Filesystems

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Introduction

What are Filesystems?

- Filesystems manage the storage and retrieval of files from storage media.
- Filesystems are an abstraction layer between storage media (SSDs, HDDs, disk drives, even tape drives).
- Filesystems exist on *partitions*, physically contiguous segments of the disk.

Filesystems are Responsible for...

- **Space management:** filesystems allocate and manage space in discrete chunks. Filesystems must keep track of what data is stored at each chunk.
- **Filenames:** identify a storage location in the file system. Can be case sensitive (ext4) or case insensitive (HFS, NTFS).
- **Directories (folders):** group files into separate collections. Modern filesystems allow arbitrary nesting of directories.
- **Metadata:** filesystems store book-keeping information about their contents (e.g. file sizes, last accessed date, owner and permissions, etc.).
- **Access Control:** prevent unauthorized access to files on disk.
- **Data Integrity:** filesystems must be resilient to failure, some are better at this than others.

History of Filesystems

The First Filesystems

The filesystem was originally thought of as part of the operating system.
One of the first filesystems that had a name was DECTape. DECTape stored an astoundingly small 184 kilobytes (kilo, not mega) of data per tape on the PDP-8.

Current Filesystems

Linux

ex4

Windows & mac

NTFS

HFS, HFS+ & APFS

Flashdrives

FAT32

Other Options

Alternative Filesystems

Btrfs

XFS

ZFS

TFS

`TFS` is a work-in-progress filesystem for the Redox operating system. Intended as a modern alternative to ZFS, the feature list is mouth-watering.

Pros

- Concurrent & non-blocking
- Lightweight full-disk compression
- Zero-overhead revision history
- Automatic corruption detection
- $O(1)$ recursive directory copies
- Designed for solid state drives
- Perfectly resilient to power loss

Cons

- Not fully implemented yet

Network Filesystems

What is a network filesystem?

You can access remote storage devices over the internet using a *network filesystem*.

NFS

Samba

Virtual Filesystems

What is a virtual filesystem?

There is no reason why a filesystem needs to be backed by a real partition on a real storage device. The exist plenty of *virtual filesystems* that are purely procedural or abstract other kinds of devices.

tmpfs

proc filesystem

FUSE

Filesystem in Userspace (FUSE) is an interface for creating filesystems without writing any kernel-level code, which makes it incredibly useful for creating virtual filesystems. It is an available in Linux, FreeBSD, OpenBSD, NetBSD, OpenSolaris, Minix 3, Android, and macOS.

`libfuse`...

- is a C library
- provides a high-level interface for FUSE
- makes creating new filesystems really easy
- has bindings for Python, Rust, etc.

sshfs

`sshfs` is a network filesystem implemented through libfuse. You can use it to mount remote directories via ssh.

Pros

- Very easy & quick to setup (one command)
- Remote machine only needs ssh installed

Cons

- Intended to be temporary
- Generally slower than NFS

Configuration/maintenance

Questions?

References

- https://en.wikipedia.org/wiki/File_system
- http://www.tldp.org/LDP/sag/html/filesystems.html
- https://arstechnica.com/gadgets/2008/03/past-present-future-file-systems/2/

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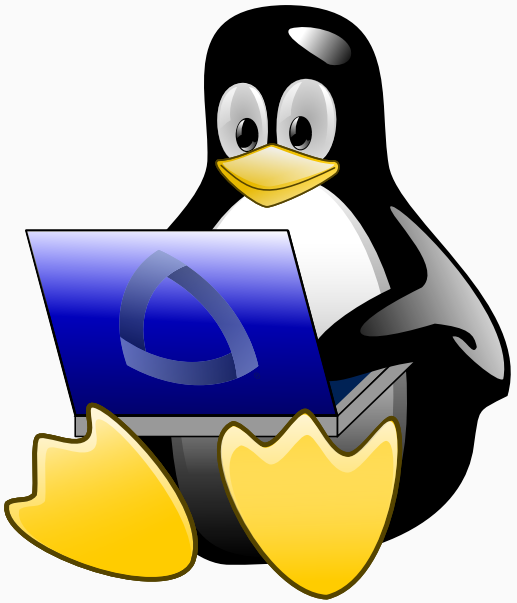

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