

Abstract

Power is the greatest lifetime cost in an archival system, and, as decreasing costs make disks more attractive than tapes, spinning disks account for the majority of power drawn. To reduce this cost, we propose reducing the number of times disks have to spin up by grouping together files such that a typical spin-up handles several file accesses. We calculate that in a typical system if only 30% of the total accesses occur while disks are still spinning, we can conserve 12% of the power cost. We classify files according to directory structure and see access hit rates of up to 66% for a power savings of up to 52% of the power cost of spinning up for every read in easily-separable workloads.

Overview

- Storage array is broken up into *access groups* representing files likely to be accessed together
- When a group is spun up, it is left on for 50s to catch subsequent accesses
- Save power by avoiding repeated spin-ups



- Distributed storage system with MAID-like semantics
- Number of index servers and redundancy can vary by requirements
- Access groups can be on different media
- Read: Spin up access group if necessary, read file, and then leave file group spun up for 50s
 - Read cache handles repeat identical file accesses
 - Scrub and handle delayed writes in this time
- Write: Extract file features, classify into file group • Can write immediately if necessary or wait in a buffer until group is spun for read

Semantic Data Placement for Power Management in Archival Storage

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Power Savings

Power is saved as the hit rate increases, but enough single accesses can offset this gain.





- Hit Rate: Percent of accesses that occurred while the appropriate group was still spinning
- Single: Percent of accesses that had no subsequent hits

Data Sets

- Washington: 5,000,000 accesses, [2007–2010], 16.5 TB
- Water Management: 90,000 accesses, [2007–2009], 2.3 GB

Classification

- If you have no access history use feature-based grouping • If you have a large feature space, reduce with principal component analysis
- With history, classify new data into existing access groups and create new access groups appropriately
- Hierarchical clustering (unsupervised)
- Time-based: Start with component analysis and re-allocate after access data is collected (semi-supervised)



to access personal records.



Future Work

- Create better access similarity metric
- Dynamic classification
- More Data Sets!

Washington



Accesses

Water

• Water: Search bots account for the spike of accesses • Washington: Flash crowd is unexplained, likely a one-off project

• Power is affected by the search indexers, which create singletons.