SSD/NVM Technology Boosting Ceph Performance

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Agenda - Overview

- SSDs for Ceph today, The future SSDs is here -NVM Express™
- 3D NAND and 3D XPoint™ for Ceph tomorrow
- Yahoo! Case study w/Intel NVMe SSD+Intel Cache Acceleration software
- ALL SSD Ceph performance data reviews
- Summary, Q&A

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Typical SSD usage today at Ceph

SSD as Journal and Caching

- SSD as Journal drive + Caching drive
- Intel Cache Acceleration Software (CAS with hinting technology is optimized for Ceph

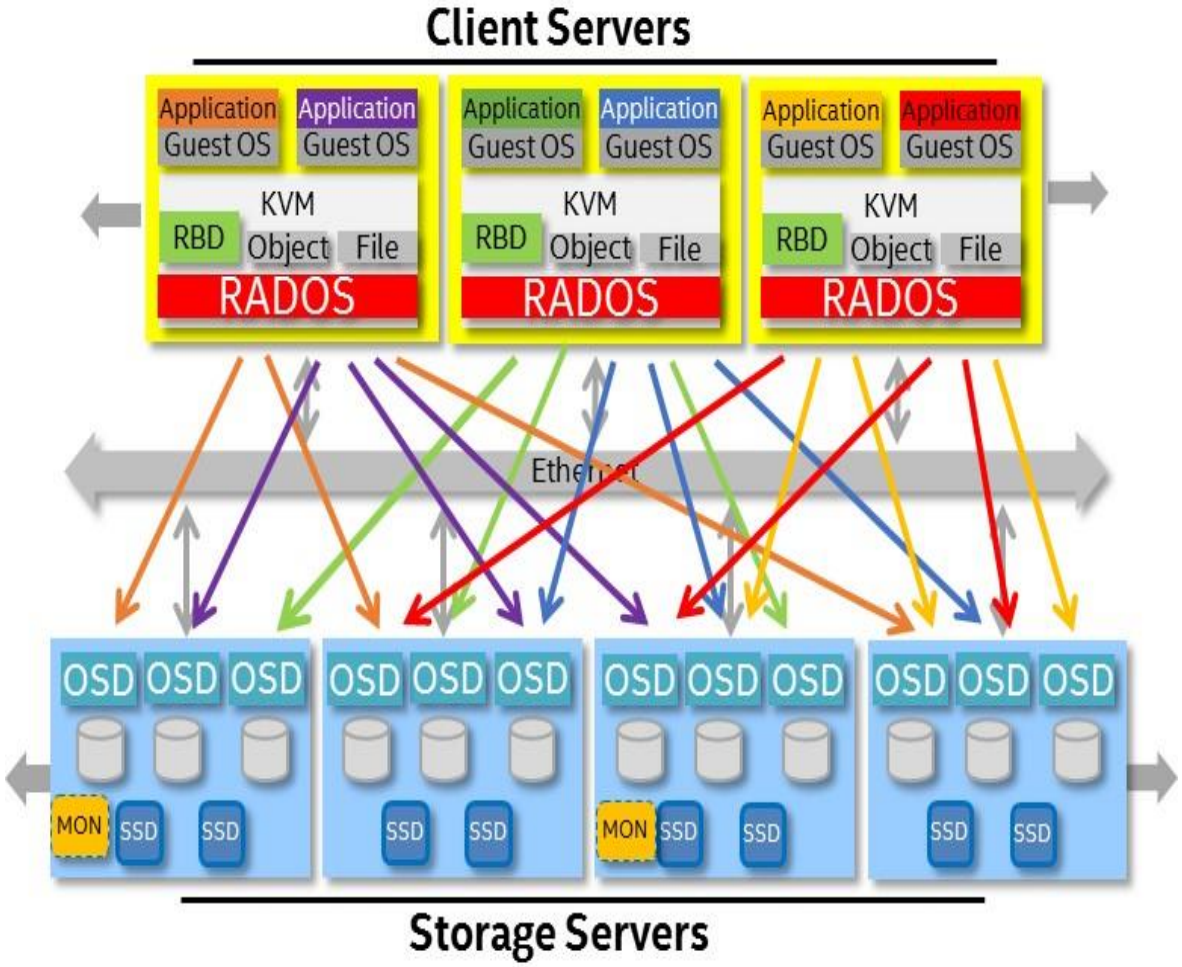
  Example, Intel CAS + Intel P3700 for Yahoo! Ceph
- Separate Journal and Caching with different SSD

SSD : HDD ratio (recommendation)

- Not all SSDs are same, different density may have different performance
- Example, Intel SSD as Journal

  SATA SSD: 1 S3700: 5 HDDs

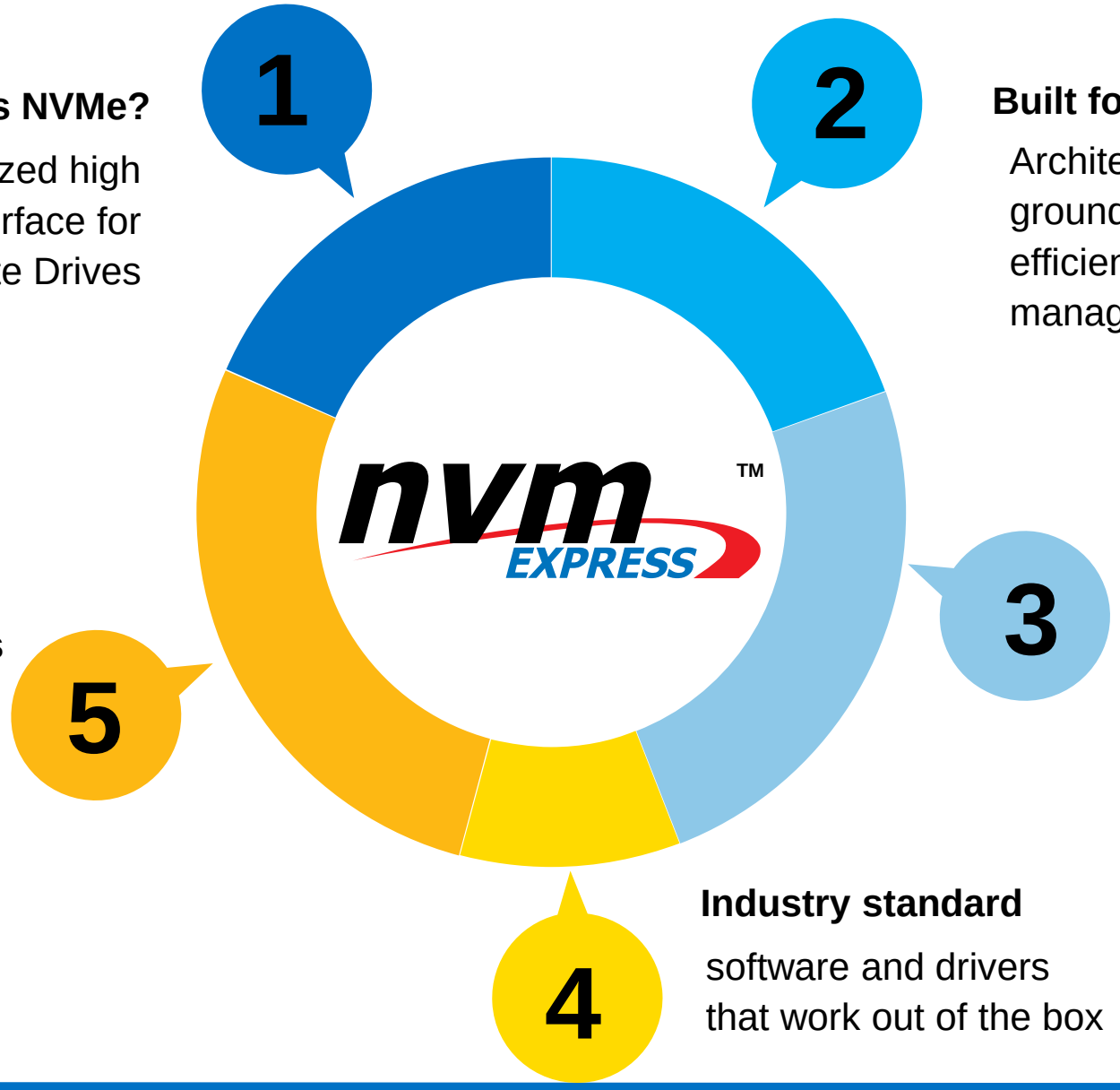
  PCIe/NVMe SSD: 1 P3700 : 20 HDDs



The Future is Here – NVM Express™

What is NVMe?

NVM Express is a standardized high performance software interface for PCI Express® Solid-State Drives



Built for SSDs

Architected from the ground up for SSDs to be efficient, scalable, and manageable

Developed to be lean

Streamlined protocol with new efficient queuing mechanism to scale for multi-core CPUs, low clock cycles per IO

Industry standard

software and drivers that work out of the box

Ready for next generation SSDs

New storage stack with low latency and small overhead to take full advantage of next generation NVM

ALL SSD Solutions for Ceph

- All NVMe/PCIe SSDs

  Best performance but:

  a) High cost, low capacity (today)

  b) NIC bandwidth

- NVMe + Low Cost SATA high density SSDs

  a) Best TCO for performance, can have higher storage density

  b) Example, P3700 800GB for Journal drive, 4x S3510 1.6TB as data

- SSDs for Client nodes

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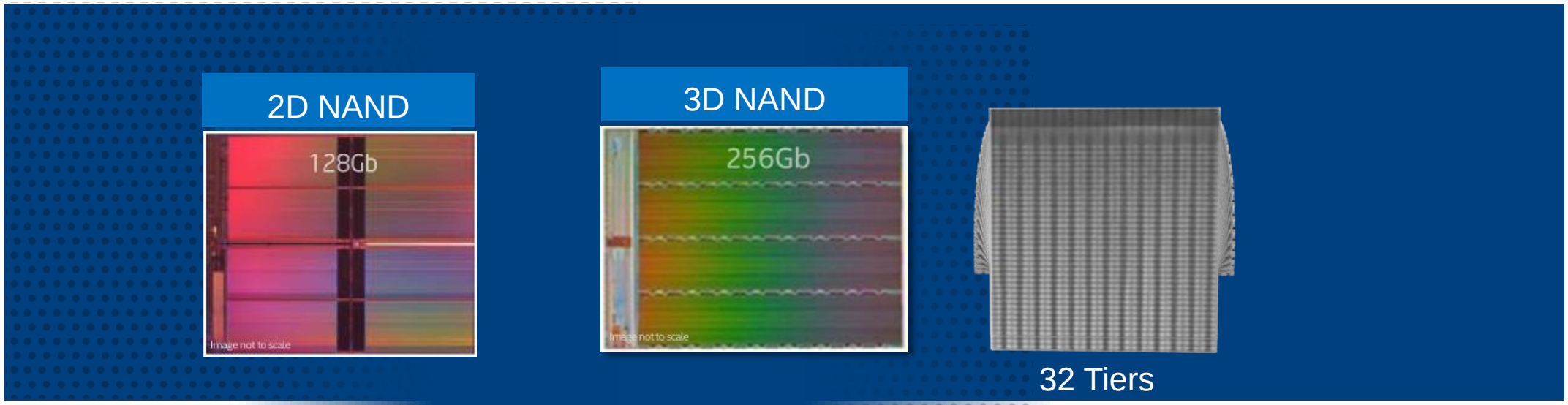
Intel Continues to Drive Technology

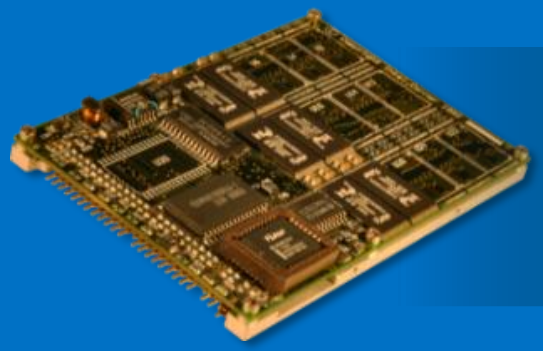
Accelerating Solid State Storage in Computing Platforms



CAPACITY	Enables high-density flash devices
COST	Achieves lower cost per gigabyte than 2D NAND at maturity
CONFIDENCE	3D architecture increases performance and endurance

Moore’s Law Continues to Disrupt the Computing Industry

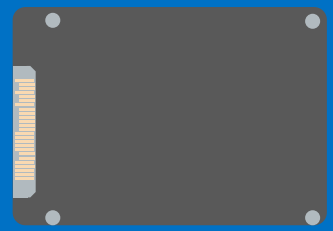
1992 12MB



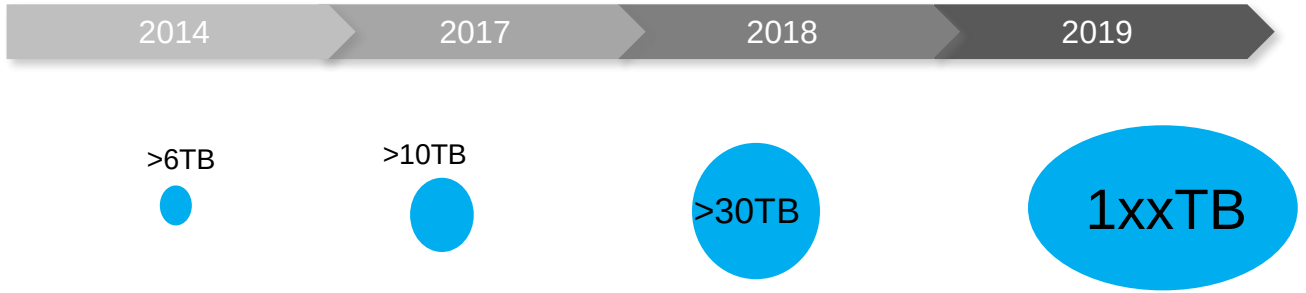
First Intel® SSD for Commercial Usage

1,000,000x
the capacity while shrinking the form factor

2017 >10TB



U.2 SSD



Source: Intel projections on SSD capacity

3D XPoint™ TECHNOLOGY

A new class of non-volatile memory Media

1000X
FASTER
THAN NAND[1]

1000X
ENDURANCE
OF NAND[1]

10X
DENSER
THAN DRAM[1]

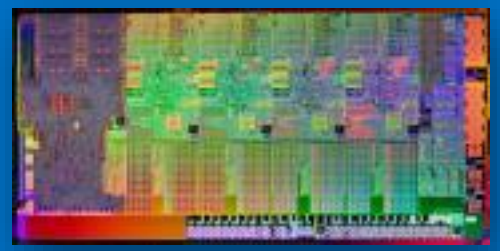
NAND-LIKE DENSITIES AND DRAM-LIKE SPEEDS

[1]Technology claims are based on comparisons of latency, density and write cycling metrics amongst memory technologies recorded on published specifications of in-market memory products against internal Intel specifications

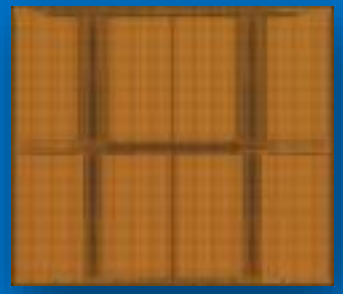
3D XPoint™ TECHNOLOGY

Breaks the Memory Storage Barrier

SRAM
Latency: 1X
Size of Data: 1X



DRAM
Latency: ~10X
Size of Data: ~100X



STORAGE

3D XPoint ™ Memory Media
Latency: ~100X
Size of Data: ~1,000X

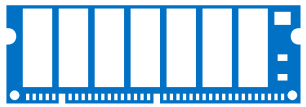
NAND SSD
Latency: ~100,000X
Size of Data: ~1,000X

HDD
Latency: ~10 MillionX
Size of Data: ~10,000X

MEMORY

Technology claims are based on comparisons of latency, density and write cycling metrics amongst memory technologies recorded on published specifications of in-market memory products against internal Intel specificatio

New Faster SSDs Emerge, Where Will They be Used?



Extend DRAM

In memory database
Key value store, memcache, RDMA replacement, NEW Applications/Businesses
goal is to lower TCO and execute larger datasets

Faster SSD

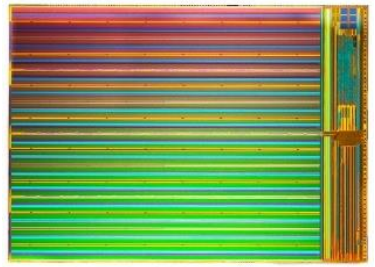
Real time analytics – targeting noSQL databases
Fraud detection, ad bidding, real time decision making, trading
Cloud hosting – amazing QoS for better application SLAs
Ultra High Definition all professional video production

Caching

Cloud hosting, all flash array, SAN
Write buffer for RAID array

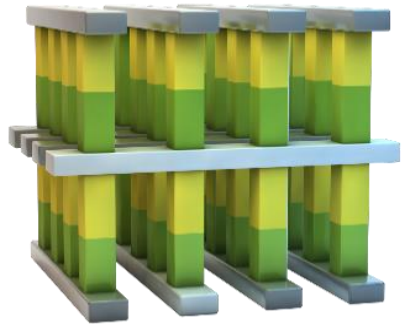
NAND Flash vs 3D XPoint™ Technology for Ceph tomorrow

3D MLC and TLC NAND



Enable higher capacity OSDs at lower price

3D XPoint™ Technology



Higher performance, opening up new use cases, DRAM extended, Key/value…

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Intel® NVMe SSD Accelerates Ceph for YAHOO!

CHALLENGE:

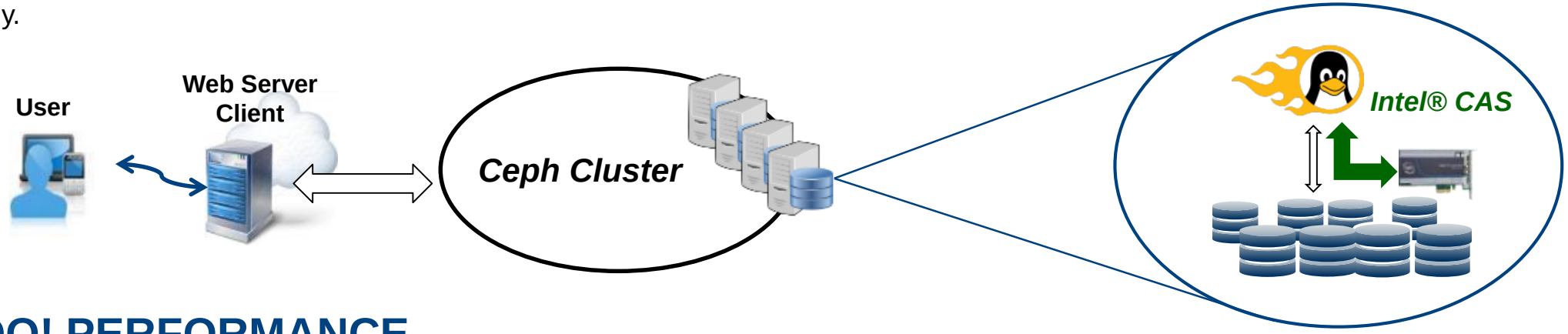
- How can I use Ceph for scalable storage solution?

(High latency and low throughput due to erasure coding, write twice, huge number of small files)

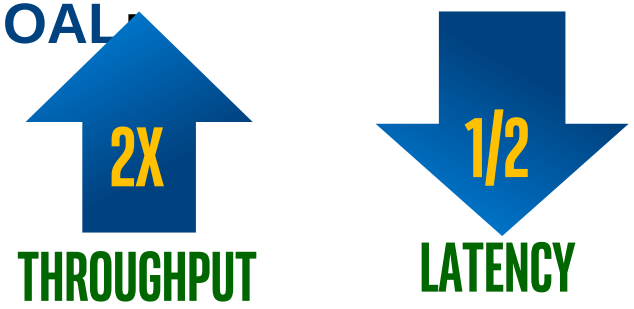
- Use over-provision to address performance is costly.

SOLUTION:

- Intel® NVMe SSD – consistently amazing
- Intel® CAS 3.0 feature – hinting
- Intel® CAS 3.0 fine tuned for Yahoo! – cache metadata



YAHOO! PERFORMANCE GOAL:



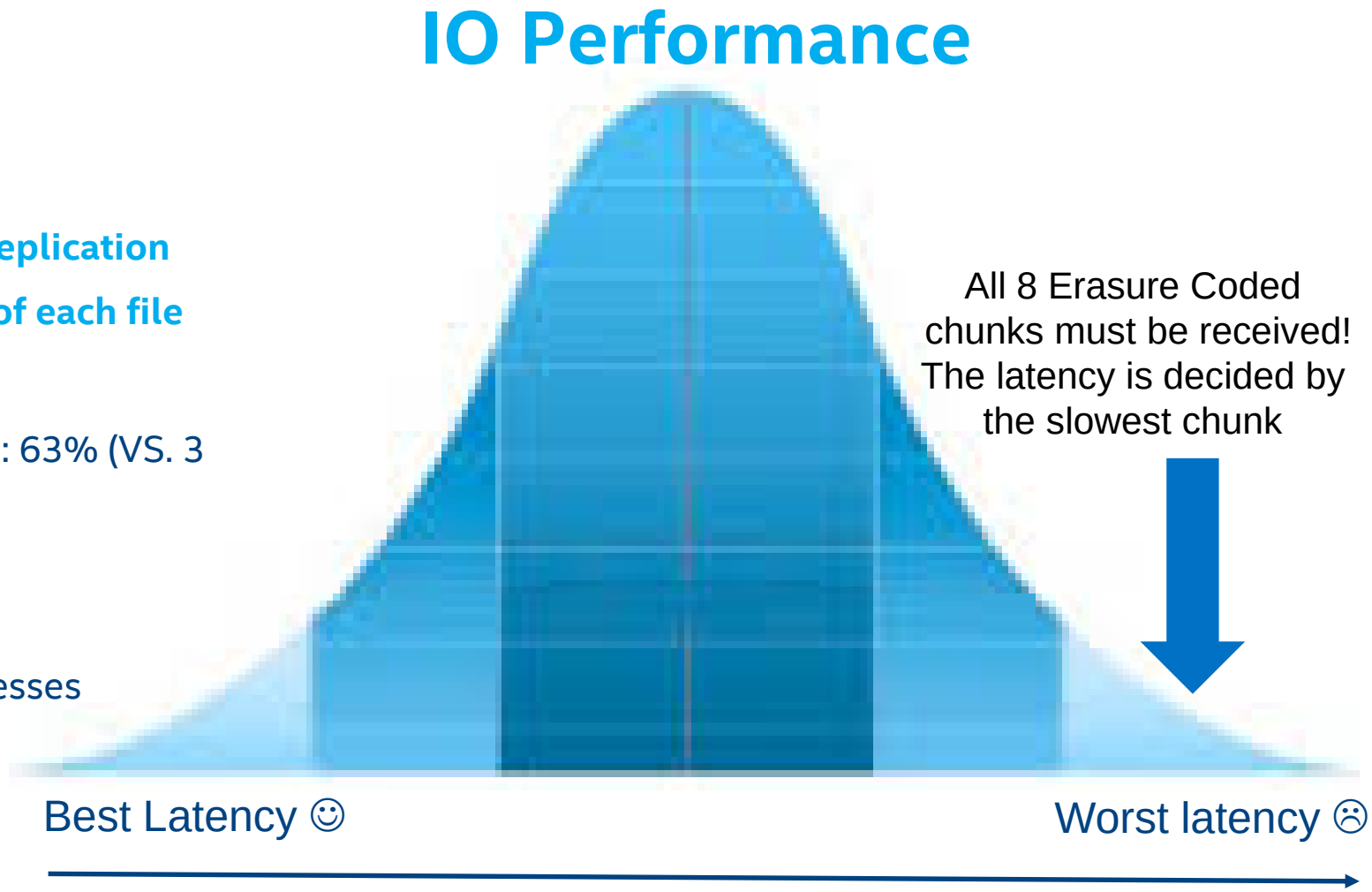
COST REDUCTION:

- ***CapEx savings*** *(over-provision ↓)*
  OpEx savings *(Power, Space, Cooling… ↓)*
- ***Improved scalability planning*** *(Performance and Predictability ↑)*

Yahoo! CEPH Challenges

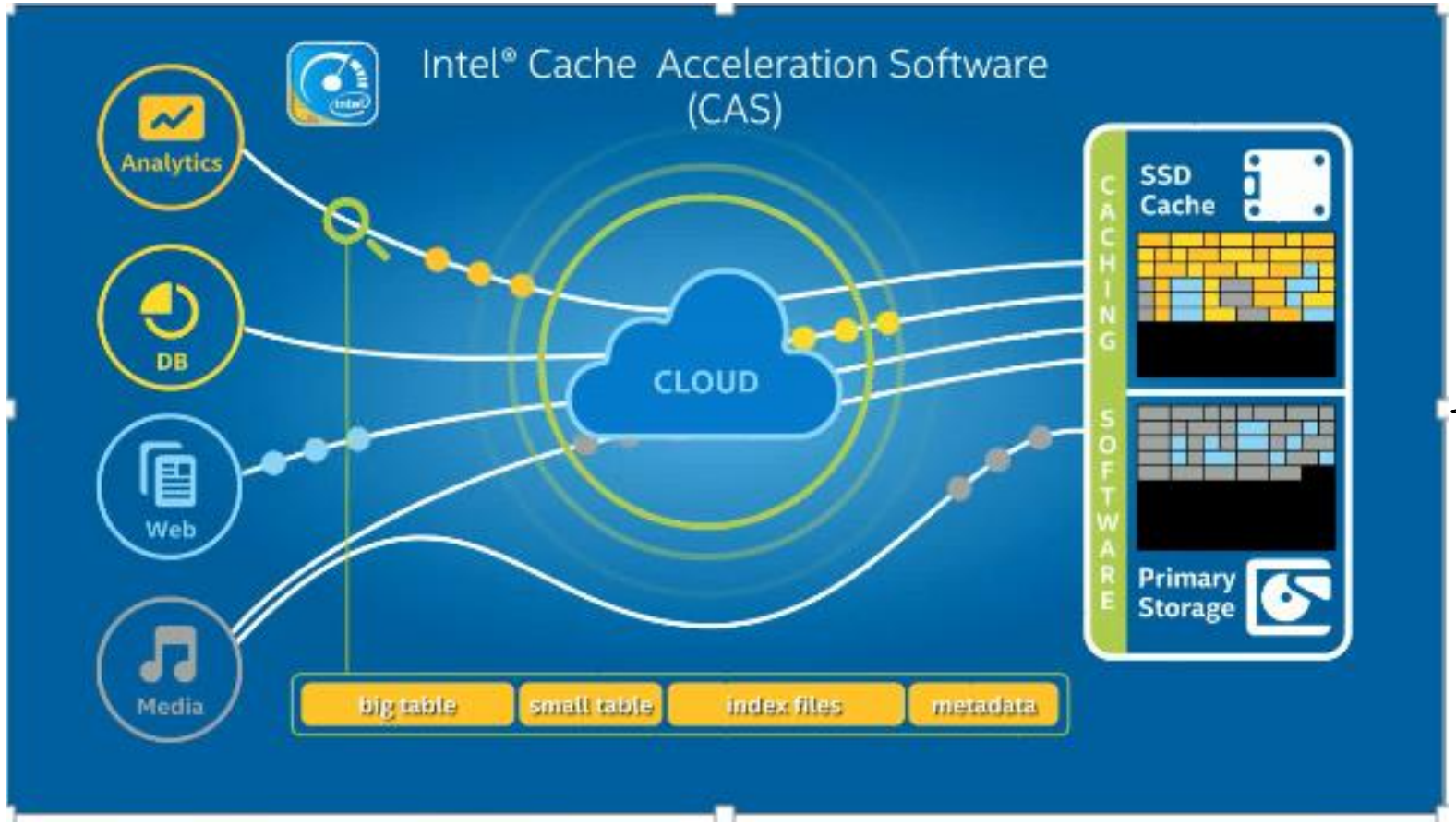
Huge number of small files, why?

- **Write twice**
- **Erasure Code**
  - **Great for data efficiency –vs- RAID1 replication**
  - **But bad for # of file and smaller size of each file**
- Example:
  - Erasure Coding (8+3) higher utilization: 63% (VS. 3 replications: 25%)
  - 1M photo: become 11 x 128K
  - Number of files: 64 – 128 millions files
  - One file access: become 3-4 disks accesses



Intel CAS Linux 3.0 Feature – Hinting

Not all data equal. As cache, we treat them differently.



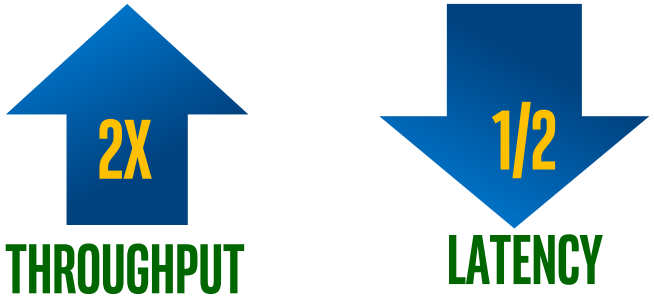
Click to play video

Compelling Solution. Now What?

- ***Consideration to adopt***
  - Use Intel NVMe SSD as cache
  - Intel CAS Linux 3.0 with hinting feature will be released by end of this year
  - Support RHEL, SLES, CentOS, ext4, ext3, xfs.
  - Intel will help to fine tune performance for your Ceph workload
  - Sign up with us as early engagement customer

- ***Take Away Message: 5% caching for 2X performance!***

YAHOO! PERFORMANCE GOAL:



- ***To Learn More***
  - Ceph IDF 2015 Demo:
    https://www.youtube.com/watch?v=vtIIbxO4Zlk
  - Special yahoo speaker IDF 2015:
    http://intelstudios.edgesuite.net//idf/2015/sf/aep/SSDS002/SSDS002.html

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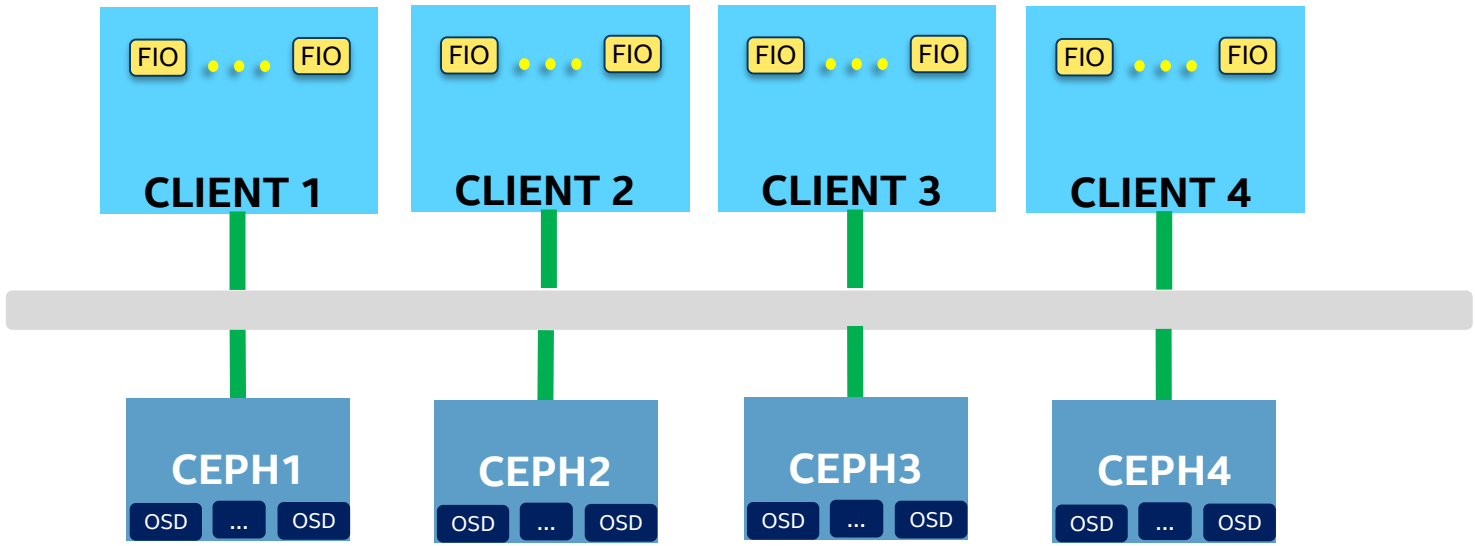
System Configuration



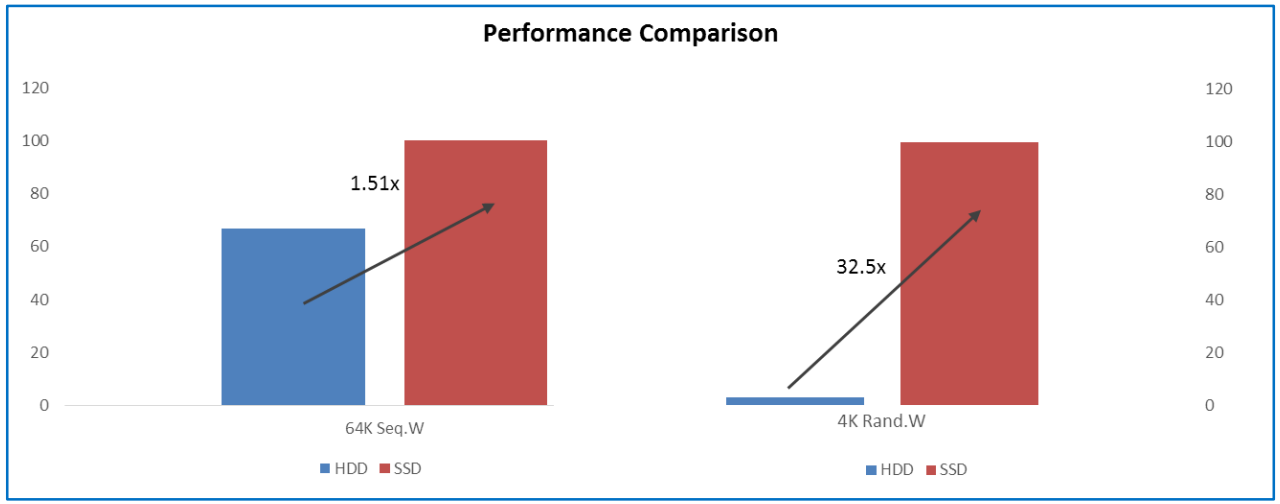
Client Node

- 4 nodes with Intel® Xeon™ processor E5-2699 v3 @ 2.30GHz, 64GB memory
- OS : Ubuntu Trusty

Storage Node

- 4 nodes with Intel® Xeon™ processor E5-2699 v3 @ 2.30GHz, 64GB memory
- Ceph Version : 0.94.2
- OS : Ubuntu Trusty
- SSD Setup
  - 16 DC 3700 400 GB for OSD
  - 4 P3600 SSD for Journal

SSD Cluster vs. HDD Cluster



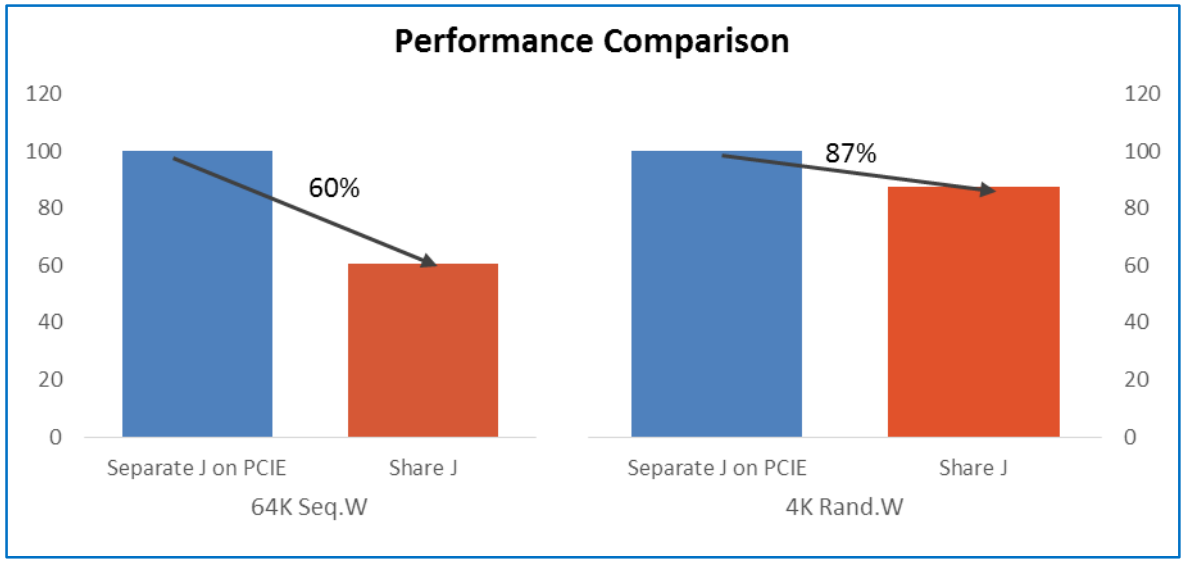
- ***Compared to HDD cluster***
  - 40 HDDs with journal on SSD
  - For 4K random write, need ~ 32x HDD Cluster (~ 1300 HDDs) to get same performance
  - For 64K Sequential write, need ~ 1.5x HDD Cluster (~ 60 HDDs) to get the same performance

For the use cases that require high performance, using SSD can significantly reduce TCO

Comparison with Journal on the same SSD

Deployments

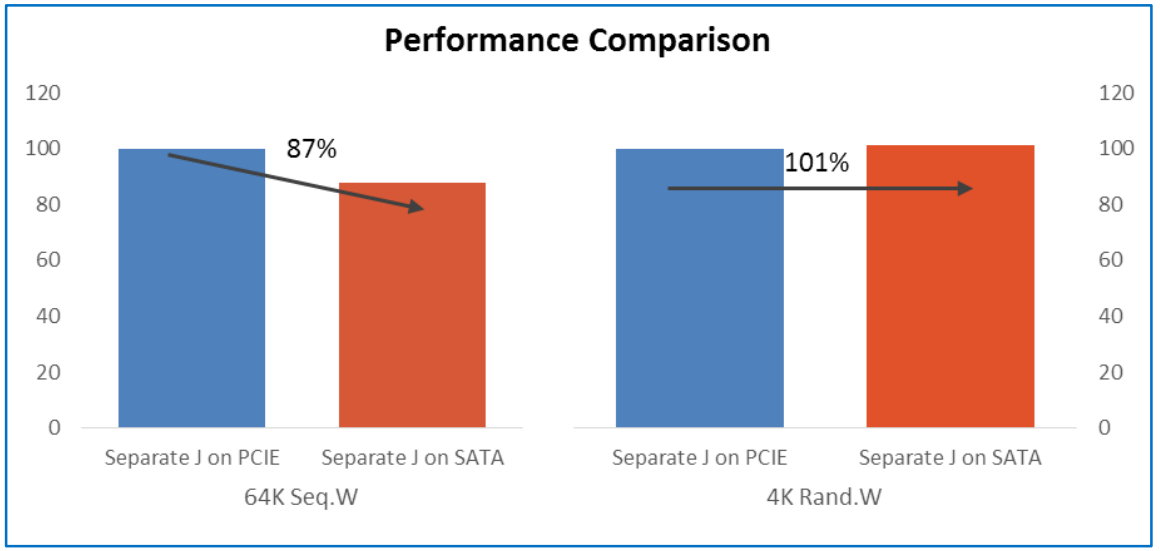
1. **Journal on separate PCIe SSD**
2. **Journal on same SATA SSD**



~67% higher for 64K Sequential write & 14% higher for 4K random write.

Comparison with Journal on the Separate SATA SSD

Deployments
Journal on separate PCIe SSD
Journal on separate SATA SSD



Same IOPS for 4K random write, ~ 14% higher performance for 64K Sequential write. Using NVMe SSD as journal can spare more slots so maybe we can eliminate external storage enclosures

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Summary

- NVMe™ was built for high-performance SSDs with the future in mind - and ready today, using PCIe SSD as journal can get higher performance and eliminate external storage enclosure
- Intel iCAS with hinting is a leading caching solution
- All SSD solutions provide best ever performance, and bright TCO, while there are still lots of space for further improvements
- 3D NAND is the building block for the high capacity, low cost SSDs –- candidate for future OSD drives
- 3D XPoint™ technology delivers high performance and low latency –- opening new fastest NVM applications/usages

Q & A

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