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Selecting a Disk Drive: How Not to Do Research

January 28, 2014
By Henry Newman
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I wasn't impressed last week when I saw Brian Beach's blog on what disk drive to buy. I wasn't impressed due to the lack of intellectual rigor in the analysis of the data he presented. In my opinion, clearly Beach has something else going on or lacks understanding of how disk drives and the disk drive market work.

Let me preface this article with the following full disclosure: I own no stock in Seagate, WD, or Toshiba, nor do I have family or close friends working at any of those companies. I do not buy disk storage, as in my consulting role I am not allowed to resell hardware or software by agreement. I do know people in two of the three companies and have for years, but I have not been given free stuff nor would I take it. Basically, the only agenda I have is a comprehensive factual analysis, which in my opinion is lacking in Beach's blog post.

Let's start at the second table in Beach's article. I have added a few columns in green that were not part of the original, but the information in these columns can be found on the web with a bit of work, and as you will see are pretty important.

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Model	Release Date	Size	Number of Drives	Average Age in Years	Backblaze Annual Failure Rate	Hard Error Rate	Vendor AFR from web site	Load/Unload Cycles in 1000s
Seagate Barracuda 7200(ST31500341AS)	4/26/2006	1.5TB	539	3.8	25.40%	1 in 10E14 bits	0.34%	300
Western Digital Green (WD10EADS)	10/23/2008	1.0TB	474	4.4	3.60%	1 in 10E14 bits	N/A	300
Western Digital Green (WD10EACS)	10/23/2008	1.0TB	84	5	n/a	1 in 10E15 bits	N/A	300
Seagate Barracuda LP (ST31500541AS)	4/22/2009	1.5TB	1929	3.8	9.90%	1 in 10E14 bits	0.32%	50
Seagate Barracuda LP (ST32000542AS)	4/22/2009	2.0TB	288	2	7.20%	1 in 10E14 bits	0.34%	300
Hitachi GST Deskstar 7K2000 (HDS722020ALA330)	8/6/2009	2.0TB	4716	2.9	1.10%	1 in 10E14 bits	N/A	300
Seagate Barracuda XT (ST33000651AS)	9/21/2009	3.0TB	293	2	7.30%	1 in 10E14 bits	0.34%	300
Hitachi GST Deskstar 5K3000 (HDS5C3030ALA630)	12/14/2010	3.0TB	4592	1.7	0.90%	1 in 10E14 bits	N/A	300
Hitachi Deskstar 7K3000 (HDS723030ALA640)	12/14/2010	3.0TB	1027	2.1	0.90%	1 in 10E14 bits	N/A	600
Seagate Barracuda Green (ST1500DL003)	12/14/2010	1.5TB	51	0.8	120.00%	1 in 10E14 bits	0.34%	300
Seagate Barracuda (ST3000DM001)	3/1/2011	3.0TB	4252	1.4	9.80%	1 in 10E14 bits	<1%	300
Hitachi Deskstar 5K4000 (HDS5C4040ALE630)	12/12/2011	4.0TB	2587	0.8	1.50%	1 in 10E14 bits	N/A	600
Seagate Barracuda XT (ST4000DX000)	3/1/2013	4.0TB	179	0.7	n/a	1 in 10E14 bits	0.34%	300
Seagate Desktop (ST4000DM000) HDD.15	3/20/2013	4.0TB	5199	0.3	3.80%	1 in 10E14 bits	N/A	300
Western Digital Red (WD30EFRX)	9/3/2013	3.0TB	346	0.5	3.20%	1 in 10E14 bits	0.88%	600

Let's talk about the release data first.   The oldest drive in the list is the Seagate Barracuda 1.5 TB drive from 2006. A drive that is almost 8 years old! Since it is well known in study after study that disk drives last about 5 years and no other drive is that old, I find it pretty disingenuous to leave out that information. Add to this that the Seagate 1.5 TB has a well-known problem that Seagate publicly

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admitted to, it is no surprise that these old drives are failing.

Now for the other end of the spectrum, new drives. Everyone knows that new drives have infant mortality issues. Drive vendors talk about it, the industry talks about it, RAID vendors talk about it, but there is not a single mention of what, if anything, is done in the Backblaze environment or how that figures into any of the calculations. This is never discussed in terms of: does Backblaze have a burn in period? Are they buying drives from someone that has burned in some and not others? There are lots of questions here.

Next let's move to the hard error rate in bits. One of the definitions of consumer drives as compared to enterprise drives is that hard error rate is 1 bit in 10E14 bits for consumer drives and 1 bit in 10E15 bits for enterprise drives. The following table shows how many bits are moved before the storage vendors say there will be an error on the drive. So move about 11.3 TiB of data on a consumer drive and expect a failure.

Device	Hard error rate in bits	Equivalent in bytes	PiB 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

Let's analyze a few things that were stated and the implications. First the blog stated, "At the end of 2013, we had 27,134 consumer-grade drives spinning in Backblaze Storage Pods. The breakdown by brand looks like this:

Brand	Number of Drives	Terabytes	Average Age in Years
Seagate	12,765	39,576	1.4
Hitachi	12,956	36,078	2.0
Western Digital	2,838	2,581	2.5
Toshiba	58	174	0.7
Samsung	18	18	3.7

I've noted that we just found that the Seagate 1.5 TB drives are about 8 years old since release, for the failure rate, but the average age of the Seagate drives in use are 1.4 years old. Averages are pretty useless statistic, and if Seagate drives are so bad then why buy so many new drives? Yet this is not the big issue. There is nothing in the blog about how much data is written to a set of drives that has had failures. If the drive exceeds the manufacturer's specification and it fails, while another drive that is not being read or written to as much does not fail, is that really a problem?

My answer is that you cannot discuss drive failures unless you state clearly that the amount of I/O being done to the drives is the same. You should expect that an 8-year-old drive – besides being beyond its life expectancy – has had more data read and written to it, so it's approaching the hard error rate for the drive.

On a side note, it is interesting that the claimed failure rate of the Seagate Barracuda Green ST1500DL003 drives is 120%. Is that because 100% of the drives failed and were replaced with another 100% and then 20% failed, or what? Is the cause of the failure because, as was stated, "The drives that just don't work in our environment are Western Digital Green 3TB drives and Seagate LP (low power) 2TB drives. Both of these drives start accumulating errors as soon as they are put into production. We think this is related to vibration. The drives do somewhat better in the new low-vibration Backblaze Storage Pod, but still not well enough."

A simple read of the drive specification compared to other drives shows that this drive should not be used in high vibration environments. Does this mean that Backblaze engineering does not spend the time to read the drive specifications for each drive they purchase?

The next column is the vendor supplied AFR (Annualized Failure Rate), which Seagate supplies for most of their drives and WD supplies for a single drive. These numbers are the best case values for the drive to respond to a command. For the 1 drive that Seagate does not provide an AFR, the ST4000DM000, Seagate states in their manual that: *Average rate of <55TB/year. The MTBF specification for the drive assumes the I/O workload does not exceed the average annualized workload rate limit of 55TB/year. Workloads exceeding the annualized rate may degrade the drive MTBF and impact product reliability. The average annualized workload rate limit is in units of TB per year, or TB per 8760 power-on hours. Workload rate limit = TB transferred × (8760/recorded power-on hours).*

Tags: IOPS, disk drive, enterprise data

5 Comments (click to add your comment)

By **Bruce**   January 29 2014 18:58 PST
Just because a drive was released in 2008 does not mean that that same model drive, when used somewhere else, was purchased in 2008. Indeed, it could have been purchased any time between 2008 and the present. Just saying ...

Reply to this comment

By **Bill Jackson**   January 29 2014 18:55 PST
Lots of errors you made in your analysis. You think a design is frozen and never improves from, say 2006 as you refer to the Barracudas = Seagate never changes. In fact almost all aspects of drives, from bearings and heads to control software are undergoing active development and improvement so the most recent 2013 Barracuda will be cheaper to make and more reliable than the 2006 model. I find an operating herd approach that backblaze uses to analyze and optimize their operation is a valid approach. If there was never a flood, some of the poor drives might not be in the fleet at all, the Backblaze approach would weed them out early.

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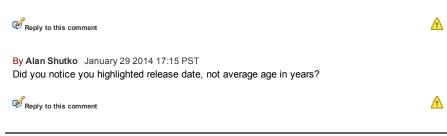By **Mr. CPU**   January 29 2014 18:55 PST
It doesn't seem like the original backblaze post was intended to be a rigours scientific study, only some interesting statistics about their observations in their environment. For them, the results are the results, and mocking them for not spending a fortune to conduct a more thorough study just seems like a waste of time. I did enjoy reading your article as well, lots of useful little tidbits to flesh out some of the data, but I guess for me, the backblaze was anecdotal, not some kind of gospel, and meant to be taken as such. YMMV.

Reply to this comment

By **Phil21**   January 29 2014 17:23 PST
I'm not sure what this article is refuting really. The Backblaze blog post mimics my experience with these Seagate 1.5TB drives nearly exactly. They are the worst drives we have spinning, and unfortunately at the time we bought a few hundred of them. It's raw data. Interpret however you like to. In this business, anyone utilizing consumer drives realizes they are making a trade off of cost vs. reliability and support. We absolutely expect higher failure rates, which is offset by how much less expensive the drives are. Many workloads (such as backblaze) allow for this tradeoff, and some do not. I found the Backblaze article very helpful - I know about duty cycle and MTBF, but some drives work better than others even when rated the same. The fact the Seagates are failing at a ~20% rate for Backblaze *and* us, shows at least to me the data is nominally accurate. It's not just old age, this has been a trend since the day they were put into production. All your article states to me really is exactly what everyone already knows. Buy enterprise for more reliable disk. Even with the 20% failure rate on these, it's far cheaper to buy consumer for our use with little downside.
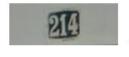
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By **Alan Shutko**   January 29 2014 17:15 PST
Did you notice you highlighted release date, not average age in years?

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