# OPEN POSSIBILITIES.

#### Autonomous Drive Regeneration

#### Challenges, Opportunities & Best Practices



Storage

## Autonomous Drive Regeneration

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Increasing storage capacity requires more components inside storage devices, HDDs or SSDs alike



# What Happens with More Components?

Every head represents a smaller portion of drive capacity



More heads increase probability that at least one head encounters challenges (everything else equal)

Number of Heads: N Prob. {Single Head Issue} = pProb. {Single Head Healthy} = 1 - pProb. {All Heads Are Healthy} =  $(1 - p)^N$ 

With more heads, if the entire device is treated as a failure, due to a single head issue: not only would it occur at a higher rate but also discard more remaining capacity





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## What Happens to Device Failures?

Swapped

Crushed





**Hold Your Horses!** 

<u>70% of datacenter failures are caused by human errors</u> per Uptime Institute Crushed HDDs is a significant portion of <u>global e-waste</u> per International Solid Waste Association

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## Technical Solution to Assist with Deployment Robustness

Exos CORVAULT finds a way to minimize human intervention and reduce e-waste







Samsung SSDs implemented Fail-in-Place to address similar issues





## CORVAULT Implementation of Autonomous Drive Regeneration

Reducing e-waste, increasing <u>Sustainability</u>





4. Volume is rebalanced with renewed drive



2. Controller offloads data to other drives and removes drive from logical volume



#### **Maximize Sustainability**

CORVAULT self-healing capability (ADR) enable drives to continue functioning insystem when other systems require HDD return and replacement

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3. Drive & controller diagnose incidents and regenerate drive

**1.** Drive alerts controller of issues



## How Drives Support ADR?



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#### Feature Set in <u>T10</u> & <u>T13</u> Standards

- Storage Element Depopulation
- Collaboration of all major storage device suppliers



#### **Command Set**

- REMOVE ELEMENT AND TRUNCATE
- RESTORE ELEMENTS AND REBUILD



## Sustainability: A Clear Industry Trend







## **TCO** Benefits

Direct TCO benefits can be achieved with ADR

- TCO modeling on a 100EB system in two different modus operandi for two boundary conditions
  - On-site staff swapping drives ASAP
  - Unmanned system with drives kept in slots permanently

 YMWV – TCO modeling requires numerous assumptions specific to systems
Key Message – TCO savings are achievable with ADR





## A Snapshot of Field Returns

# Among drives with true issues: 56% could be good ADR candidates



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No Issues with drive (no ADR necessary)

Minor issues with single head (> 70% ADR success)

Single head errors with mild signs on second head (20-70% ADR success)

Single head severe errors with minor issues on second or more heads, or drive DNR (< 20% ADR success)

Hard errors on multiple heads, or hardware issues (< 5% ADR success)



## Interested to Implement ADR?

- --showPhysicalElementStatus to inquire drive for health status on each element (head)
- --removePhysicalElement x to depopulate element x (head x)
- --repopulateElements

to repopulate all elements (heads) with best attempt

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# We Are Here to Help!





## A Glimpse of Future Directions

Recording industry has been well aligned to support Storage Element Depopulation

Efforts are being made to ease implementation in storage systems Can we expedite the process?

Make background format optional
Handshake with hosts

Can we further simplify the process?

- Maintain data validity on heads not depopulated
  - How much would this help **you**?





### Call to Action

- Treating a drive as failure due to single head issues has become less prudent and more costly in recent product generations
- Autonomous Drive Regeneration, supported by Storage Element Depopulation feature, enables recovery from issues associated with single heads (majority of drive returns) to allow continued usage
- By avoiding unnecessary swaps, benefits from ADR include less human intervention, reduced e-waste and direct reduction of TCO
- We promote wide adoption of Autonomous Drive Regeneration
- This is the time to let the industry know how you need the Storage Element Depopulation feature to be further enhanced



#### **Open Discussion**

