# Intro to Capacity Optimization Methods (COMs)

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SNIA Emerald™ Training

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# Outline

- COM overview
- How they work

# COM overview

- COM = Capacity Optimization Method
- Basic idea: figure out a way to store more data in less space
  - energy use is theoretically proportional to space used

# Currently acknowledged COMs

- Parity RAID (no longer evaluated by Emerald Tests)
- Thin Provisioning
- Read-only Delta Snapshots
- Writeable Delta Snapshots
- Data Deduplication
- Compression

# The key to it all

- For ENERGY STAR, all that matters is the ratio of data segments to parity segments
  - A larger number translates directly into power savings
  - Less power to store a given amount of data is the goal
- RAID 1 is 1 to 1
  - This is what we want to improve on
  - E.g. RAID 5 with 8 drives is 7 to 1

# RAID summary

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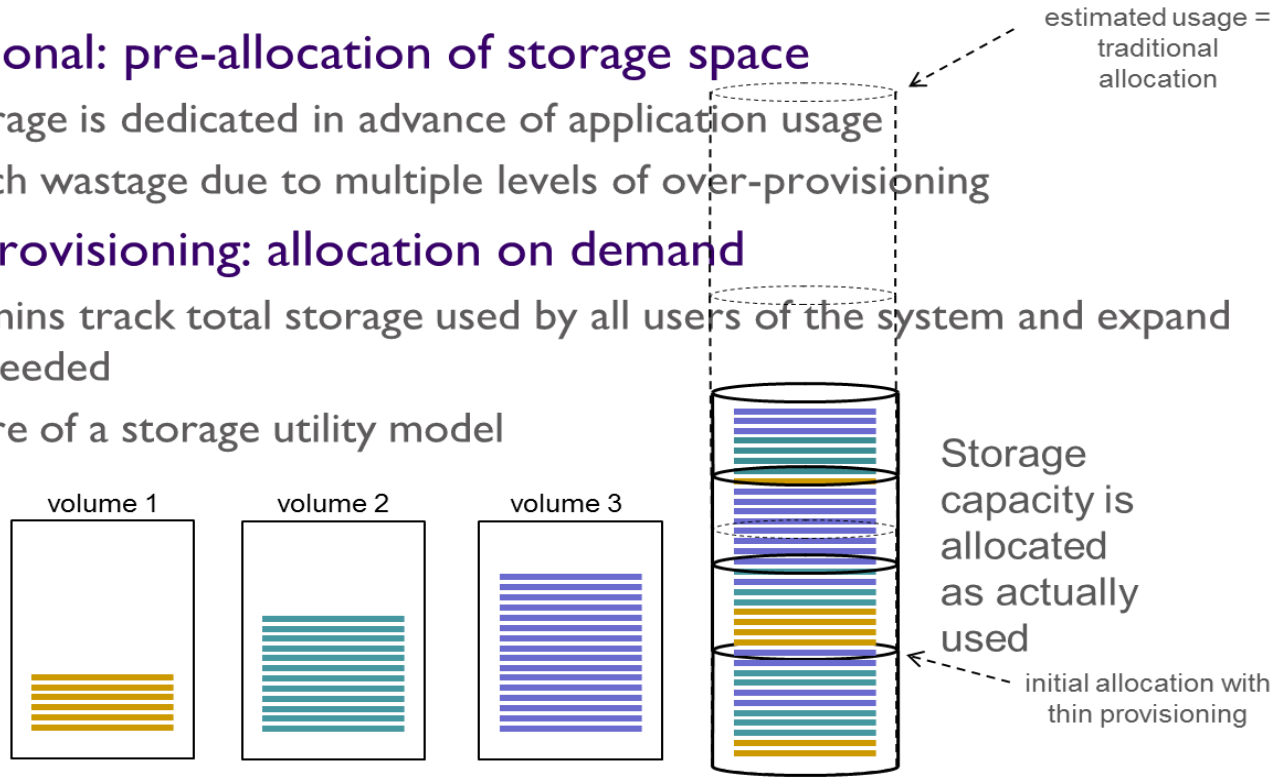
## Types of RAID

| | | | |
|---|---|---|---|
| RAID 0 | simple striping | not really RAID | |
| RAID 1 | mirroring | NOT parity RAID | |
| RAID 4 | parity on a separate drive | okay for ES | *only good for smaller drives* |
| RAID 5 | parity striped across drives | okay for ES | |
| RAID 6 | double parity | okay for ES | *protection against failures during RAID reconstruct* |
| "erasure codes" | non-XOR parity | okay for ES | |
| distributed parity | multiple parity, widely distributed [1] | okay for ES | |
| RAID 0+1, 1+0, RAID 10 | striping+mirroring | NOT parity RAID | |
| replication | e.g. Hadoop, AWS | NOT parity RAID | |

# Thin Provisioning

- **Traditional: pre-allocation of storage space**
  - Storage is dedicated in advance of application usage
  - Much wastage due to multiple levels of over-provisioning
- **Thin provisioning: allocation on demand**
  - Admins track total storage used by all users of the system and expand as needed
  - More of a storage utility model

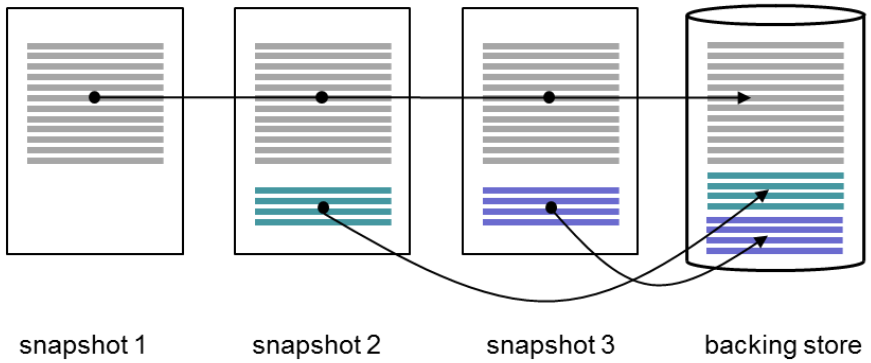


# Thin provisioning, cont.

- Thin provisioning power saving effects are indirect
  - Avoid buying and powering up storage ahead of need
  - I.e. minimize the amount of unused space on a system
  - Good administrative practices greatly increase its effectiveness
    - An empty system is an empty system, no matter what

# Delta Snapshots

- Snapshot
  - A Point-in-time (PIT) copy of some data
  - Usually at a volume or filesystem level
- Traditional method
  - Full copy
  - Lock volume, suspend or log writes, make copy, write log, unlock
- Delta method
  - Copy on write
  - Snapshots share blocks

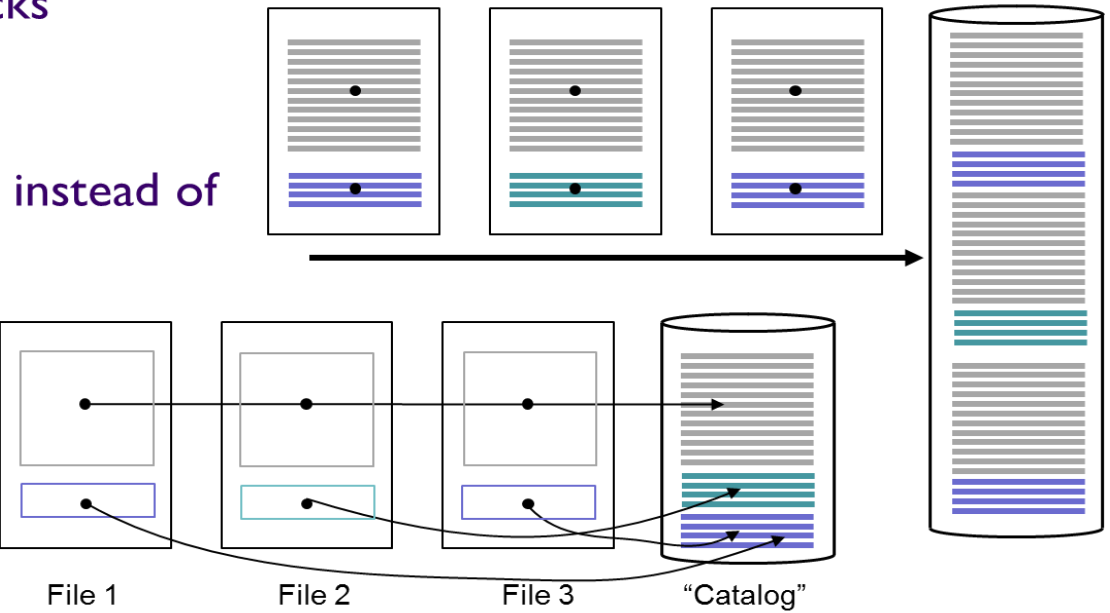


# Delta Snapshots cont.

- Read only
  - Live copy continues as before
  - PIT copy cannot be written
  - Useful for backups
- Writeable
  - Live copy continues as before
  - PIT copy can be written
  - Useful for “what if” scenarios, test runs on live data
  - Example: Data cloning for disaster recovery testing

# Data Deduplication

- A.K.A. "dedup"
- Basic idea: replace duplicate blocks with pointers to shared blocks



# Data Deduplication

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- Two fundamental types
  - "Inline" – Dedup at wire speed, before writing to disk
    - Usually used for streaming backup systems
    - Note: streaming backup systems are not "online" systems in the SNIA taxonomy, so are not covered by the ES spec
  - "Post process" – Dedup performed after initial write to non-volatile media
- Global vs. local
  - Global dedup works across all the nodes in a cluster– very hard
    - i.e. system-wide, not global in the planetary sense
  - Most dedup is "local" to a given node

# Deduplication, cont.

- Many variations
  - File or object level
    - Coarsest grained, least overhead
  - Block level
    - Granularity at 4K or larger
  - Variable-size
    - Finer granularity, but more overhead
  - Yada yada
    - Whatever

# Compression

- Old and venerable technology
- Well understood
- Zip, pkzip, WinRAR, others
- Finer grained than dedup
  - Byte level dedup inside typically a 32K sliding window
- Difficult, but possible, to combine with dedup
- Which is “better” depends on dataset

# COM Benefits summary

- All COMs allow you to store more data in less space
- Parity RAID
  - replacement for mirroring
  - Usually 40-some percent power savings over RAID 1
- Thin provisioning
  - Can take systems from 30% utilization (legacy) to 80%
- Delta snapshots
  - Huge savings possible when change delta is small
- Deduplication
  - Savings depend on several factors, can be large
  - Think of backing up thousands of laptops, all originally burned from the same master image
- Compression
  - Savings vary with data characteristics, can be large
  - As compression is local to a file or block, it can't achieve what dedup can

# Q&A - Intro to Capacity Optimization Methods (COMs)

## Thank You for Your Attention

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