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

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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

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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%
 - <https://sata-io.org/developers/sata-ecosystem/shingled-magnetic-recording-boosting-capacity-and-lowering-costs>
- 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)

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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>
 - 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

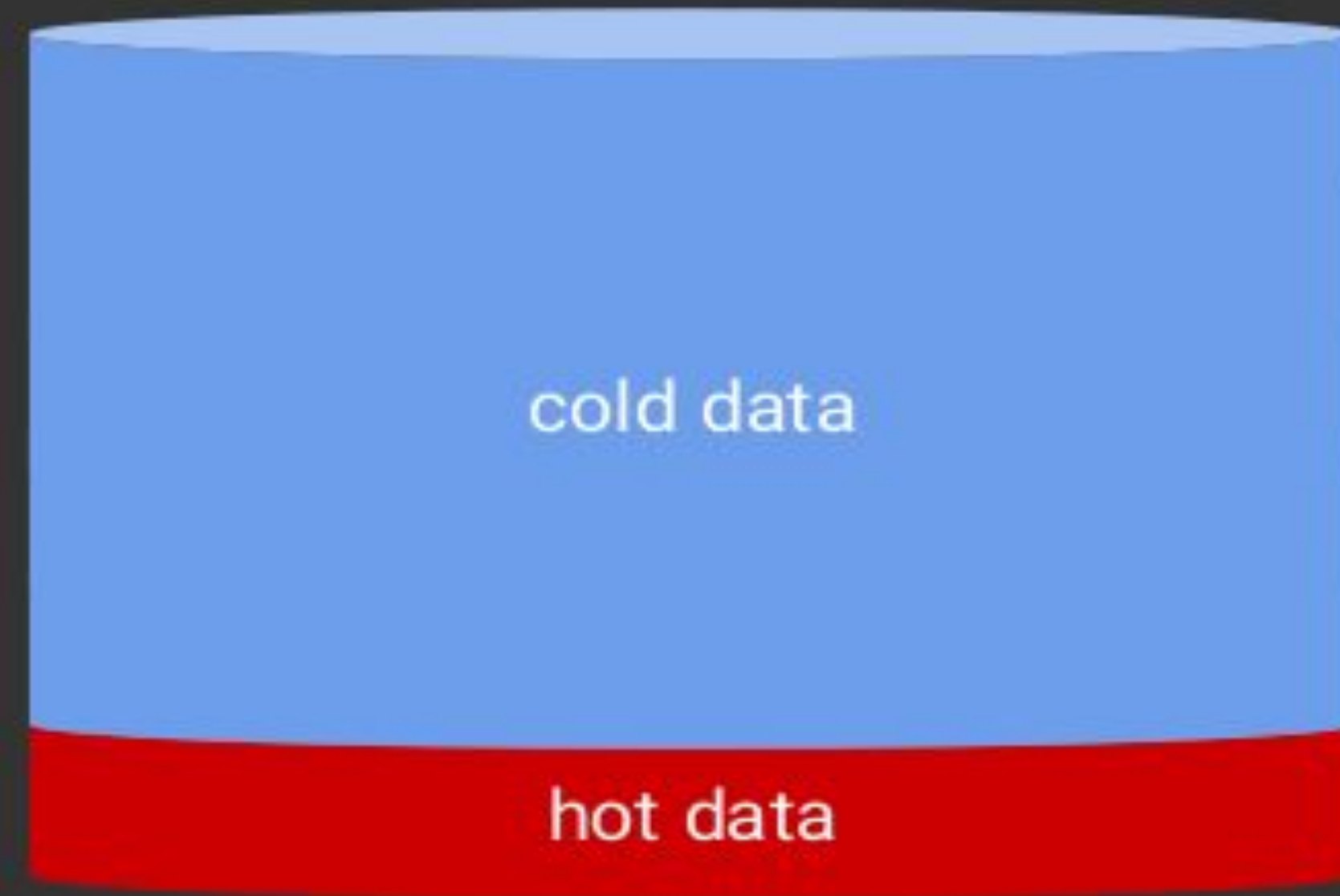
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What we want



small disk



big disk

Equal amounts of hot data (spindle is busy)
Rest of disk filled with cold data (disks are full)

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Why Hybrid SMR drives?

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 - 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
- From “Disks for Data Center” paper
 - <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

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When?

- As soon as possible. :-)
- Both Seagate and WDC have announced that they are working on Hybrid SMR
 - <https://blog.seagate.com/intelligent/new-flex-dynamic-recording-method-redefines-data-center-hard-drive>
 - <https://blog.westerndigital.com/dynamic-hybrid-smr>
- T13 held a Study Group Meeting on Hybrid SMR on March 2nd with another scheduled on March 26th

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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!

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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

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Conclusion

- Hybrid SMR represents an 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.

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