Hybrid SMR Disk Drives: Who, What, Why, When, and Where?

Theodore Ts’o
Technical Lead
Google
Who am I?

- Linux Kernel Maintainer
  - Ext4 Maintainer
  - Served program committees for LSF/MM, Linux Plumbers Conference, Linux Kernel Summit, Usenix FAST and Usenix ATC
- Technical Lead at Google
  - Kernel Storage Team
  - Hybrid SMR Project
  - Co-author of the “Disks for Data Centers” white paper
What are SMR disk drives?

- Disk drives where the tracks partially overlap
  - Relies on the write head being wider than the read head
  - Like roof shingles

- Increases the capacity of disk drives by up to 25%

- Disk broken up in 256 MiB zones
  - Writes must be append-only within a zone
  - To re-record a zone, it must be erased
  - Much like an erase block on Flash storage
What are Hybrid SMR drives?

- Allows portion of the media to be converted from Conventional Magnetic Recording (CMR) to SMR
- Backwards compatible with Conventional HDD’s
- Conversion can be done while the disk is serving
  - Non-destructive for unaffected regions of the disk
- Uses separate LBA ranges for CMR and SMR
  - Conversion brings CMR sectors off-line and SMR sectors on-line (or vice versa)
Why Hybrid SMR drives?

- Managing hot and cold data in a cluster file system
  - PDSW Keynote in 2017: “Colossus: Cluster-Level Storage @ Google”
    - [http://www.pdsw.org/keynote.shtml](http://www.pdsw.org/keynote.shtml)
  - To use all of the bytes and IOPS of each disk
    - Spread hot data across all of the disks in the cluster file system
    - Use the rest for cold data
What we want

Equal amounts of hot data (spindle is busy)
Rest of disk filled with cold data (disks are full)
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    - Spread hot data across all of the disks in the cluster file system
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- From “Disks for Data Center” paper
  - [https://research.google.com/pubs/pub44830.html](https://research.google.com/pubs/pub44830.html)
  - SMR friendly data tend to be cold
  - Disk IOPS is a perishable resource -- “use it or lose it”
  - To avoid stranding IOPS, store SMR and CMR data on a Hybrid SMR disk
When?

- As soon as possible. :-)
- Both Seagate and WDC have announced that they are working on Hybrid SMR
  - [https://blog.westerndigital.com/dynamic-hybrid-smr](https://blog.westerndigital.com/dynamic-hybrid-smr)
- T13 held a Study Group Meeting on Hybrid SMR on March 2\textsuperscript{nd} with another scheduled on March 26\textsuperscript{th}
Where?

- **T10/T13 standards committee**
  - Device Interface standardization only

- **OCP’s Cloud-HDD Storage community**
  - Cloud Product Requirements specification
  - Similar division of labor as in the Fast-Fail Read proposal
  - Work on Hybrid SMR drives slated to begin 1-2 months from now.
  - New Joint Development Agreement coming soon
    - To be drafted by the OCP Leadership Team
    - Please consider signing it and joining this activity!
What Else?

- At the 1st Study Group Meeting it was clear there was interest in converting between CMR, SMR, and HSMR modes of operation
  - From HDD vendors: SKU reduction
  - From at least some customers: being able to use a single pool of drives that can be used for traditional 100% CMR and 99.9% Host-Managed SMR drives
- This will be on the agenda for next week’s study group meeting in Milpitas
Conclusion

- Hybrid SMR represents a new opportunity to use SMR technology
  - Takes advantage of the unique characteristics of hyperscale cluster file systems
  - Will help lower the cost of cloud storage for customers
- OCP will accelerate the unification of the product requirements of Hybrid SMR for Cloud.