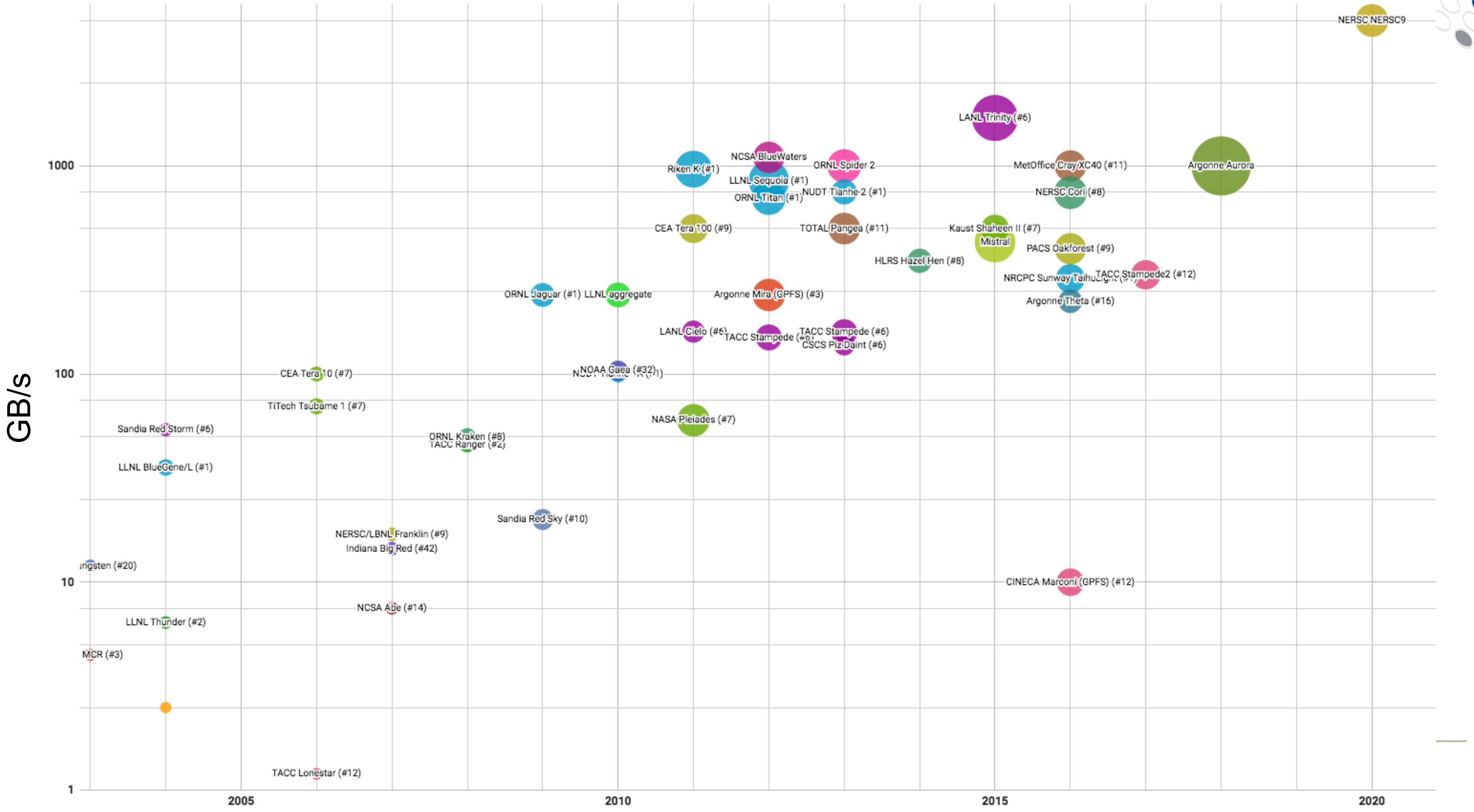
Lustre Feature Renaissance

Nathan Rutman
Lug 2018

14 Years of Scaling



Years of effort spent on performance and scaling

Not an exhaustive list

- ldiskfs scaling, ZFS
- Recovery: interop, VBR, AT, FSCK, Imperative Recovery
- CLIO, MDS rewrite, FIDs
- IO scaling: LRU, read cache, readahead, wide striping, multi-MB rpc, DoM
- MD scaling: statahead, DNE, MMR
- tons of diverse performance improvements
- bugs bugs bugs

Features too of course: mountconf, Kerberos, NRS, HSM, changelogs, pools, multirail

Capable infrastructures in place

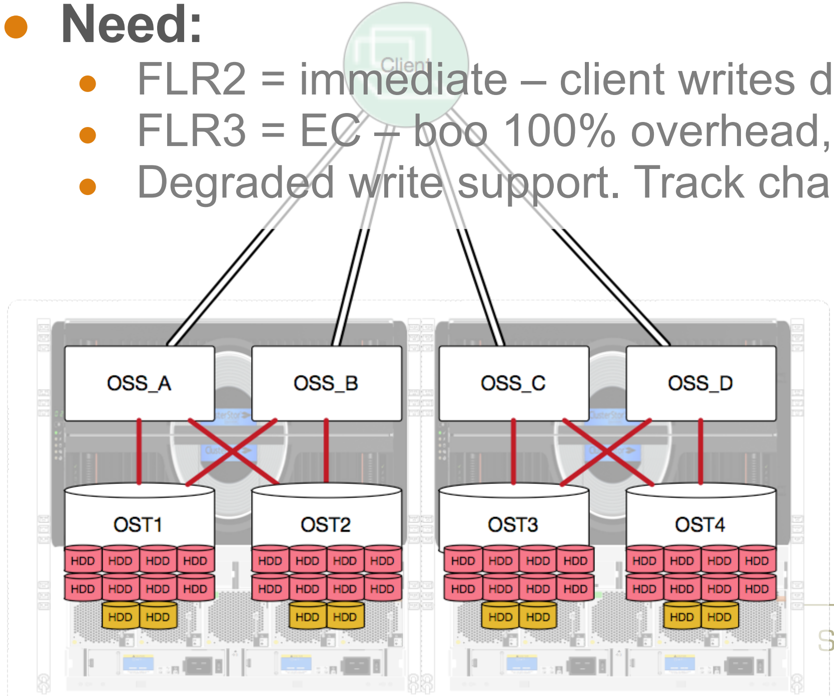
- DNE – MD horizontal scaling
- Complex layouts – much more interesting data placement
- FLR – data redundancy inside Lustre

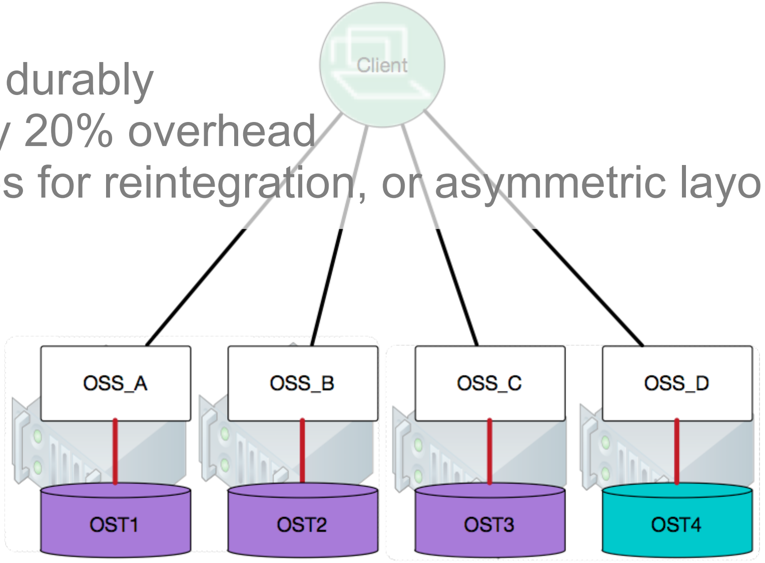
Time to reap some Feature rewards

- Let’s look at some possible features
- These aren’t even designs, just ideas

FLR – data redundancy *inside* Lustre

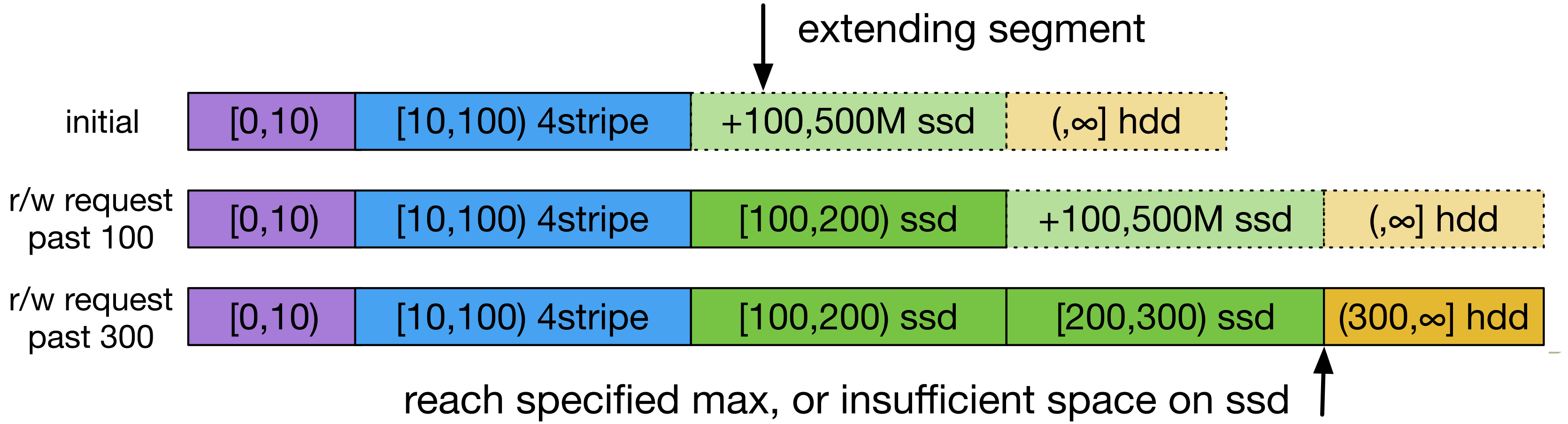
- One small (?) step for Layouts, one giant leap for Lustre systems design
- No longer need to rely on ~~Failover~~ for data access
- Dual-ported, dual-server, dual-path, dual-$ - nope.
- Need:
  - FLR2 = immediate – client writes data durably
  - FLR3 = EC – boo 100% overhead, yay 20% overhead
  - Degraded write support. Track changes for reintegration, or asymmetric layouts?





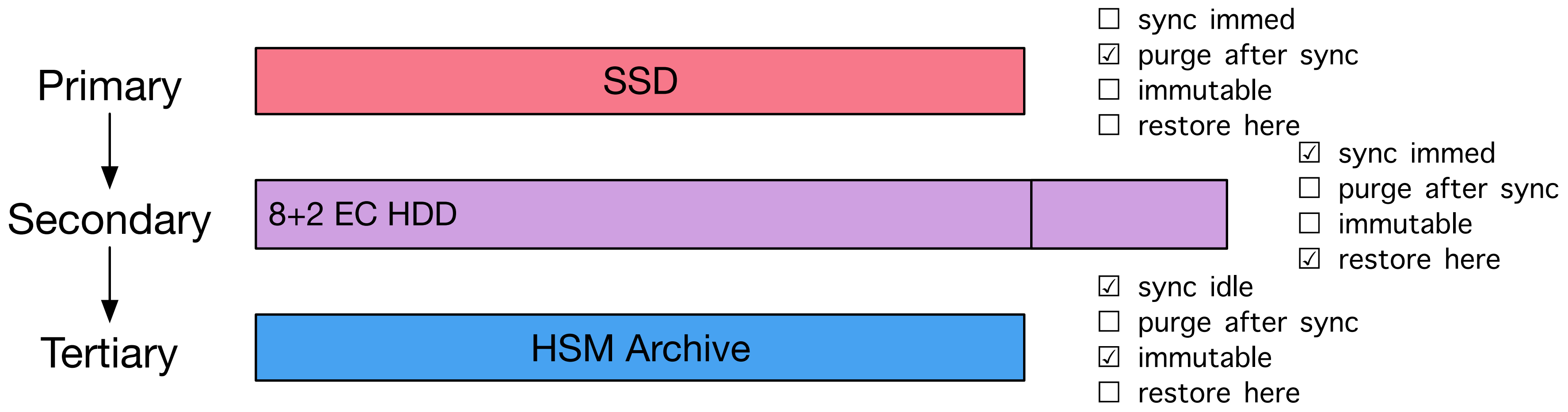
Spillover Space: death to ENOSPC

- **Self-extending PFL** (LU-10070, LU-10169)
- **Some PFL segments are virtual, instantiated on demand**
- **Request in a virtual segment requires layout update**
- **MDS adds a new component on demand**
- **Can choose the new component striping based on dynamic conditions (e.g. free space)**



ILM Layouts

- Layout implies an action: stale FLR copy = resync w/ lfs mirror
- And a timeframe: (immediate | eventual)
- Simple ILM policy *already* encoded into layout
- Add some flags to layout and/or policy ref
- Make HSM a true layout (LU-10606): stale HSM copy = resync w/ lfs hsm
- Use Coordinator and Copytool for all movement (LU-6081)

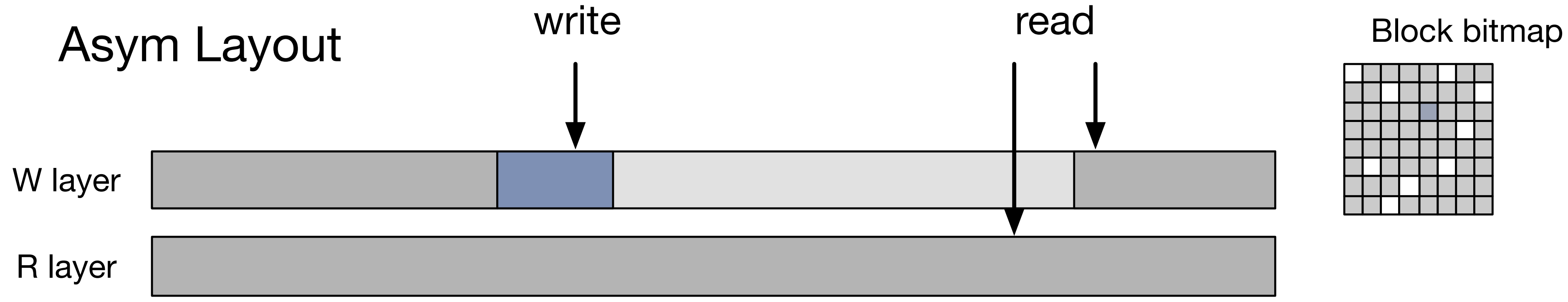


Asymmetric Layouts

- Reads go to R iff not in W
- Block bitmap on W tracks newly written data
- Client caching and DIO insure full-page writes
- W controls all locks, gives bitmap along with lock grants
- Clients access R or W directly, all under W's locks

Why?

- Write to flash, read from HDD
- Continue writing to new W if an OST fails (checkpoint) (or ENOSPC)
- EC degraded write case – point of EC is to remain usable in failures



Fast Find

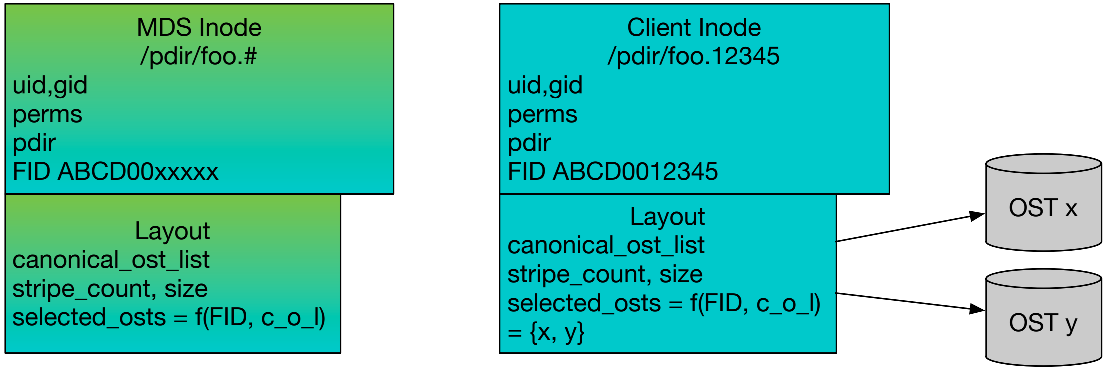
- **Why do we copy Lustre MD into DB's or scan raw ldiskfs?**
- **Need to quickly find files that match certain criteria**
- **A great 'lfs find' could do the same thing, saving the tools effort**
  - Server side. RPC from client, returns filtered list
  - Logical combinations of filters
  - Unix-style piping: *lfs find /lustre -size +20M | lfs hsm archive*
- **Add new MDT indices to efficiently generate initial candidate lists**
  - LRU, file heat, mtime, size
  - dt_index_operations (eg IAM) provides generic indexing code
  - Update indices transactionally with MD updates

Rough SoM

- FLR records file size on MDS; comes with sync
- DoM records file size on MDS
- Straightforward to get maximum size, if we don’t care about evicted/failover case
- Rough size is fine for many purposes (e.g. policies)
- Record the quality of SoM, let users decide if usable
- Strict, Rough, Stale, Unknown (LU-9538)
- Don’t return as POSIX size unless strict

Clone Files: extreme create scaling

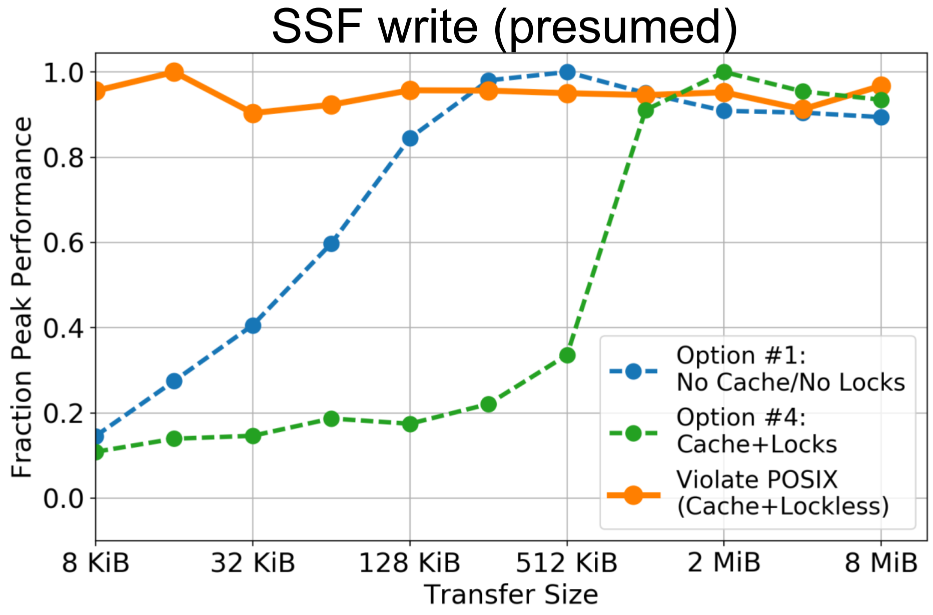
- File create: ask MDS to create, lock dir, create inode, assign objects
- Clone create: create “all” the files at once
- Single MDS inode, single namespace entry: foo.#
- FID is prefix+#
- Layout is f(FID)



- Shared MD (clones!) but different objects / data / sizes
- open(foo.4,O_CREAT) is now a client-local operation

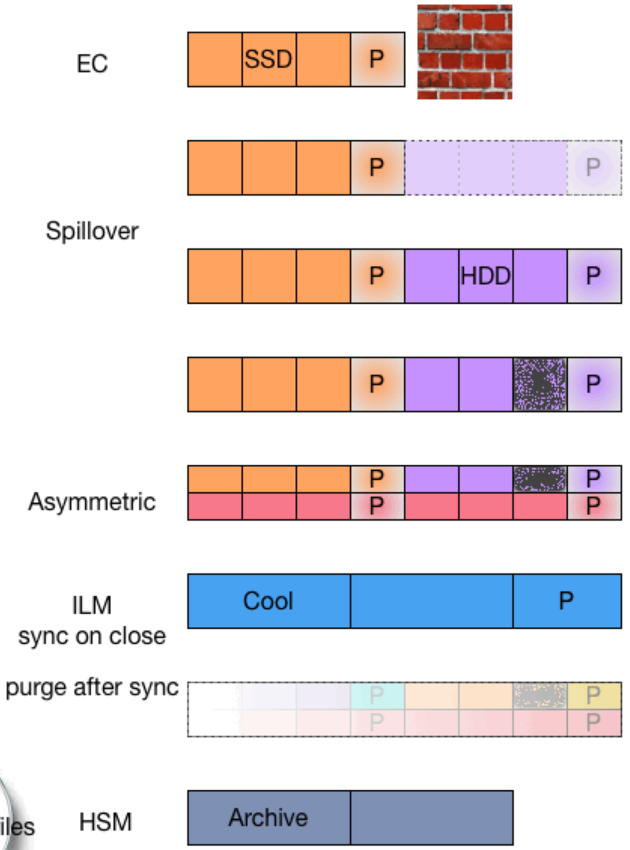
Alternate Consistency Models

- **POSIX API vs POSIX consistency semantics**
- **Caching allow write coalesce, local latency**
- **But pay a penalty for locks**
- **Solutions in Lustre, but requires effort**
  - Lockless DIO, Grouplocks
- **Make it easier**
  - ladvise?
  - Persistent file tags?
  - Automatically change modes?



Glenn Lockwood
https://www.nextplatform.com/2017/09/11/whats-bad-posix-io/

All Together Now



Feature Vote?

1. FLR EC with degraded writes
2. ~~Spillover Space~~ Cray
3. ILM Layouts
4. Asymmetric Layouts
5. Fast Find
6. ~~Rough SoM~~ DDN
7. Clone Files
8. Alternate Consistency Hints

Implementation Plan

1. Ignore Nathan's slideware
2. <insert smart developer here>

3. Implement!