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Backblaze Hard Drive Stats for 2016

January 31st, 2017

Backblaze has recorded and saved daily hard drive statistics from the drives in our data
centers since April 2013. At the end of 2016 we had 73,653 spinning hard drives. Of that

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then present the data for all of 2016, and finish with the lifetime statistics for all of the drives Backblaze has used in our cloud storage data centers since we started keeping track. Along the way we'll share observations and insights on the data presented. As always you can download our Hard Drive Test Data to examine and use.

Hard Drive Reliability Statistics for Q4 2016

At the end of Q4 2016 Backblaze was monitoring 72,100 data drives. For our evaluation we remove from consideration those drives which were used for testing purposes and those drive models for which we did not have at least 45 drives. This leaves us with 71,939 production hard drives. The table below is for the period of Q4 2016.

Hard Drive Annualized Failure Rates for Q4 2016
Reporting period 10/1/2016 - 12/31/2016 inclusive

MFG	Model	Drive Size	Drive Count	Avg. Age (months)	Drive Days	Drive Failures	Failure Rate
HGST	HDS723030ALA640	3 TB	978	61.21	90,415	9	3.63%
HGST	HDS5C3030ALA630	3 TB	4,476	55.87	412,752	13	1.15%
HGST	HDS5C4040ALE630	4 TB	2,625	45.35	241,665	4	0.60%
Toshiba	DT01ACA300	3 TB	46	44.12	4,232	-	0.00%
Seagate	ST4000DX000	4 TB	184	38.54	17,354	7	14.72%
WDC	WD30EFRX	3 TB	1,105	30.39	100,259	9	3.28%
HGST	HMS5C4040ALE640	4 TB	7,014	29.48	648,393	9	0.51%
WDC	WD60EFRX	6 TB	446	24.14	41,304	5	4.42%
HGST	HUH728080ALE600	8 TB	45	22.99	4,140	-	0.00%
Toshiba	MD04ABA500V	5 TB	45	22.15	4,140	-	0.00%
Seagate	ST4000DM000	4 TB	34,738	21.73	3,196,552	234	2.67%
Seagate	ST6000DX000	6 TB	1,889	21.48	173,720	8	1.68%
Toshiba	MD04ABA400V	4 TB	146	20.61	13,432	-	0.00%
WDC	WD40EFRX	4 TB	75	17.16	4,232	-	0.00%
HGST	HMS5C4040BLE640	4 TB	9,407	15.51	809,119	14	0.63%
Seagate	ST8000DM002	8 TB	8,660	4.72	663,697	30	1.65%
Seagate	ST8000NM0055	8 TB	60	1.44	1,560	-	0.00%
		Totals	71,939		6,426,966	342	1.94%

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1. The failure rate listed is for just Q4 2016. If a drive model has a failure rate of 0%, it means there were no drive failures of that model during that quarter.

2. 90 drives (2 storage pods) were used for testing purposes during the period. They contained Seagate 1.5TB and 1.0 TB WDC drives. These are not included in the results above.

3. The most common reason we have less than 45 drives of one model is that we needed to replace a failed drive, but that drive model is no longer available. We use 45 drives as the minimum number to report quarterly and yearly statistics.

8 TB Hard Drive Performance

In Q4 2016 we introduced a third 8 TB drive model, the Seagate ST8000NM0055. This is an enterprise class drive. One 60-drive Storage Pod was deployed mid-Q4 and the initial results look promising as there have been no failures to date. Given our past disdain for overpaying for enterprise drives, it will be interesting to see how these drives perform.

We added 3,540 Seagate 8 TB drives, model ST8000DM002, giving us 8,660 of these drives. That's 69 petabytes of raw storage, before formatting and encoding, or about 22% of our current data storage capacity. The failure rate for the quarter of these 8 TB drives was a very respectable 1.65%. That's lower than the Q4 failure rate of 1.94% for all of the hard drives in the table above.

During the next couple of calendar quarters we'll monitor how the new enterprise 8 TB drives compare to the consumer 8 TB drives. We're interested to know which models deliver the best value and we bet you are too. We'll let you know what we find.

2016 Hard Drive Performance Statistics

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drive failure stats for 2016. As with the quarterly results, we have removed any non-production drives and any models that had less than 45 drives.

Hard Drive Annualized Failure Rates for 2016
Reporting period 1/1/2016 - 12/31/2016 inclusive

MFG	Model	Drive Size	Drive Count	Avg Age (months)	Drive Days	Drive Failures	Failure Rate
HGST	HUH728080ALE600	8 TB	45	22.99	16,155	-	0.00%
Seagate	ST8000DM002	8 TB	8,660	4.72	1,075,720	48	1.63%
Seagate	ST8000NM0055	8 TB	60	1.44	1,560	-	0.00%
Seagate	ST6000DX000	6 TB	1,889	21.48	684,840	16	0.85%
WDC	WD60EFRX	6 TB	446	24.14	166,152	25	5.49%
Toshiba	MD04ABA500V	5 TB	45	22.15	16,425	1	2.22%
HGST	HDS5C4040ALE630	4 TB	2,625	45.35	987,011	14	0.52%
HGST	HMS5C4040ALE640	4 TB	7,014	29.48	2,579,698	28	0.40%
HGST	HMS5C4040BLE640	4 TB	9,407	15.51	2,436,130	34	0.51%
Seagate	ST4000DM000	4 TB	34,738	21.73	12,359,750	938	2.77%
Seagate	ST4000DX000	4 TB	184	38.54	72,615	27	13.57%
Toshiba	MD04ABA400V	4 TB	146	20.61	52,983	-	0.00%
WDC	WD40EFRX	4 TB	75	17.16	16,790	1	2.17%
HGST	HDS5C3030ALA	3 TB	4,476	55.87	1,647,137	34	0.75%
HGST	HDS723030ALA	3 TB	978	61.21	361,937	22	2.22%
Toshiba	DT01ACA300	3 TB	46	44.12	16,900	2	4.32%
WDC	WD30EFRX	3 TB	1,105	30.39	390,379	35	3.27%
	Totals		71,939		22,882,182	1,225	1.95%

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No Time For Failure

In 2016, three drives models ended the year with zero failures, albeit with a small number of drives. Both the 4 TB Toshiba and the 8 TB HGST models went the entire year without a drive failure. The 8 TB Seagate (ST8000NM0055) drives, which were deployed in November 2016, also recorded no failures.

The total number of failed drives was 1,225 for the year. That's 3.36 drive failures per day or about 5 drives per workday, a very manageable workload. Of course, that's easy

The overall hard drive failure rate

and well below the 6.39% failure rate for 2014.

Big Drives Rule

We increased storage density by moving to higher-capacity drives. That helped us end 2016 with 3 TB drives being the smallest density drives in our data centers. During 2017, we will begin migrating from the 3.0 TB drives to larger-sized drives. Here's the distribution of our hard drives in our data centers by size for 2016.

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Backblaze data centers as of 12/31/2016.

Less than 1% are the 5 TB drives.

8TB
(12%)

3TB
(9%)

6TB
(3%)

4TB
(76%)

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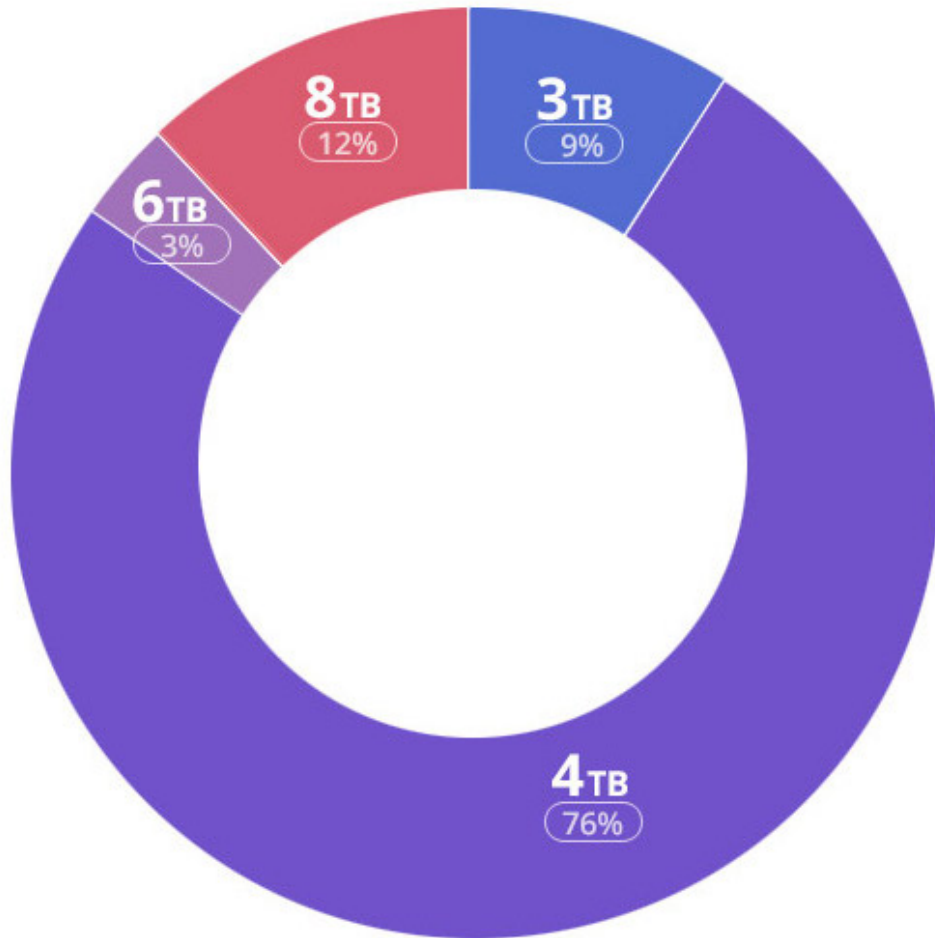
Digging in a little further, below are the failure rates by drive size and vendor for 2016.

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Drive Size	Drive Count	Drive Days	Drive Failures	Failure Rate
3 TB	6,605	2,416,353	93	1.40%
4 TB	54,189	18,504,977	1,042	2.06%
5 TB	45	16,425	1	2.22%
6 TB	2,335	850,992	41	1.76%
8 TB	8,765	1,093,435	48	1.60%
Totals	71,939	22,882,182	1,225	1.95%

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Hard Drive Failure Rates by Manufacturer
For 2016, as of 12/31/2016

MFG	Drive Count	Drive Days	Drive Failures	Failure Rate
HGST	24,545	8,028,068	132	0.60%
Seagate	45,531	14,194,485	1,029	2.65%
Toshiba	237	86,308	3	1.27%
WDC	1,626	573,321	61	3.88%
Totals	71,939	22,882,182	1,225	1.95%

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Computing the Failure Rate

Failure Rate, in the context we use it, is more accurately described as the Annualized Failure Rate. It is computed based on Drive Days and Drive Failures, not on the Drive Count. This may seem odd given we are looking at a one year period, 2016 in this case, so let's take a look.

shown on the chart for 4 TB drives is 2.06%. The trouble with just dividing Drive Failures by Drive Count is that the Drive Count constantly changes over the course of the year. By using Drive Count from a given day, you assume that each drive contributed the same amount of time over the year, but that's not the case. Drives enter and leave the system all the time. By counting the number of days each drive is active as Drive Days, we can account for all the ins and outs over a given period of time.

Hard Drive Benchmark Statistics

As we noted earlier, we've been collecting and storing drive stats data since April 2013. In that time we have used 55 different hard drive models in our data center for data storage. We've omitted models from the table below that we didn't have enough of to populate an entire storage pod (45 or fewer). That excludes 25 of those 55 models.

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MFG	Model	Size	Count	Days	Failures	Rate
HGST	HUH728080ALE600	8.0TB	45	30,958	2	2.36%
Seagate	ST8000DM002	8.0TB	8,660	1,075,720	48	1.63%
Seagate	ST8000NM0055	8.0TB	60	1,560	0	0.00%
Seagate	ST6000DX000	6.0TB	1,889	1,201,586	47	1.43%
WDC	WD60EFRX	6.0TB	458	340,821	53	5.68%
Toshiba	MD04ABA500V	5.0TB	45	30,015	2	2.43%
HGST	HDS5C4040ALE	4.0TB	2,639	3,354,643	81	0.88%
HGST	HDS5C4040ALE630	4.0TB	75	38,914	3	2.81%
HGST	HMS5C4040ALE640	4.0TB	7,085	6,069,981	108	0.65%
HGST	HMS5C4040BLE640	4.0TB	9,362	4,264,374	56	0.48%
Toshiba	MD04ABA400V	4.0TB	146	88,972	3	1.23%
Seagate	ST4000DM000	4.0TB	34,737	22,933,912	1,810	2.88%
Seagate	ST4000DX000	4.0TB	212	238,415	37	5.66%
WDC	WD40EFRX	4.0TB	46	46,684	3	2.35%
Toshiba	DT01ACA300	3.0TB	58	64,470	7	3.96%
HGST	HDS5C3030ALA	3.0TB	4,595	5,934,094	134	0.82%
HGST	HDS723030ALA	3.0TB	1,027	1,313,124	69	1.92%
Seagate	ST3000DM001	3.0TB	4,247	2,205,148	1,614	26.72%
Seagate	ST33000651AS	3.0TB	293	222,147	26	4.27%
WDC	WD30EFRX	3.0TB	1,102	1,029,747	162	5.74%
WDC	WD30EZRX	3.0TB	388	123,577	25	7.38%
HGST	HDS722020ALA	2.0TB	4,716	5,294,695	229	1.58%
Seagate	ST32000542AS	2.0TB	288	119,309	32	9.79%
Seagate	ST320LT007	2.0TB	85	67,332	88	47.70%
WDC	WD20EFRX	2.0TB	132	66,485	9	4.94%
Seagate	ST1500DL003	1.5TB	51	30,913	77	90.92%
Seagate	ST31500341AS	1.5TB	539	330,431	216	23.86%
Seagate	ST31500541AS	1.5TB	1,929	1,427,627	397	10.15%
WDC	WD10EACS	1.0TB	84	60,690	5	3.01%
WDC	WD10EADS	1.0TB	474	369,302	37	3.66%
		Totals	85,467	58,375,646	5,380	3.36%

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Fun with Numbers

Since April 2013, there have been 5,380 hard drives failures. That works out to about 5 per day or about 7 per workday (200 workdays per year). As a point of reference,

The 58,375,646 Drive Days translates to a little over 1.4 Billion Drive Hours. Going the other way we are measuring a mere 159,933 years of spinning hard drives.

You'll also notice that we have used a total of 85,467 hard drives. But at the end of 2016 we had 71,939 hard drives. Are we missing 13,528 hard drives? Not really. While some drives failed, the remaining drives were removed from service due primarily to migrations from smaller to larger drives. The stats from the "migrated" drives, like Drive Hours, still count in establishing a failure rate, but they did not fail, they just stopped reporting data.

Failure Rates Over Time

The chart below shows the annualized failure rates of hard drives by drive size over time. The data points are the rates as of the end of each year shown. The "stars" mark the average annualized failure rate for all of the hard drives for each year.
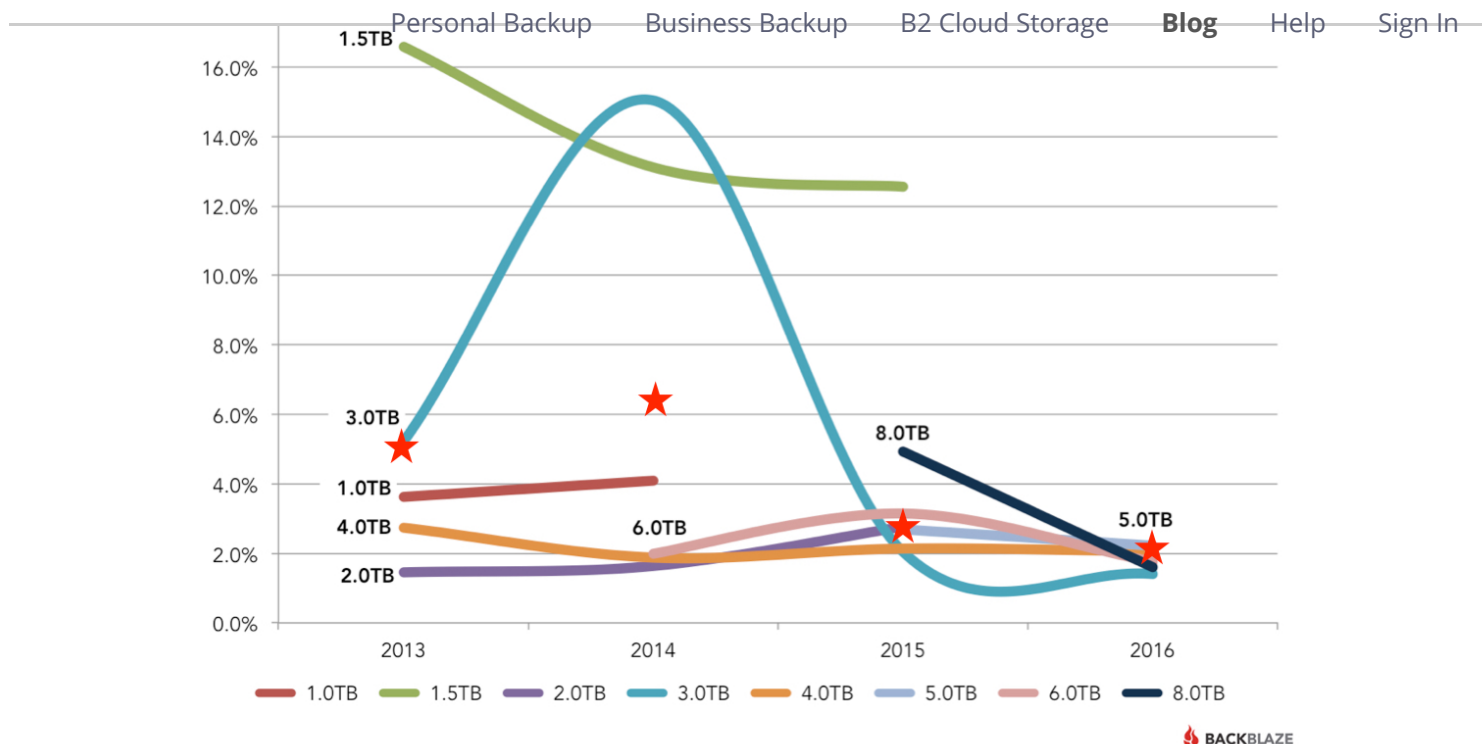
Notes:

1. The "8.0TB" failure rate of 4.9% for 2015 is comprised of 45 drives of which there were 2 failures during that year. In 2016 the number of 8 TB drives rose to 8,765 with 48 failures and an annualized failure rate of 1.6%.
2. The "1.0TB" drives were 5+ years old on average when they were retired.
3. There are only 45 of the "5.0TB" drives in operation.

Can't Get Enough Hard Drive Stats?

We'll be presenting the webinar "Backblaze Hard Drive Stats for 2016" on Thursday February 2, 2017 at 10:00 Pacific time. The webinar will be recorded so you can watch it over and over again. The webinar will dig deeper into the quarterly, yearly, and lifetime hard drive stats and include the annual and lifetime stats by drive size and manufacturer. You will need to subscribe to the Backblaze BrightTALK channel to view the webinar. Sign up for the webinar today.

free for your own purpose, all we ask is three things 1) you cite Backblaze as the source

if you use the data, 2) you accept that you are solely responsible for how you use the

data, and 3) you do not sell this data to anyone, it is free. If you just want the

summarized data used to create the tables and charts in this blog post you can

download the ZIP file containing the MS Excel spreadsheet.

Good luck and let us know if you find anything interesting.

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Andy Klein

Andy has 20+ years experience in technology marketing. He has shared his
expertise in computer security and data backup at the Federal Trade
Commission, Rootstech, RSA and over 100 other events. His current
passion is to get everyone to back up their data before it's too late.

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Join the discussion…

Royi • 8 days ago

Hi,
The real data would be a graph to show the chances of a drive to survive x Days with no fail.
Currently the data mixes very old drives with new.

If I buy an HD I'd like to know what are the chances of it to work with no failure for 1 Year, 2 Years, etc...

Could you show something like that?

Thank You.

7 ∧ | ∨ • Reply • Share ›

> **Andy Klein** Mod → Royi • 8 days ago
>
> If I understand the question correctly, you are looking for survival analysis for the different drive models. If that's the case Ross Lazarus applied Kaplan-Meier statistics to the to our data set. You can find his work here: http://bioinformare.blogspot.c....
>
> ∧ | ∨ • Reply • Share ›

>> **Royi** → Andy Klein • 7 days ago
>>
>> It seems to be what I looked for.
>> But I'd rather it be done by BackBlaze and their exact data.
>>
>> It is really simple given access to data.
>>
>> ∧ | ∨ • Reply • Share ›

>>> **Tom Gabriele** → Royi • 7 days ago
>>>
>>> If it's simple, can you do it and share your results?
>>>
>>> ∧ | ∨ • Reply • Share ›

>>> **Royi** → Tom Gabriele • 7 days ago
>>>
>>> I don't have the data over time.
>>> What's needed is per each HD its operation start date and failure date (Per drive, not a model or family of drives).
>>>
>>> Given that data, it is easy.
>>>
>>> ∧ | ∨ • Reply • Share ›

>>> **Jesper Monsted** → Royi • 3 days ago

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⌃ ⌄ Reply • Share ›

usmc5939 • 9 days ago

I thoroughly enjoy reading these every year, if not for the statistics. Seagate needs to pick up the pace, again!

2 ⌃ | ⌄ • Reply • Share ›

fredzfrog • 8 days ago

Hi, thanks for the data. I'm a bit confused by the 2016 annualized failure percentage. By my math, 1225 out of 71939 is 1.70%. How did you come up with your stated 1.95% failure rate?

1 ⌃ | ⌄ • Reply • Share ›

> **Andy Klein** Mod ➜ fredzfrog • 8 days ago
>
> Your assumption is based on each of the drives putting in the same number of days. But the reality is that drives enter and leave the system all the time. We use drive days, the amount of days each drive contributes, to better reflect our environment.
>
> 2 ⌃ | ⌄ • Reply • Share ›

>> **fredzfrog** ➜ Andy Klein • 8 days ago
>>
>> That would explain it, thanks :)
>>
>> ⌃ | ⌄ • Reply • Share ›

> **fredzfrog** ➜ fredzfrog • 8 days ago
>
> You also stated "The total number of failed drives was 1,225 for the year. That's 3.36 drive failures per day". While that is impressive, 1225/366 (2016 was a leap year) is a smaller value, 3.346 drive failures/day. Still, impressive numbers. :)
>
> ⌃ | ⌄ • Reply • Share ›

H_Trickler • 8 days ago

Thank you _very much_ for sharing this data! Blackblaze imho is the only source for this kind of important data.

1 ⌃ | ⌄ • Reply • Share ›

berkus • 8 days ago

Awesome stats guys, TIL!

1 ⌃ | ⌄ • Reply • Share ›

DiaBlox • 9 days ago

I wonder why you don't use a single WD Gold drive in there? Seems like they are very high reliability like the HGST's.

1 ⌃ | ⌄ • Reply • Share ›

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instead of expensive enterprise class ones.

3 ∧ | ∨ • Reply • Share ›

> **Ardent** ➔ Spam Us • 8 days ago
>
> Then why don't they use the drives from WD's mybook 8 TB? These are currently the cheapest 8TB consumer drives. Or the 10TB Ironwolf, it's cheaper than their preferred Seagate Desktop 8TB drive, nevermind that that one's being phased out.
>
> ∧ | ∨ • Reply • Share ›

>> **Andy Klein** Mod ➔ Ardent • 8 days ago
>>
>> The best answer is availability. Generally we buy in quantities of 5,000 or more. The drives you mentioned are hard for us to get in the quantities we need. From time-to-time we do experiments with fewer drives (like 60) to see if there are any issues. Even then we'd want to know we can get them in quantity if desired.
>>
>> ∧ | ∨ • Reply • Share ›

>> **Ardent** ➔ Andy Klein • 7 days ago
>>
>> Well, I'm not into buying your kind of quantities, so I can't tell. But those you use are not available here, or in very small quantities. They're old models and replaced by new ones. The ones I mentioned are the ones that are abundantly available in stores here. Do you buy direct from Seagate or HGST or do you buy from retailers or distributors?
>>
>> ∧ | ∨ • Reply • Share ›

Mark Gomersbach • 9 days ago

ST1500DL03 seems especially bad in the last list; 77 of 51 died, somehow traveling back in time and score "only" 90.21% failure rate.
Anwyay, thank you again for making these comparisons as they do help pick new disks every year!

1 ∧ | ∨ • Reply • Share ›

> **YevP** Mod ➔ Mark Gomersbach • 9 days ago
>
> Those are a bit of a special case, we migrated off of them :)
>
> 1 ∧ | ∨ • Reply • Share ›

> **Jesper Monsted** ➔ Mark Gomersbach • 3 days ago
>
> Ugh, reminds me of the IBM Ultrastar 36LZH 18GB SCSI drives. I got 50 of them (one in each server) and RMA'ed them about 70 times. Eventually, our server builders gave me other brands when i handed in the IBMs.
>
> ∧ | ∨ • Reply • Share ›

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indicating that while only 12% of drives are of the 8tb variety they actually make up XX% of the overall storage.

1 ^ | ∨ • Reply • Share ›

Adam Allcock ➜ Shawn • 8 days ago

8TB - 21.8%
6TB - 4.4%
5TB - 0.1%
4TB - 67.5%
3TB - 6.2%

Its mostly the 8TBs that are underrepresented in the /drive stats, and 4TBs over-represented.

1 ^ | ∨ • Reply • Share ›

Илья Василевский • 6 hours ago

When I needed two drives for my NAS, I chose HGST because of your reports (the previous ones). It's nice to see that HGST keeps its high quality mark and still leading the manufacturers chart. Thank you for publishing the data!

^ | ∨ • Reply • Share ›

Alexei Martchenko • 9 hours ago

This is sooo beautiful... *Feeling nerdy*

^ | ∨ • Reply • Share ›

FollowTheORI • 7 days ago

Thanks again for the sharing of knowledge and experience.
Keep it up! :)

^ | ∨ • Reply • Share ›

Tommy Dickson Saragih • 8 days ago

what's the "drive days" mean?

^ | ∨ • Reply • Share ›

Tom Gabriele ➜ Tommy Dickson Saragih • 7 days ago

Like man-hours. The total length of time the drives are running, or the [# of drives] × [number of days].

So, 1 drive, 1 day = 1 drive day. 2 drives, 1 day = 2 drive days. 2 drives, 2 days = 4 drive days.

^ | ∨ • Reply • Share ›

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47 comments • 3 months ago•   4 comments • 2 months ago•

Damian Nowak — Seriously, folks, why don't you post *normal* tables? Can't copy HDD model names from damn images into Amazon

sunk818 — Definitely helpful to remove the crud and temporary internet files. Another way I've saved space is to use a tool called

How Heavy is the Backblaze Cloud?

Backblaze 2016 Year in Review

8 comments • 4 months ago•   3 comments • 2 months ago•

Wade Stadig — Wow, that was actually very entertaining and thought provoking. Thanks for the good lighthearted read!

Orlon Rose — Thank you Andy for the timely reply I do have the backup pods and 45 drive options in my pitch, the custom build was just

---

Thanks for scrolling all the way down the page.

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