COMP3301 Assignment 3

OpenBSD VHD Kernel Driver - Filing the System

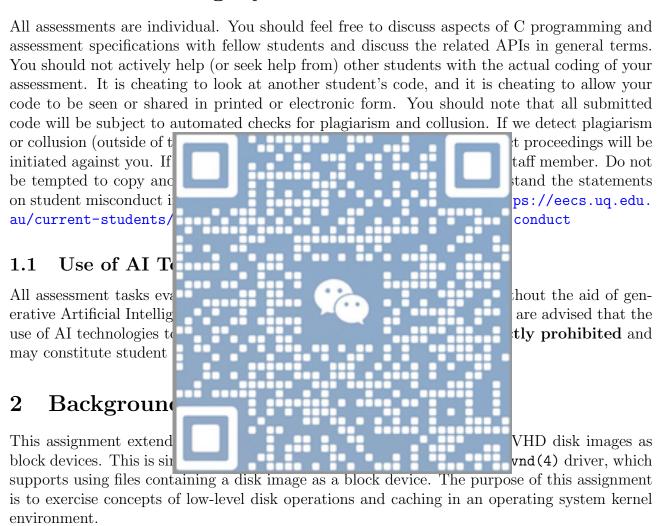
Due: 3pm Monday in Week 13 (21st of October)

Submission: Git

Code submission is marked in your prac session in week 13

Last Updated: October 12, 2024

1 Academic Integrity



From a high-level point of view, a physical disk device presents a sequence of bytes that can be written to or read from, with the ability to quickly seek an arbitrary position and read and write at that point. Note that this is a simplification that ignores that disks address and provide access to blocks of bytes, not individual bytes.

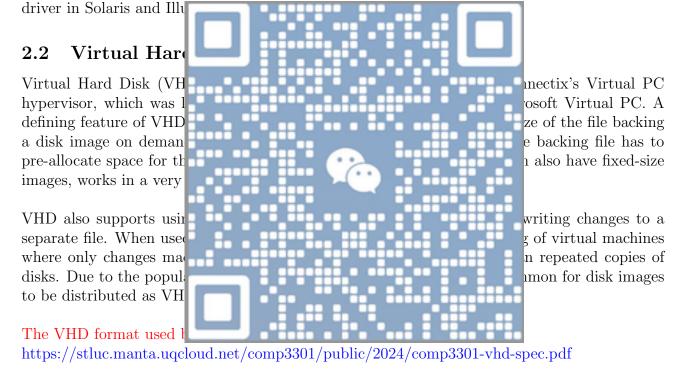
A file on most operating systems offers similar features, i.e., a sequence of bytes that can be accessed by address. Because of these similarities, it is possible for an operating system to provide a common set of operations on both files and disks (e.g., open, close, read, write, seek, etc.) and allow them to be used interchangeably. For example, you could use tar to write an archive to a file in a filesystem, or directly to a disk device. dd, cp, cat, etc can read the bytes

from a raw disk into a file or visa versa. However, operating systems generally provide extra functionality on top of disk devices such as the ability to partition disks and mount filesystems from them.

$2.1 \quad \text{vnd}(4)$

The vnd(4) driver in OpenBSD provides a "disk-like interface to a file". This means the OpenBSD kernel can open a file and present it as a block device to the rest of the system, which in turn allows for the creation and use of filesystems on these disk images.

The vnd(4) driver currently only supports using raw disk images as backing files. There's a one-to-one mapping of data offsets for data in the end disk device and the byte offset of that data in the underlying file. This makes the implementation very simple, with the downside that the backing file has to be the same size as the disk vnd is presenting. If you have a 32G disk image, the file will be 32G regardless of how much data is actually stored inside a filesystem mounted on top of it. Similar functionality exists in the loop driver in Linux, and the lofi



The same file can be found on Blackboard. This specification differs from the official Microsoft specification in that it includes annotations for ease of understanding and contains corrections to errors in the official specification. The official VHD format is documented by Microsoft in Virtual Hard Disk Format Spec_10_18_06.doc.

3 Instructions

To complete the assignment, you will need to do the following:

1. Download the base code patch

```
cd ~
ftp https://stluc.manta.uqcloud.net/comp3301/public/2024/comp3301-2024-
a3.patch
```

2. Create the a3 branch

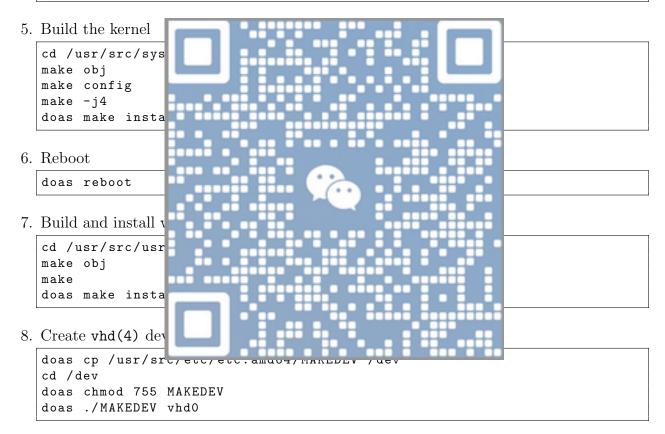
```
cd /usr/src
git checkout -b a3 openbsd-7.5
```

3. Apply the base code patch

```
git am < ~/comp3301-2024-a3.patch
```

4. Install the includes

```
cd /usr/src/include
doas make includes
```



4 Specifications

You will be extending the OpenBSD kernel to add support for using VHD files as a backend for a vhd(4) virtual block device. vhd(4) is roughly based on vnd(4). Boilerplate code for the device entry points and command line utility will be provided, but you will be implementing the handling of the file and the VHD file format within the provided kernel driver.

Only a subset of the VHD functionality listed in Microsoft's specification of the file format is required. The following functionality is required:

• Read support

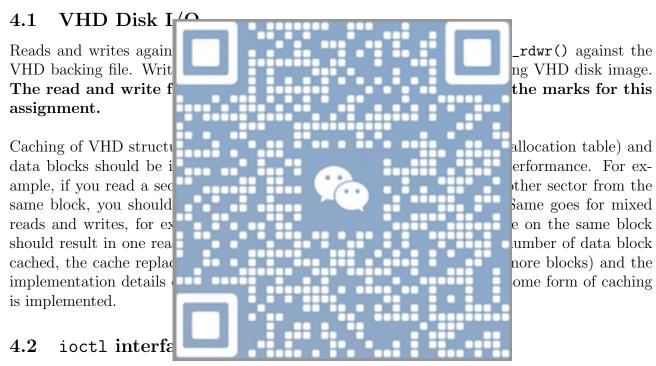
• Fixed-size images

• Write support

• Dynamic images

Differencing images do not need to be supported. In addition to supporting the VHD file format, the kernel should implement the following:

- Deny attaching VHD files which are invalid, corrupted or contain features not supported by your kernel driver.
- Deny detaching VHD files when the disk is open unless the force flag is passed to the VHDIOCDETACH ioctl.
- Return the name of the VHD file the device was attached to for the VHDIOCFNAME ioctl.
- Populate a struct stat for the currently attached VHD file for the VHDIOCSTAT ioctl.



The following ioctls should only work on the raw partition of the character device associated with each vhd disk. Except for VHDIOCATTACH, they should only work when a vhd disk is attached to a backing file.

VHDIOCATTACH

Specify the VHD file to attach as a block device, and parameters for using the disk in the kernel. The vhd_attach struct contains the following fields:

- vhd_file The name of the VHD file to attach a vhd disk to.
- vhd_readonly The vhd disk can be written to when set to 0, and if the VHD file is read-only, the vhd disk should fail to attach. The vhd disk should be read-only when set to a non-zero value, and the VHD file should be opened read-only.

VHDIOCDETACH

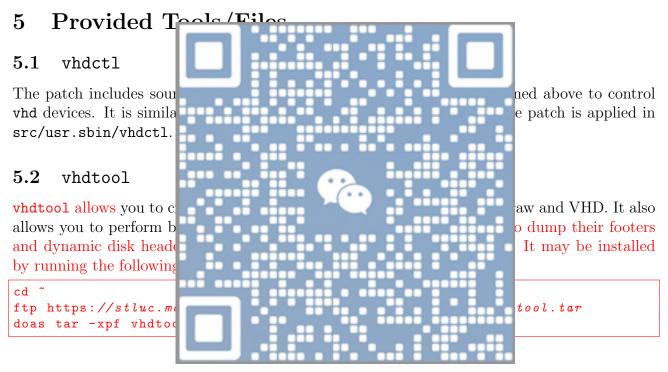
This ioctl requests the block device be detached, and the backing file closed. If the disk is in use, the request should fail with EBUSY unless the unsigned int ioctl argument is set to a non-zero value. A non zero value requests the forced removal of the block device and close of the backing VHD file.

VHDIOCFNAME

This ioctl requests the name of the VHD file used for the currently attached block device. The name should be the same as what was passed as the filename in the VHDIOCATTACH ioctl.

VHDIOCSTAT

This ioctl is equivalent to an fstat(2) system call against the backing file.



5.3 rawtest.img

This is a raw disk of size 10 MiB which contains a filesystem with the following files:

```
-rw-r--r--
             1 root
                               10 Oct
                                        4 21:37 comp3301.txt
                      wheel
drwxr-xr-x
             2 root
                      wheel
                              512 Oct
                                       4 21:39 folder/
                             6496 Oct 4 21:40 hello*
             1 root
                      wheel
-rwxr-xr-x
-rw-r--r--
             1 root
                      wheel
                               94 Oct 4 21:40 hello.c
-rw-r--r--
                               13 Oct 4 21:36 hello.txt
             1 root
                      wheel
-rw-r--r--
                             2739 Oct
                                        4 21:38 test.txt
             1 root
                      wheel
```

Download:

https://stluc.manta.uqcloud.net/comp3301/public/2024/rawtest.img.