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Enterprise Drives: Fact or Fiction?

Brian Beach December 4, 2013

Last month I dug into drive failure rates based on the 25,000+ consumer drives we have and found that consumer drives actually performed quite well. Over 100,000 people read that blog post and one of the most common questions asked was:

> "Ok, so the consumer drives don't fail that often. But aren't enterprise drives so much more reliable that they would be worth the extra cost?"

Well, I decided to try to find out.

In the Beginning

As many of you know, when Backblaze first started the unlimited online backup service, our founders bootstrapped the company without funding. In this environment one of our first and most critical design decisions was to build our backup software on the premise of data redundancy. That design decision allowed us to use consumer drives instead of enterprise drives in our early Storage Pods as we used the software, not the hardware, to manage redundancy. Given that enterprise drives were often twice the cost of consumer drives, the choice of c sumer drives was also a relief for our founders' thin wallets.

There were warnings back then that using consumer drives would be dangerous with, people saying:

> "Consumer drives won't survive in the hostile environment of the data center."
> "Backblaze Storage Pods allow too much vibration – consumer drives won't survive."
> "Consumer drives will drop dead in a year. Or two years. Or …"

As we have seen, consumer drives didn't die in droves, but what about enterprise ones?

Failure Rates

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In my post last month on disk drive life expectancy, I went over what an annual failure rate means. It's the average number of failures you can expect when you run one disk drive for a year. The computation is simple:

Annual Failure Rate = (Number of Drives that Failed / Number of Drive-Years)

Drive-years a measure of how many drives have been running for how long. This computation is also simple:

Drive-Years = (Number of Drives x Number of Years)

For example, one drive for one year is one drive-year. Twelve drives for one month is also one drive-year.

Backblaze Storage Pods: Consumer-Class Drives
We have detailed day-by-day data about the drives in the Backblaze Storage Pods since mid-April of 2013. With 25,000 drives ranging in age from brand-new to over 4 years old, that's enough data to slice the data in different ways and still get accurate failure rates. Next month, I'll be going into some of those details, but for the comparison with enterprise drives, we'll just look at the overall failure rates.

We have data that tracks every drive by serial number, which days it was running, and if/when it was replaced because it failed. We have logged:

14719 drive-years on the consumer-grade drives in our Storage Pods.
613 drives that failed and were replaced.

Commercially Available Servers: Enterprise-Class Drives
We store customer data on Backblaze Storage Pods which are purpose-built to store data very densely and cost-efficiently. However, we use commercially available servers for our central servers that store transactional data such as sales records and administrative activities. These servers provide the flexibility and throughput needed for such tasks. These commercially available servers come from Dell and from EMC.

All of these systems were delivered to us with enterprise-class hard drives. These drives were touted as solid long-lasting drives with extended warranties.

The specific systems we have are:

- Six shelves of enterprise-class drives in Dell PowerVault storage systems.
- One EMC storage system with 124 enterprise drives that we just brought up this summer. One of the drives has already failed and been replaced.

We have also been running one Backblaze Storage Pod full of enterprise drives storing users' backed-up files as an experiment to see how they do. So far, their failure rate, has been statistically consistent with drives in the commercial storage systems.

In the two years since we started using these enterprise-grade storage systems, they have logged:

368 drive-years on the enterprise-grade drives.
17 drives that failed and were replaced.

Enterprise vs. Consumer Drives
At first glance, it seems the enterprise drives don't have that many failures. While true, the *failure rate of enterprise drives is actually higher than that of the consumer drives!*

	Enterprise Drives	Consumer Drives

Drive-Years of Service	368	14719
Number of Failures	17	613
Annual Failure Rate	4.6%	4.2%

It turns out that the consumer drive failure rate does go up after three years, but all three of the first three years are pretty good. We have no data on enterprise drives older than two years, so we don't know if they will also have an increase in failure rate. It could be that the vaunted reliability of enterprise drives kicks in after two years, but because we haven't seen any of that reliability in the first two years, I'm skeptical.

You might object to these numbers because the usage of the drives is different. The enterprise drives are used heavily. The consumer drives are in continual use storing users' updated files and they are up and running all the time, but the usage is lighter. On the other hand, the enterprise drives we have are coddled in well-ventilated low-vibration enclosures, while the consumer drives are in Backblaze Storage Pods, which do have a fair amount of vibration. In fact, the most recent design change to the pod was to reduce vibration.

Overall, I argue that the enterprise drives we have are treated as well as the consumer drives. And the enterprise drives are failing more.

So, Are Enterprise Drives Worth The Cost?
From a pure reliability perspective, the data we have says the answer is clear: No.

Enterprise drives do have one advantage: longer warranties. That's a benefit only if the higher price you pay for the longer warranty is less than what you expect to spend on replacing the drive.

This leads to an obvious conclusion: If you're OK with buying the replacements yourself after the warranty is up, then buy the cheaper consumer drives.

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Tags: Cloud Storage, Storage Pod, TechBytes

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Chris M Evans · Director at Langton Blue Ltd
Guys, what EMC array are you using? You should be aware that enterprise-class arrays will proactively spare a potentially failing disk even if it isn't failed. This makes RAID rebuild much quicker and safer as a RAID rebuild can hit an unrecoverable read error and so fail to rebuild data. Were your failures true failures or soft failures?
Reply · 3 · Like · Follow Post · December 4, 2013 at 5:52pm

Greg Knieriemen · Westlake, Ohio
Chris is absolutely right - there is a huge distinction between soft and hard failures - and completely invalidates your findings without the details.
Reply · Like · Edited · December 4, 2013 at 9:46pm

Chris Hacken · Follow · Top Commenter · Founder at Tier Engine
Greg Knieriemen They did state that the drives were "replaced", so I doubt they would replace a drive if it just dropped out of an array.
Reply · Like · December 18, 2013 at 1:55pm

John Winney · University of Oxford

Chris Hacken Almost all Enterprise drive failure are 'soft', from error counters being reach that just aren't counted with a consumer drive. Users of these drives value data protection more, so want more drive to be proactively failed out. This alone makes the statistic meaningless, add to that Scott's point below on the maths involved and its a double zero. Still, I do like your backup service and the info you share about the pods and consumer drives is very interesting :-)

Reply · Like · December 19, 2013 at 3:47pm

Scott M. Rosenberg · Follow · Hicksville, New York

To paraphrase Mr. Plinkett: I can't put enough quotation marks around the word "statistics", so I won't try.

You can't use an assumption like "the enterprise drives we have are treated as well as the consumer drives" to prove a conclusion ("the answer is clear").

Also, your sample space for the enterprise drives is a tiny fraction of that for the consumer drives. Two fewer enterprise drive failures and you'd have "proven" the opposite to your assertion that "the failure rate of enterprise drives is actually higher than that of the consumer drives!" If you were unlucky and a bunch of drives in one of your enterprise arrays came from a bad production run then that only proves that you're unlucky, and not that enterprise drives are less reliable in general.

You need to start with a lot more data (and many more enterprise drives) to come to any sort of useful conclusion. Temperature and vibration over time, drive age at time of failure, and blocks read/written over time come to mind.

I appreciate how transparent you guys are about your infrastructure; That's one of the reasons I'm a customer. However I've seen this posting linked and referenced in a few different places now, and it's a bit irresponsible to provide an unsupported and possibly inaccurate conclusion to the internet-at-large. I'd hate to see a young IT manager make mission-critical purchasing decisions based upon your findings.

Reply · 1 · Like · Follow Post · December 18, 2013 at 5:52pm

Michael Herf · Follow · Los Angeles, California

Several years ago some of the consumer firmware was just terrible (e.g., Seagate 7200.11 "bricking" debacle, which went on for about a year), and the enterprise drives didn't seem to have the same bugs at the time. I assumed they were being more careful with the enterprise firmware.

Agreed with Andrew that performance variability is quite large for consumer, and for some kinds of RAID this can matter.

Reply · 1 · Like · Follow Post · December 18, 2013 at 10:33am

Dale Robertson · Worcester, Massachusetts

Take a set of SAS 15K Enterprise drives and a set of NL 7200 RPM drives running the same random workload, from the same head/media technology generation, running 24/7 at the upper edge of their temp limit, then report your findings. Why aren't these guys using their own hardware for their business transactions?

Reply · Like · Follow Post · January 28 at 11:00am

Mike Bijon · Follow · Software Engineer at Consultant, Software Engineering

In the past your consumer drive failure rates have decreased after the first year, then head steady until about 3 years of age. Since your EMC system is only about a year old, and represents a large set of your enterprise samole, could you actually be seeing a lower 1st year failure rate? Any chance you could plot failure rate by age with these enterprise drives? Would love to see if the failure rate "bathtub" is steeper than what you've published for consumer drives in the past.

Reply · Like · Follow Post · January 25 at 7:19pm

if0ff (signed in using yahoo)

Hi all, I'm a backblaze customer and I admire the approach and the company. I also like the drive fail analysis they've done a while back. This article is however by far not reflecting the reality in a broader scope. Being faced everyday with customers who use ten-thousands of enterprise drives, I guess I'm in a position to judge that. The failure rates are way below the failure rates experienced by Backblaze. I can only guess that you are using drives with a well known issues and/or outdated firmware etc.
While the approach of Backblaze with consumer drives is very suitable for their workload, I doubt that they will be any useful for higher demanding workloads. Also, who knows that every single bit can be recovered from those drives? Enterprise drives/systems have tons of technologies integrated that protects from things like silent data loss or corruption. I'm talking about things like enhanced checksumming, lost write protection and regular disk and filesystem scrubs. Things that are often unknown since they are completely transparent for users and admins, but they ensure data is protected. I would recommend to stop guessing around consumer vs. enterprise and focus on your very cool and useful service and the custom built infrastructure behind it, that obviously perfectly serves your needs.

Reply · 1 · Like · Follow Post · December 11, 2013 at 7:40am

Ted Vaczy · Director, Information Systems at University of Rochester Medical Center

You make no mention of the type of drive failures that are being experienced and perhaps you cant tell. Is it a failure in the electronics (i.e. circuit board components) or the mechanical components of the spinning drive.? If I had to guess, I would bet that all of the mechanical components of consumer and enterprise drives are pretty much the same. It's too expensive to have different sets of components to do the same type of function and then support different supply chains and manufacturing processes - that kills profits and reduces the benefits of large volume procurement. I would guess that the most likely failure point is in the mechanical components.

If you want to get more scientific in your assessment there are statistical procedures (a T-test for instance which compares the means between sample groups) that can help you mathematically ascertain if the failures you experience in each group of drives are random events or truly representative of the larger population of hard drives, ie. statistically significant.

Reply · 1 · Like · Follow Post · December 11, 2013 at 2:42pm

Patrick Kuras · Grand Rapids, Michigan

I'm surprised no one has mentioned that the Enterprise drives almost certainly spin faster than the consumer drives. I can't imagine that the wear difference between a 7200 RPM drive and a 15,000 RPM drive is insignificant. Also, you can't get high RPM, SAS and other Enterprise features on the consumer drives - so there are many reasons besides reliability to choose Enterprise drives.

Reply · Like · Follow Post · January 21 at 6:33pm

Alan Brown · Follow

Regarding your comments about vibration.... This begs the question: Is it better to rigidly hold a drive in a bay (and possibly couple vibration from adjacent ones) or is it better to put it in a mount with some damped compliancy in it so that coupling is eliminated? How can you then chose 60-80 drives in a large drive drawer and have everything work? Should you use backplanes with rigidly fixed connectors or should the connectros themselves be able to move with the drive, etc etc.

Is backblaze in a position to measure latencies, etc as in the classic "Don't shout at your disk drives" youtube video? (said video really does drive home the importance of vibration isolation.

I'm still watching, as I'd like to see your designs become sucessful enough to deploy in the datacentres I work in (I herd about 500TB of space science data and that's constantly increasing)

Reply · 1 · Like · Follow Post · Edited · December 5, 2013 at 1:00pm

Gleb Budman · Follow · Top Commenter · Backblaze

The vibration question is an interesting one. Certainly we've seen that reducing vibration helps. We initially reduced vibration by putting "anti-vibration sleeves" around each drives (basically high-end rubber bands). In the v3.0 of the Storage Pod, we both increased the pressure on the drives (adding rigidity), but also added dampening. That definitely seemed to help.

As for using the Storage Pods for your purposes, we store 75 petabytes on them, and hundreds of other companies/orgs use them as well, so they're ready to store your data. However, I would make sure the data is kept redundantly no matter what system you store it on.

Reply · Like · December 5, 2013 at 6:47pm

Jay Ashworth · Top Commenter

Alan: particularly if that science data is on NASA projects, we'd like to see some meta discussion from you on what you have to manage, too, I suspect. :-)

Reply · Like · January 21 at 9:19pm

Alan Brown · Follow

It is and it isn't. I'm at a university space lab and we work with all agencies who have orbiting equipment (primarily ESA, NASA and CNSA). Most of what I'm currently having to deal with is planetary imaging data products (terrestrial and martian) with current emphasis on measuring albedo products (global warming assessments) for the first and mapping mars for the second (we can see the rovers and have a quite accurate idea of where they are vs where NASA says they are). There are severe cost pressures, but also a rigid d requirement for 5 year support and having data online enough to enable ftp access. It's a very fine tightrope to walk.

I have a couple of ideas where I'd like to see the pod design go, most notably picking up Nexsan's "back to back" drive arrangement to help cancel out vibration along with using floating sat... See More

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Alan Brown · Follow

The single largest probloem with consumer drive is the incredibly long "hang" times you get out of them when they encounter a bad sector. This used to be tunable (scterc) but the HDD makers realised there was money to be made and locked the parameter, forcing clients to use the newly introduced next model up ("NAS drives") - which is only different from consumer drivers in that the timeout paramater is tunable - This means consumer drives are difficult to use in RAID setups for nothing other than marketing reasons. (I used to use consumer drives all the time and have been forced to go upmarket simply so that RAID arrays don't go offline for 5 minutes at a time if there's a minor error.)

Reply · 1 · Like · Follow Post · December 5, 2013 at 12:50pm

Gleb Budman · Follow · Top Commenter · Backblaze

Alan, the drive companies have claimed that the enterprise drives have more to them than just the "hang" times - but on the reliability metric, if they are different, it doesn't seem to help.

As for the "hang" times, yes, that may impact performance, but from a storage reliability/density/cost perspective, the consumer drives are clearly a win - even in RAID arrays.

Reply · Like · December 5, 2013 at 6:44pm

Alan Brown · Follow

I know what they claim. It's just that experience simply doesn't seem to back that up. Consumer drives are shipped by the million and low reliability would (and HAS) put a company out of business. There's some milage in greater ECC but not enough to justify the extra cost (ZFS makes that all moot anyway).

Reply · Like · Edited · January 23 at 8:53am

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