A Study of NVRAM Performance Variability under Concurrent I/O Accesses

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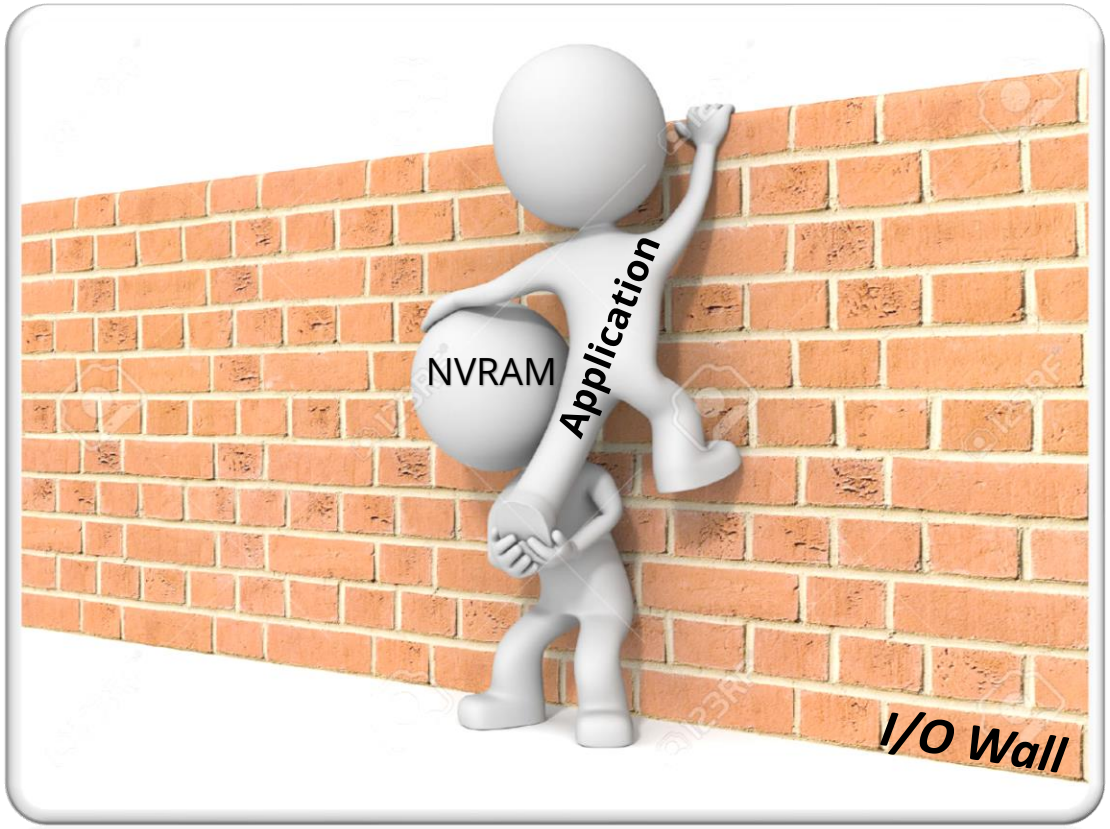
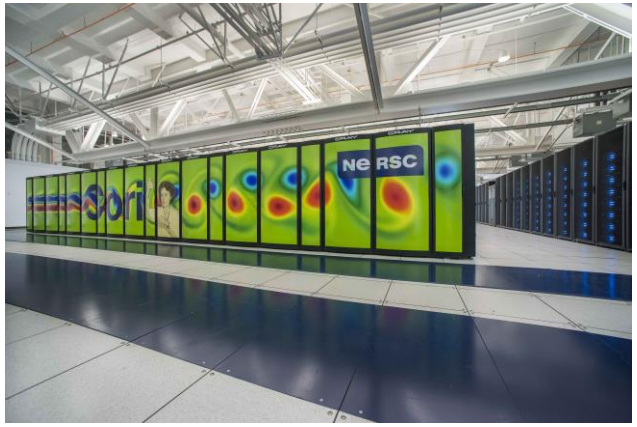
Introduction

- Improvement in the speed of disk-based storage systems has been much slower than that of memory, creating a significant performance gap, the so called **I/O wall.**
- Non-Volatile RAM (NVRAM) offers lower latency and higher bandwidth and can help alleviate the issue.



NVRAM in the wild!



	Capacity	Bandwidth
RAM	expensive	cheap
NVRAM	**OK**	**OK**
DISK	cheap	expensive

In this study…

- We aim to explore NVRAM's performance characteristics
  - Bandwidth and latency
  - Concurrent access
  - Sequential vs Random
- ***Medium Sensitivity:***

$$Medium - Sensitivity = \frac{Application\ Concurrency}{Medium's\ Access\ Lanes} \times \frac{Reduction\ in\ BW\ (observed)}{Maximum\ BW\ (theoretical)}$$

- Is defined as the rate at which each medium experiences a bandwidth reduction due to concurrent accesses competing for the resource.

Testbed

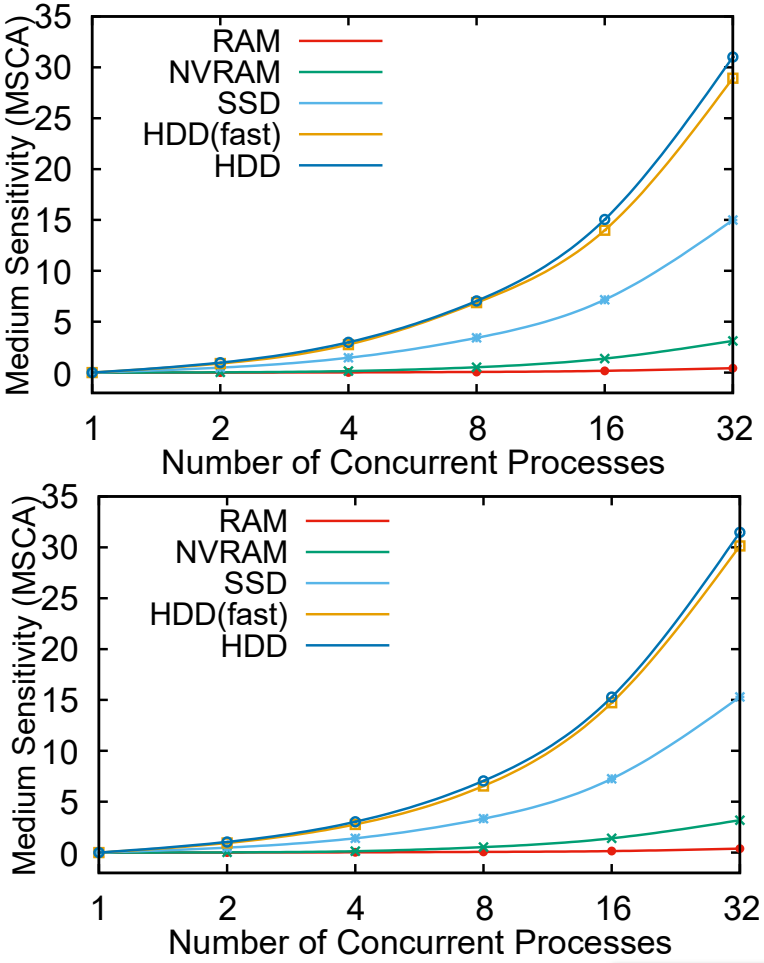
- Chameleon System
  - Storage Hierarchy Appliance
  - Centos 7.1, Mpich 3.2, OrangeFS 2.9.6
- Synthetic benchmark
  - 2 GB total I/O
  - 64 MB requests
  - File-per-process
  - Sequential

Device	RAM	NVRAM	SSD	HDD fast	HDD
Model	M386A4G40DM0	Intel DC P3700	Intel DC S3610	Seagate ST600MP0005	Seagate ST9250610NS
Connection	DDR4 2133Mhz	PCIe Gen3 x8	SATA 6Gb/s	12Gb/s SAS	SATA 6Gb/s
Capacity	512 GB(32GBx16)	1 TB	1.6 TB	600 GB	2.4 TB
Latency	13.5 ns	20 µs	55-66 µs	2 ms	4.16 ms
RPM	-	-	-	15000	7200
Buffer	-	-	-	128 MB	64 MB
Max Read BW	65000 MB/s	2800 MB/s	550 MB/s	215 MB/s	115 MB/s
Max Write BW	59000 MB/s	1900 MB/s	500 MB/s	185 MB/s	95 MB/s

Results

Observations:

- RAM is the least sensitive to concurrent access with only a small bandwidth reduction.
- Spinning drives and SSD are bound from the SATA controller
- However, SSD has some degree of internal parallelism (e.g., 2 channels) and thus is somewhere in the middle.
- **NVRAM** demonstrated behavior similar with RAM mostly because the NVMe controller uses the PCIe gen3 bus with x8 lanes and internal parallelism.



Q&A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Баярлалаа
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mercé
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rahmat
তোমাকে ধন্যবাদ
감사합니다
xièxie
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merci