

Operating Systems 20/21

Task 1: The Real-time Clock

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Overview



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Your first task is to implement a device driver for a

Real Time Clock

Deadline

The **STRICT** deadline is: **Week 4 04/02/2021**

Thursday at **4pm GMT**

Specification Document and Submission



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Available on the course website, under the coursework section:

<https://course.inf.ed.ac.uk/os>

What is a device?



A device is something that **puts information in**, and/or **gets information out** of the computer. They are normally **real entities** that are **physically attached** to the computer.

Devices can be:

- **Input** devices, e.g. mouse, keyboard, microphone, joystick, real time clock.
- **Output** devices, e.g. monitor, printer, headphones.
- **Input/Output** devices, e.g. hard-disk, USB stick.



What is a device driver?



A device driver is an **operating system program**, or a **set of routines**, that manage the **lifetime** and **operation** of a particular device.

They provide a **software abstraction**, of a **hardware device**.

Device drivers are usually **vendor-specific**, meaning they know how to control exactly one type of device, made by a **specific manufacturer**.

Often, they implement a **generic interface** to that device, so that the operating system doesn't have to account for differences between vendors.

InfOS Device Model

Every attached device is represented by an **instance** of a subclassed “**Device**” object.

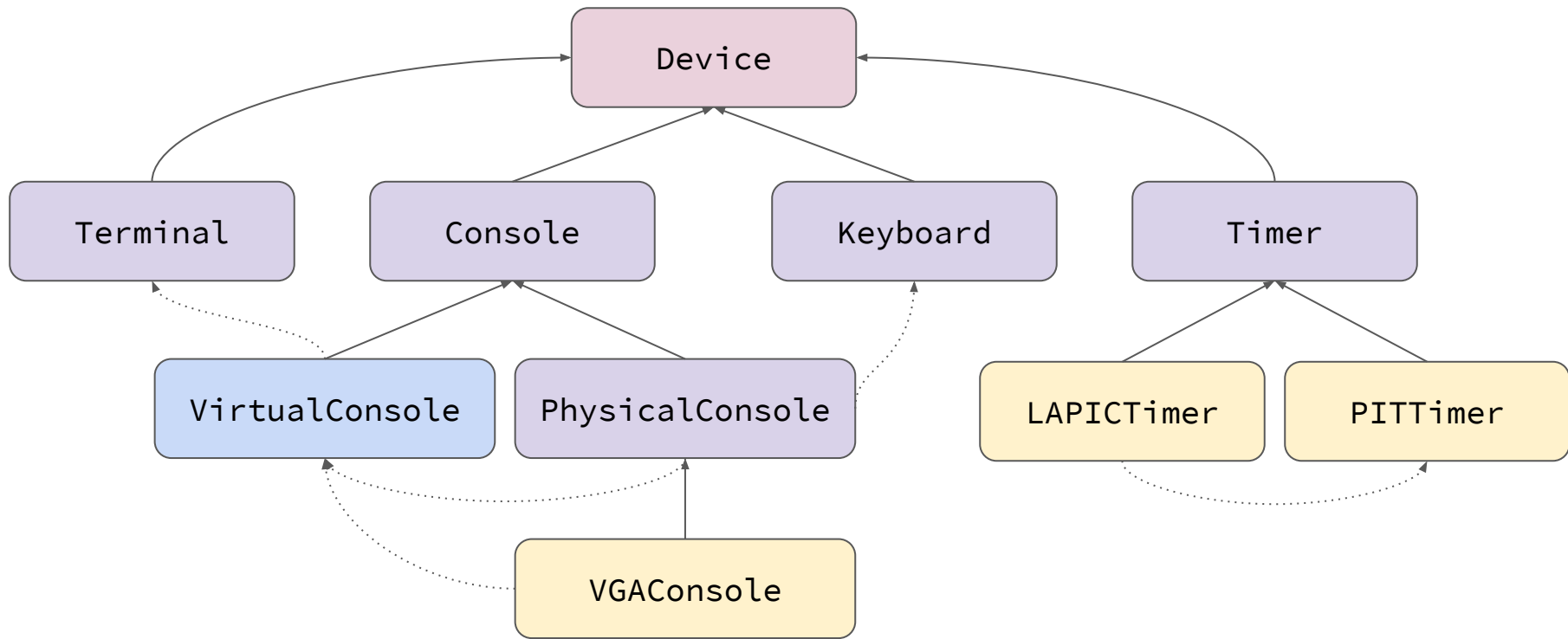
The subclass implements the **functionality** of the device driver.

Devices may **depend** on other devices.

There are normally **multiple levels** in the inheritance hierarchy. **More derived** classes implement **more specific** functionality.

Device
Console
PhysicalConsole
VGAConsole

Device
Keyboard



Subset of device inheritance hierarchy/interactions

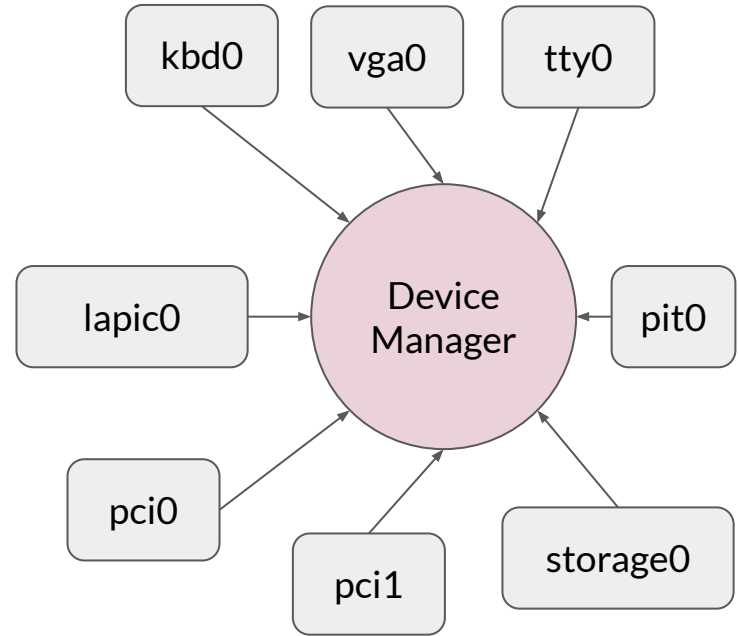
Registering and Resolving Devices



When the system boots, the **platform** is **probed**, and discovered devices are **instantiated**, then **registered** with the “**Device Manager**”.

When a component of the system requires a particular device (or class of device) the “**Device Manager**” is asked to return it.

When a device **depends** on another device, the **dependee** must have been initialised first!



Observing the Device Tree



Every device is assigned a unique name by the device manager.

These names can be listed in the InfOS shell, by issuing the command:

```
> /usr/ls /dev
```

Directory Listing of '/dev':

```
ioapic0 (0 bytes)
```

```
vc0 (0 bytes)
```

```
pci3 (0 bytes)
```

```
...
```

InfOS Keyboard Device Driver



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A **keyboard** is a very straightforward **input** device.

The **generic InfOS keyboard interface** requires a “**sink**” to be registered.

When a key is **pressed**, the keyboard device tells the “**sink**” that a key is “**down**”.

When the key is **released**, the “**sink**” is told the key is “**up**”.

A “**sink**” is anything that is interested in listening for key presses - such as the “**physical console**”. The physical console registers itself with the keyboard as a “sink”.

The keyboard driver uses **interrupts** to detect when a key is **pressed** or **released**.

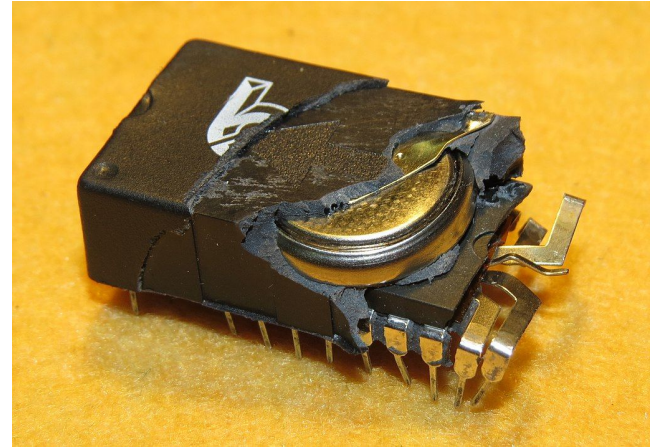
When the interrupt **fires**, the **sink** is notified accordingly.

Real Time Clock

A **real time clock** (RTC) is a device that provides the system with a value (hopefully) representing the current “**time of day**”.

The actual device itself simply **increments** it's internal counter every second, and is usually battery powered, so that time continues **progressing**, when the system is **powered off**.

The **internal counter** may or may not be set to the correct time - the device **doesn't care** about this.



RTC Driver



You are tasked with implementing an RTC driver for the CMOS RTC.

This involves **subclassing** the RTC device class (already provided in the **skeleton**), and interrogating the **CMOS register space**.

The RTC device class provides an **interface** for accessing the current time-of-day.

This interface is realised through the “**read_timepoint**” method, and you must implement this routine.

This routine should interrogate the real RTC device, and fill in the values of the “**tp**” structure (passed in as a **reference** parameter).

CMOS RTC



The CMOS RTC is a device that is present on **nearly every** modern x86-based platform. It can be accessed by reading from I/O registers in a specific way.

On x86, the I/O registers are accessed using the `__in{b,w,l}` and `__out{b,w,l}` helper functions. The suffix indicates the **width** of the access.

- **b** = 1 byte/8 bits
- **w** = 2 bytes/16 bits
- **l** = 4 bytes/32 bits

These helpers are in the `infos/arch/x86/pio.h` header file, so you'll need to `#include` this in your source-code to use them.

Reading the values



Read the description of the CMOS area on the OSDev website in **great detail**.

Read the coursework specification document in **great detail**.

Pay attention to how values should be correctly read from the RTC, with regards to the access protocol for the CMOS registers, and the conditions that should be met to perform the read.

Do not use **inline assembly** for your implementation. InfOS provides all the functionality you require through helper methods.

Interpreting the values



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You will need to determine whether or not the RTC is providing values in binary coded decimal (BCD), or binary format.

Your implementation **MUST** support both of these formats.

https://en.wikipedia.org/wiki/Binary-coded_decimal

Testing



You have **no influence** over whether or not the RTC provides values in **BCD** or **binary format** - this is up to QEMU. Write a small (external) test program to check that your conversion algorithms work.

Boot InfOS and run **/usr/date**

The results should be that the **system date and time**, should be **approximately** equal to the **hardware date and time**, which should be the **same** as your **host system's date and time**.

If you see:

warning: No RTC available to synchronise TOD
then your driver hasn't been loaded.