requests the driver also may need to:

  ▶ initialize the device
  ▶ manage the power supply of the device → power up / standby / power down
  ▶ protect device from harmful commands
  ▶ deal with availability → hot pluggable
Device Driver

- Access I/O registers
  - need privileged access
  - run in kernel space
- Require detailed knowledge of device hardware
  - made by device manufacturer

⇒ Security problem!
Device Driver

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Abstraction

- Desired to simplify programming
- Desired for code lifetime/reuse

But:

- May get in the way of optimization
  - physical device can differ from abstract model assumed by OS
Potential Drivers on LaFortuna

- Buttons and Rotary encoder
- Display Driver
- File System
  - SD card
  - EEPROM?
- Audio Output
How to write a driver?

- Start with the data sheet
  - What commands are available?
- Any sample code provided?
  - Getting a complex device to react for the first time can be a challenge
- Pay detailed attention to reset conditions and the required timing for initialization
Connecting Hardware to a Microcontroller

- Low-level hardware develops fast
- To reach volume hardware is very adaptable → complex to configure
- Documentation often poor
- Sample code generally poor
- Chips are often substituted with variants
- Chips have bugs → know the Errata
Connecting Hardware to a Microcontroller

You may want to connect, e.g., a Bluetooth module (from £6.-), a GPS module (from £12.-), a Wifi Module (from £3.-) or a LoRa Long Range Radio (from £16.-).

Precautions

▶ while unconnected sensitive to electrostatics
  ▶ touch a metal case before handling
  ▶ wrap in aluminum foil for storage

▶ never reverse polarity on power supply lines

▶ if the μC and the module run on different voltage check whether extra circuitry is needed
TFT LCD Display

- Displaytech DT022BTFT
- 2.2” Thin-Film-Transistor Liquid-Crystal Display
- 320 dots \times 240 RGB pixels on 45.12 mm \times 33.84 mm
- 262K colours (18 bit)
- Driver\(^1\): Ilitek ILI9341 or compatible

\(^1\) Here ”driver” refers to the driver circuit driving the > 1000 lines of the display, not the software driver providing the device independent interface.
ILI9341 TFT Display Driver

- 168 kB Video RAM
- 6-, 8-, 9-, 16-, 18-bits parallel interface
- 3-, 4- line serial interface
- sleep and idle (8 color) mode
μC Interface Modes

Here the interface mode is selected by hardware with pins.

Other devices (e.g. SD card) may start a negotiating process on the simplest/slowest interface.

DT022BTFT DS, p. 5
8-bit Parallel \( \mu \text{C} \) Interface

- Supports two color depth:
  - 262K Colours (3 \( \times \) 6 bits for RGB)
  - 65K Colours (5-6-5 bits for RGB)
16 bit per pixel colour transmission

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