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I/O Challenges: Todays I/O Challenges for Big Data Analysis

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The Challenge is Archives

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- Big data in HPC means archive and archive translates to a tape archive at least today
  - Cost per PB per year

Drives Per PB RAID-6 or 5 8+x	ES4 Drive SAS interface 4TB		Enterprise Value CS 1TB		Savio 15K 300 GB		Savio 10K 900GB	
Drive Count	300		1200		3750		1250	
	Typical	Idle	Typical	Idle	Typical	Idle	Typical	Idle
Kw Cost								
0.08	$2,771.38	$2,391.21	$5,457.49	$4,192.61	$18,875.61	$18,875.61	$7,061.70	$6,543.54
0.10	$3,464.23	$2,989.01	$6,821.87	$5,240.76	$23,594.51	$23,594.51	$8,827.12	$8,179.43
0.12	$4,157.08	$3,586.81	$8,186.24	$9,060.29	$28,313.42	$28,313.42	$10,592.55	$9,815.32

  - What about reliability?

Device	Hard error rate in bits	Equivalent in bytes	PB equivalent
SATA consumer	10E14	1.25E+13	0.01
SATA Enterprise	10E15	1.25E+14	0.11
Enterprise SAS/FC	10E16	1.25E+15	1.11
LTO and some Enterprise SAS SSDs	10E17	1.25E+16	11.10
Enterprise Tape	10E19	1.25E+18	1110.22

- For the foreseeable future, tape is the archive medium of choice

Archive challenges

- Networking challenges
- Cost challenges
- RAS challenges
- Scalability challenges
- I/O performance challenges
- Metadata challenges
- Final thoughts

Networking Challenges

Those who own the archive own the big data solutions as you cannot move data around

Cannot move archive data

- Networking data rates are not increasing as fast as data generation
- In a perfect world:

	1 PB	10 PB	40 PB	100 PB
Network	**Days to read the archive**			
OC-3	802	8018	32071	80178
OC-12	200	1998	7992	19980
OC-48	51	506	2023	5057
OC-192	13	126	506	1264
OC-384	3	32	126	316
OC-768	1	8	32	79

- So if you wanted to read the whole archive to search for new information even with an OC-192 channel, it may take years

Cost Challenges or Business Opportunity

Those who control the archive own the big data solutions and the resulting benefits

Cost

- Justifying keeping data you might or might not need today is difficult
  - In the 80s for example the DNA between chromosomes was called junk DNA
    - We know today it is not junk
- Do we know what we need to keep?
  - We do not know what information we will find in the data we collect today
- Some industries have a policy of keeping everything forever
  - Geosciences is a good example
  - Satellite imagery is another
- These industries build in the cost of archives into the operational costs
  - These costs are well defined and well known based on industry trends

RAS Challenges

Those who own the archive own the big data solutions, as it is difficult to maintain data integrity and availability over long periods of time, will benefit

RAS is not easy

- Though tapes might last 30 years:
  - Interfaces, OSs and hardware do not
    - Try to find a supported fibre channel 1 Gbit interface
    - Try to find an operating system where this hardware is supported
    - How many motherboards still support PCI-X?
- What about things like silent corruption?
  - Shameless plug for tutorial I am giving on this topic at IEEE Mass Storage Conference next week
    - http://www.storageconference.org/2013/Presentations.html
      - » Slides will be up in a few weeks
- What about the time to migration to new technology?
  - Architecting for availability and meeting SLAs is difficult when migrating
    - Becomes a bigger issue when namespaces are broken up into smaller chunks

Scalability Challenges

Those who control the archive own the big data solutions, and as more data is collected and the size of the archive grows, and the organization will continue to win

Archives are hard

- Today's largest single namespace archives have over 55 PB
  - Scaling for archives technologies choices
    - How many namespaces do you want to manage?
      - 1, 5, 10, 100, 1000?
- Large namespaces are important for more than just searching for your file
  - You can always put in a DB interface to search for a file
  - Large namespace size is important for management efficiency
    - Namespace load leveling is labor intensive

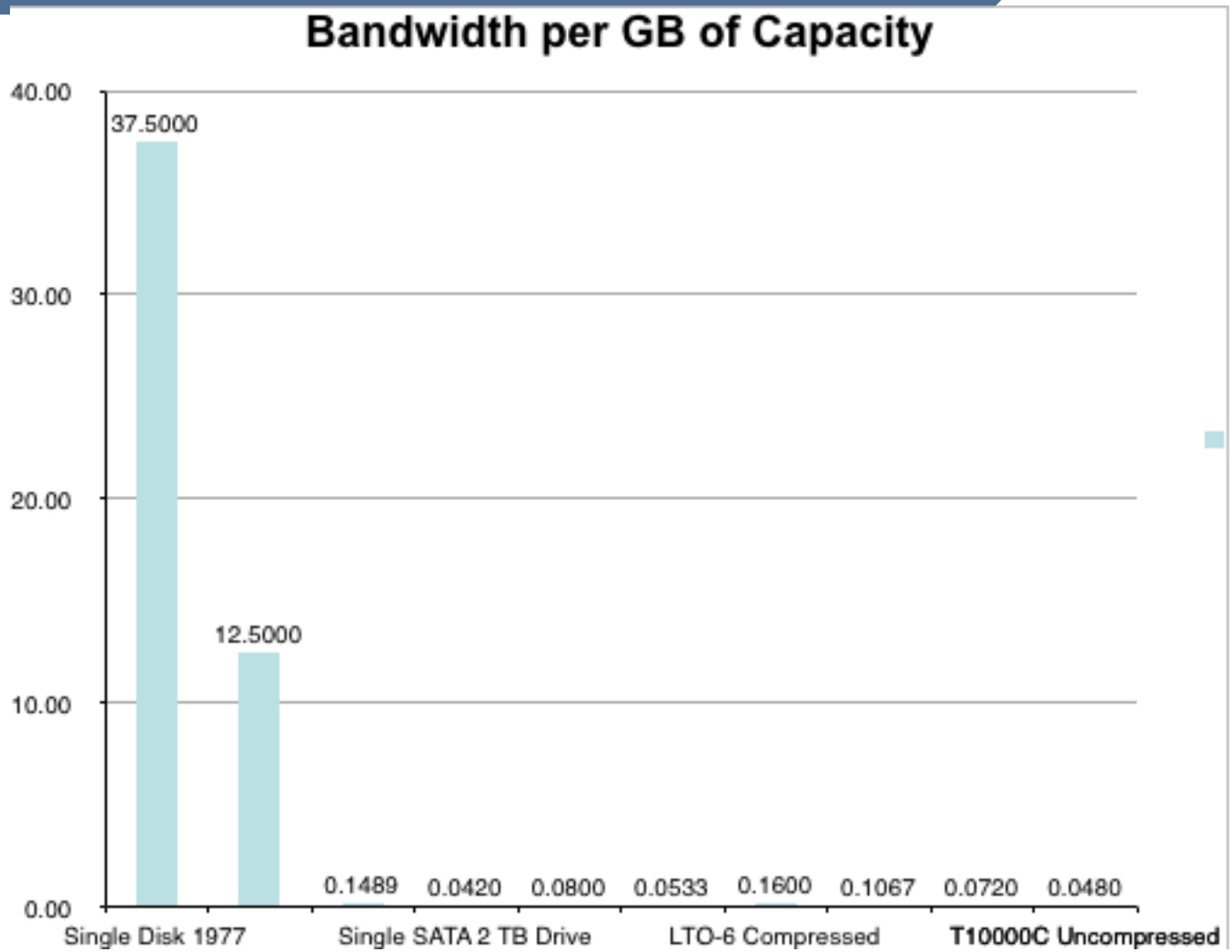
I/O Performance Challenges

Those who understand technology direction will be able to use the archive effectively and will be successful

I/O performance is not scaling

- Performance is not increasing with density growth for any technology (SSD, disk, tape)
  - This trend is not expected to change
- This impacts archives in many different ways
  - Migration to new technology
  - Access time for data
    - Architecture and design must take this into account

MB/sec per GB of storage



Metadata Challenges

Those who own the archive own the big data solutions as re-indexing metadata remotely at future scale will be impossible

Metadata

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- Bringing back a large archive over the network and indexing for new information is impossible
  - If someone has a new idea for how to use data and the archive is owned by someone else, you would not want to run the re-indexing on their machines
    - You would need to bring the database back to your location
- There seems an industry goal of outsourcing archives
  - This could have a long term negative financial impact on those companies

Final Thoughts

- Archives are and will be the central point for big data analysis
  - To be successful with archives, planning for costs, reliability, scalability and how the archive will be used is critical to the success
    - Those that have successful archives, like the geosciences industry, do all of the above
- Archive performance must be matched with data usage requirements
  - Do you need to use 1 TB per day or 100 TB per day?
  - Do you need to ingest 10 TB a day or 500 TB per day?
- Archive management and design requires careful planning
  - Spend the time and money to do it right the 1st time as doing the second time is far more costly

Last Thought

- Without owning the archive, you are dependent on a 3rd party for your future
  - That 3rd party might or might not be a competitor
- Ownership of the raw data is critical to your business and potential to the future of a nation

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Thank you

Thanks for listening