

Vibration Management System for Storage Performance

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Gus Malek-Madani, Founder and CTO

Green Platform Corp.

- MSME, PE with twenty five years experience in related industries
- Seasoned leader as well as a creative technologist
- Holds several US and International patents related to Carbon Fiber
- Founder and CEO of three companies
 - Venture backed Composite Rotor: Centrifuges and Rotors for Biotech industry
 - Composite Products: High-End Audio/Video
 - Green Platform Corp: Vibration Management System for storage performance and reliability

Vibration Penalty

The You-tube yell video

<http://www.youtube.com/watch?v=tDacjrSCeq4>

What's the Problem with Vibration?

- ❑ Un-wanted vibration reduces signal/noise ratio and performance
- ❑ Extended delays to read data can cause applications to stop
- ❑ Reduces reliability; Shortens product life
- ❑ Wastes energy
- ❑ Hard to remediate because it is random and complex.

Vibration costs \$

Vibration Primer...

- The highly complex vibration force $F(t)$ in data centers is random and across a wide range of frequencies
- The system's dynamic properties and its response to vibration can be represented as:

$$MX'' + CX' + KX = F(t)$$

Where M is mass, C damping, K stiffness of the system, X the system's motion response (displacement), X' is the rate of change of displacement (velocity) and X'' is the rate of change of velocity (acceleration) to $F(t)$ vibration forces.

- K and C of materials are frequency dependent

Many Different Sources to Manage

Disk Drives



Cooling



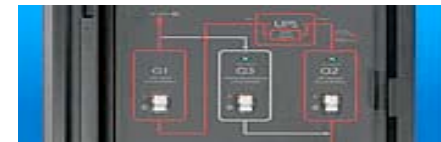
Power Distribution



Increasing Storage System Density



UPS & Floor



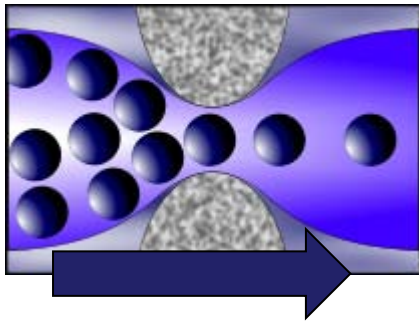
Fans



All Data Centers Vibrate Constantly

Storage is the Bottleneck

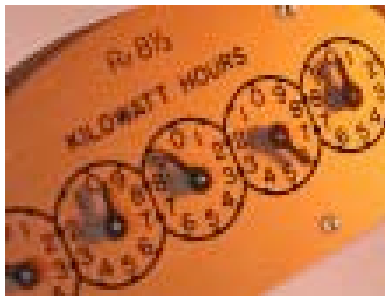
Storage Speed is IT
Bottleneck



Wastes Hardware



Wastes Energy



Wastes Space



The Problem is Getting Worse

- ❑ **More to Store** – Data to be stored doubling every 18 months (IDC)
- ❑ **Higher Capacity Drives** – More vulnerable to vibration
- ❑ **Consolidation** – Storage systems with 600+ drives intensify vibration
- ❑ **Persistent problem** – Data Centers can't control the sources of vibration

The Storage Industry Knows it...



“An important issue in disk aggregation is the effect of external vibration from neighboring disks on the delivered performance of the disk drives in the aggregation.”

COMPUTERWORLD

“Vibration can be a significant problem when several drives are packed together. The tracks on today's ultra-dense drives are brain meltingly tiny, so head positioning is critical.”



“A new culprit has arisen in the form of reduced disk drive and overall system performance . . . vibration”

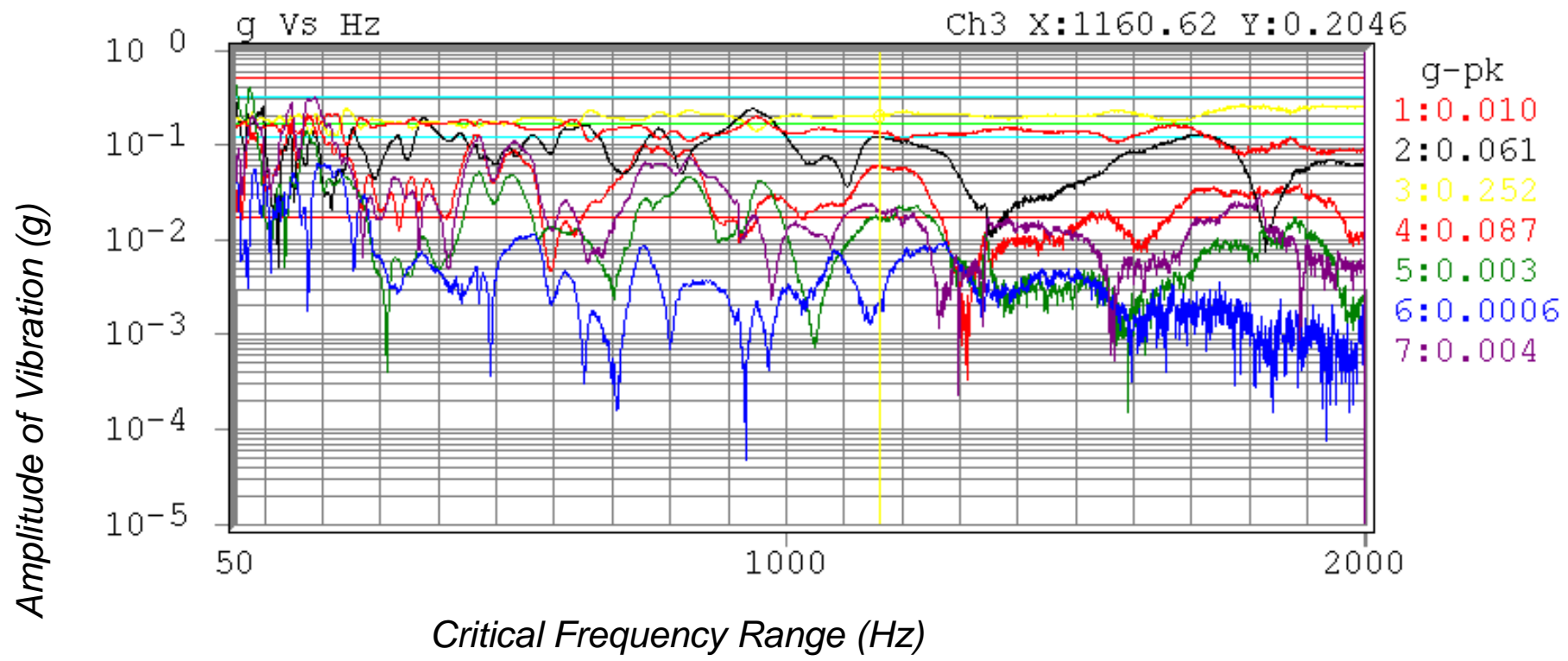


“...Rotational Vibration (RV) can push the head off track causing missed revolutions and delays in data transfers....reductions (over 50%) in performance.”



“One of the greatest hindrances to hard disk performance is vibration.”

Lab Shake Table Testing - Vibration Reduced 10X-1000X



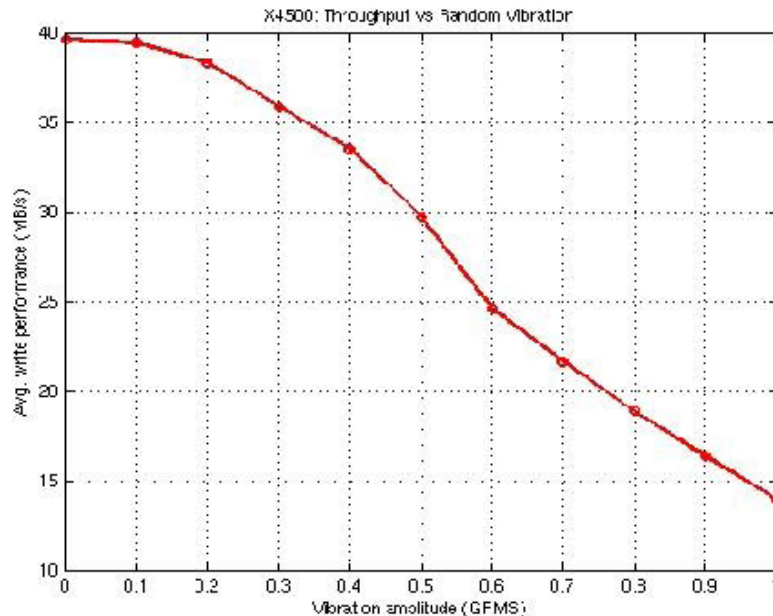
Case #1: Tier 1 Storage Manufacturer

1. **Validated “Vibration Penalty”**
 - Validated vibration as a major source of inefficiency in Data Centers. I/O dropped by 2/3
2. **Established Effectiveness of the Anti-Vibration Solution**



Case # 1: The Vibration Penalty on Throughput

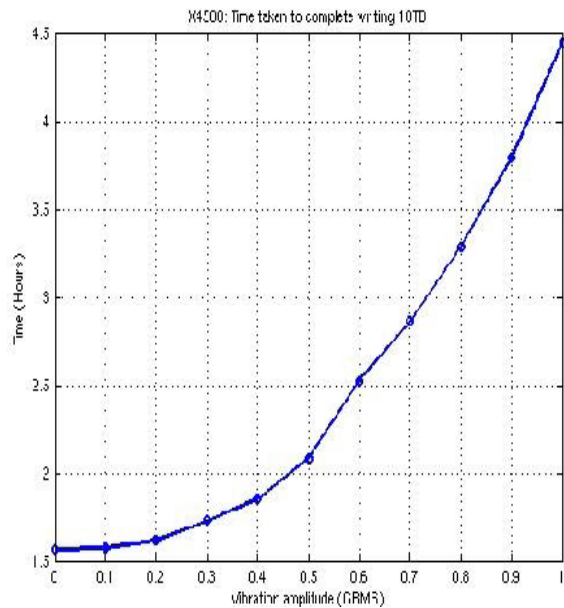
Disk Throughput vs Random Vibration



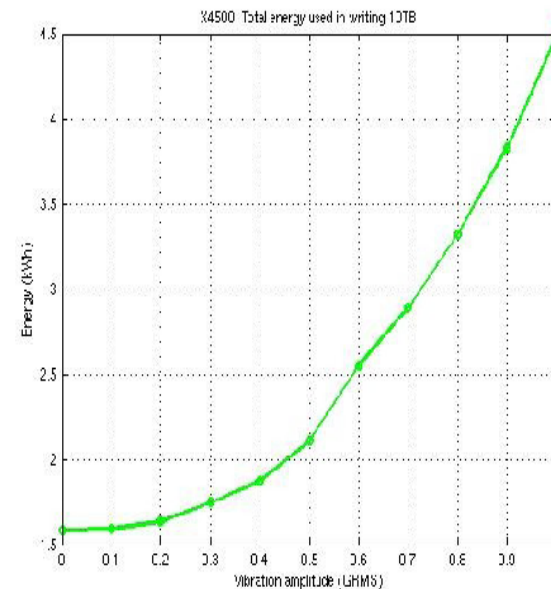
- Writing 10 TB of sequential data
- HDD: 500GB SATA drive

Case # 1: Vibration Penalty and Efficiency

Time taken to update 10TB database vs Random vibration

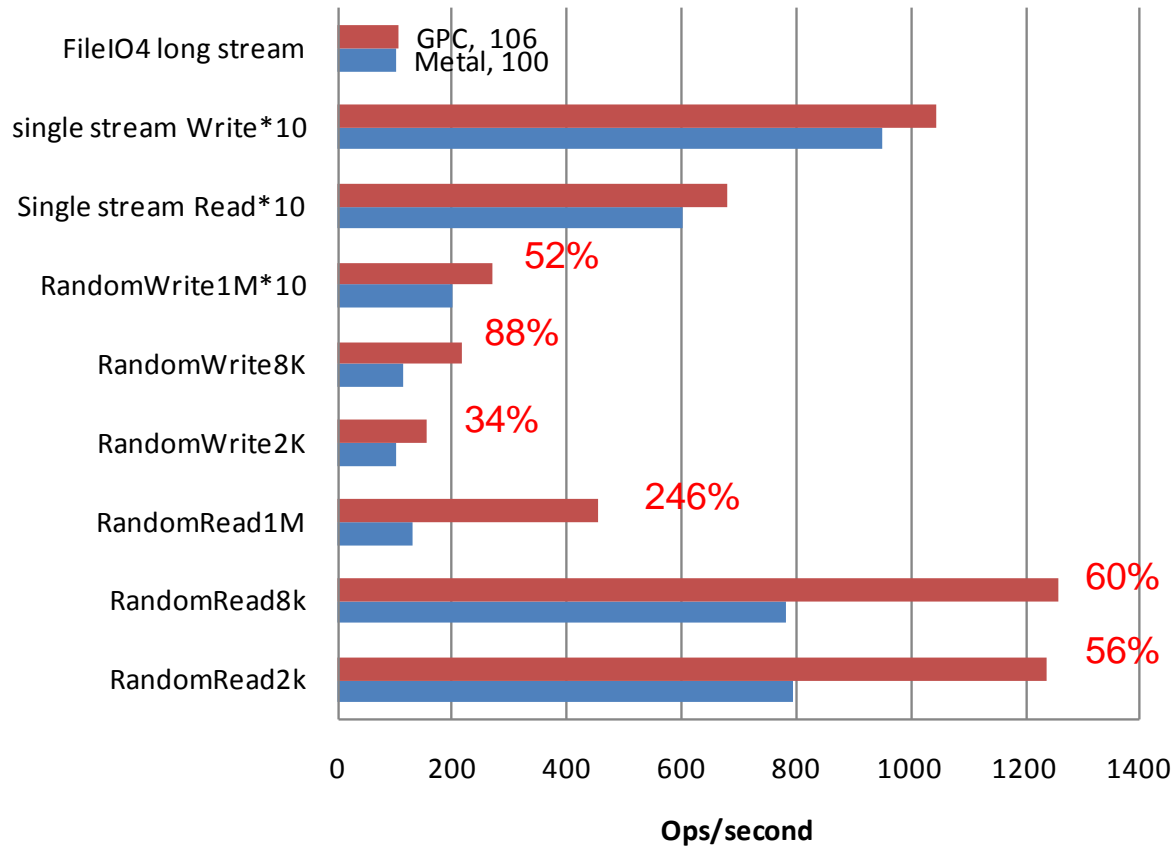


Power consumed in updating 10TB database vs Random vibration



Case #2: USENIX Paper/Presentation

Read Write Performance

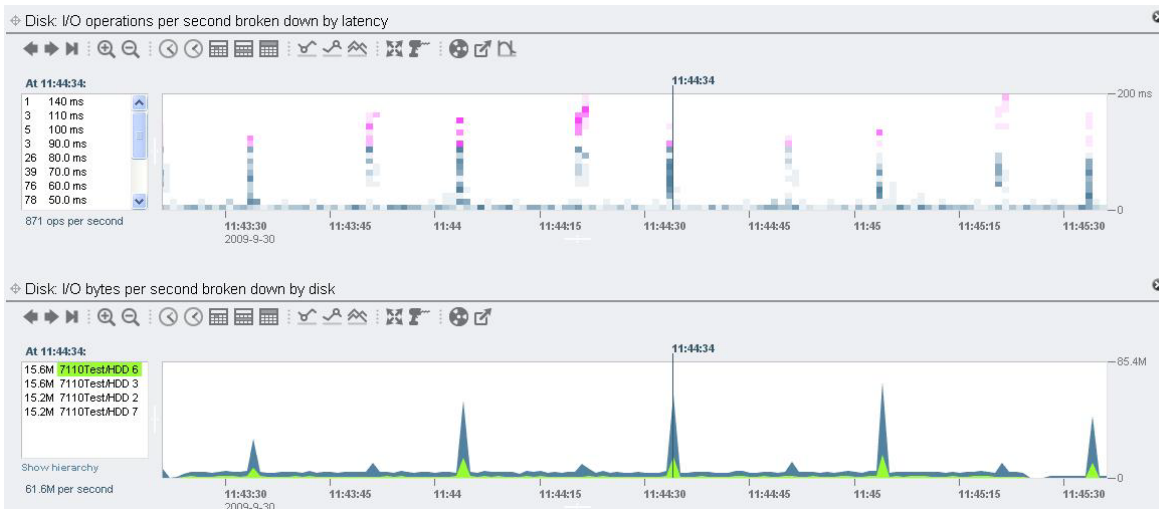


Q
Associates

Case #2: Side-By-Side Benchmark Testing



Disk Latency:
NAS on Metal Rack
is very high
(300 events >100ms)



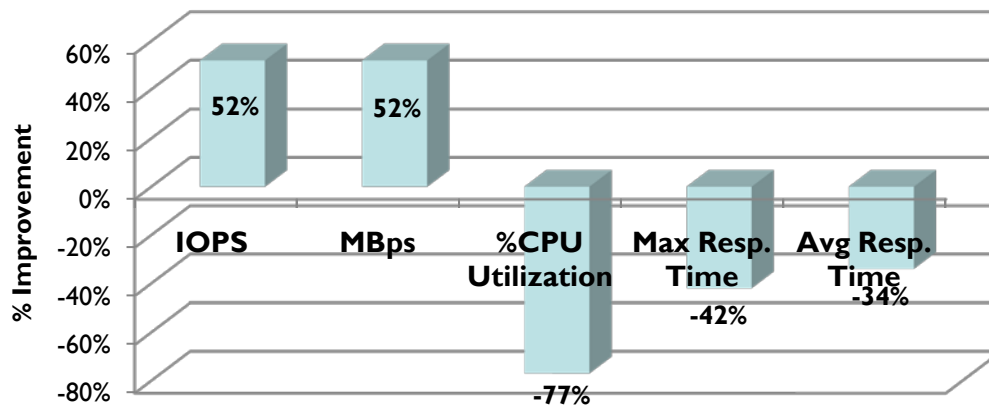
Disk Latency:
NAS on GPC's AVP is
much lower
(4 events >100ms)

Case #3: Large Consulting Firm

Top Tier Consulting Firm

- 52% increase in IOPs of SAN environment
- Allows additional storage capacity utilization
- Restore VMware Stall

GPC 's AVP Improves Storage Performance by Removing Vibration



“The Green Platform increases the maximum number of VMs on a LUN without a performance decrease, giving me more options to utilize my infrastructure more effectively and save”
Lead Engineer

A five-hour test was run in the data center environment under heavy I/O load from VMware using the Iometer “All in one” test pattern loaded for one worker.

Target Applications

- ❑ Situations where performance is governed by native HDD performance
- ❑ Large Unstructured Data Applications
 - ❑ Hadoop Deployments
 - ❑ HPC and Technology Computing
 - ❑ Oil and Gas Seismic Studies
 - ❑ Web Content Analytics
 - ❑ Financial and Marketing Analytics and Modeling
 - ❑ Product Design and Simulations
- ❑ Digital Media/Video Streaming

❑ Expensive and Underutilized

- ❑ Over-Provisioning—Adding drive spindles \$10K to \$20K per extra storage shelf
- ❑ Solid State Disks /Cache —narrow use: fit to data requirement
- ❑ Short Stroking—Using only 10% of drive leaves 90% of drive capacity unused

❑ Technically Complex

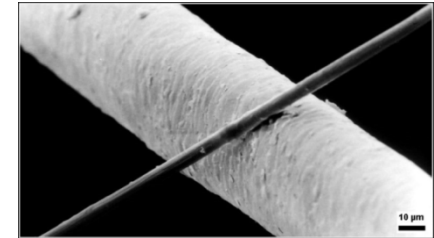
- ❑ Tiering — Requires re-design of applications

❑ Difficult to Implement

- ❑ Long time to value
- ❑ Consulting and Integration Required

What's so cool about Carbon Fiber?

- ❑ Very strong and stiff and light
- ❑ Excellent damper of vibration
- ❑ An-isotropic properties; Different properties in different directions
- ❑ Product can be highly customized; hundreds of variations offering wide ranges of Price/Performance
- ❑ Many fabrication methods; final product performance depend on the fabrication method and quality



A 6 μm diameter carbon filament (running from bottom left to top right) compared to a human hair.

The Opportunity for the Storage Industry

- ❑ Do more with less--- vibration
 - ❑ Performance: More IOPS/\$
 - ❑ Energy Efficiency: More IOPS/kWh
- ❑ Well suited for applications that are not cache friendly
- ❑ Fast time to value
- ❑ Low risk implementation