

Stream CSD: Reducing Enterprise/DC SSD WA & Improving SS Performance

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Agenda^o

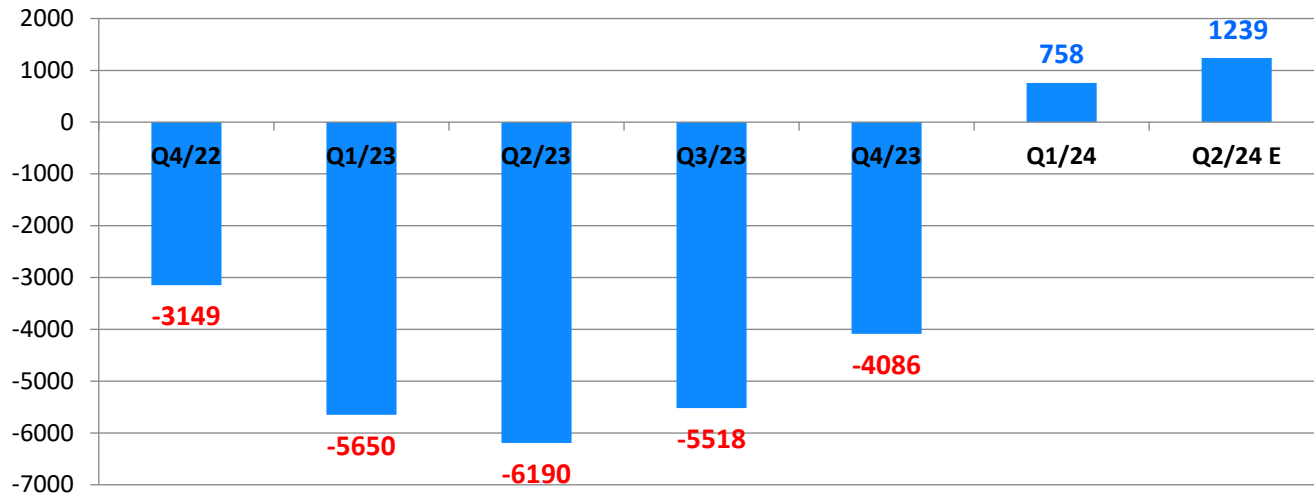
- Trends in the Storage Industry
- Garbage Collection(GC) Issues in NAND Flash
- Existing Approaches to Reduce Block Interface Tax
- Technologies Enabling DapuStor StreamCSD
- Design Overview of StreamCSD
- Benefits of DapuStor StreamCSD

What's Happening in the Industry?

-How to Balance Demand & Supply ?

Unit: M USD

NAND Only



Source: Public info.

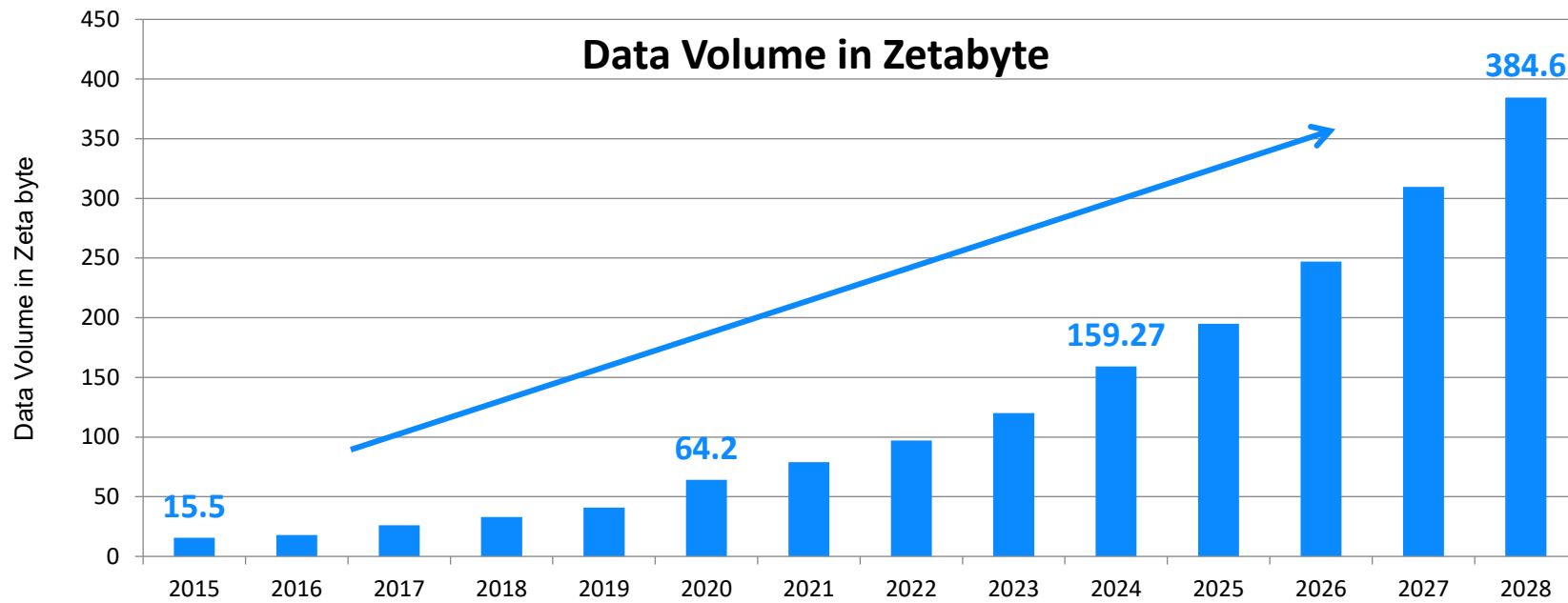
Vendors	2024 CapEx YoY
Samsung	-15%
SK Hynix	-38.7%
Micron	-10%

Source: Trendforce

Operating Profit (Loss): Samsung, SK Hynix, Micron, and KIOXIA incurred a \$24.593 billion loss in their NAND business.

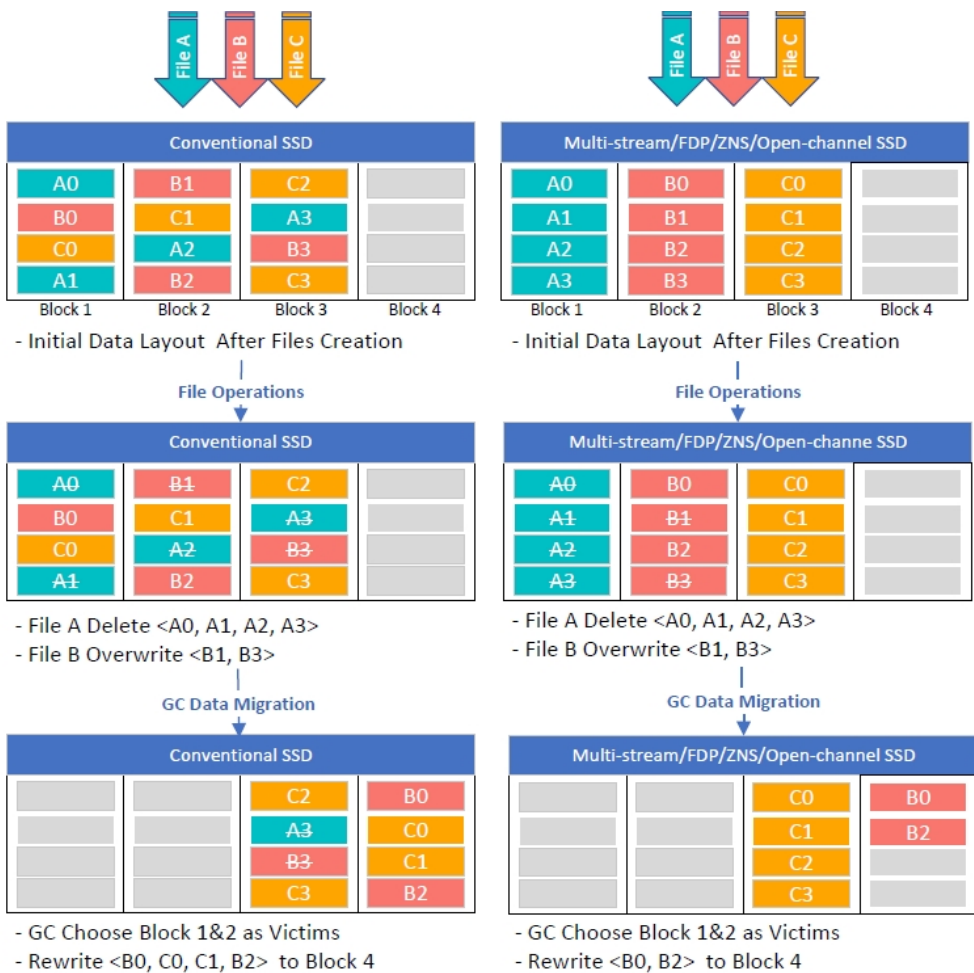
Unlikely to recover the losses by the end of 2024

Globe Data is About to Explode[Ⓞ]



Source: IDC, Statista and etc.,

An Inevitable Issue of NAND Flash Memory: Garbage Collection (GC) [©]



Program operations (writes) occur at the **page level**. Pages cannot be overwritten; they can only be re-written after they have been erased. Erases happen at the **block level**.

Directly causes **WA** (Write Amplification)

Impact **SSD Performance & Lifespan**

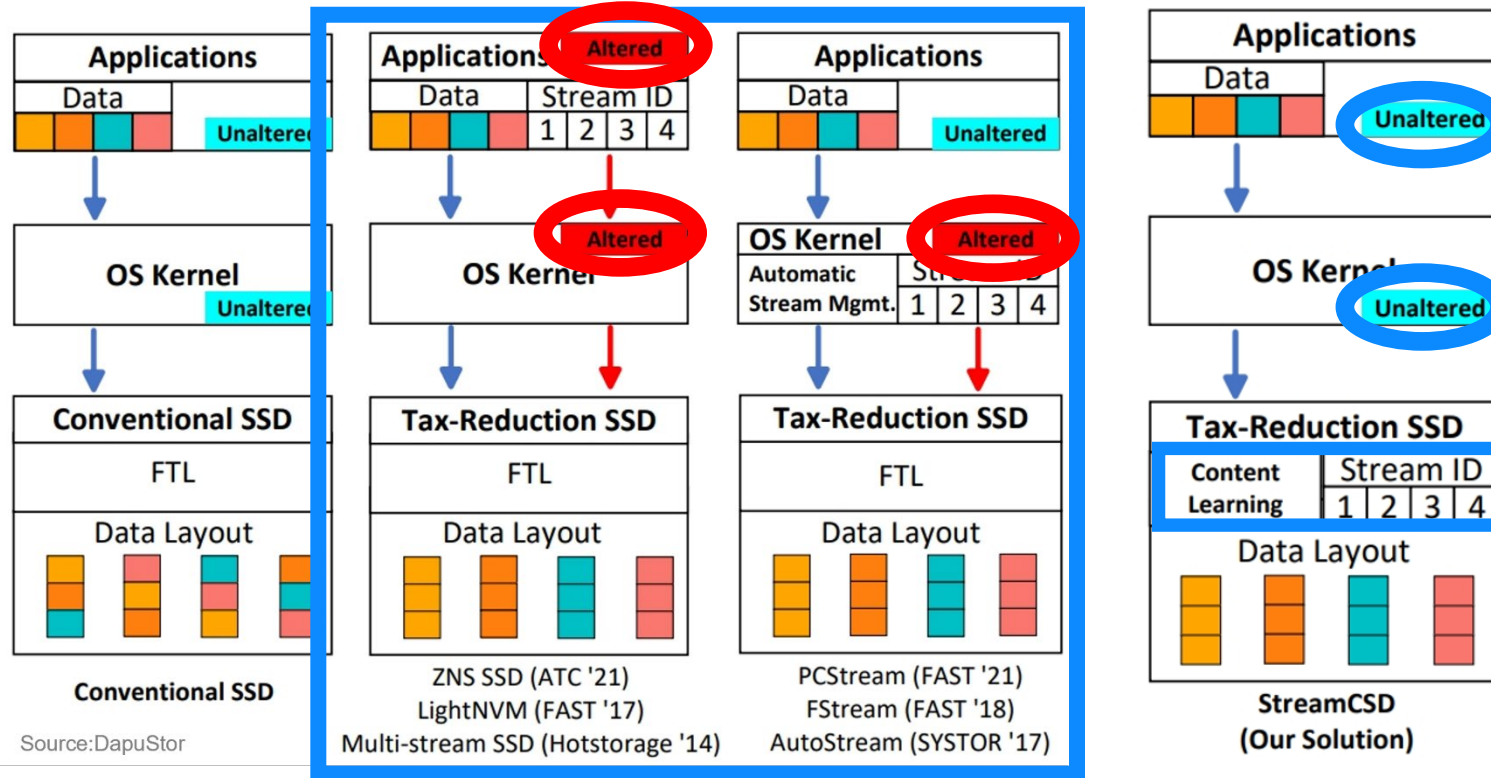
Drive require **OP** (Over-provisioning)

For decades, the entire industry has been seeking various solutions to **optimize the GC process and reduce WA**.

The Garbage Collection Process

Source: DapuStor

Existing Approaches to Reduce Block Interface Tax



DapuStor's Solution:
StreamCSD

Drawbacks

- ⊙ Host involvement is required
- ⊙ Ecosystem compatibility challenge

Technologies Enabling DapuStor StreamCSD[®]

| Data Content & Compression Ratio

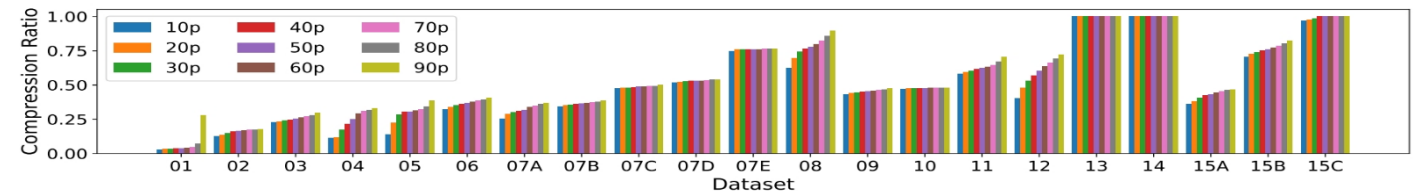
ID	Application	Format	Description
01	Biology	VCF	Gene sequence variations
02	EarthScience	CSV	Sea surface temperature
03	GIS	GeoJSON	Geographical coordinates
04	Security	JSON	IP flow records
05	Networks	CORS	UCSD-NT FlowTuple
06	Agriculture	TXT	Plants Database
07A	Advertising	JSON	Checkin timestamps
07B	Advertising	JSON	Business location and attributes
07C	Advertising	JSON	User short tips text
07D	Advertising	JSON	User full review text
07E	Advertising	JSON	User friend mapping
08	Energy	H5	Household energy usage
09	Healthcare	CSV	Curated medical text data
10	ImageProcess	TSV	Image url, size, and digest
11	Neuroscience	EEG	Electroencephalography
12	SocialNetwork	TXT	YouTube video relation graph
13	MachineLearning	NPZ	Numpy compressed array
14	Weather	PNG	Weather image
15A	AIGC	TXT	OpenAI ChatGPT
15B	AIGC	PNG	OpenAI Dall-E
15C	AIGC	MP3	OpenAI TTS

DATASET

Source: DapuStor

18 Large-scale datasets from various domains.

3 AI-generated content (AIGC) data from OpenAI, such as ChatGPT text, Dall-E image, and TTS voice.

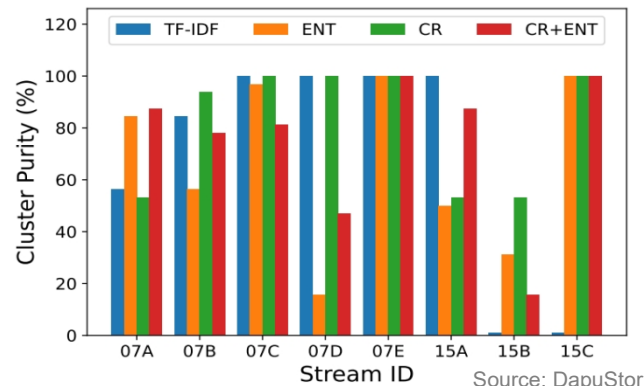


Potentially Achievable:
Make Streams More Differentiated by CRs

Technologies Enabling DapuStor StreamCSD[®]

| TF-IDF & K-means Clustering

Clustering Accuracy

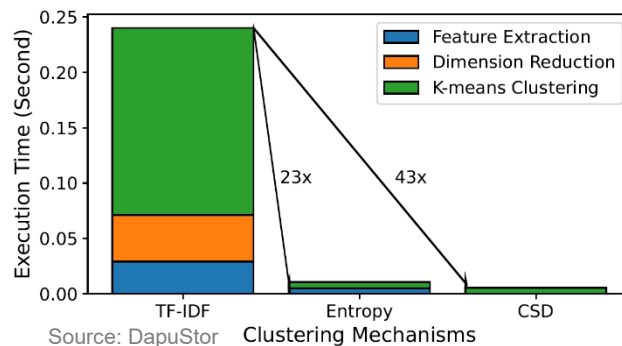


Source: DapuStor

*7A-7F are TF-IDF friendly, and 15A-15C from AI applications

1. TF-IDF works well for some datasets, **but not all**.
2. Traditional K-means clustering is based on entire batches (multi-pages).
3. DapuStor StreamCSD **operates directly on pages**, ensuring better performance.

Computational Overhead

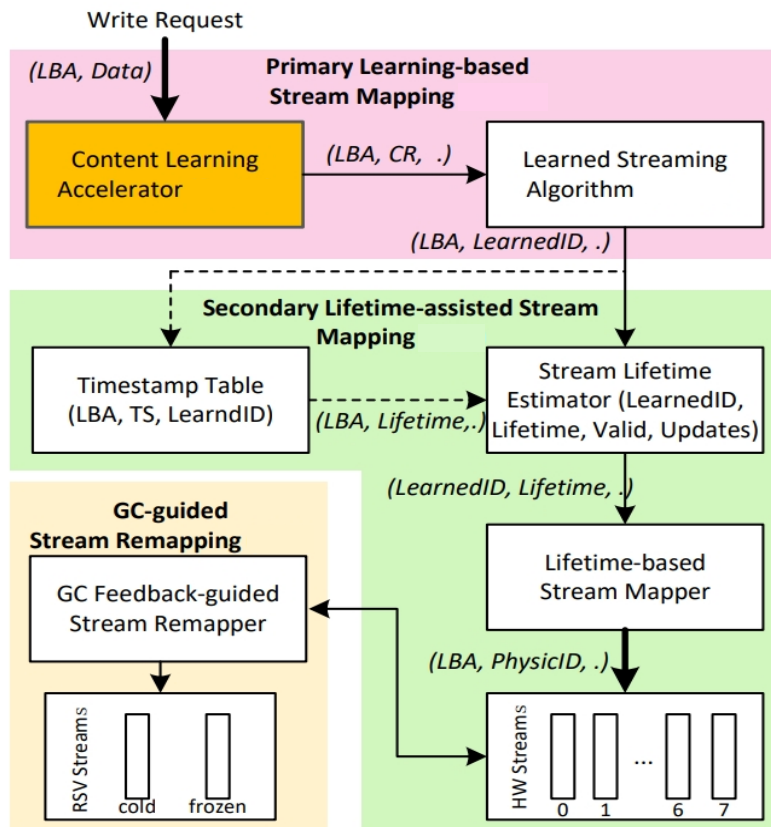


Source: DapuStor

Clustering Mechanisms

Design Overview of StreamCSD

Firmware Running Process



Source: DapuStor

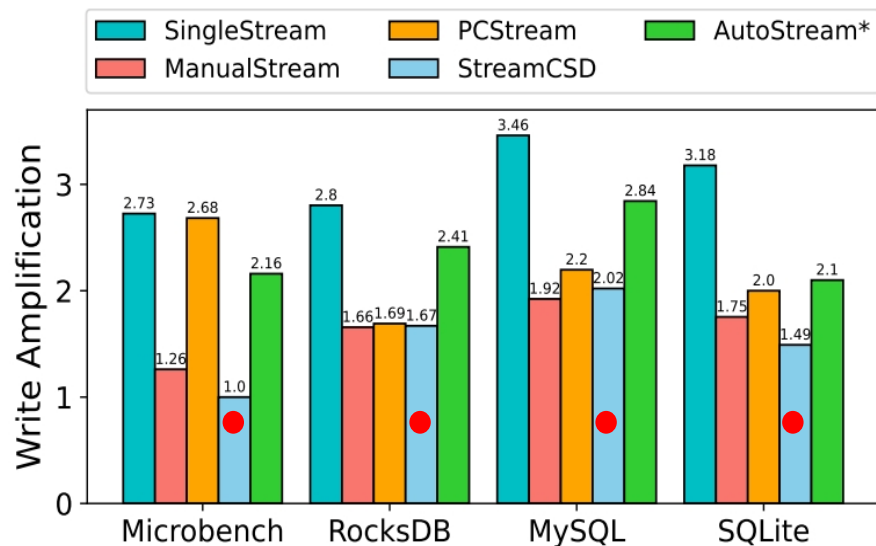
The Most Important Step

Using **CR(Compression Ratio)**
to divide data pages into different learned streams

Major Benefits of StreamCSD[Ⓞ]

WAF Improvements

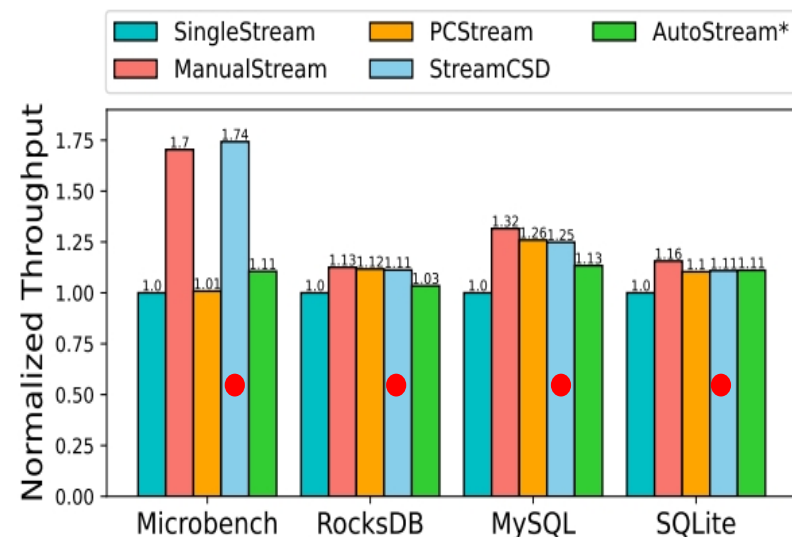
(The lower, the better)



Source: DapuStor

SSD Performance Benchmark

(The higher, the better)



Source: DapuStor

- Ⓞ StreamCSD achieves up to **63.4%** reductions in WAF.
- Ⓞ StreamCSD offers performance comparable to other host-involvement methods.

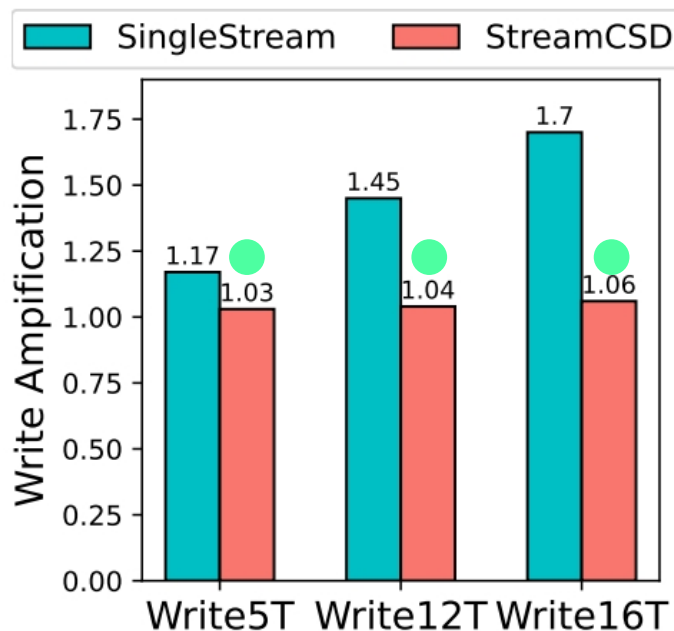
What We Can Do for Multimodal Generative AI Workloads?

Major Benefits of StreamCSD [⊙]

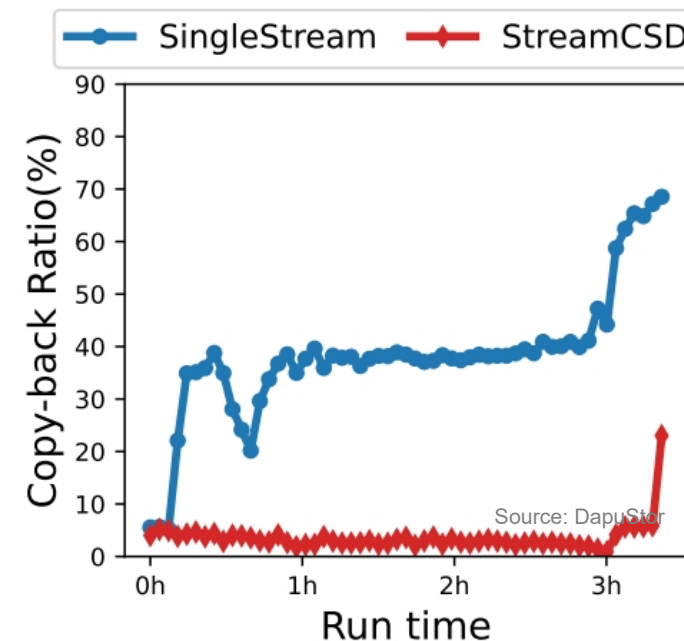
Use StreamCSD to check performance using data from **OpenAI & Runway**

Focus on the **multimodal scenario**, streaming ChatGPT txt, DALL-E png, OpenAI TTS mp3, and Gen-2 mp4 data into a **7.68TB SSD**

Achieved a maximum decrease in WAF by **37.6%**



(a) WAF.



(b) Copy-back ratio.

Benefits of DapuStor StreamCSD

DapuStor Roealsen6 StreamCSD

To the Users

- **Host transparent**— easy to use
- Improved SS performance
- Extended drive lifespan(**5-8years**)
- Reduced **TCO**



To the Industry

- **A ground-breaking method** to address GC/WAF issues
- Balancing the **booming demand** trend and the **NAND supply**

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