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Parallel E2fsck

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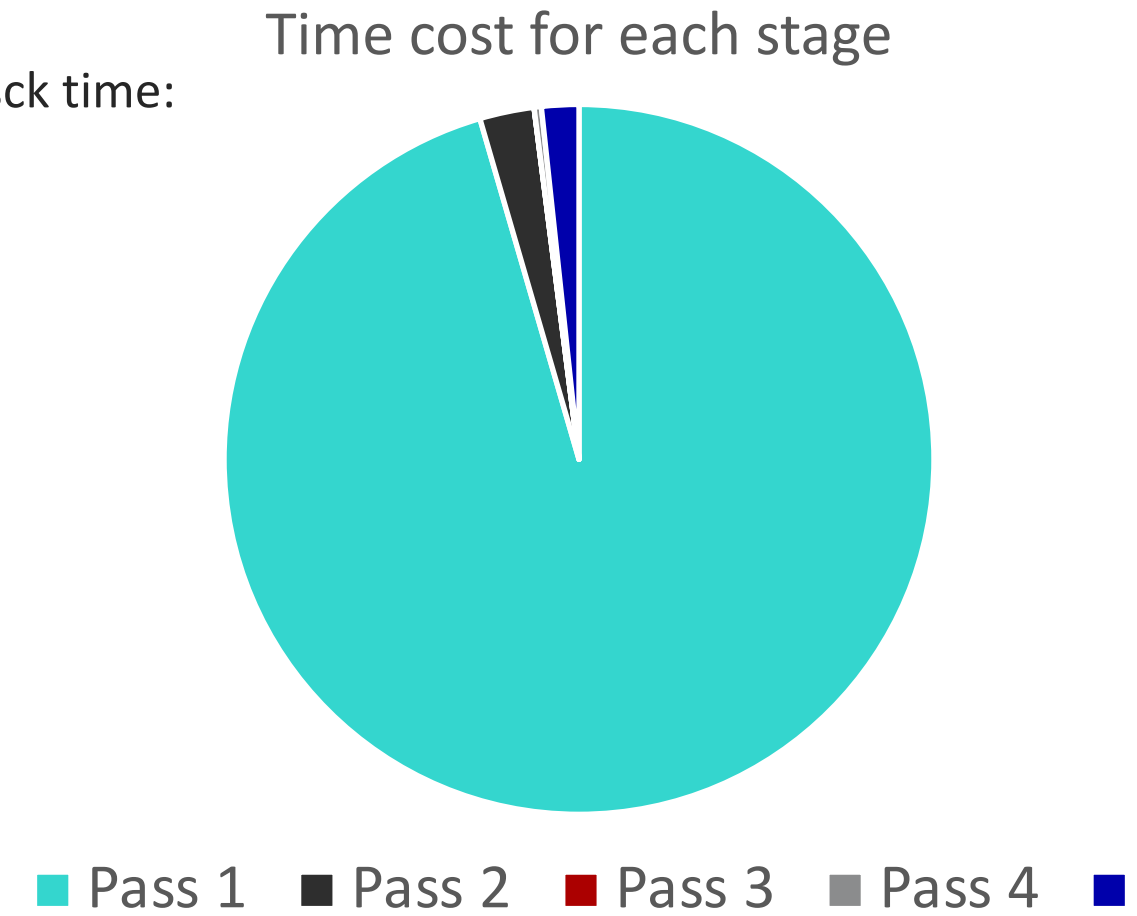
Background

- LU-8465
- 1 PB+ OST is coming
- On 1PB OST with 105M inodes, e2fsck time:
  - Pass 1: 3771
  - Pass 2: 98
  - Pass 3: 0.02
  - Pass 4: 12.94
  - Pass 5: 66.93



Need to Improve Pass1 Step

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- Pass 1 takes 95% of the e2fsck time
- Why Pass 1 is slow
  - Walk through the entire inode table
  - On each inode
    - Read and check the inode attributes
    - Check the blocks used by each inode
    - A lot of inserting and searching of data structures
- How to improve
  - Fortunately, the check of each inode is almost independent
  - Different threads can check different inodes in parallel

Challenges & Solutions

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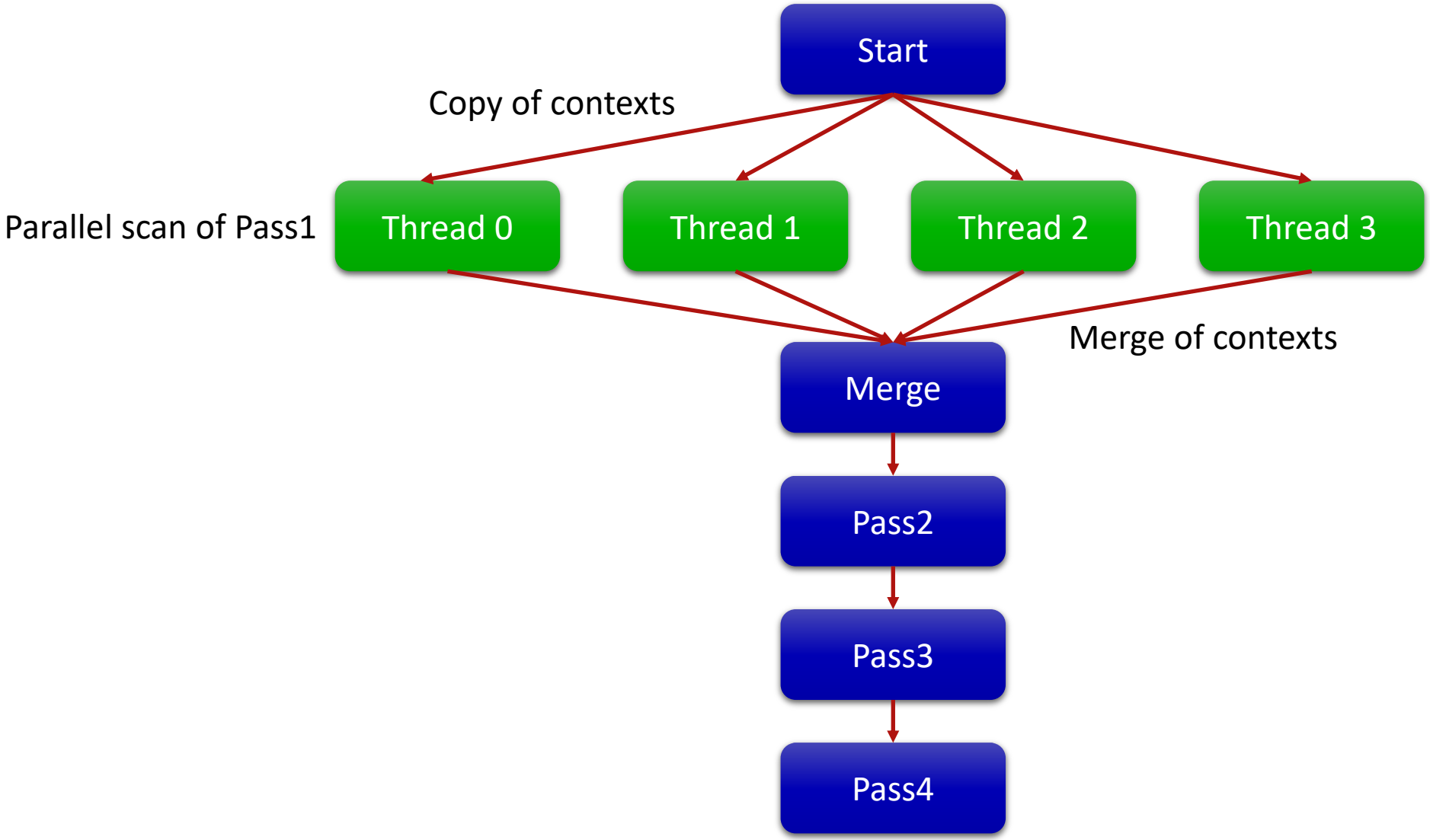
- The result of Pass1 will be used by Pass2/3/4 too
  - Merge step is needed after threads finish
- Synchronization will be needed between threads in some cases
  - Bad blocks should be synced to avoid using them
  - Used blocks should be synced to avoid allocating them in multiple threads
- The threads of Pass1 shouldn’t change disk at the same time
  - Lock need to be held to avoid any conflict of writing disk
- Correctness is very hard to confirm
  - Wrong e2fsck would cause/escalate data corruption
  - Need to pass all regression tests of e2fsprogs
  - Fortunately, there are already 186 regression tests
  - Strict review

Design


Start
Copy of contexts
Parallel scan of Pass1
Thread 0
Thread 1
Thread 2
Thread 3
Merge of contexts
Merge
Pass2
Pass3
Pass4

Steps towards Parallel E2fsck

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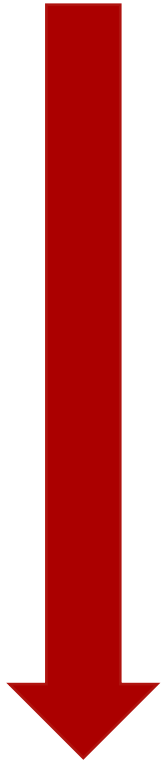
- Step 1: Proof of concept: Done
  - Do not care whether the patch is clean or not
  - Get performance number to confirm the performance is improvable
- Step 2: Multiple threads run sequentially: Woking on
  - Merge the pass1 results from multiple threads properly
  - All regression tests need to be passed no matter how many threads
  - Pass the tests then thread number is 1, 2, 3, … n
- Step 3: Multiple threads run in parallel: Future
  - Threads need to sync with each other from time to time
  - Tests might not be able to be passed any more
  - Any way to pass the tests
- Step 4: Review, test and merge: Future
  - Need strict review to make sure nothing breaks
  - Codes need to be rewritten for better quality



Harder and harder

Sequential run of threads for regression tests

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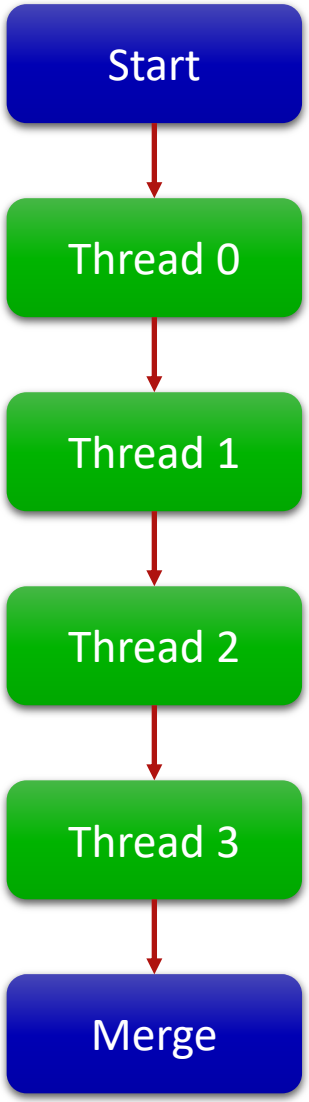
Output and result should be exactly the same with original e2fsck



Current status

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- 40+ patches, a lot more is coming
- Speedup for more than X4 times, from 3771 seconds to 800 seconds
- More speedup is possible with better load balancing and more threads
- Bigalloc feature might help a lot too
- ”libext2fs: optimize ext2fs_convert_subcluster_bitmap()” patch improves E2fsck speed a lot
- All tests can be passed with single thread, except occasional crash because of

Thought & Concerns

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- E2fsck codes really need to be cleaned up
  - A lot of similar codes that could be put into shared library, e.g. binary search
  - Cleanup is hard because things can be easily broken
- E2fsck correctness is tooooo critical
  - Review of the patches needs to be really careful
  - Not able to reuse the regression tests for parallel fsck
- Any more ways to test the correctness?
  - Regression tests that already exists
  - Valgrind command to detect memory leak
  - E2fsck on huge Ext4 with hundreds of millions inodes to confirm no performance regression.

New ideas

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- The parallel fsck can be only used for check
  - If any problem is found, restart to use single threads check
- Several choice to fix problem
  - Thread 0 fix all the found problems
  - Fix the problem at the thread that found it
  - Fix the problem after all threads join

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