File systems

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KTH

2021

The bigger picture

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- a *file* is persistent i.e. it survives the termination of a process
- a *file* can be access by several processes i.e. a shared resource
- a *file* can be located given a *path* name

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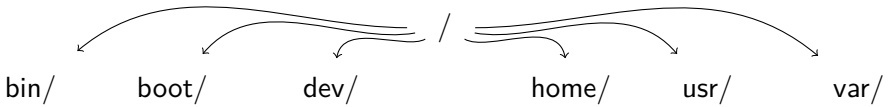

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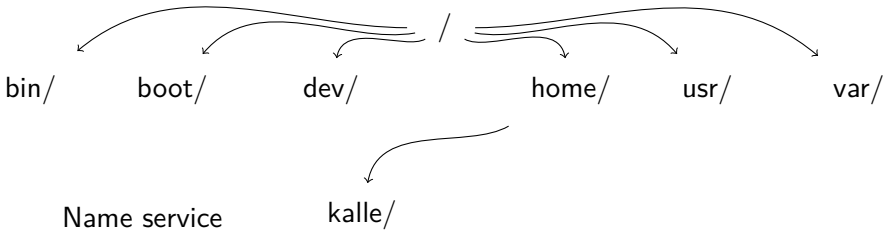

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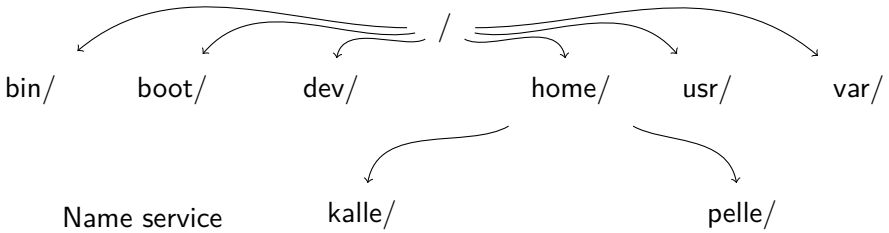

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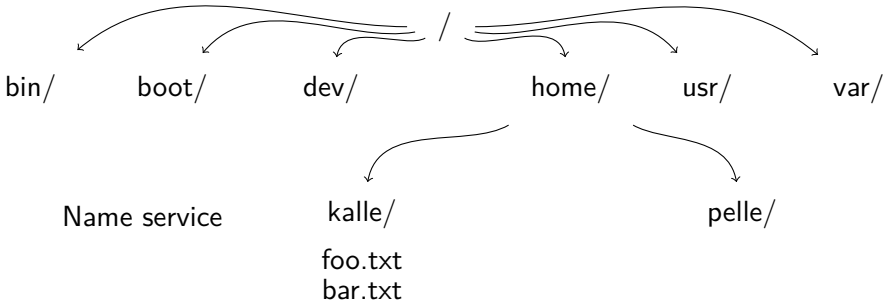

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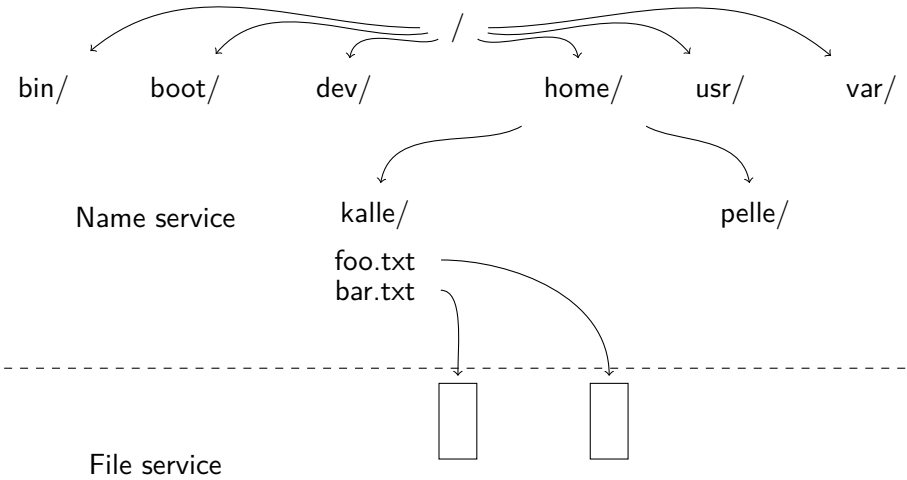

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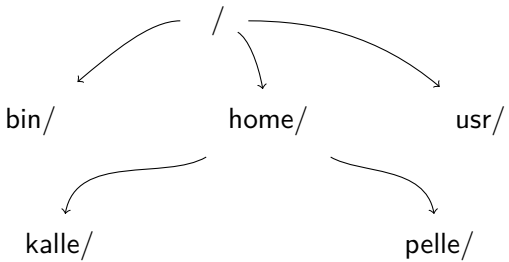

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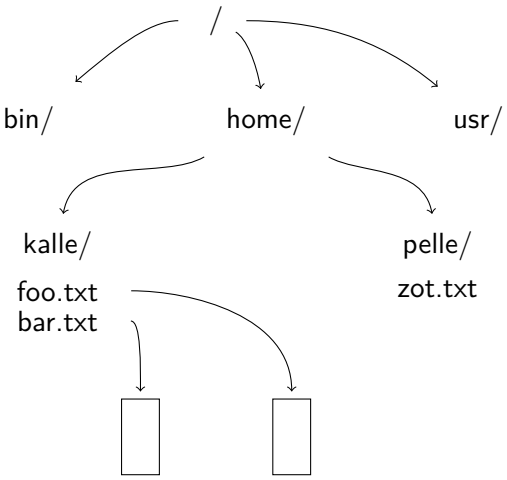

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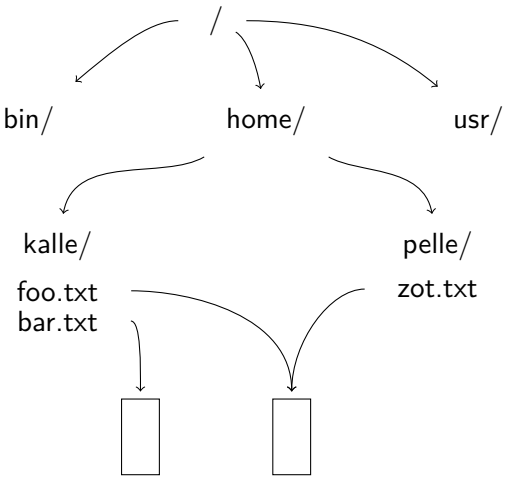

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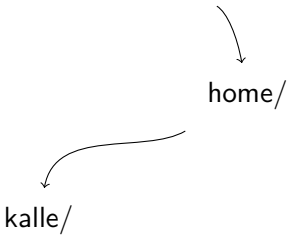

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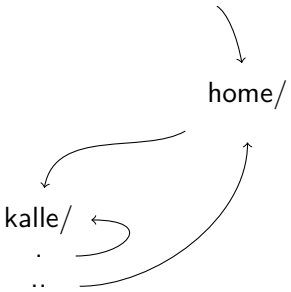

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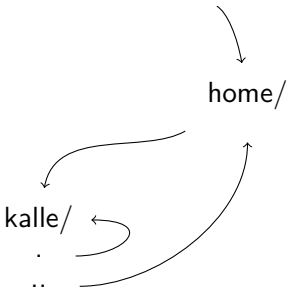

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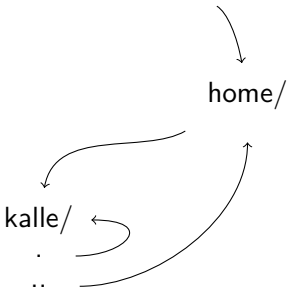

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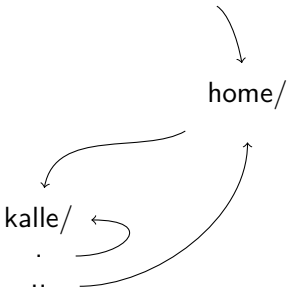

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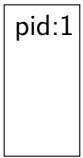

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processes

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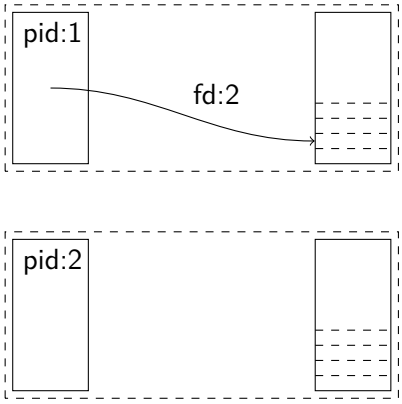

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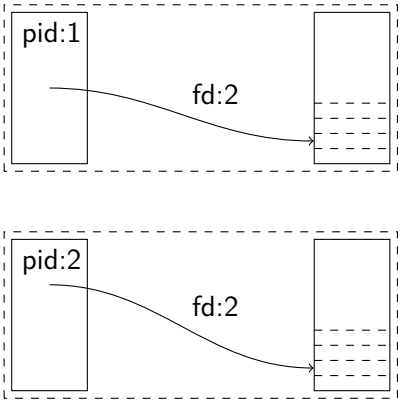

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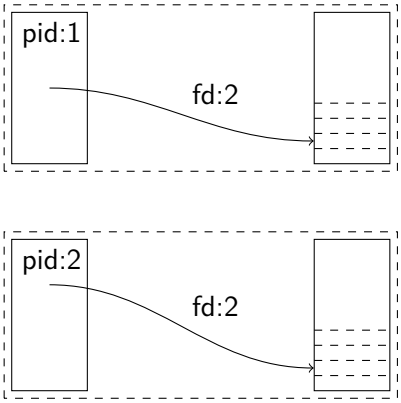

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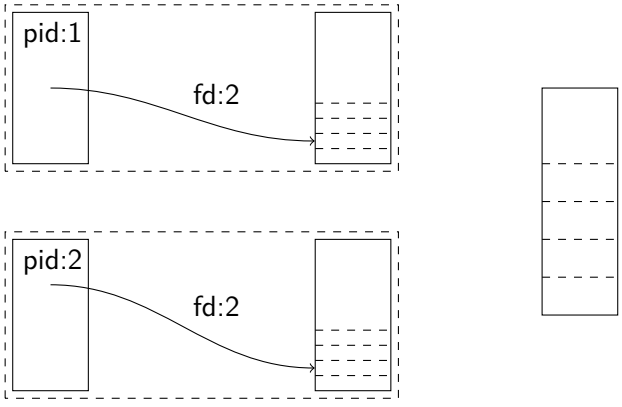

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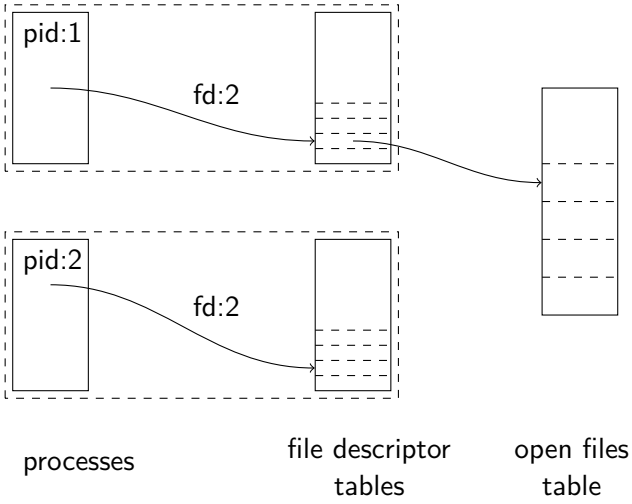

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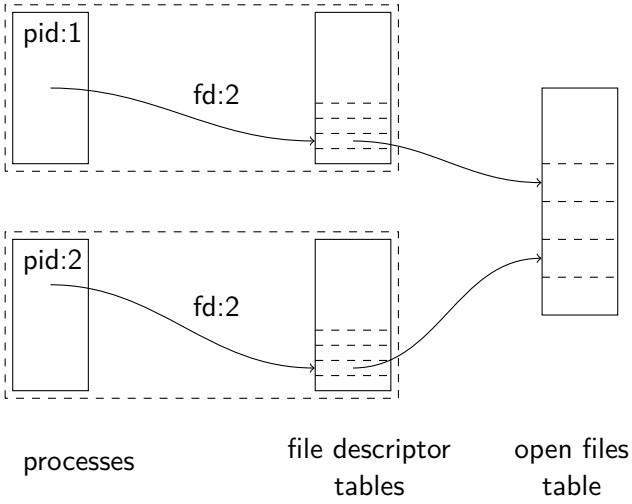

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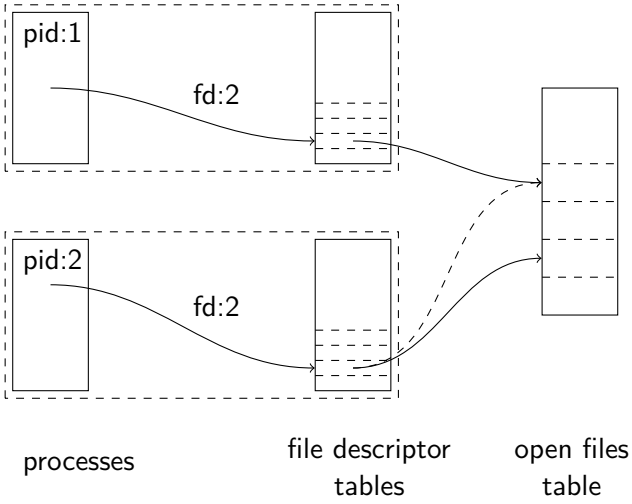

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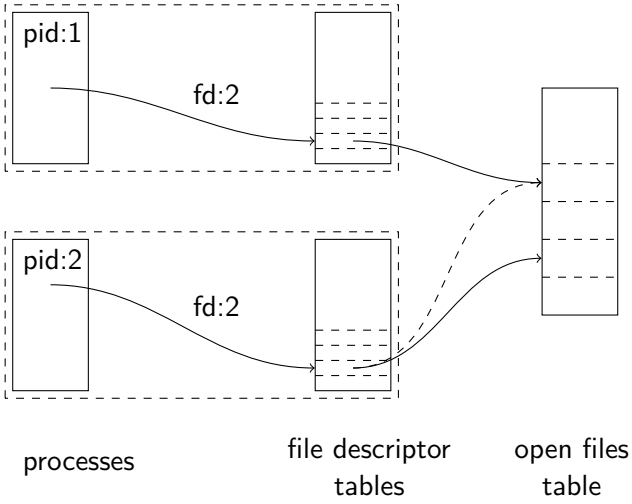

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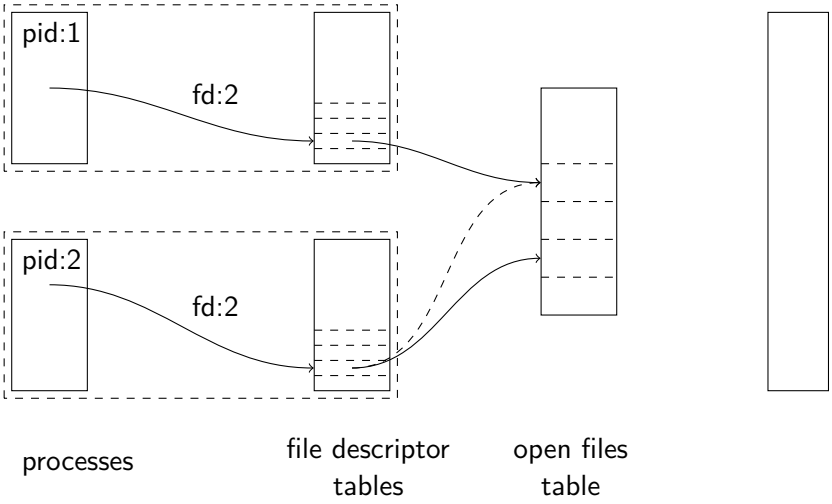

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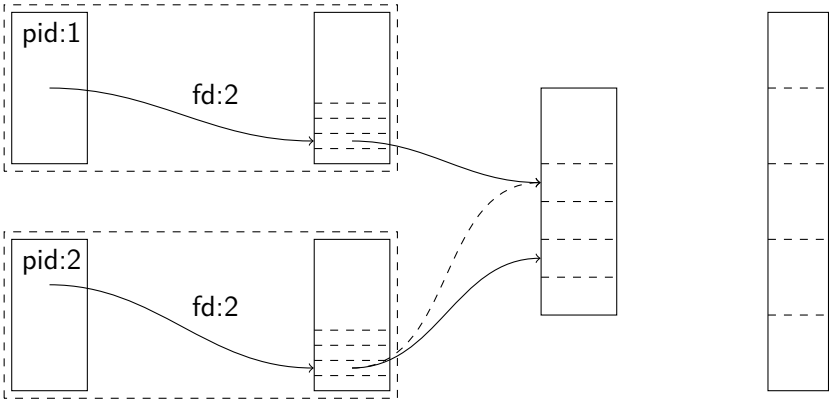

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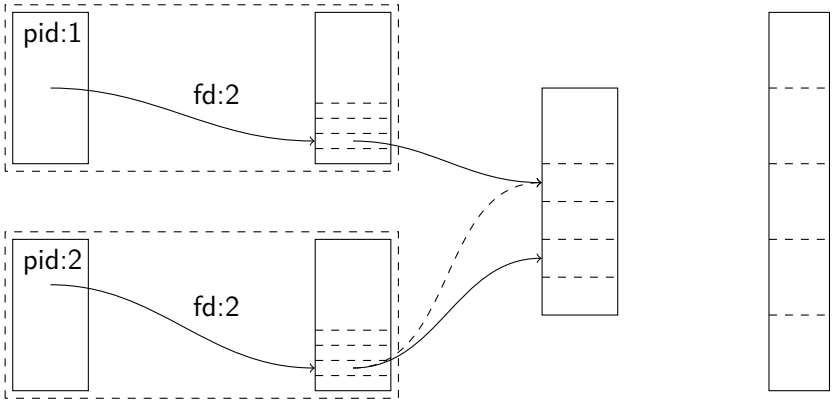

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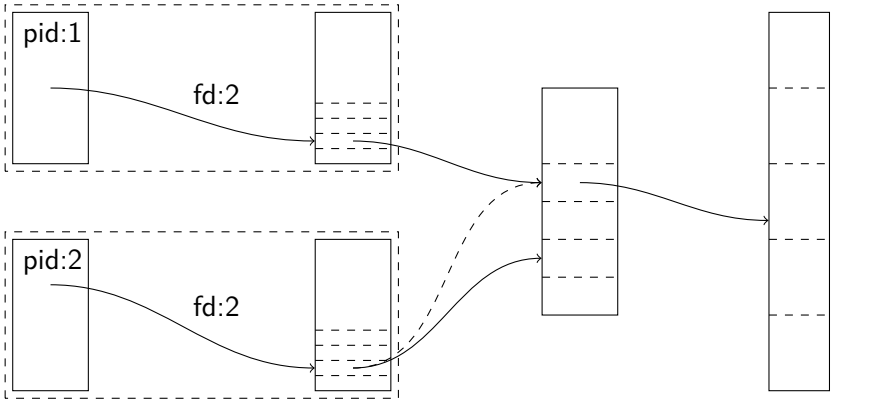

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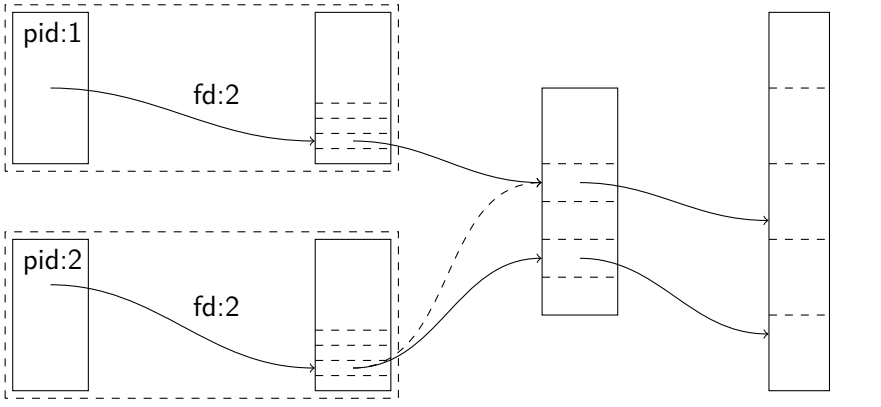

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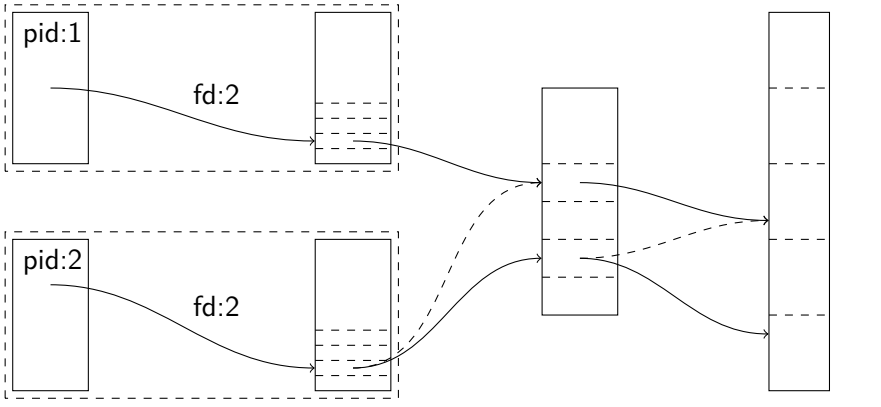

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Note - a forked process can share file table entry with mother.

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lseek() will only modify the file tabels entry i.e. it will not read anything from disk.

The inode

- mode: access rights
- number of links: when zero the file is deleted
- user id: the owner of the file
- group id: the associated group
- size: file size in bytes
- blocks: how many data blocks have been allocated
- identifiers: block identifiers (more on this later)
- generation: incremented when inode is reused
- access time: last time read
- modify time: last time modified
- change time: the time the inode was changed

The file system

The *file system* determines how files and directory structures are organized on a disk.

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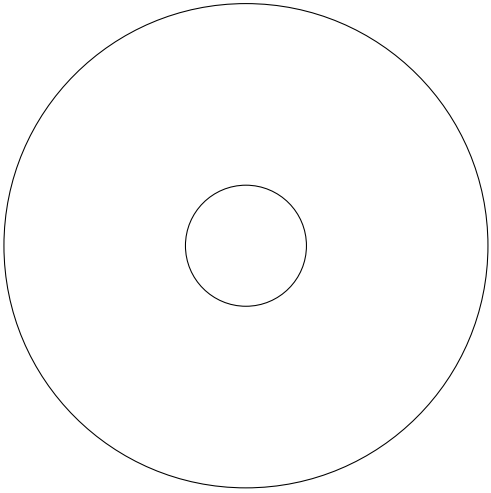
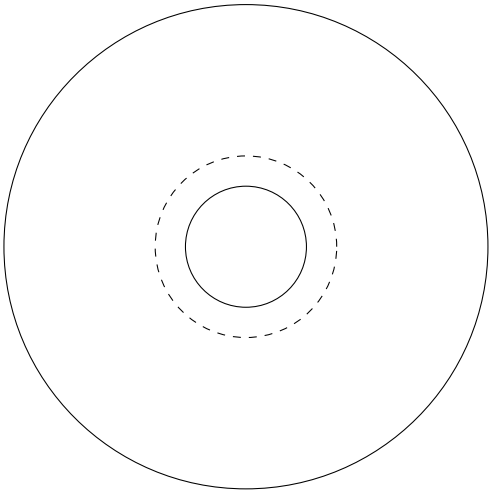
An operating system can *mount* different file systems, all accessible from the same directory structure.

Do `mount`, to see which file systems you have mounted.

Anatomy of a HDD

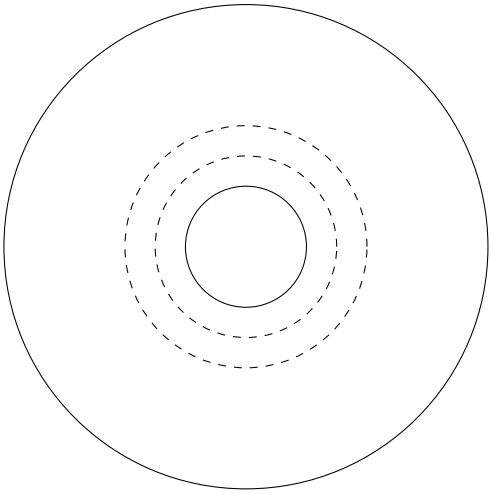


Anatomy of a HDD



How do we store a file system in the sectors of a hard disk drive.

Anatomy of a HDD



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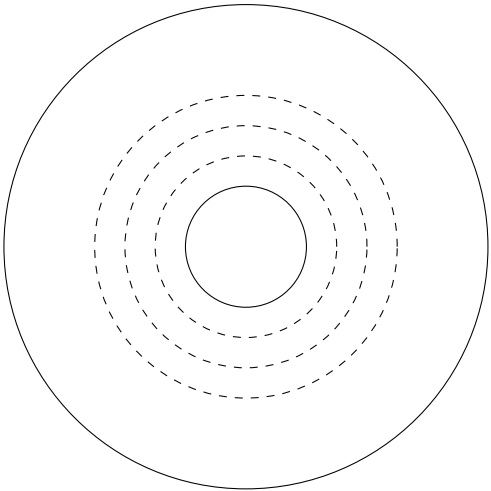

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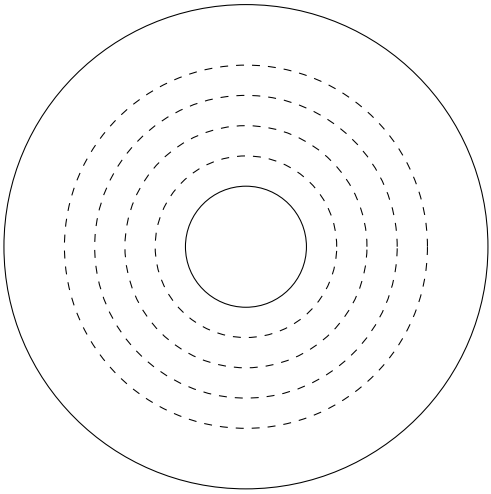

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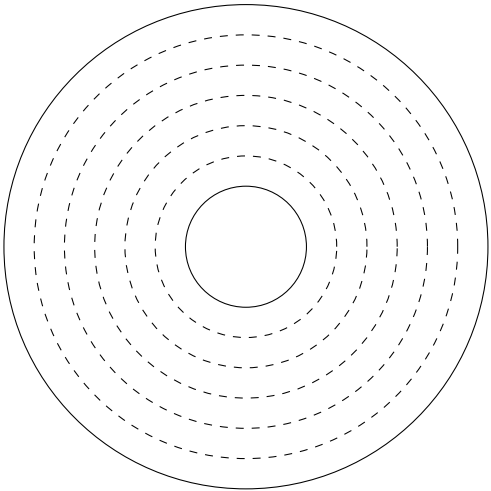

- track/cylinder

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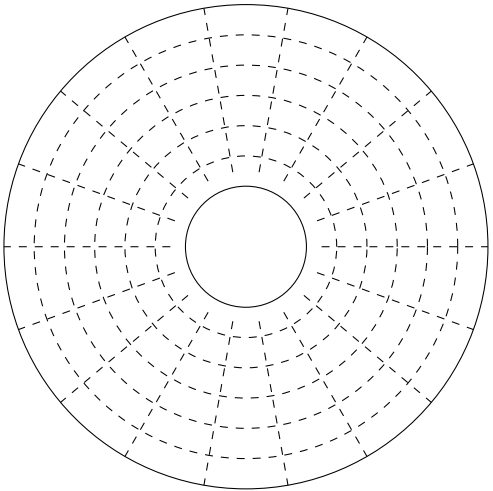
Anatomy of a HDD



- track/cylinder
- sectors per track varies

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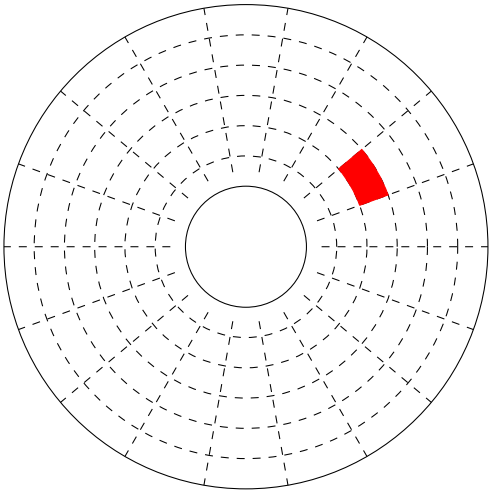

- track/cylinder
- sectors per track varies
- sector size: 4K or 512 bytes

How do we store a file system in the sectors of a hard disk drive.

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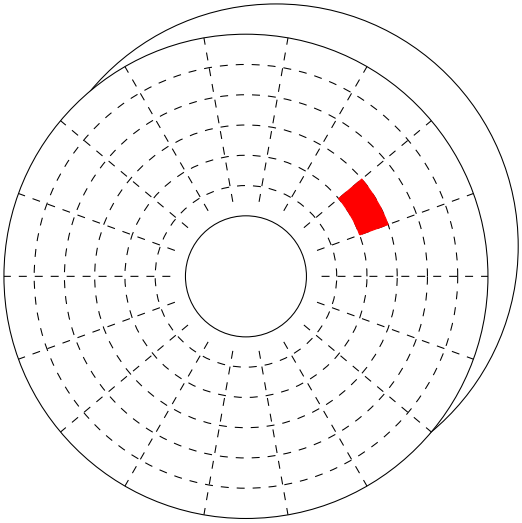

- track/cylinder
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- sector size: 4K or 512 bytes
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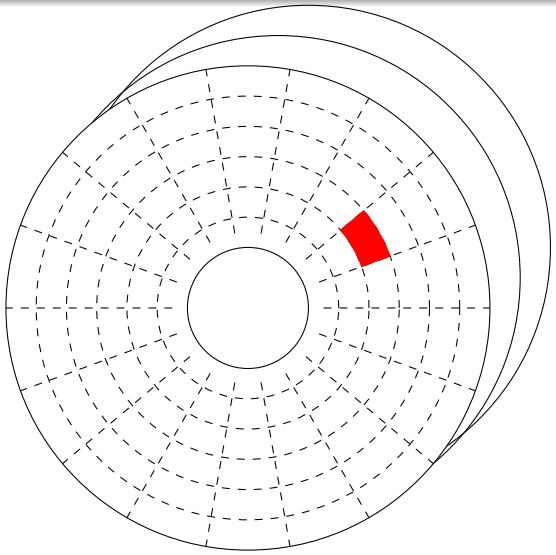

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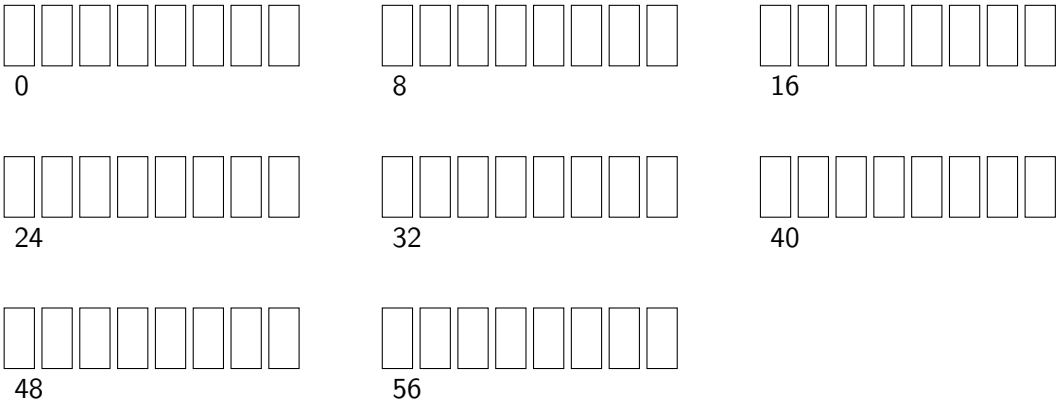
How do we store a file system in the sectors of a hard disk drive.

The Very Simple File System



Each block is 4Kbytes, an inode 256 bytes.

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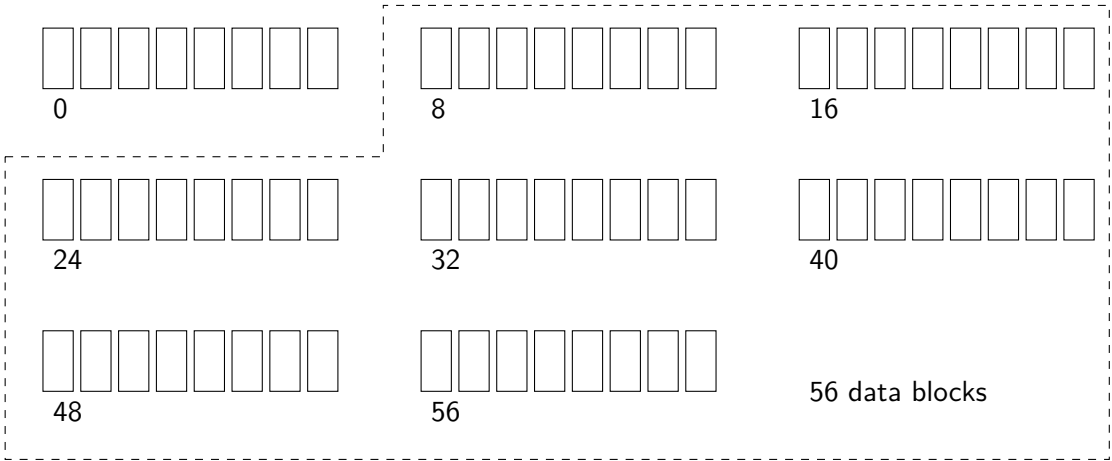

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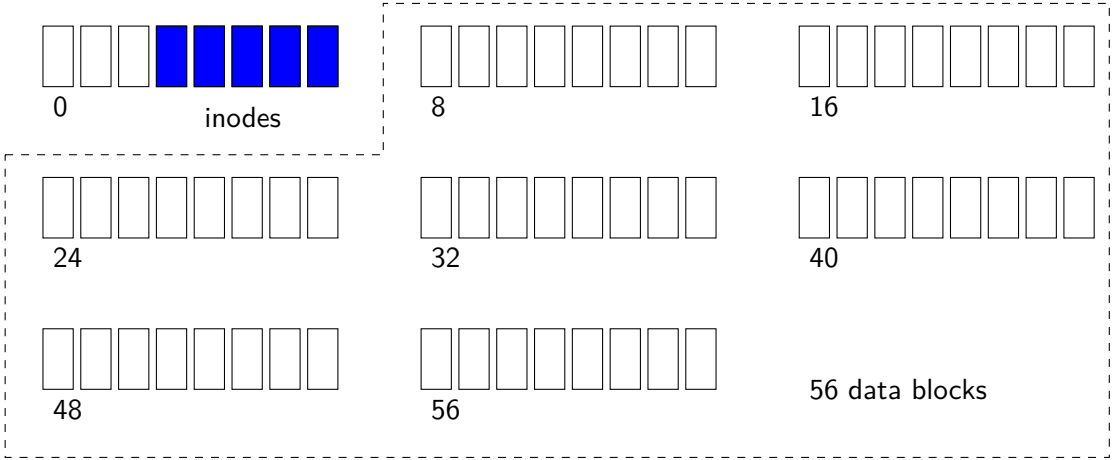

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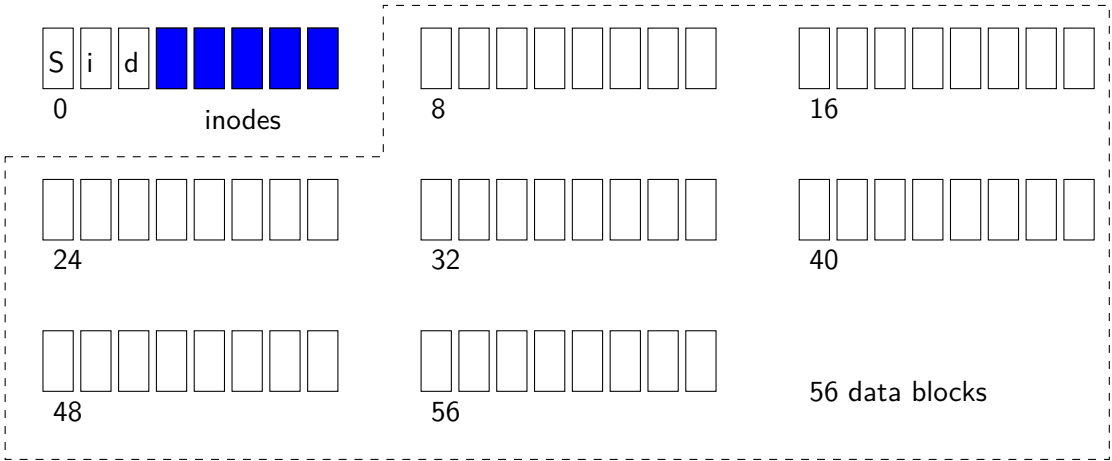

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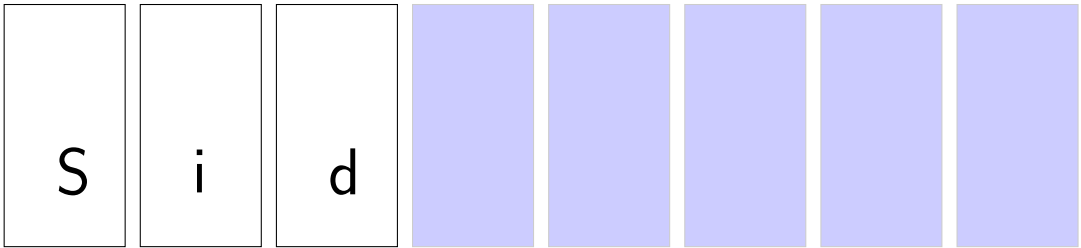
The super block, bitmaps and inodes



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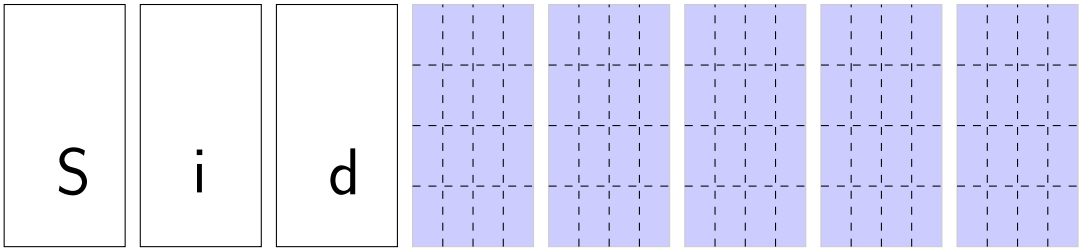

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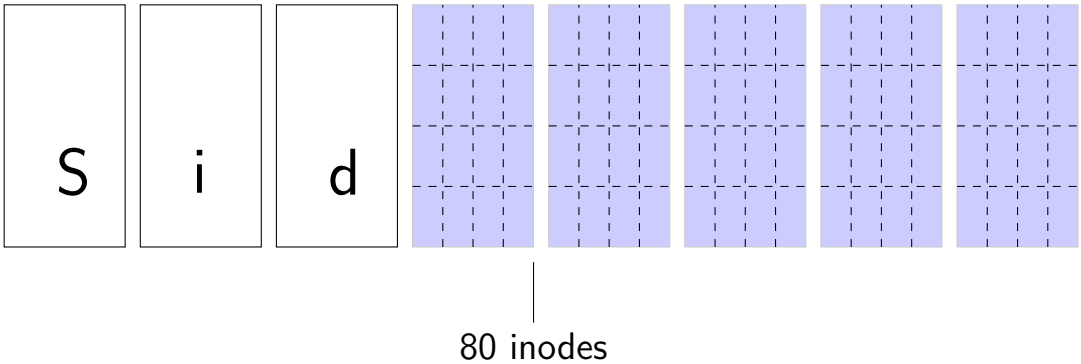

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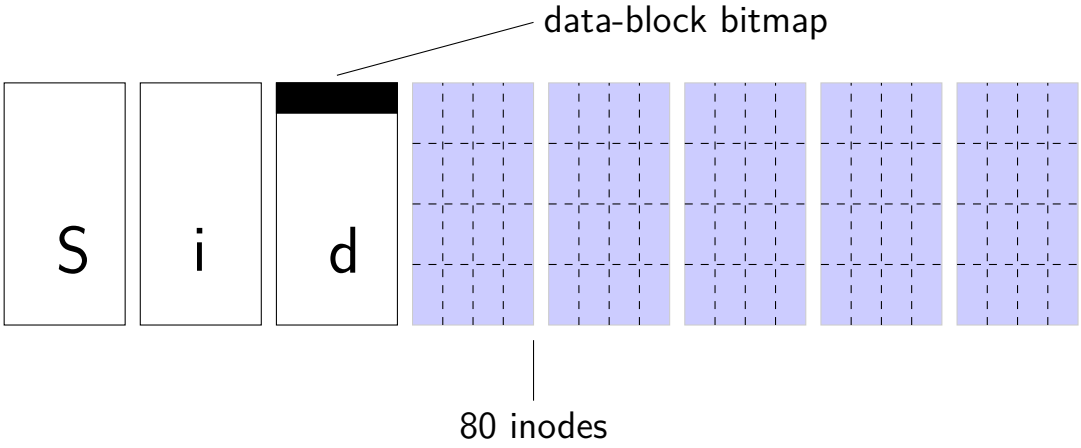

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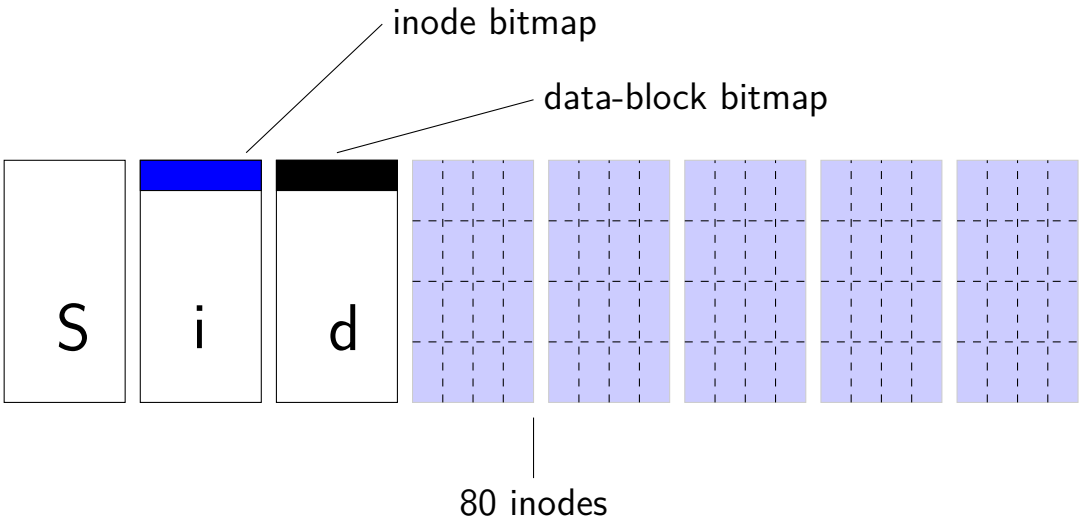

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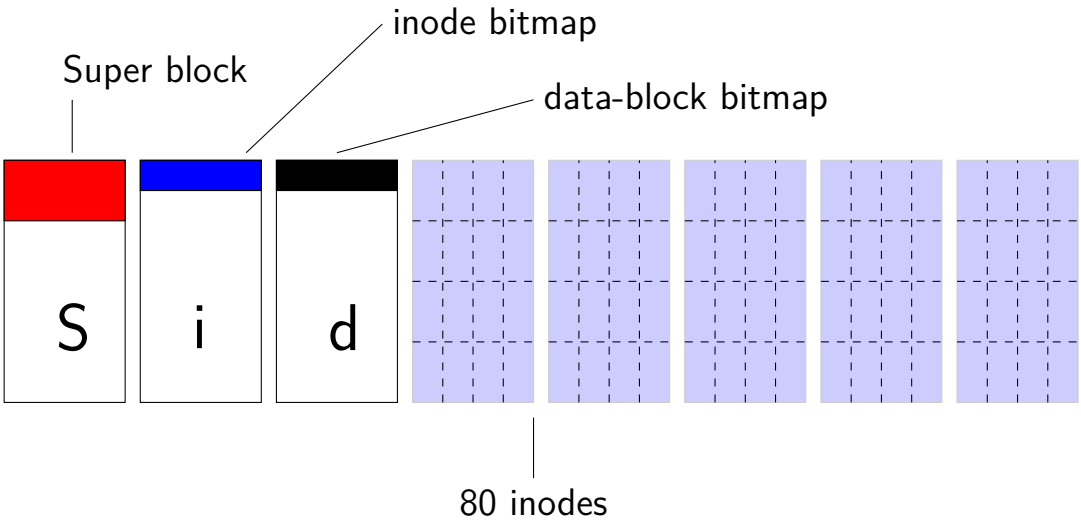

The super block, bitmaps and the inodes

The super block

- describes the file system
- how many inodes, where are they located
- how many data blocks, where are they located
- where are bitmaps

The super block, bitmaps and the inodes

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The bitmaps

- which inode blocks are available
- which data blocks are available

The super block, bitmaps and the inodes

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- how many inodes, where are they located
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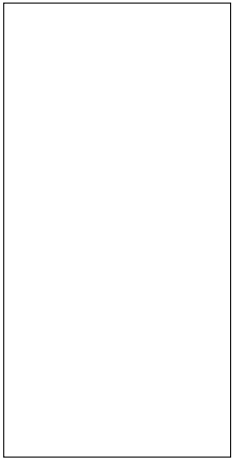
The bitmaps

- which inode blocks are available
- which data blocks are available

The inodes

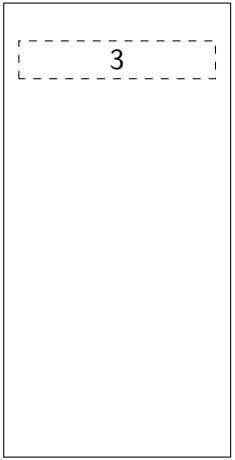
- all meta-data of the file
- which data blocks are used

the inode revisited



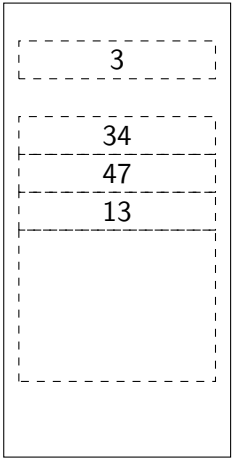
the inode revisited

- blocks: how many data blocks have been allocated



the inode revisited

- blocks: how many data blocks have been allocated
- identifiers: block identifiers



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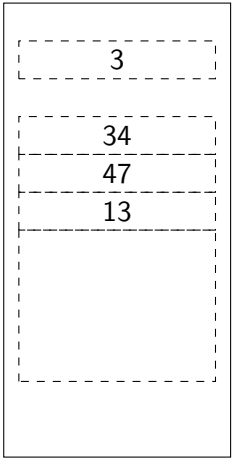

If the inode has room for 15 block identifiers ..... what is the maximum file size?

Multi-level index

- If the first fourteen entries are block identifiers,

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- If the first fourteen entries are block identifiers,
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Why not have a balanced tree?

where are the directories?

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A directory is stored as a file using an inode and (almost always) one data block.

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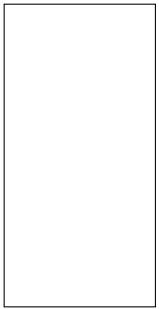
A directory is stored as a file using an inode and (almost always) one data block.

The data block contains a mapping from names of files and directories to inode numbers.

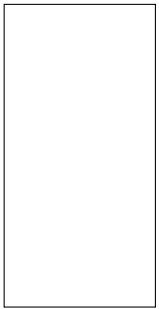
a directory



.

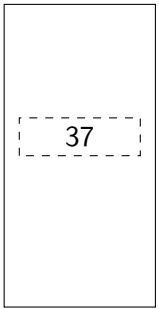
a directory

inode 2



.

inode 2



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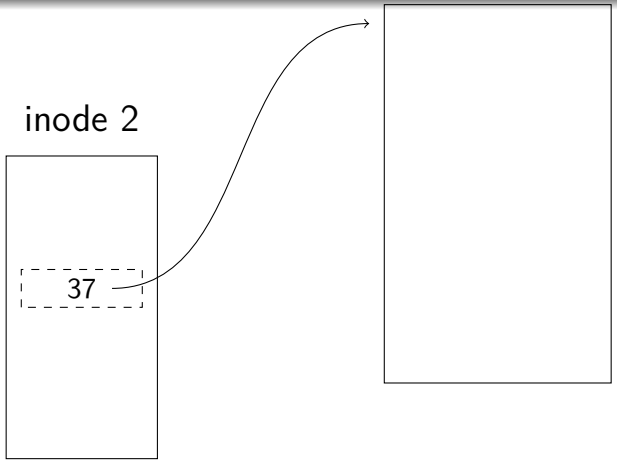

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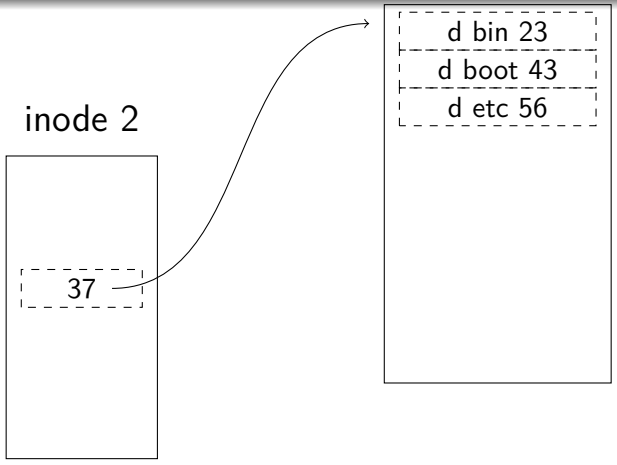

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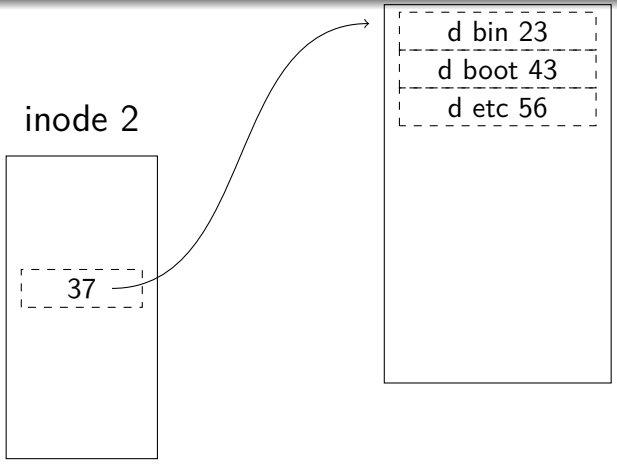

The inode of the root directory is specified by the file system (possibly in the super block).

try this

- `ls -ila ./`
  - list the current directory, show inode numbers

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to use istat, install: sudo apt install sleuthkit

reading a file

Assume we want to read the first 100 bytes of `/foo/bar.txt`.

Open the file:

- read inode of / (the root dir) - why?

reading a file

Assume we want to read the first 100 bytes of `/foo/bar.txt`.

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- create a file descriptor entry

Read from the file:

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Read from the file:

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Think about this the next time you complain about your computer being slow.

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Assume we want to create and write to a new file `/foo/bar.txt`.

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Write to the file:

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Create the file:

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- read the data block of /
- read inode of `foo`
- read the inode bitmap - find a free inode
- update the inode bitmap
- write the data block of `foo`
- write the `bar.txt` inode
- write the inode of `foo`

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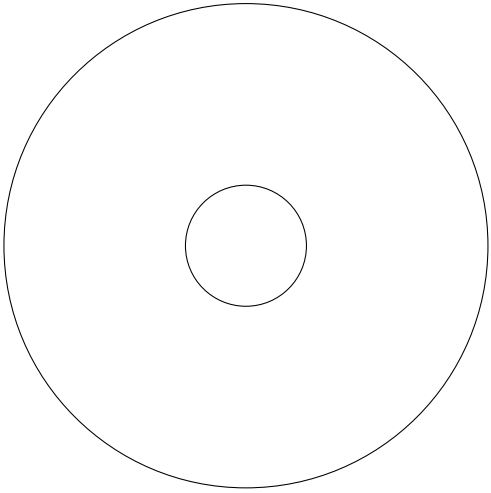

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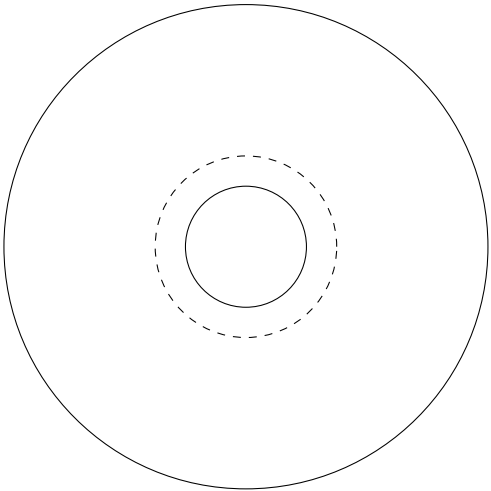

How do we store a file system in the sectors of a hard disk drive?

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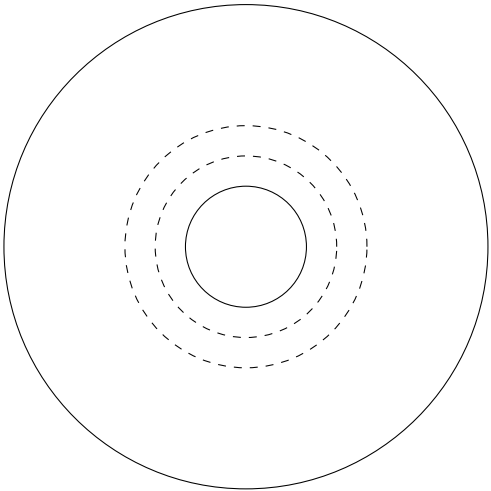

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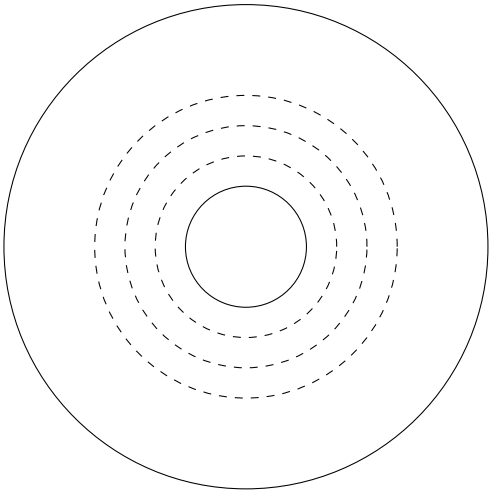

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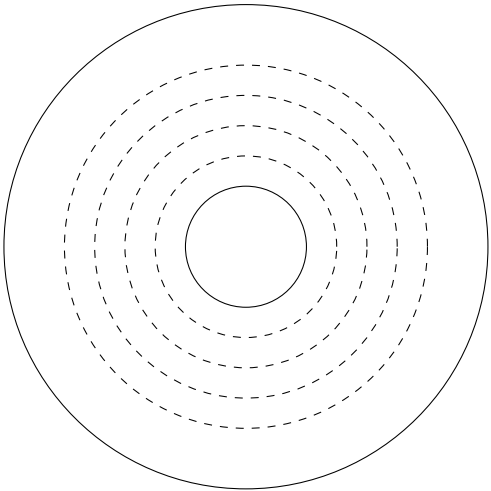

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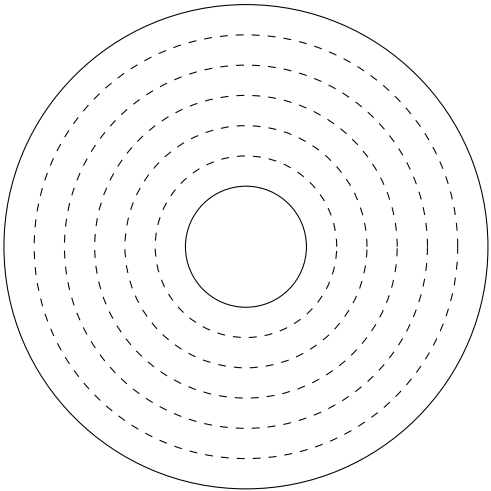

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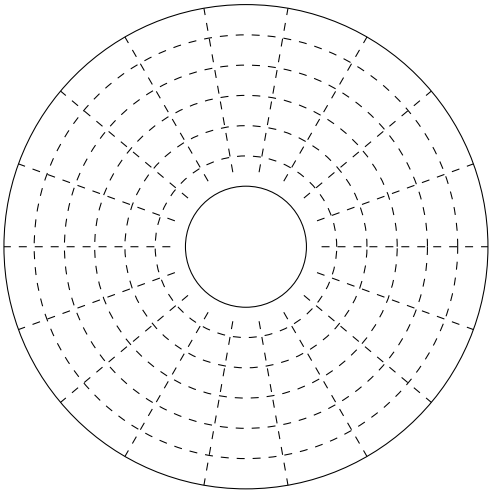

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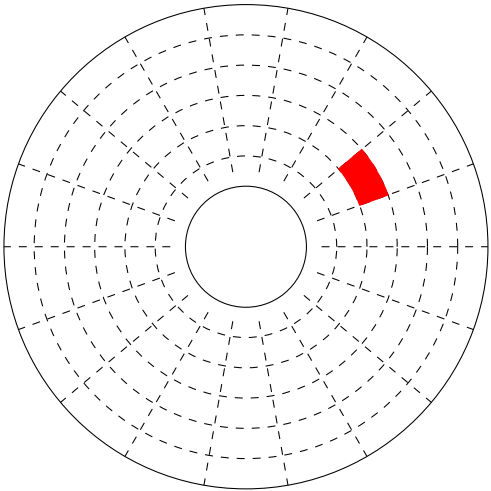

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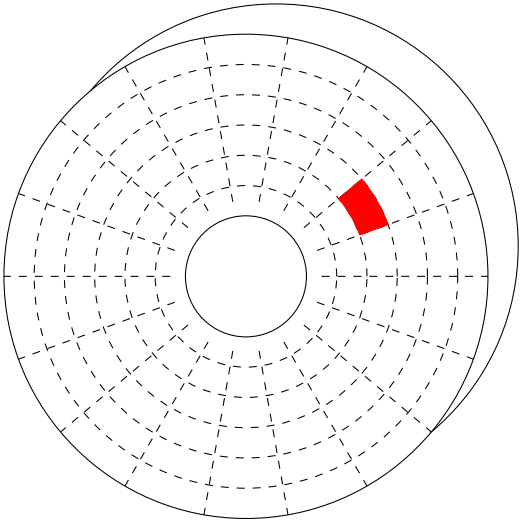

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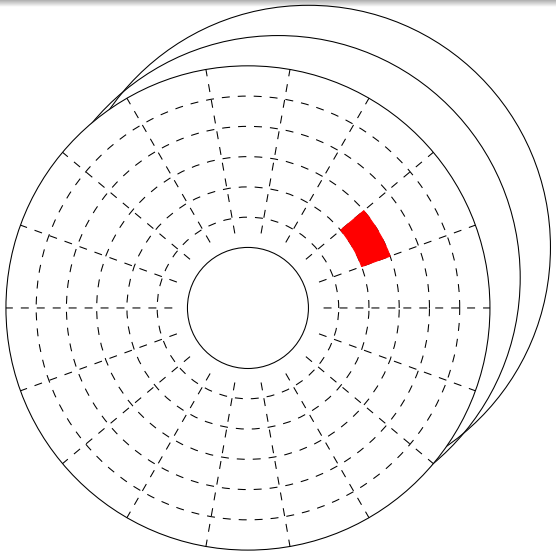

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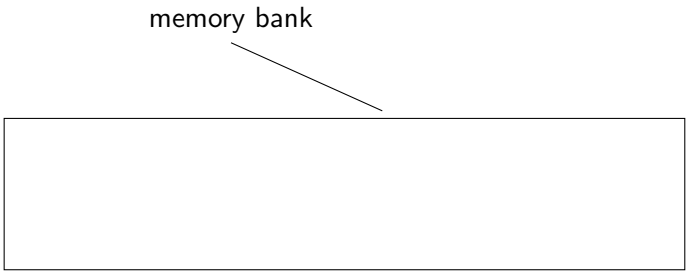

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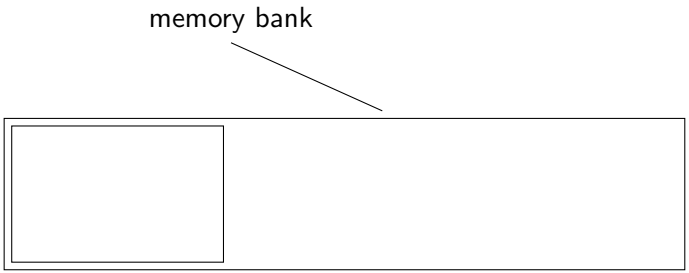

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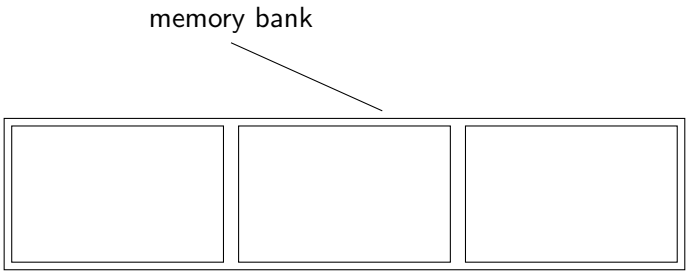

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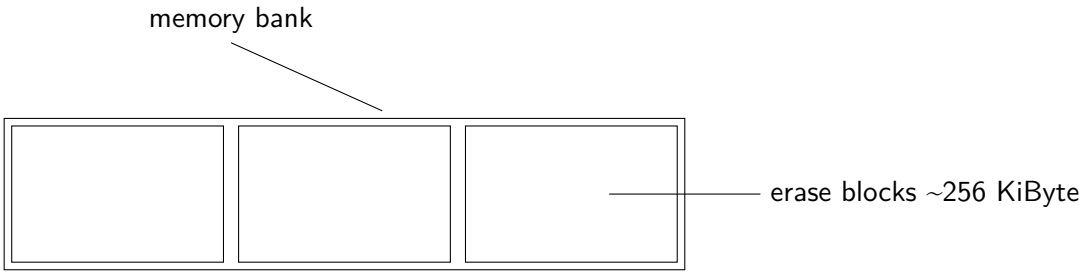

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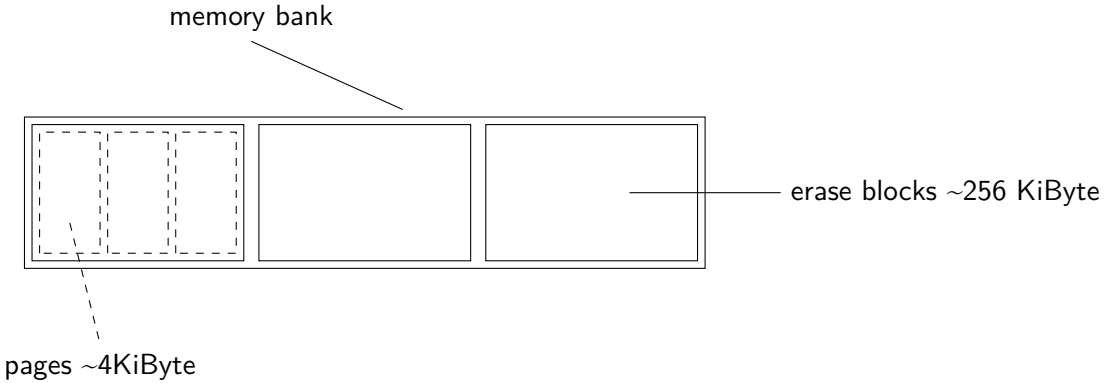

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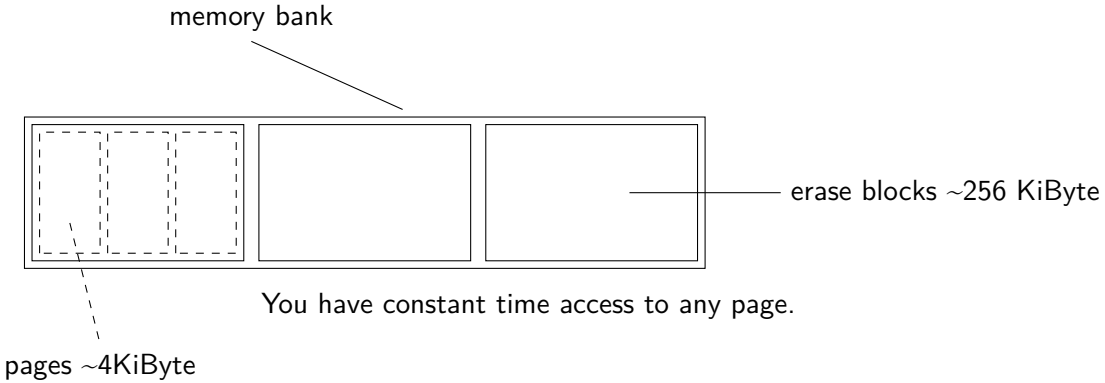

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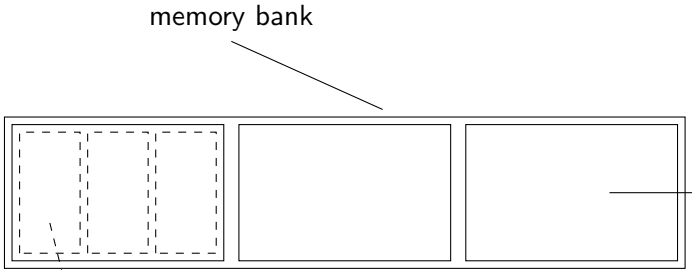

You have constant time access to any page.
You can only write to (or program) an erased page.

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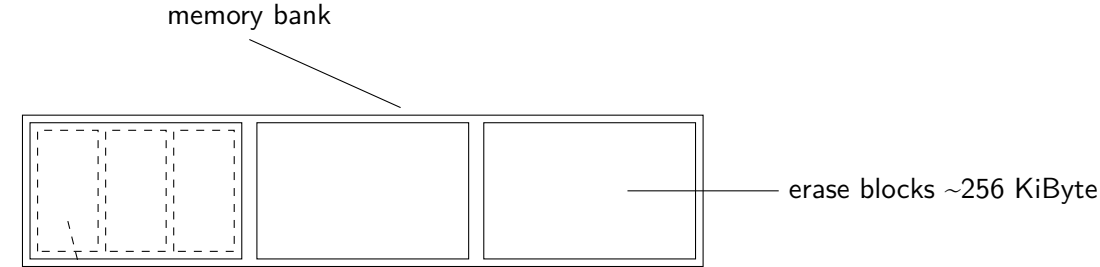

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- Do we provide persistent storage?
- Is the storage much larger or cheaper than main memory?
- Can processes use the file system to share data?

man mount

All files accessible in a Unix system are arranged in one big tree, the file hierarchy, rooted at `/`. These files can be spread out over several devices. The mount command serves to attach the filesystem found on some device to the big file tree. Conversely, the umount(8) command will detach it again.

The standard form of the mount command is:

```
mount -t type device dir
```

This tells the kernel to attach the filesystem found on `device` (which is of type `type`) at the directory `dir`. The previous contents (if any) and owner and mode of dir become invisible, and as long as this filesystem remains mounted, the pathname `dir` refers to the root of the filesystem on device.

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- `FAT32` : older file system from Microsoft, used if you want maximal portability

Summary

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