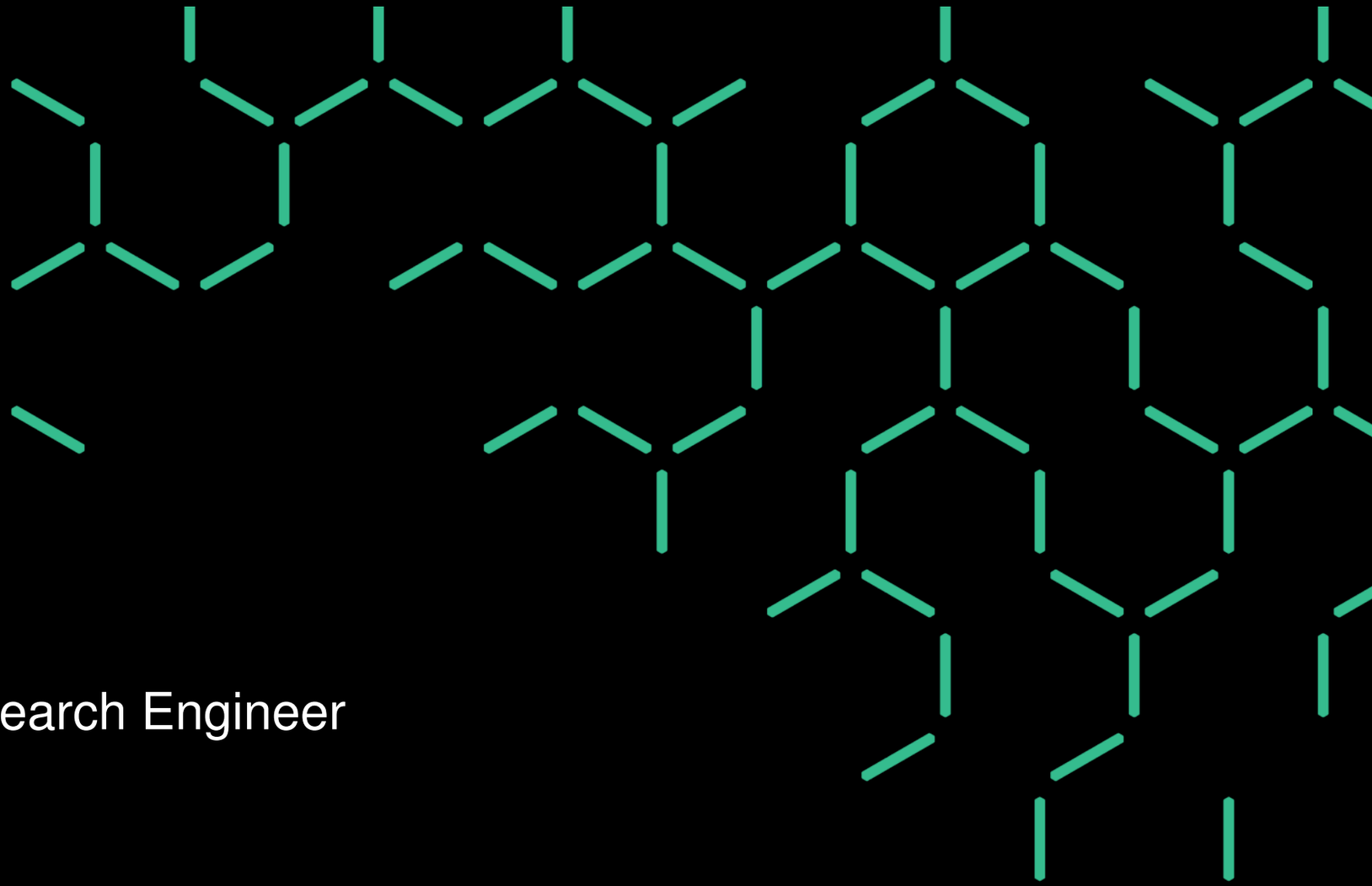

DB as FS

Peter Chubb | Principal Research Engineer

January 22, 2019

Once upon a time

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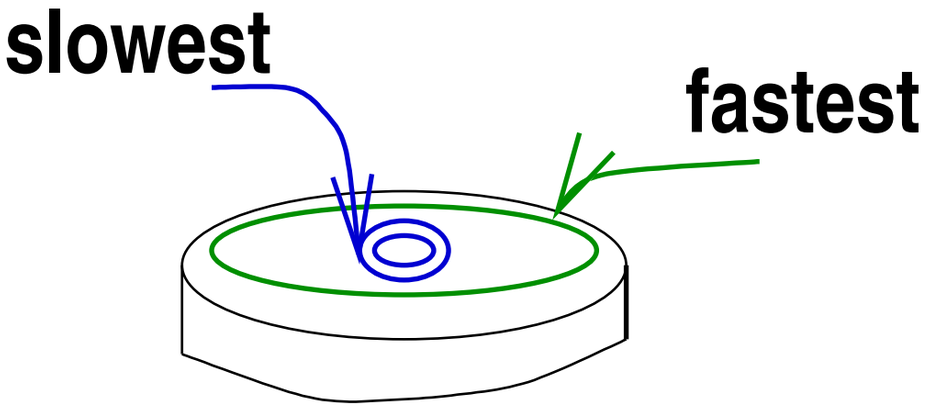
- Common Recommendations: *Use raw discs for transaction logs* . . .



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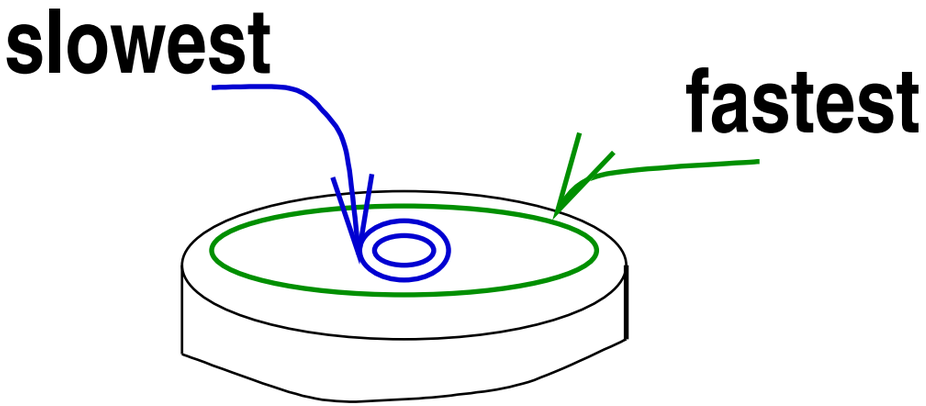

Once upon a time

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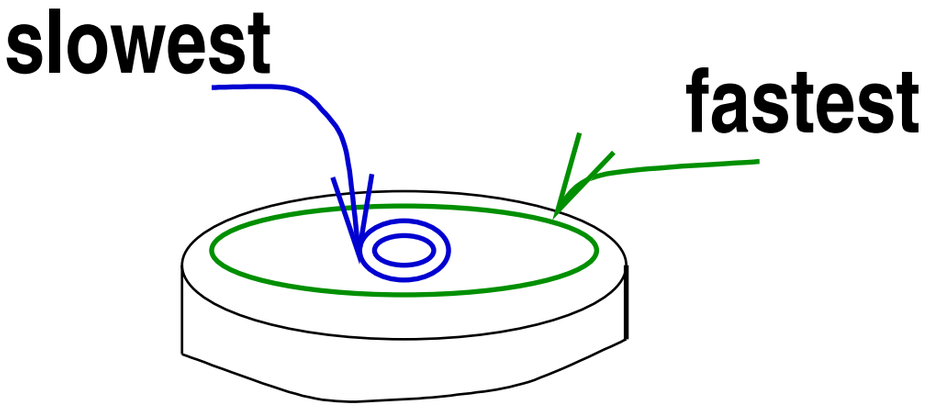
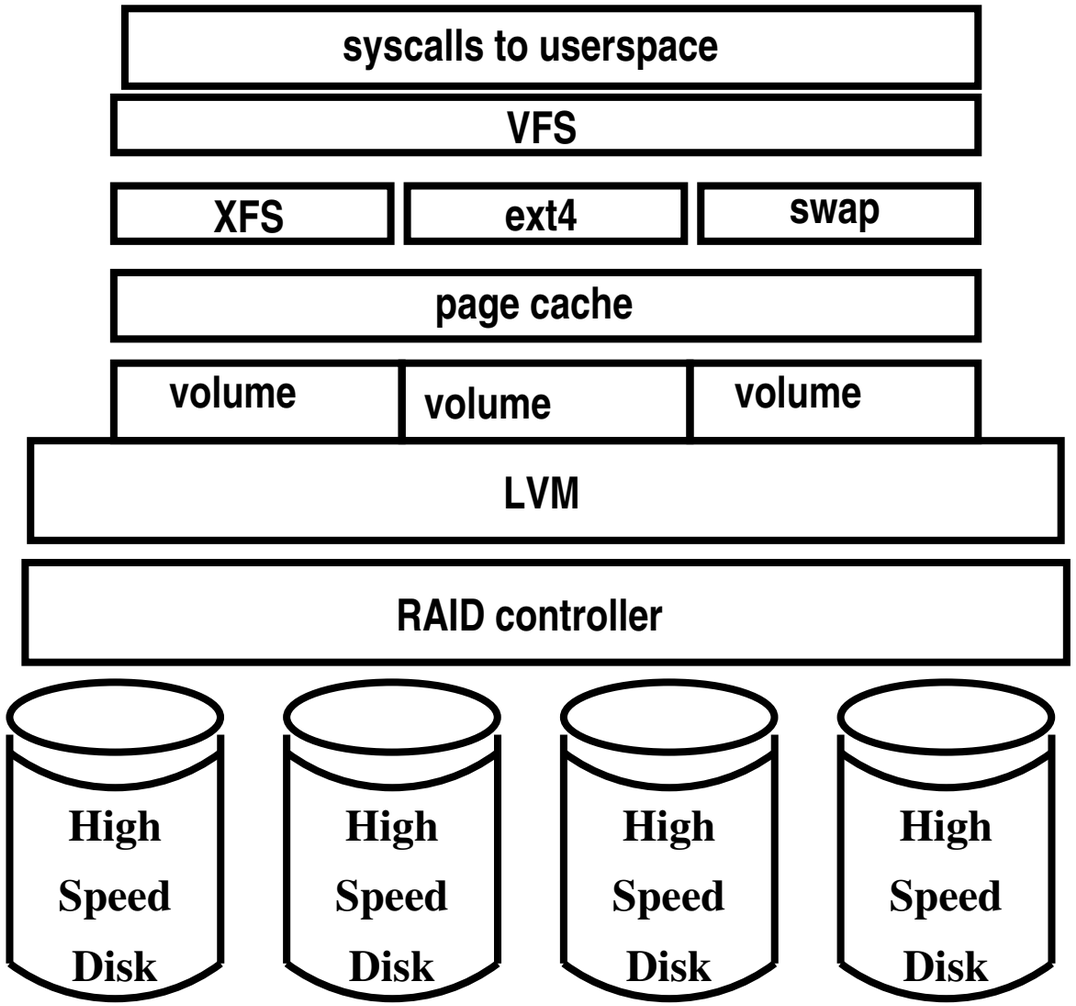
- Common Recommendations: *Use raw discs for transaction logs* . . .
  - *And for data areas as appropriate*
- Stripe table space across spindles



Typical storage stack



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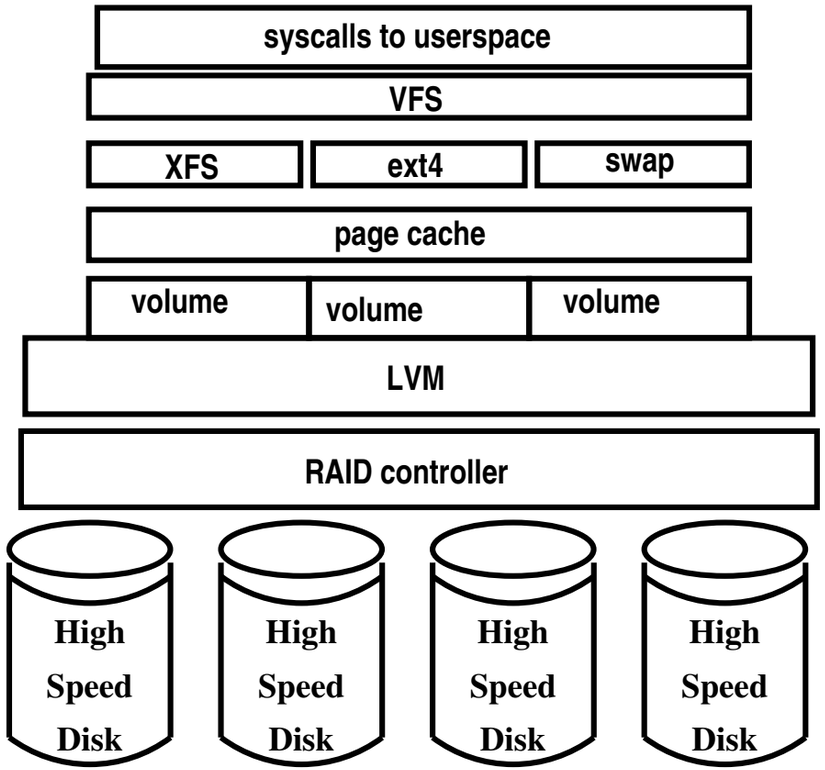
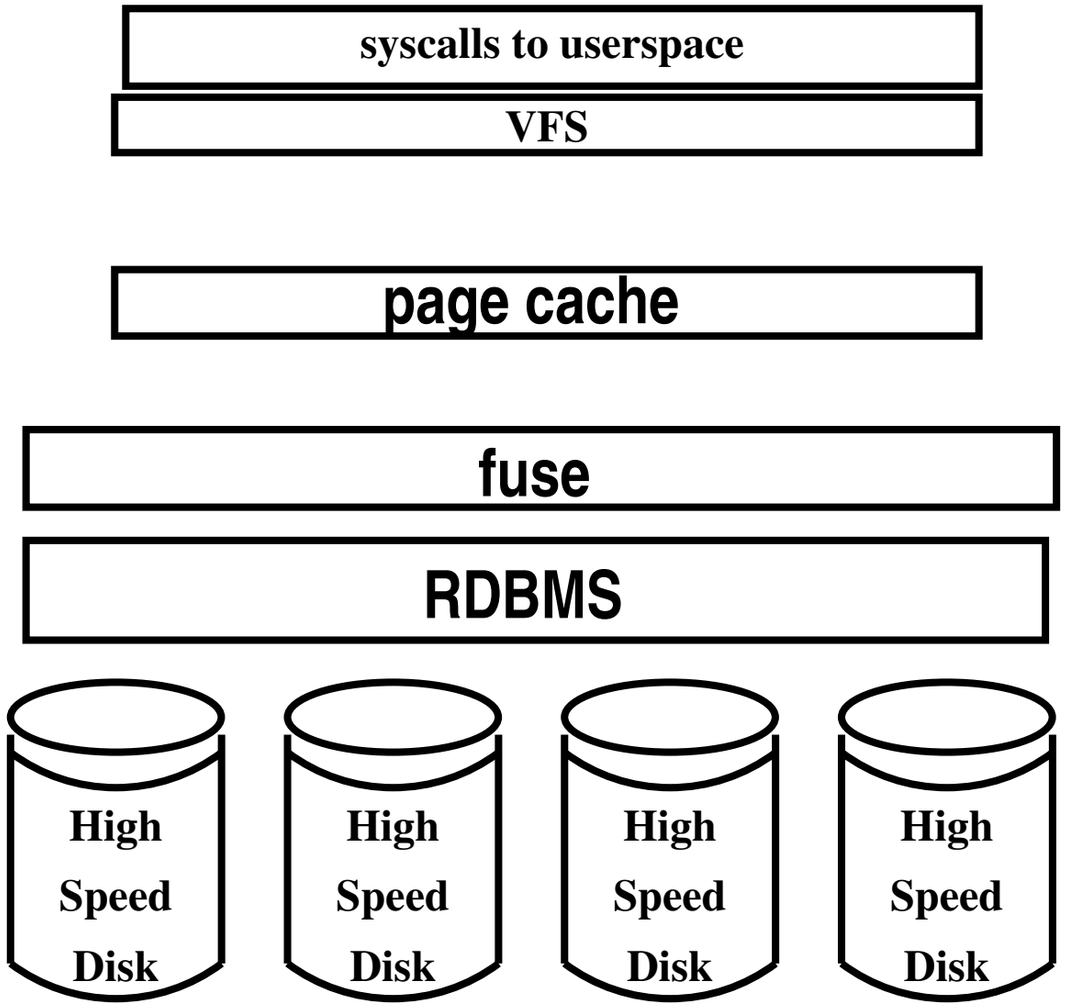
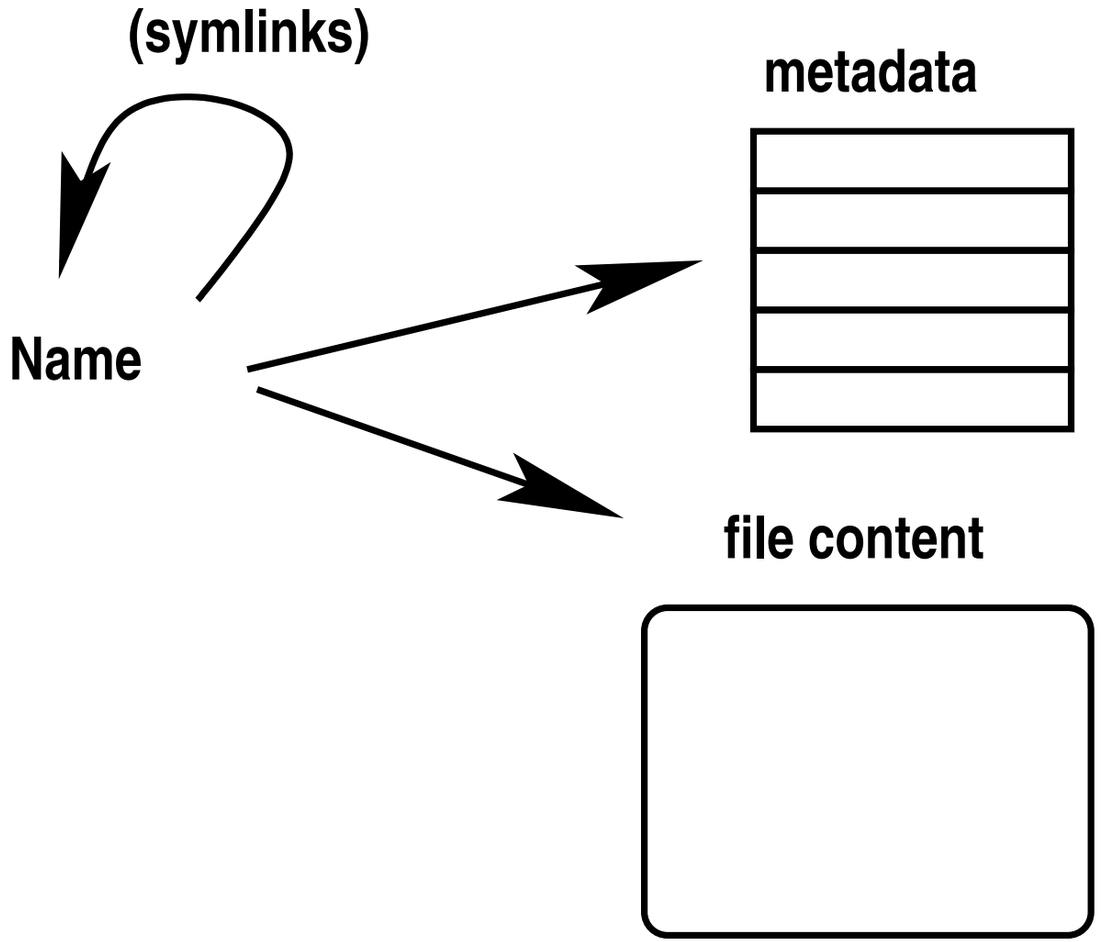


- Userspace doesn't understand disc layout — can't optimise.
- Filesystems can't see disc layout – can't optimise

Turn it upside-down



What's a file system?



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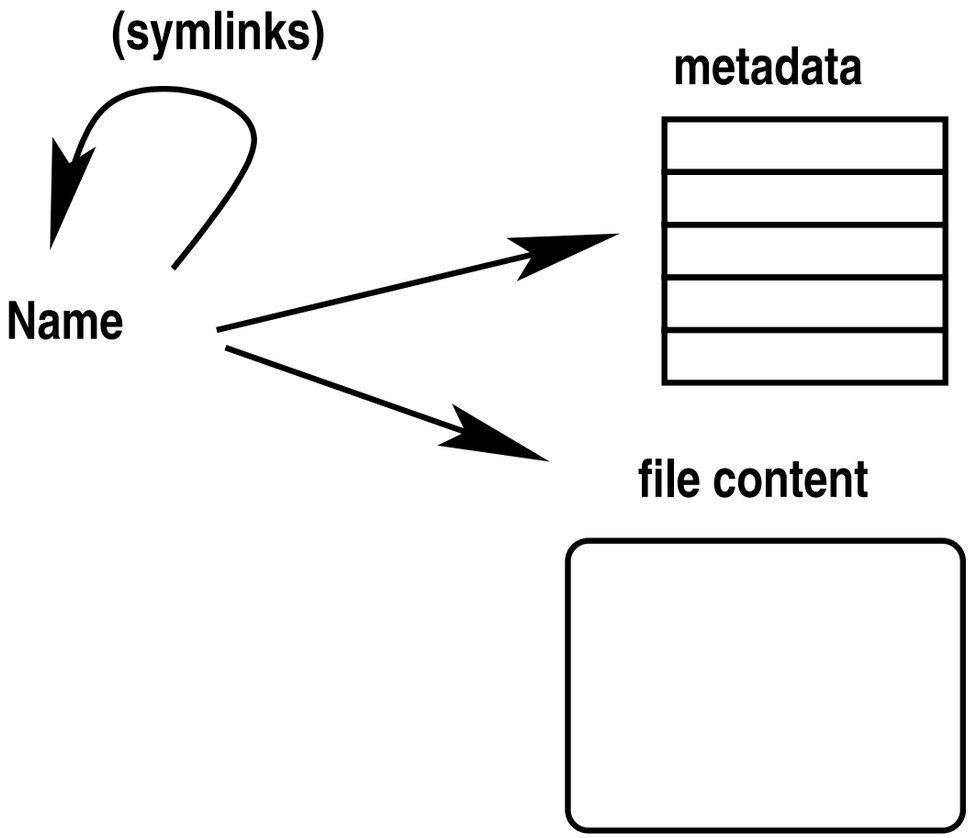


- Writes ordered for **C**onsistency
- Writes to different files are **I**solated from each other
- After `fsync()` data written survives crashes: it is **D**urable

Database ACID

- **A**tomic
- **C**onsistency
- **I**solated
- **D**urability

But wait there's more

- Use a RDBMS that handles replication (e.g., Galera MariaDB) — distributed FS for 'free'
- Easy to add attributes for experimentation
- No need for `fsck`

But:

But:

Modern RDBMS rely on FS.

But:

Modern RDBMS rely on FS.

(At least, Postgres does: discovered last night MySQL does not)

Decided to try proof of concept anyway.

Sam Li

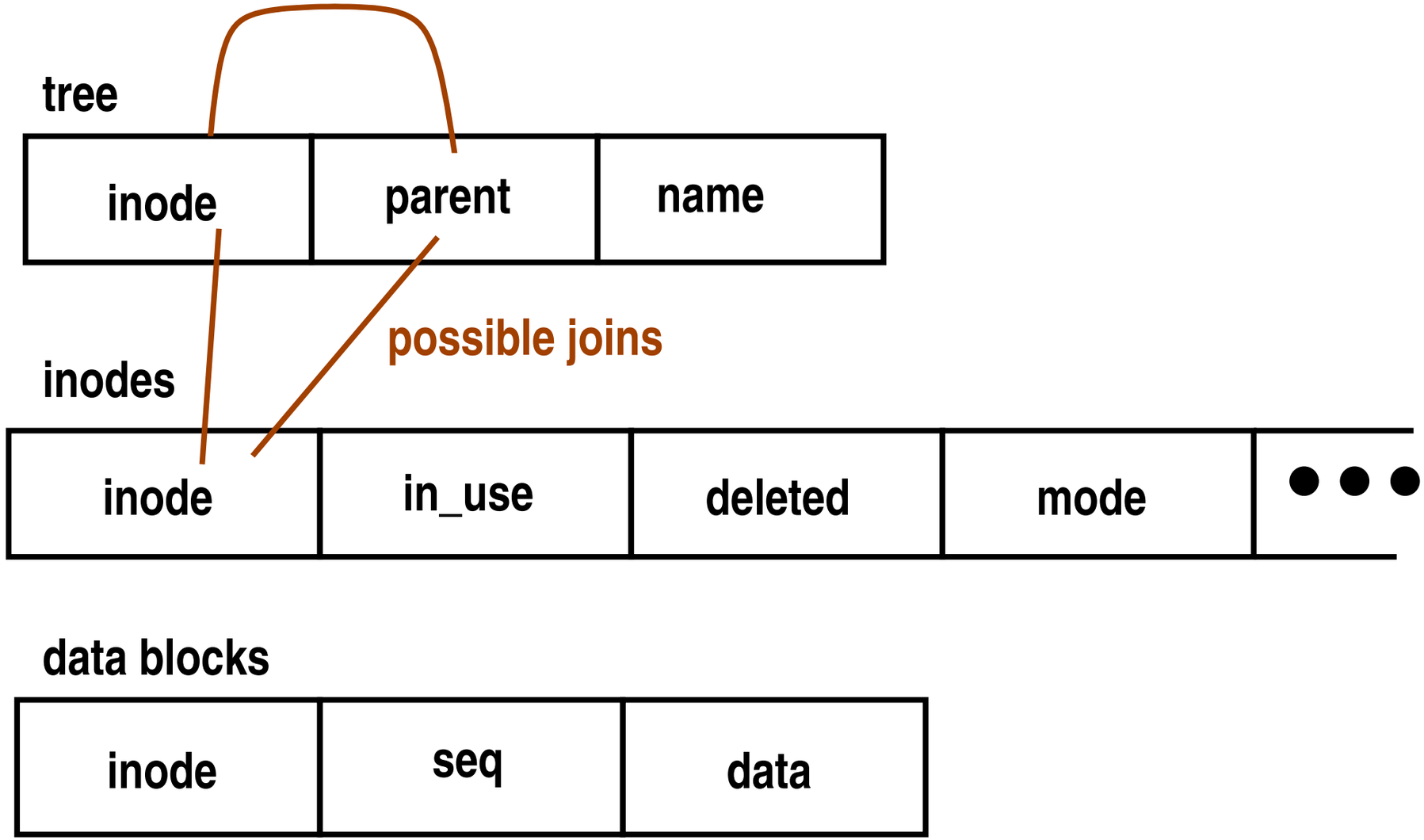
Sam Li

Tsukasa Hamano and Michal Ludvig

`https://sourceforge.net/projects/mysqlfs/`

(Not touched since 2009)

Schema


tree
inode
parent
name
possible joins
inodes
inode
in_use
deleted
mode
data blocks
inode
seq
data

Schema

`namei()` is funky join: `namei("/a/b/c")` →

```
SELECT t3.inode,
   (SELECT COUNT(inode) FROM tree AS t4 WHERE t4.inode=t3.inode)
       AS nlinks
   FROM tree AS t3
     JOIN tree AS t2 ON t3.parent = t2.inode
     JOIN tree AS t1 ON t2.parent = t1.inode
     JOIN tree AS t0 ON t1.parent = t0.inode
     WHERE t0.parent IS NULL AND
           t1.name = 'a' AND
           t2.name = 'b' AND
           t3.name = 'c';
```

Functionality

- Passes `https://www.tuxera.com/community/posix-test-suite/`

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Performance

450x slower than XFS

on `postmark`

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(machine with fast disk)

Fixes

- Move to fuse version 3 — better caching
- Fix ctime updates where it's cheap
- Reduced number of queries in `getattr()` (for `stat()`)
- Fix off-by-one errors for ENAMETOOLONG
- Refuse to rename over a non-empty directory; refuse to unlink non-empty directory
  - needs extra query in `unlink()` to check
- Use `allow_user` and `use_ino` flags to fuse

Non-Posix Semantics

- `.` and `..` are fake: don't contribute to nlinks
- ctime not updated on directories
- Directories have zero size
- `statvfs()` returns zero size and usage.

fuse bug?

every now and then sync hangs.

Performance

9x slower than XFS

on `postmark`

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2.5x CPU utilisation (Mostly in mariaDB engine)

Performance


```
$ time git clone /usr/src/linux-5.x
```

	mysqlfs	XFS
real	23m53.192s	9m2.217s
user	8m13.445s	6m20.768s
sys	1m46.557s	1m19.244s

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Hides CPU time used by DBMS – about another 10m User, 2m Sys.

Where’s all the time going?

Worst operations: `creat()`, `rename()`, `unlink()`, `write()`, `stat()`

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three queries per block written.

More improvements possible

- Cache type and mode in `tree` table
- Cache recently used inodes
- Double block size

New things possible

- Replication (with MariaDB Galera Cluster) — works, but slow.
- Fast `find` using SQL query.
- Full-text-search if index on content.
- Fast fsck
- Easy to add other features (e.g., resource fork, HFS style)

Summary

- Get it from
  `https://github.com/samzyy/DB-based-replicated-filesystem`
- More-or-less works
- Performance not *too* painful
- May serve as experimental platform for FS features
- Pull requests welcome.