Extending Datacenter Capacity To Drive ROI

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Aug 6, 2014

Hyperscale Datacenters & SSD Adoption
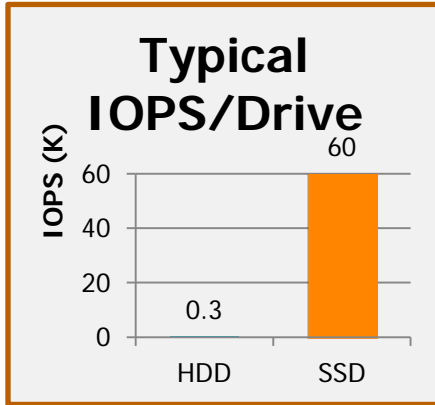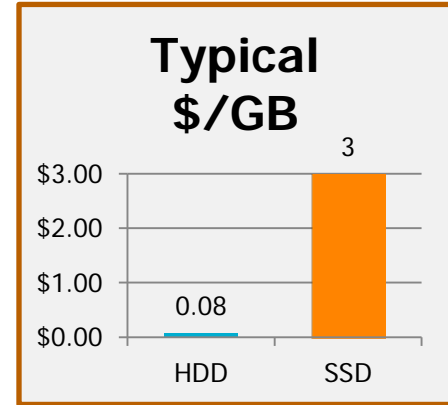
2013
Enterprise SSDs
Over $3B USD*

Capacity ↑ Cost ↓

Performance ↑ Endurance ↑
Most critical levers

*Forward Insights

Typical IOPS/Drive

	HDD	SSD
IOPS (K)	0.3	60

Flash is clearly faster than HDDs

Typical IOPS/$

	HDD	SSD
IOPS (K)	3.75	20

Although the performance tier has over 5x better performance/$

Typical $/GB

	HDD	SSD
$/GB	0.08	3

However $/GB alone is too high to replace all HDDs

Flash in Datacenters

Typical IOPS/Drive

IOPS (K): 60, 40, 20, 0

HDD: 0.3 | SSD: 60
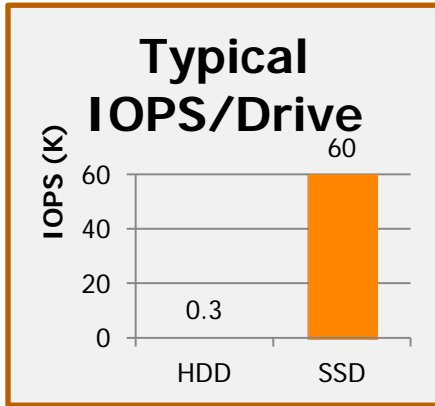
You get the same performance over HDDs

What if you could triple the capacity of the same flash?

Typical $/GB

$3.00, $2.00, $1.00, $0.00

HDD: 0.08 | SSD: 3
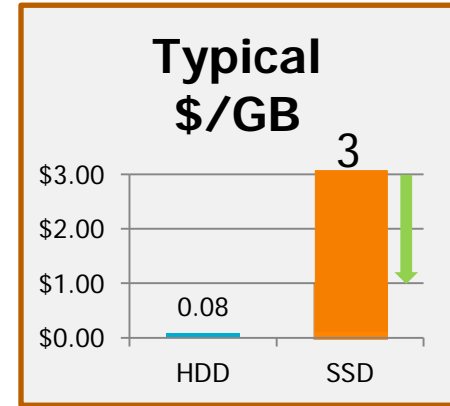
The $/GB drops to a third to replace all HDDs

Typical IOPS/$

IOPS (K): 60, 40, 20, 0

HDD: 3.75 | SSD: 60
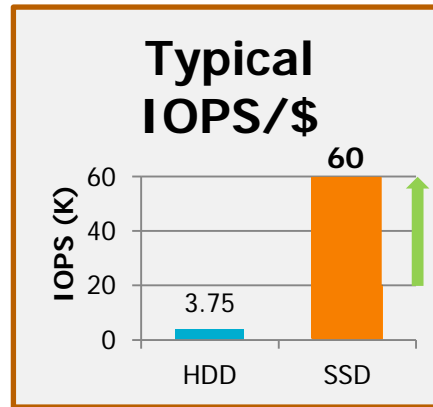
And the performance tier is 16x higher per $

Is this really feasible in an SSD?

Most data does not have 100% entropy and data reduction helps

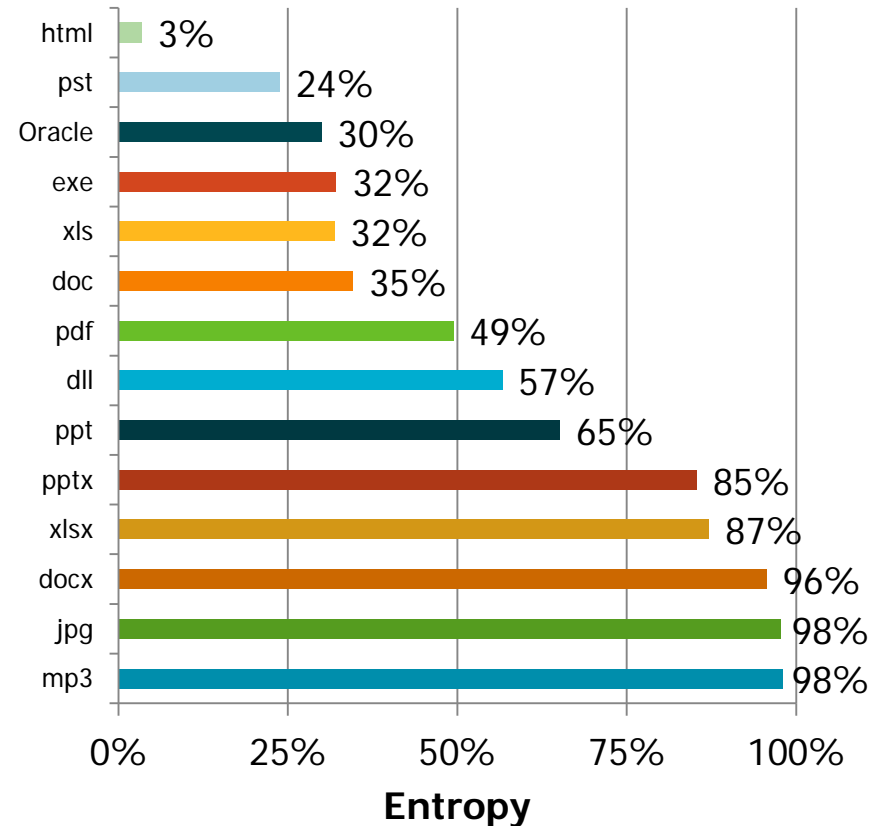### Linux® Web hosting distributions Show ~60% entropy[1]

Binaries and Shared Libraries

Database entropy as low as only ~30%[2]

Entropy by file type[3]

File type	Entropy
html	3%
pst	24%
Oracle	30%
exe	32%
xls	32%
doc	35%
pdf	49%
dll	57%
ppt	65%
pptx	85%
xlsx	87%
docx	96%
jpg	98%
mp3	98%

Entropy

[1] LSI calculations on Oracle Database solutions
[2] http://www.thesmarterwaytofaster.com/pdf.php?c=LSI_WP_NytroWD-DuraWrite_040412
[3] Measured by WinZip

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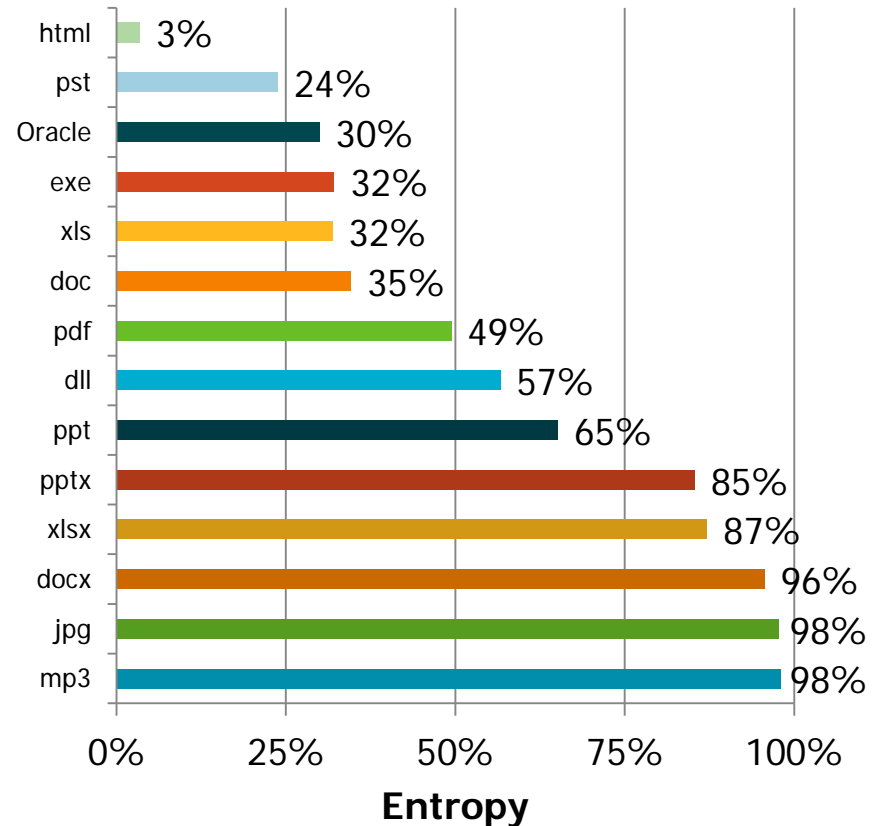[3] Measured by WinZip

Compression Engine Location	Issue	Solution / Concern
All Locations	▪ Need some level of predictable entropy ▪ Operating systems today don't understand variable max capacity	▪ Datacenters now have more knowledge of their data ▪ Customize drivers or modify already custom OS
CPU	▪ Expensive resource and limited max throughput	▪ Use a device-based solution
HDD	▪ No variable mapping table; assumes 1:1 map from host	▪ Major re-architecting required
SSD	▪ FTL must be re-architected to support non-constant data size	▪ Complex FTL must be created for data placement, garbage collection, etc.

This is not a simple problem to solve

What SSDs today support variable map sizes?

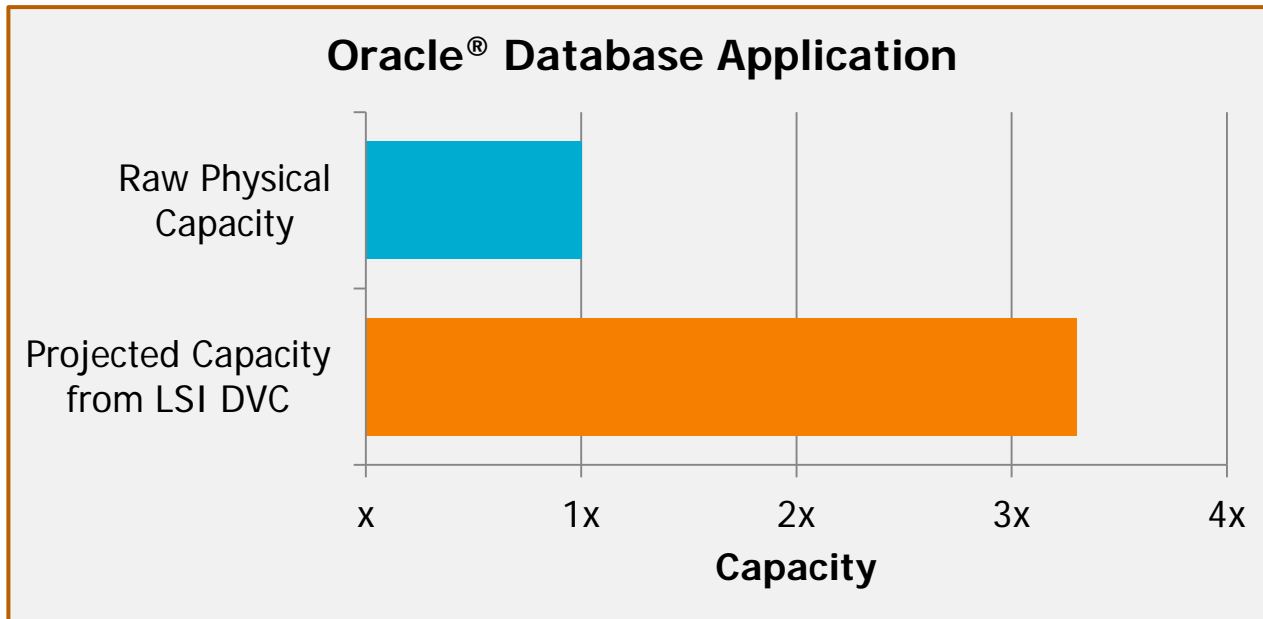- ## LSI® SandForce® Flash Controllers employ DuraWrite™ data reduction
  - Manages variable-size data placement on the flash

DuraWrite Feature	Benefit
Incorporates a novel Flash Translation Layer (FTL)	▪ Handles variable-sized data for writing, reading, and garbage collection ▪ Manages data spanning flash page boundaries to maximize space utilization
Supports variable data length	▪ Incoming data size not restricted to be a power-of-two ▪ Each LBAs can be a unique size
Provides for multiple flash page sizes to support variable code rate	▪ Working in conjunction with SHIELD™ technology

LSI DuraWrite™ Virtual Capacity (DVC)

- **Increases the available storage capacity for typical data**
- **The lower the entropy, the higher the capacity increase**
- **Continue to get SSD endurance or performance benefits**

Oracle® Database Application

Raw Physical Capacity

Projected Capacity from LSI DVC

Capacity: x 1x 2x 3x 4x

DVC greatly lowers the $/GB of available capacity to the user

DVC Explained

Flash Memory SUMMIT

Speed & Endurance

Enterprise Data Drive

120 GB User Data	8 GB OP

128 GB SSD

DVC

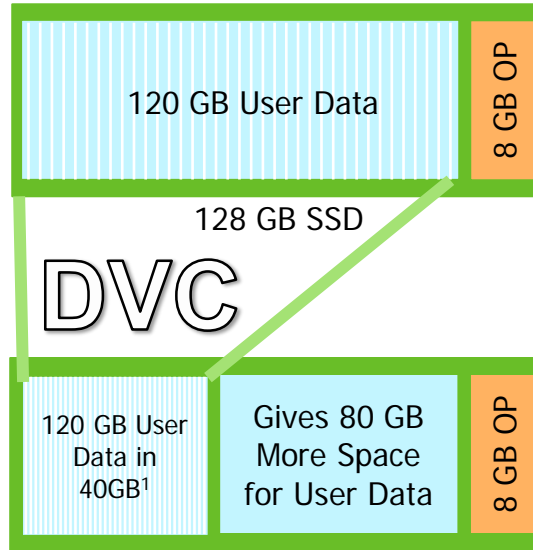| 120 GB User Data in 40GB[1]	88 GB Dynamic OP
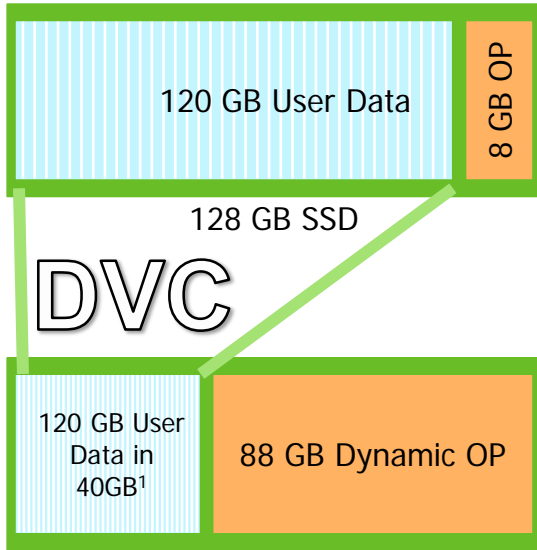
Greater Dynamic Over Provisioning increases performance and endurance

Extra user data space

30% entropy database

120 GB User Data	8 GB OP

128 GB SSD

DVC

120 GB User Data in 40GB[1]	Gives 80 GB More Space for User Data	8 GB OP

Database actually sees 360GB of high performance SSD

Minimize costs

60% entropy boot drive

88GB User Data	8 GB OP

96GB SSD

DVC

120GB of data[2]	8 GB OP
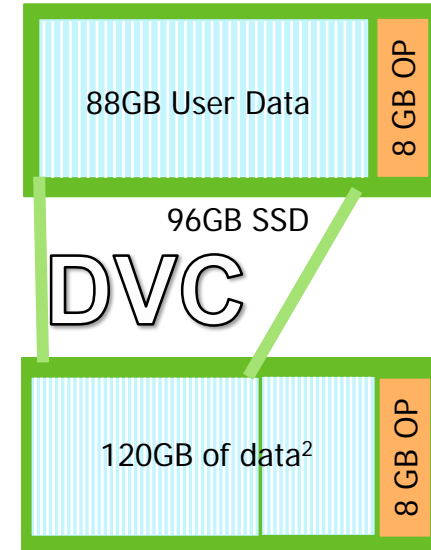
Able to use a lower cost SSD solution

[1]Assumes a 33% entropy. Actual size reduction dependent upon data entropy.

[2] Assumes a 60% entropy. Actual size reduction dependent upon data entropy.

DVC Use Cases

Use Case	Native User Data Storage	Dynamic Caching
What	▪ Additional flash space appears as a user accessible SSD	▪ Additional flash space managed by caching application
Pros	▪ User capacity increases for same flash cost	▪ Increases cache size for same flash cost ▪ No OS changes
Cons	▪ Requires OS driver changes −Easier with Linux or custom OS	▪ Requires integrated caching application
Support	▪ LSI Nytro™ product line ▪ Select SandForce Driven® program SSDs	▪ LSI Nytro product line ▪ Select SandForce Driven program SSDs
Market	▪ Enterprise with custom OS or Linux ▪ Client with Linux	▪ Enterprise focus

Summary

- **Flash use in datacenters is expanding**

- **Compression can greatly reduce capacity & cost concerns**

- **Major complexities around on-the-fly compression**

- **LSI DuraWrite Virtual Capacity addresses those concerns**

- **Available in LSI Nytro product line & select SandForce Driven SSDs**

- **All-flash performance at hard disk price may not be a dream**