F2FS and EXT4 Reliability

Michael Meerbott

Motivation

- F2FS created for Flash storage devices - notably phones
- Not much data on reliability of F2FS
- Only info on reliability was found on old forums from ~2014
- Native Android Filesystem is EXT4
    - How does F2FS compare with EXT4?

Configurations

aineshbakshi/Git-Benchmark:

- Runs 1-3:
  - Total Pulls: 10,000
  - Pulls Per Test: 100
- Runs 4-5:
  - Total Pulls: 5,000
  - Pulls Per Test: 50

System:

- Ubuntu 16.04.5
- Linux 4.4.0-104-generic

Micro SD Card (SDHC):

- SanDisk Ultra Class 10
- 32 GB
  - 4 Partitions of 7.43 GB
    - 2x F2FS
    - 2x EXT4

GCC

- Version *5.4.0 - 20160609*

Configurations

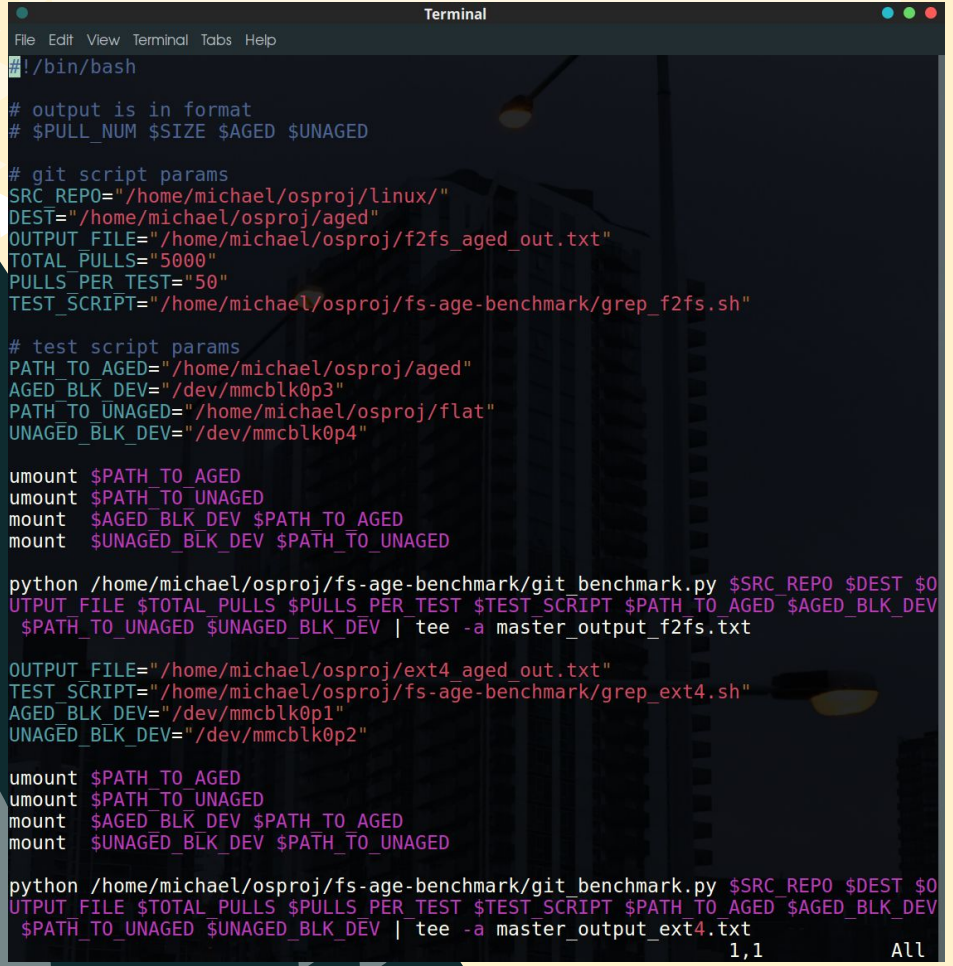
EXT4:

- rw
- block_validity
- delalloc
- barrier
- user_xattr
- acl
- resuid=0
- resgid=0
- errors=continue
- commit=5
- min_batch_time=0
- max_batch_time=15000
- stripe=0
- data=ordered
- inode_readahead_blks=32
- init_itable=10
- max_dir_size_kb=0

F2FS:

- *F2FS-tools: mkfs.f2fs Ver: 1.6.1 (2016-03-22)*
- *Info: Debug level = 0*
- *Info: Label =*
- *Info: Segments per section= 1*
- *Info: Sections per zone = 1*
- *Info: Trim is enabled*
- *Info: sector size = 512*
- *Info: total sectors = 62325760 (30432 MB)*
- *Info: zone aligned segment0 blkaddr: 512*
- *Info: Discarding device*
- *Info: This device doesn't support TRIM*
- *Info: Overprovision ratio = 1.150%*
- *Info: Overprovision segments = 352 (GC reserved = 181)*
- *Info: format successful*

Runner Script



F2FS Script

```
AGED_PATH=$1
AGED_BLKDEV=$2
UNAGED_PATH=$3
UNAGED_BLKDEV=$4

# remount aged and time a recursive grep
umount $AGED_PATH &>> log_f2fs.txt
mount $AGED_BLKDEV $AGED_PATH &>> log_f2fs.txt
AGED="$(TIMEFORMAT='%3R'; time (grep -r "t26EdaovJD" $AGED_PATH) 2>&1)"
SIZE="$(du -s $AGED_PATH | awk '{print $1}')"

# create a new f2fs filesystem, mount it, time a recursive grep and dismount it
mkfs.f2fs $UNAGED_BLKDEV #&>> log_f2fs.txt
mount $UNAGED_BLKDEV $UNAGED_PATH &>> log_f2fs.txt
cp -a $AGED_PATH/* $UNAGED_PATH 2>/dev/null
umount $UNAGED_PATH &>> log_f2fs.txt
mount $UNAGED_BLKDEV $UNAGED_PATH
UNAGED="$(TIMEFORMAT='%3R'; time (grep -r "t26EdaovJD" $UNAGED_PATH) 2>&1)"
umount $UNAGED_PATH &>> log_f2fs.txt

# return the size and times
echo "$SIZE $AGED $UNAGED"
```

Modifications

git_benchmark

```
145     try:
146         subprocess.check_call(shlex.split(git_pull_cmd),
147                               cwd = dest_repo, stderr = devnull,
148                               stdout = devnull)
149     except:
150         traceback.print_exc()
151         output_file.write("<<pull {} failed>>\n".format(pull))
152         print ("<<pull  {} failed>>\n".format(pull))
153         continue
154
```

Results

F2FS:

0 332388 20.872 21.549
50 337380 21.763 21.274
100 341276 23.086 22.322
150 346040 23.767 21.946
200 349492 24.435 23.281

<<pull 204 failed>>
<<pull 240 failed>>

250 358072 25.104 23.132

<<pull 255 failed>>
<<pull 441 failed>>

450 416888 27.622 24.846

<<pull 451 failed>>
<<pull 633 failed>>

650 446108 29.366 27.029
700 450104 30.591 26.278
750 455456 31.896 27.348
800 461052 32.246 28.230

<<pull 813 failed>>
<<pull 3234 failed>>

Git error 128

EXT4:

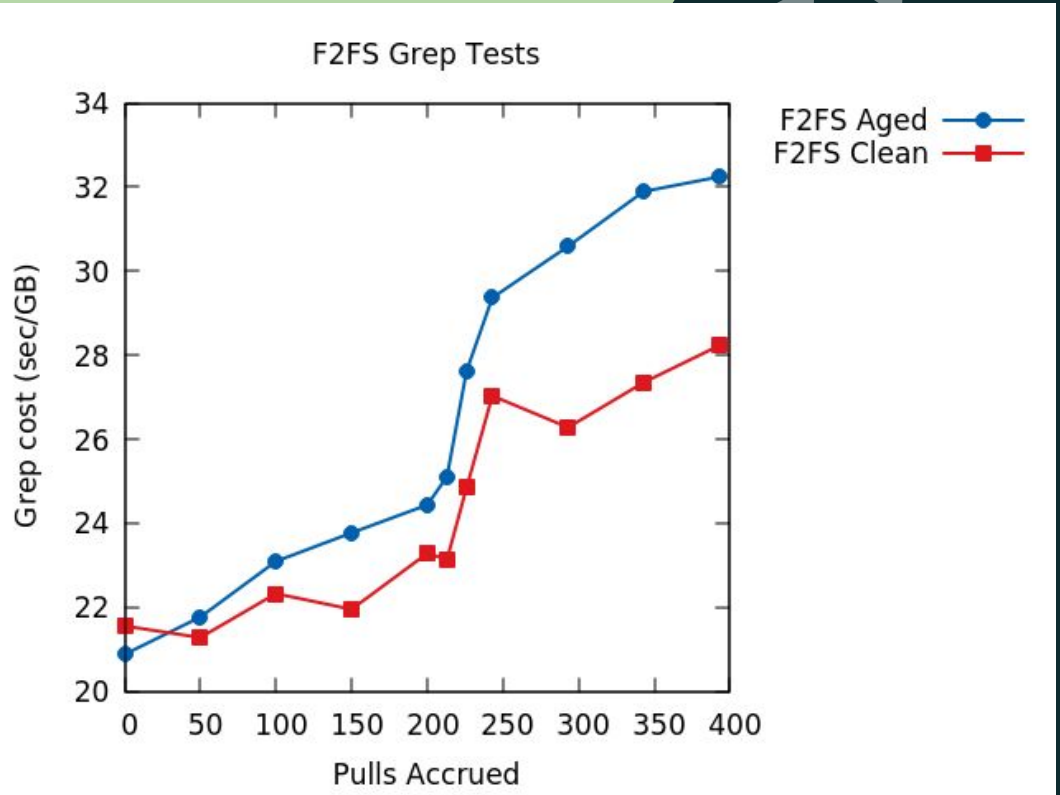
pulls output
0 290588 13.377 13.858
50 293444 14.331 14.805
100 295616 15.082 15.056
150 298696 15.371 15.736
200 300724 15.607 15.707

<<pull 204 failed>>
<<pull 633 failed>>

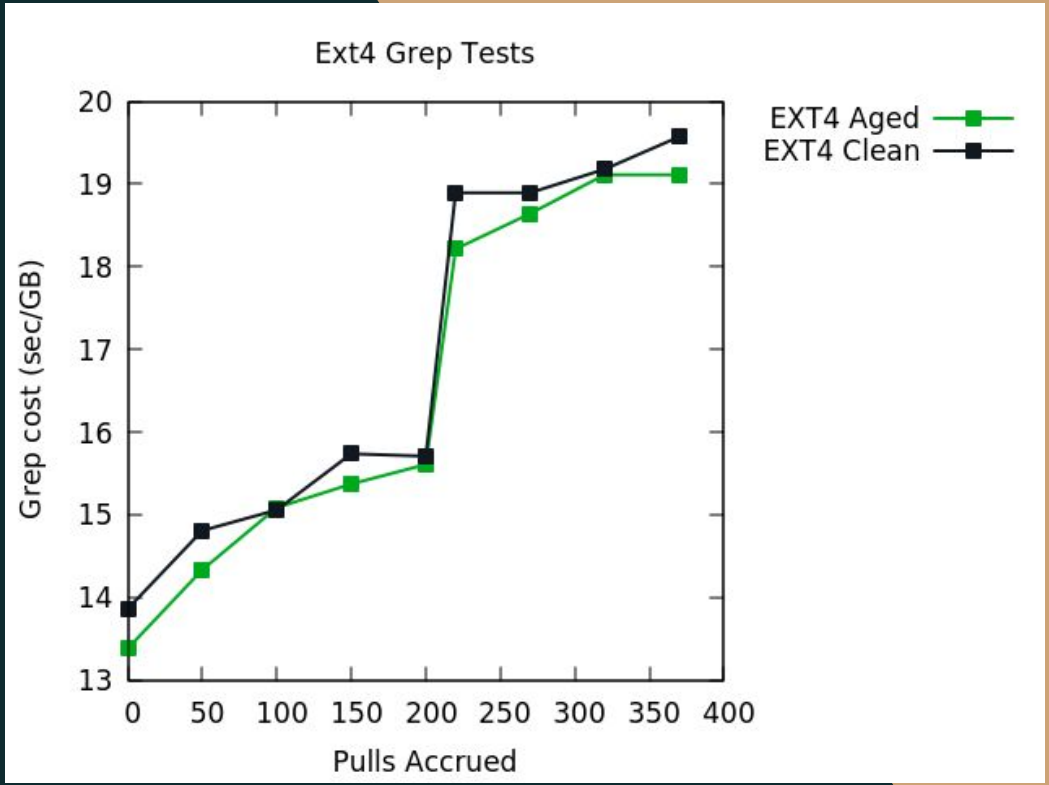
650 385856 18.214 18.895
700 388228 18.643 18.890
750 391332 19.113 19.180
800 394928 19.113 19.573

<<pull 813 failed>>
<<pull 2375 failed>>

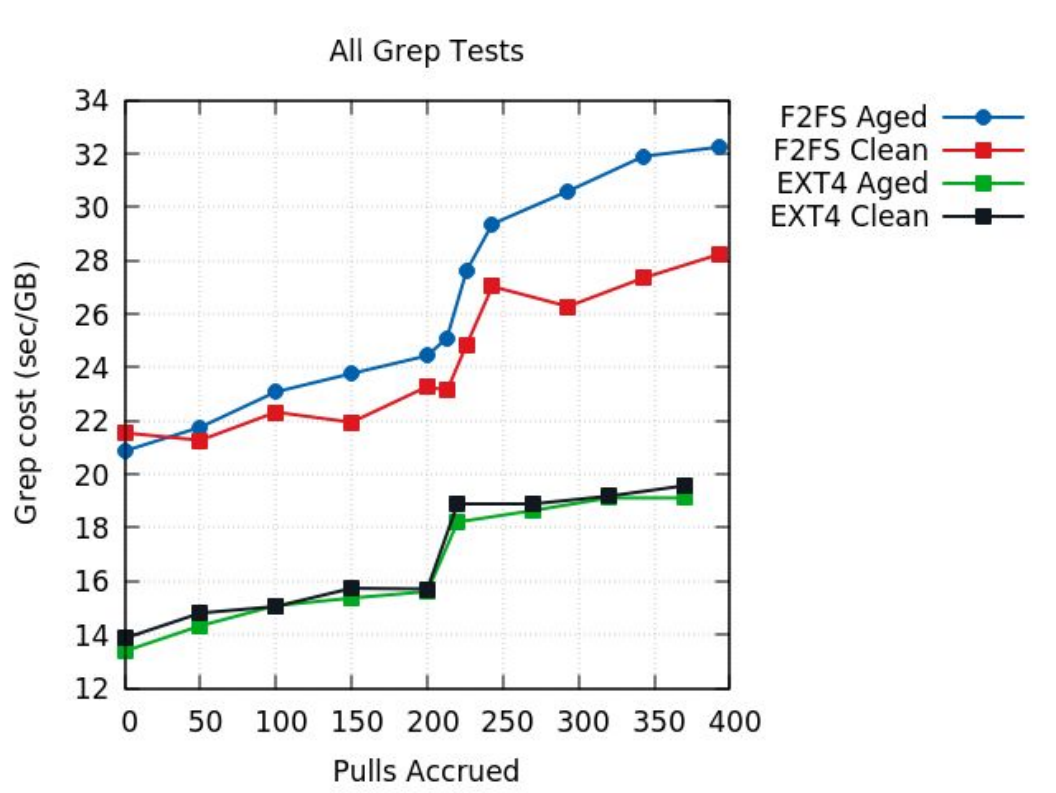
Results


F2FS Grep Tests
Grep cost (sec/GB)
34
32
30
28
26
24
22
20
0
50
100
150
200
250
300
350
400
Pulls Accrued
F2FS Aged
F2FS Clean

Results


Ext4 Grep Tests
Grep cost (sec/GB)
Pulls Accrued
EXT4 Aged
EXT4 Clean
20
19
18
17
16
15
14
13
0
50
100
150
200
250
300
350
400

Results


All Grep Tests
Grep cost (sec/GB)
34
32
30
28
26
24
22
20
18
16
14
12
0
50
100
150
200
250
300
350
400
Pulls Accrued
F2FS Aged
F2FS Clean
EXT4 Aged
EXT4 Clean

Results

- Results are inconclusive
  - Not enough data/pulls
- Predictions
  - F2FS will age poorly, especially compared to EXT4
  - EXT4 will age more slowly
- Suggestions
  - Better method of aging

References

Thank You!

Alex Conway, Ainesh Bakshi, Yizheng Jiao, Yang Zhan, Michael A. Bender, William Jannen, Rob Johnson, Bradley C. Kuszmaul, Donald E. Porter, Jun Yuan, and Martin Farach-Colton. 2017. *File systems fated for senescence? nonsense, says science!.* In Proceedings of the 15th Usenix Conference on File and Storage Technologies (FAST'17). USENIX Association, Berkeley, CA, USA, 45-58