# Preparing Enterprise Flash Drives (EFDs) for Prime Time

*"Do More For Less"*

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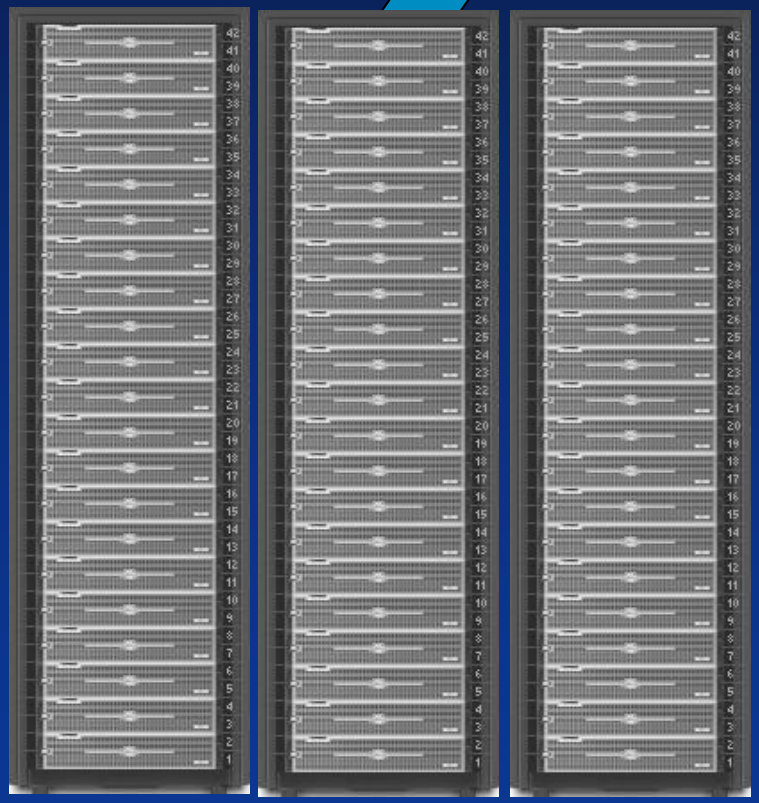
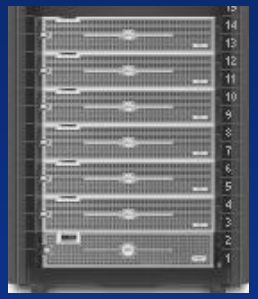
August 2009

# Simple Proposition: Do More For Less



Traditional: 1000s x HDDs

Efficient: Fewer HDD+EFD



***Benefits:***

Better Performance

Smaller Footprint

2X Lower Costs

9X Lower Power

# Example: Order Entry System

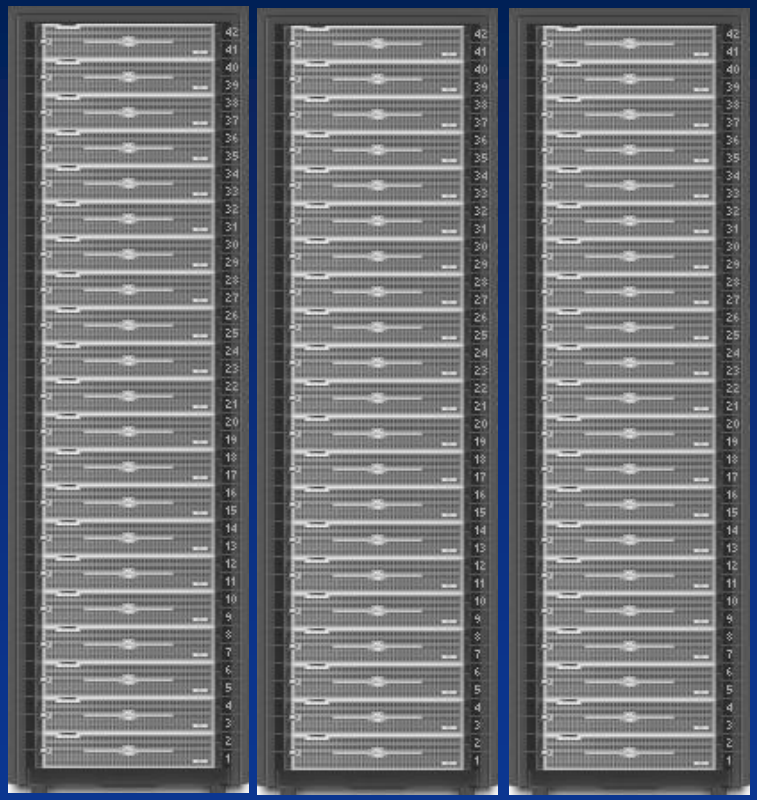
## TPC-C Benchmark:

Order-entry system with transactions including entering and delivering orders, recording payments, checking the status of orders, and monitoring the level of stock at the warehouses

## Requirements

- 640,000 transactions/minute
- 320,000 IOPS
- 18 TB database

# Current HDD Solution = High Cost/High TCO



- **40** Rack mount shelves
- **1000** 36GB HDD's
- 15K RPM
- >$450K Purchase price
- 8000 watts to operate
- 8000 watts to cool


# Enterprise Flash Drive (EFD)

- High Performance: >100,000 IOPS
  - 24x7 duty cycle with flexibility for peak demands
- Reliable: 2M hours MTBF and $>10^{16}$ data integrity
- Energy Efficient: >20,000 IOPS/watt
- High performance interface: FC or SAS
- Fit existing infrastructure and no software changes

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# New Approach for Storage Solutions

## Traditional

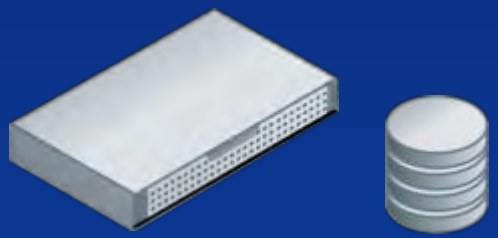
**Current Approach**

- Spread 'hot' data across all HDD's
- 15K RPM HDD's
- Short stroke HDD's
- Over provision HDD's
- Low capacity HDD's

## Innovation

**EFD+HDD Approach**

- Storage tiers:
  'Hot' data on EFD's
- 7K or 10K RPM HDD's
- Full Stroke HDD's
- High capacity HDD's




# EFD+HDD: Lowest Cost/GB

| Enterprise Rack Attributes | HDD Only Solution | EFD+HDD Solution |
|---|---|---|
| HDDs<br>Capacity/Drive | 25 (15K RPM)<br>36GB/18GB each | 21 (10K RPM)<br>147GB each |
| EFDs<br>Capacity/Drive | 0<br>n/a | 4<br>150GB each |
| Usable Capacity/Shelf<br>IOPS/shelf | 450GB<br>8000 | 3500 GB<br>52,500 |
| Cost per Shelf | $11,250 | $37,500 |

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| Usable Capacity/Shelf<br>IOPS/shelf | 450GB<br>8000 | 3500 GB<br>52,500 |
| Cost per Shelf | $11,250 | $37,500 |
| Number of Shelves Required | 40 | 6 |
| **Total Cost** | **$450,000** | **$225,000** |
| $/IOP | $1.41 | $0.72 |
| $/GB | $25.00 | $11.00 |
| Power to Operate & Cool | 16,000 watts | 2,000 watts |
| Power Eff. (IOPS/Watt) | 20 | 158 |

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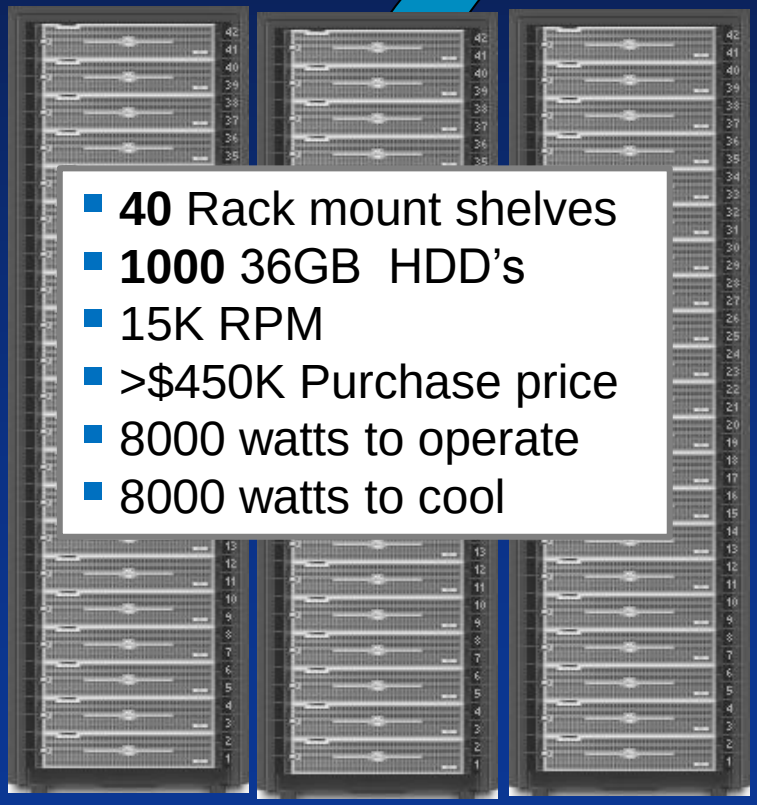

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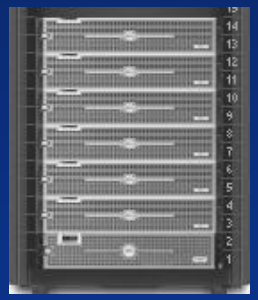
1000 x HDDs

EFD+HDD



- **6** Rack mount shelves
- **105** 147GB 10K RPM HDD's
- **20** EFD's
- <$225K Purchase price
- 1000 watts to operate
- 1000 watts to cool


# Prime Time for the Enterprise?

- Performance: The ROI must be VERY compelling
  - >100x Performance for 10x $$$
- Predictable for Enterprise Workload "Range"
  - Read/Write Mix from 95/5 to 50/50
- Improved Device and Data Reliability:
  - 2M hours MTBF and >$10^{16}$ UBER data integrity
- No Limitations on Write Operations

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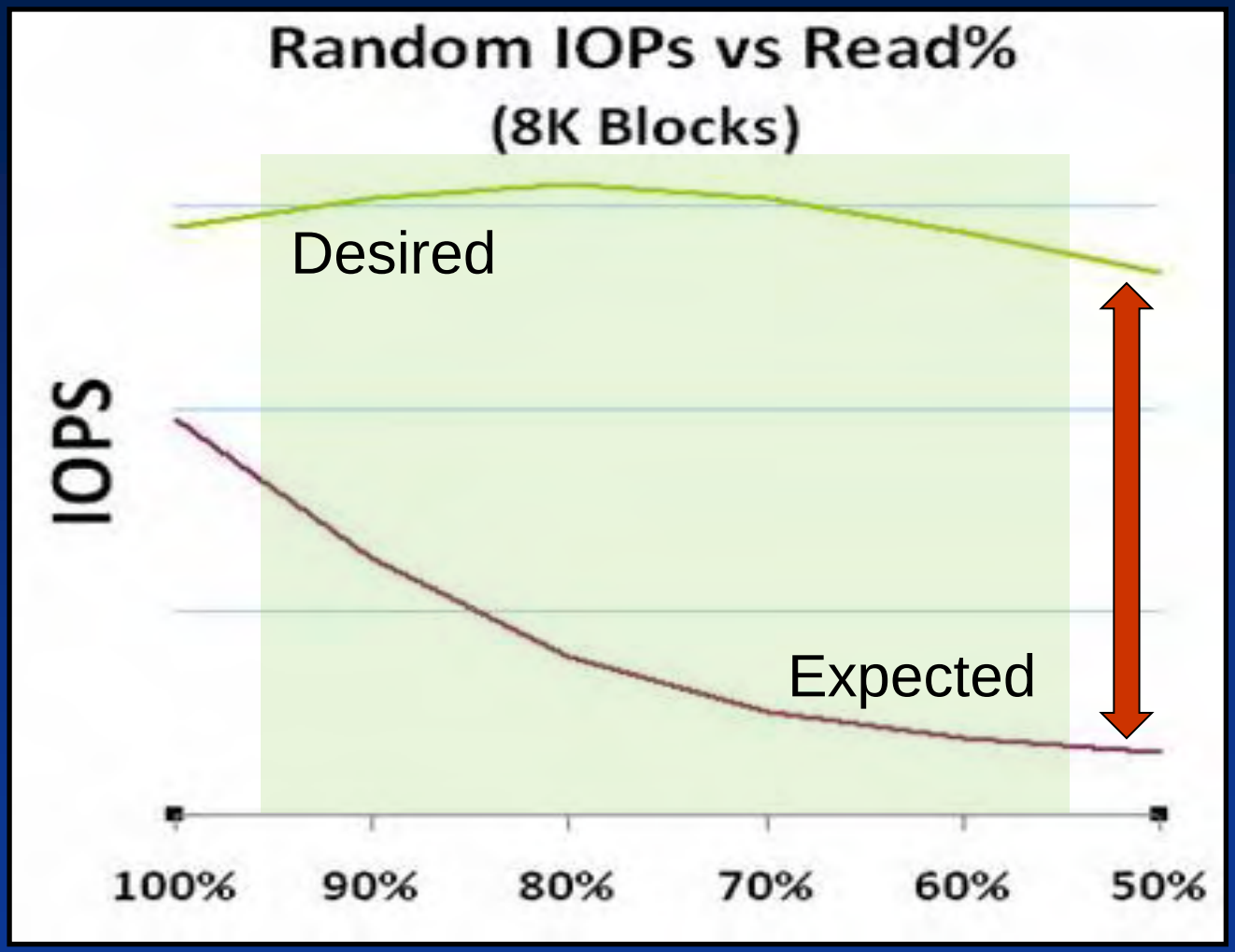
# Desired vs. Expected Profile



# Advantage of SAS (vs SATA)

SAS
Dual Port
Full Duplex

SATA
Single Port
Half Duplex

- Simultaneous Writing & Reading
- 4X the Link Bandwidth

# Enterprise Flash Drives for Prime Time

## Value = "Do More For Less"

- More Performance = Better ROI
  - Predictable across range of R/W mix
- More Reliability = Lower TCO
  - Both data and device improvements
- No Restrictions = No Changes Required
  - No restrictions on workload or usage
  - No software modifications

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