BACKBLAZE | blog

Blog Home

Search

Keep up to date:

Follow @backblaze

Follow on Facebook

Follow

Subscribe on RSS

Subscribe via email.
No spam - promise!

Subscribe

Backup with Backblaze
$5/month per computer
Unlimited Backup

Start Backing Up

Try it free

Tags

Backblaze for Business

Backblaze Fun

Backblaze Mobile

Backblaze Tips & Tricks

Backup Awareness Month

Backup Devices

Backup Needs

Backup News

Behind Backblaze

Cloud Storage

Customer Stories

Data Loss

Events

Growth Hacking

Jobs

How long do disk drives last?

Brian Beach November 12, 2013

How long do disk drives last? The short answer is: we don't know yet, but it's longer than you might guess.

Why does a company that keeps more than 25,000 disk drives spinning all the time not know how long they last? Backblaze has been providing reliable and unlimited online backup for over five years. For the past four years, we've had enough drives to provide good statistics, but ~~74%~~ 78% of the drives we buy are living longer than four years. So while ~~26%~~ 22% of drives fail in their first four years, and we have detailed information about the failure rates of drives in their first four years, we don't yet know what will happen beyond that. So how long do drives last? Keep reading.

How Drives Are Used At Backblaze

Backblaze uses lots of hard drives for storing data. 45 drives are mounted in each Backblaze Storage Pod, and the Storage Pods are mounted in racks in our data centers. As new customers sign up, we buy more disk drives, test them, and deploy them. We are up to 75 petabytes of cloud storage now.

Before being deployed, each Backblaze Storage Pod is tested, including tests on all of the drives in it. Recently, Andy posted about Poor Stephen, a disk drive that failed this testing. His post describes the process Backblaze uses to set up, load test, and deploy a Storage Pod.

**Types Of Hard Drives In The Analysis**

Backblaze has standardized on "consumer–grade" hard drives. While hard drive companies say these drives are not designed to work in RAID arrays or the 24×7 workload of a data center environment, Backblaze uses software redundancy to protect data. In a future blog post we will delve into the statistics comparing "consumer" and "enterprise" hard drives.

By far the majority of these hard drives are "raw" or "internal" hard drives. However, because the Thailand Drive Crisis made it nearly impossible to find internal hard drives for sale at reasonable prices, Backblaze started to farm hard drives. Thus, approximately 6 petabytes of the drives in this analysis were originally "external" hard drives that were "shucked" out of their enclosures.

Number of Hard Drives

The chart below shows the age distribution of the drives in the Backblaze data centers. The shape of the chart is mostly a reflection of the growth of the company, and the addition of drives as the customer base grew. Overall, not that many drives fail.
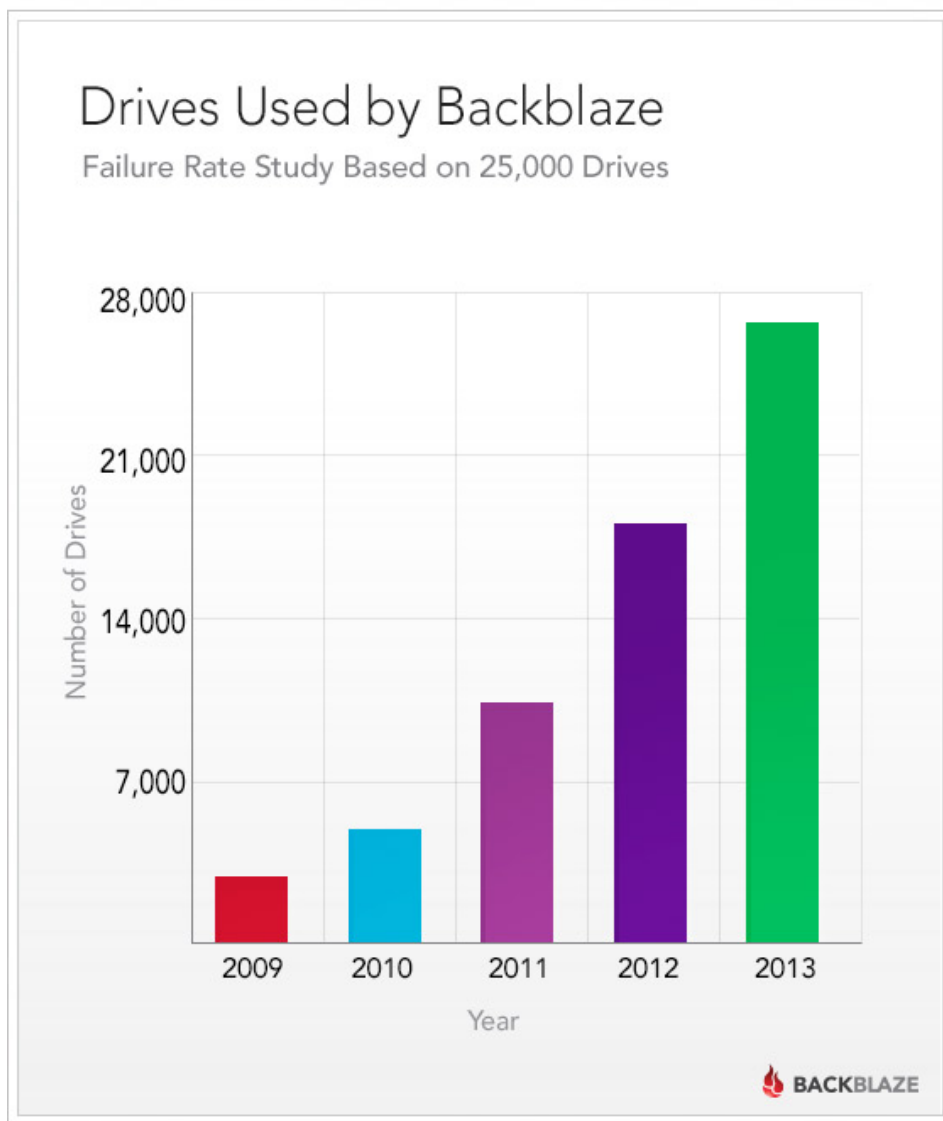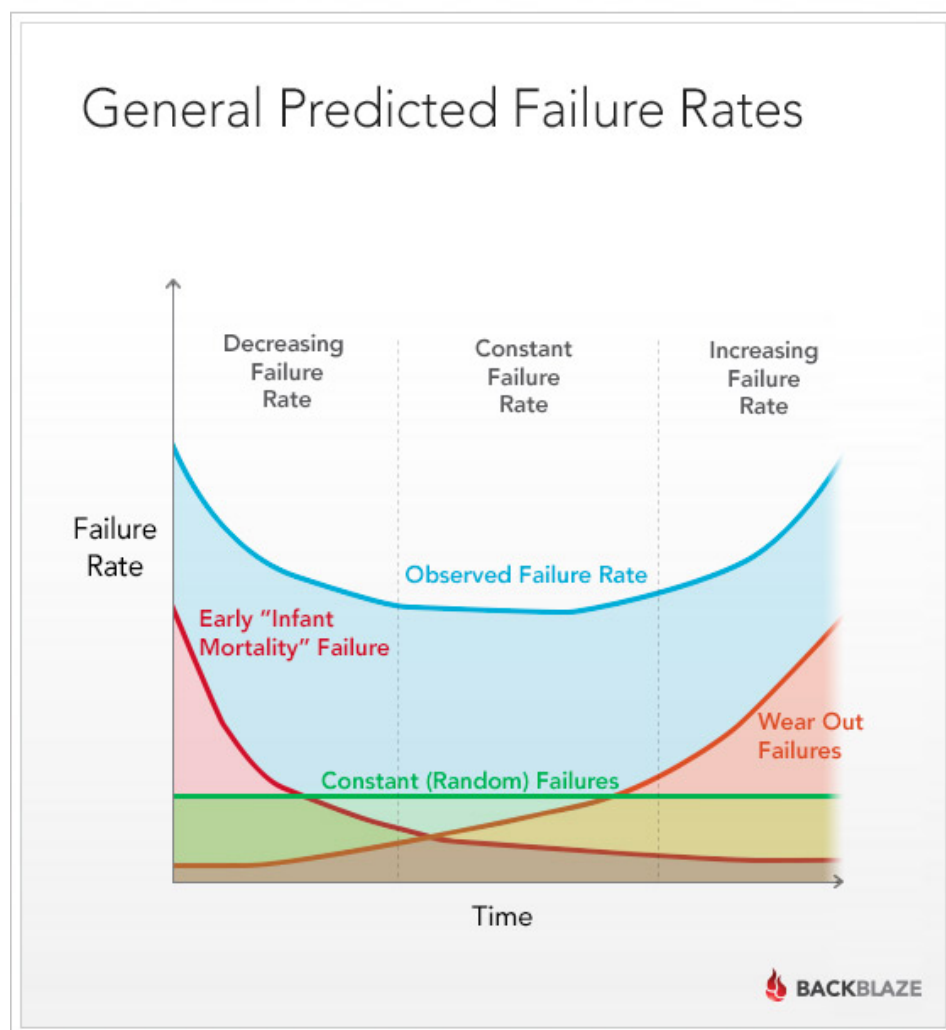

Failure Rates

Before diving into the data on failure rates, it's worth spending a little time clarifying what exactly a failure rate means. At first glance, you might think that a failure rate of 100% is the worst possible. Every drive is failing! That's not the whole story, though.

Imagine you have a disk drive supplier who provides drives that are 100% reliable for six months, but then all fail at that point. What's the annual failure rate? If you have to keep 100 drives running at all times, you'll have to replace the drive in every slot twice a year. That means that you'll have to replace 200 drives each year, which makes your annual failure rate 200%. So, in theory at least, there is no worst possible failure rate. If every

drive failed after one hour of use, the annual failure rate would be 876,000%. Fortunately, the drives that Backblaze gets are more reliable than that.

The Bathtub Curve

Reliability engineers use something called the Bathtub Curve to describe expected failure rates. The idea is that defects come from three factors: (1) factory defects, resulting in "infant mortality", (2) random failures, and (3) parts that wear out, resulting in failures after much use. The chart below (adapted from Wikimedia Commons) shows how these three factors can be expected to produce a bathtub-shaped failure rate curve.

The theory matches the reality that Backblaze experiences. The chart below shows the failure rate of drives in each quarter of their life. For the first 18 months, the failure rate hovers around 5%, then it drops for a while, and then goes up substantially at about the 3-year mark. We are not seeing that much "infant mortality", but it does look like 3 years is the point where drives start wearing out.
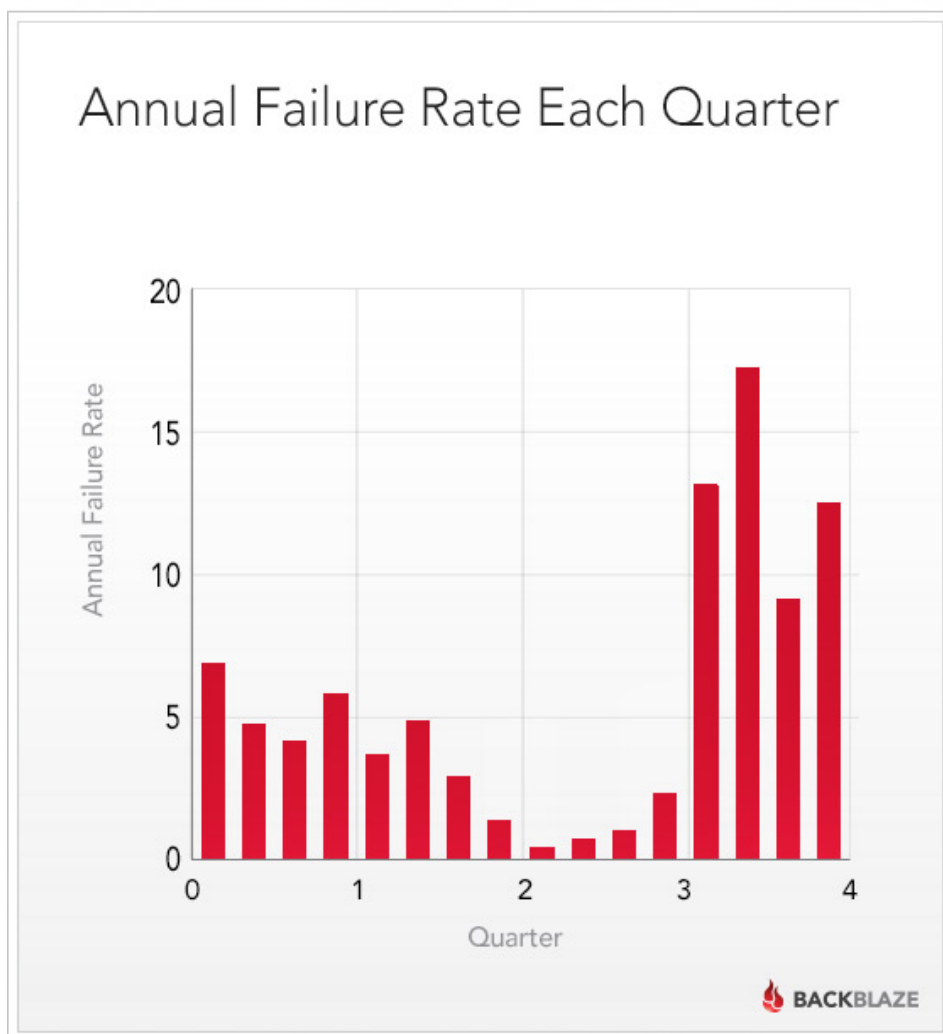
Calculating Life Expectancy

What's the life expectancy of a hard disk drive? To answer that question, we first need to decide what we mean by "life expectancy".

When measuring the life expectancy of people, the usual measure is the average number of years remaining at a given age. So when we say that the life expectancy of newborns in the world in 2010 is 67.2 years, we are saying that if we wait until all of those new people have lived out their lives in 120 or 130 years, the average of their lifespans will be 67.2.

For disk drives, it may be that all of them will wear out before they are 10 years old. Or it may be that some of them last 20 or 30 years. If some of them live a long, long time, it makes it hard to compute the average. Also, a few outliers can throw off the average and make it less useful.

The number that we will be able to compute soon, and the one that is more likely to be useful, is the median lifespan of a new drive. In other words, at what age have half of the drives failed? We are starting to get an idea what the answer will be.

Disk Drive Survival Rates

On the internet, it's surprisingly hard to get an answer to the question "How long will a

hard drive last?" What you'll find are mostly anecdotal stories, or perhaps references to Google's and CMU's studies, neither of which really answer the question.

The anecdotes you get don't give you any useful information:

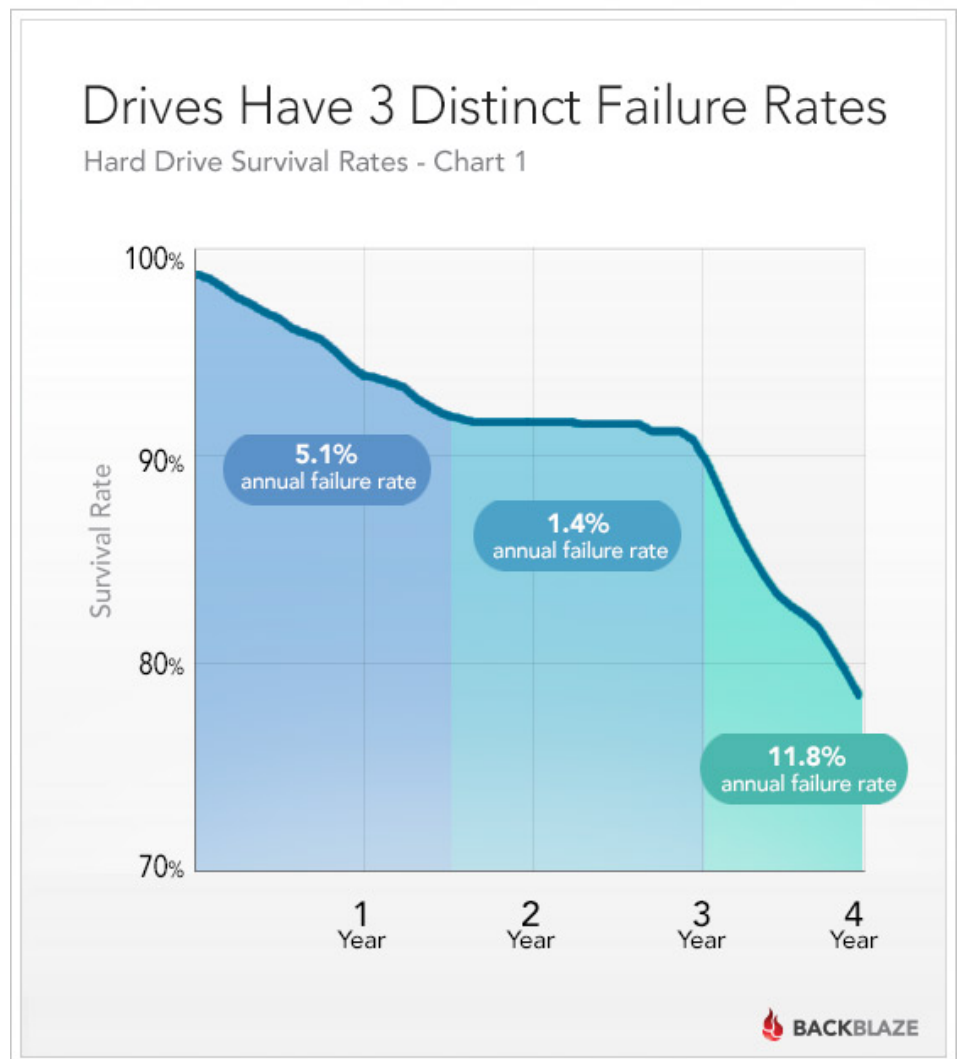⊕ From tomshardware.com: "Hard drives are mechanical and thus will eventually fail. … I've had drives arrive DOA, some die after a day, and some that have lasted 10 years. There is just no way to tell how long a drive will live."

⊕ From CNET: "I don't know about 5 years. My WD died after 2 years."

Google's study has some interesting information on failure rates. They found that temperature doesn't matter as much as you might think, and that the SMART checks of a drive aren't very good at predicting drive failure.

CMU's study found that manufacturer's MTBF (Mean Time Between Failures) ratings are exaggerated. Drives fail a lot more than the MTBF would indicate.

The chart below shows the percentage of drives at Backblaze that are still alive at different ages:

⊕ For the first 1.5 years, drives fail at 5.1% per year.

⊕ For the next 1.5 years, drives fail LESS, at about 1.4% per year.

⊕ After 3 years though, failures rates skyrocket to 11.8% per year.

Drives Have 3 Distinct Failure Rates
Hard Drive Survival Rates - Chart 1

5.1% annual failure rate

1.4% annual failure rate

11.8% annual failure rate

Most Drives Are Still Alive

The chart above could be misleading. At a glance, it appears that most of the drives have already died and all are on track to die within the next year. However, if you redraw the chart with the bottom at 0, you can see that nearly 80% of all the drives Backblaze has ever purchased are still operating!
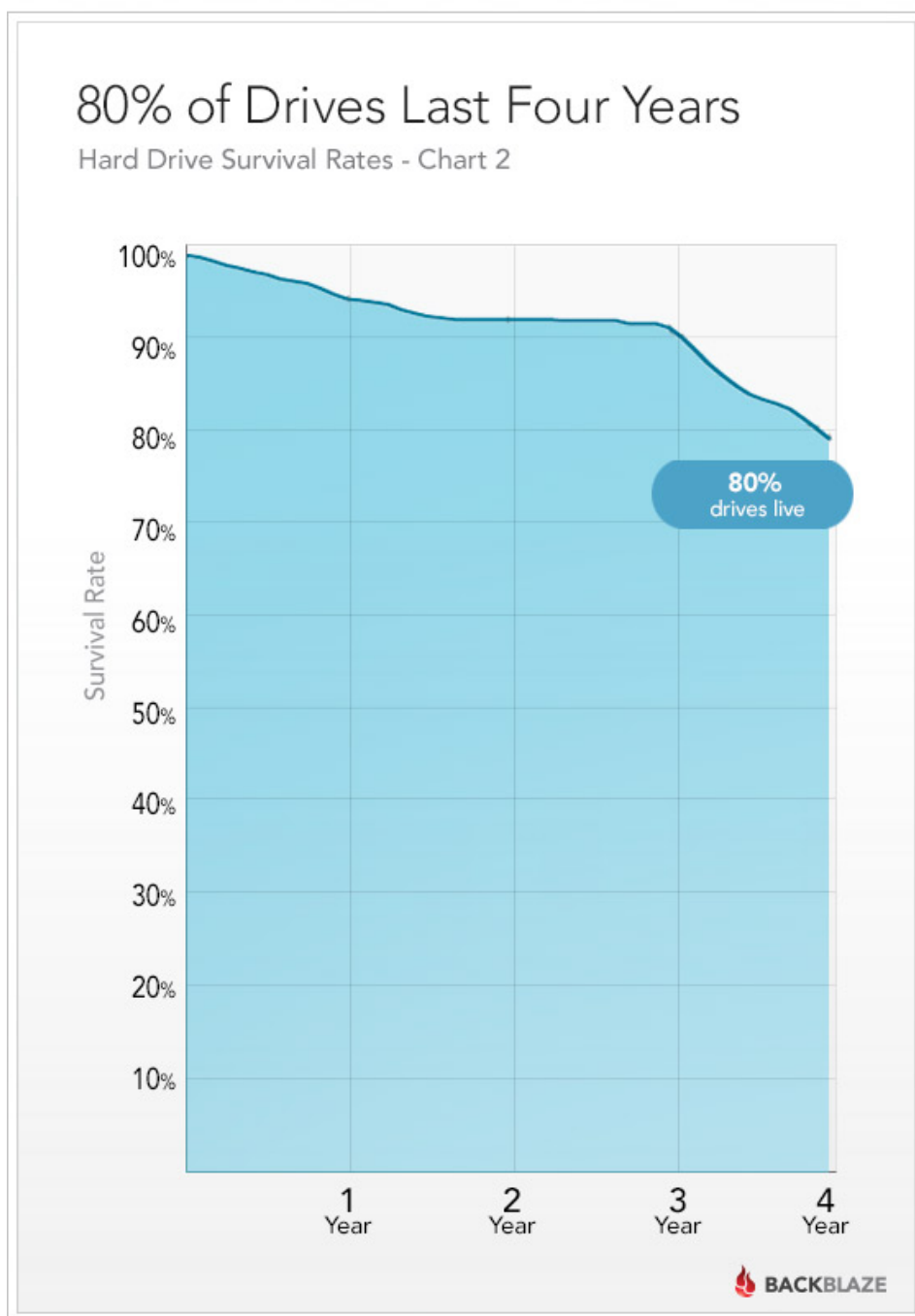

How Long WILL The Hard Drives Last?

What happens to drives when they're older than 5 years? Neither Google nor the CMU team presented any data on drives older than 5 years, although the CMU paper has a tantalizing comment in its conclusion claiming that failure rates go up after 5 years. No basis for that assertion is provided, though.

At Backblaze, we've been up and running for 5 years, and all of the drives we install are new drives, so we also don't have any data for drives older than that. We are looking

forward to finding out what will happen when drives become 5, 6, 7, and 8 years old.

If you extrapolate the line from the previous chart to estimate the point at which half of the drives have died, you get a prediction:

The median lifespan of a drive will be over 6 years.
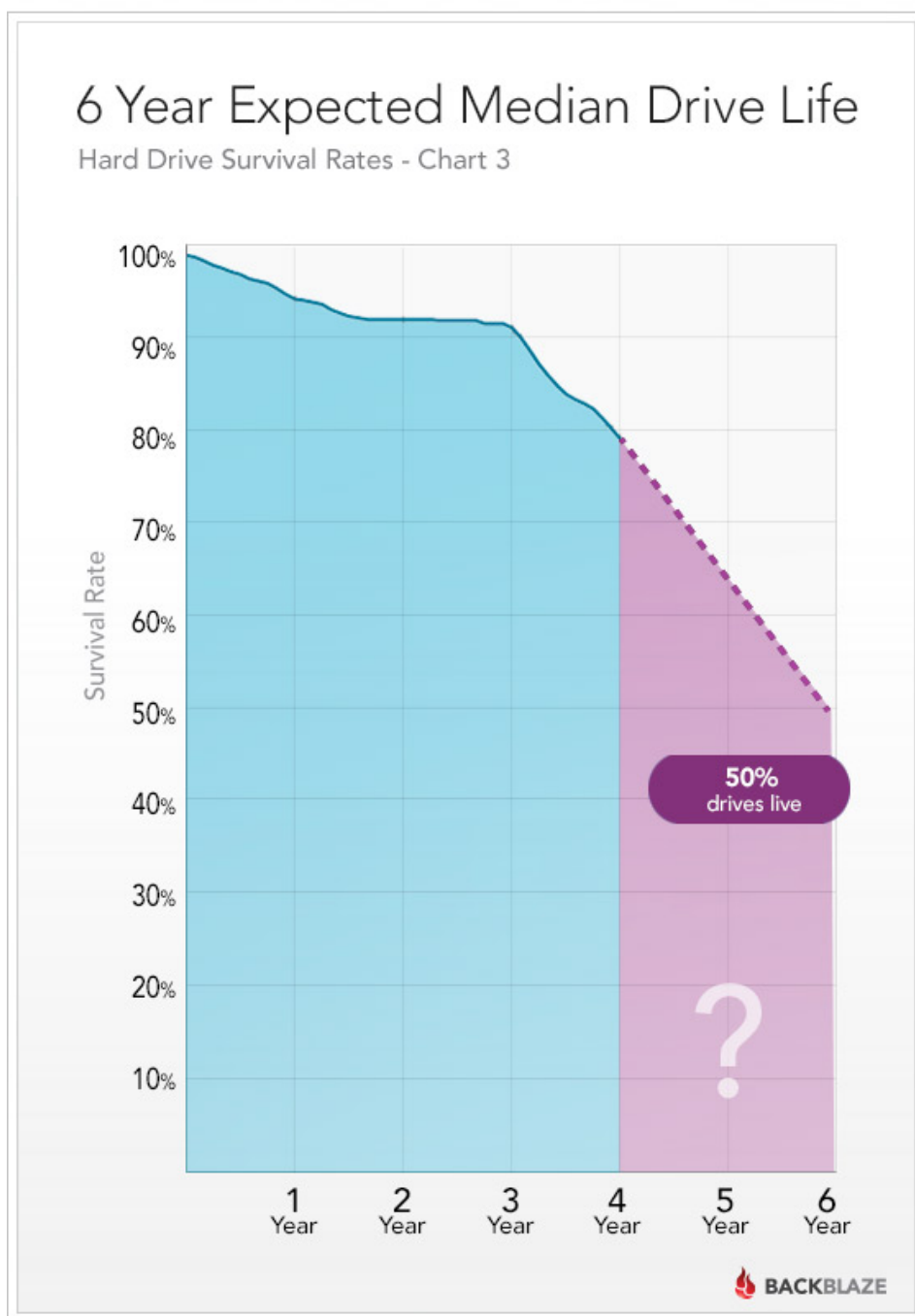
When Backblaze started, there were some concerns that consumer-grade disk drives wouldn't hold up in a data center. If this 6-year median lifespan is true, it means that more than half the drives will last six years, and those concerns were unfounded. We intend to continue to update these statistics quarterly. Thus, over the next couple of years, we'll have hard data on the median lifespan of hard drives. Stay tuned to the blog to find out the answers.

Nov 14: Update

My bad: Due to a transcription error, the percentages in the second paragraph were wrong, and were more pessimistic than necessary. 78% (not 74%) of drives are still alive after four years. The projection of a six-year median lifespan is not affected by this change. Thanks to sharp-eyed Frédéric for catching the error. – Brian

Like ⟨ 2k ⟩   g+1 ⟨ 391 ⟩   Tweet ⟨ 868 ⟩

f Share

Start Backing Up

Tags: Cloud Storage, Storage Pod, TechBytes

Comments by Facebook

88 comments   **Add a comment**

Ted Sbardella
60% of the time it works every time..
Reply · 27 · Like · Follow Post · November 12, 2013 at 9:28am

Hugo Dahl · Tyler Technologies
Granted I have nowhere near the volumes of data Backblaze has on drives, nor any empirical evidence or data, but one thing I have noticed is that, often times, when my drives (all consumer grade) have died in the past, it was only observable during startup (minus head crashes and corrupt writes that took down the OS).

Either the motor or a component of it couldn't spin the drive back up, or some other internal factor that would only happen at startup. Do the pods ever get powered down, or are there any noted failures when a pod is reinserted after service, or are all the observed failures "running failures"?
Reply · 7 · Like · Follow Post · November 12, 2013 at 7:40am

> **Gleb Budman** ·   Follow ·   Top Commenter · Backblaze
> Hi Hugo, the Storage Pods do get powered down sometimes (for example, to replace a drive). However, most of the failures are "running failures" as you call them.
> Reply · 1 · Like · November 12, 2013 at 10:50am

Allen Flores · Yale
In our data center, we have nearly 50 consumer-grade hard drives on nearly constantly. They are primarily 2Gig Western Digital green, with a mix of 1Gig and 2Gig WD black. We lose 1 or 2 hard drives per month, most of the time not a complete crash or non-start but very slow write speeds, on the order of 1/20th of their normal speed, due to constant retries and inability to store properly. At our rate (50 hard drives in use)/(1.5 failures per month) = estimated average life of 33.3 months per drive. This calculation also seems to be borne out by our warranty experience. The green's have a 3-year warranty from WD, and the black's have a 5-year warranty. We have never had a black fail and not be under warranty, and we only occasionally have a green which fails and is past warranty. (WD is great with their warranty plan; you can do ... See More
Reply · 5 · Like · Follow Post · November 12, 2013 at 4:32pm

> **Yevgeniy Pusin** ·   Follow ·   Top Commenter · Social Marketing at Backblaze Online Backup
> We're looking forward to sharing that data as well. No one ever really talks about this stuff in-depth, so we're excited to gather that data and unleash it!
> Reply · Like · November 12, 2013 at 4:48pm

> **Allen Flores** · Yale
> We enjoyed reading about your experiences stripping external hard drives during the shortage after the flood in Thailand. We thought we were the only ones smart enough to do that! We bought out all the local retail stores as soon as we saw what was happening, and we were, fortunately, in good shape until the market calmed down again.
> Reply · Like · November 13, 2013 at 9:50am

> **Yevgeniy Pusin** ·   Follow ·   Top Commenter · Social Marketing at Backblaze Online Backup

Allen Flores Yea, that was a lot of fun :)
Reply · Like · November 13, 2013 at 11:45am

View 1 more

Gleb Budman ·   Follow · Top Commenter · Backblaze

Dave C. didn't have a Facebook account so couldn't comment, but emailed me asking:
"I am also interested in brand vs. failure rate data in your study. I think any user wants to know this above almost any other data. Google, in the study you cite, had this data at their disposal but chose to not share it. Puzzling for a company that considers itself at the fore of sharing everything on the planet."

=> We're looking to see if we have kept this data fine grain enough to do this. Stay tuned.

"Also, you mention that you use consumer-grade drives not the industrial-strength models. It would be nice to hear why you decide this and if you did any comparisons to determine the economy of your choice."

=> The "enterprise" drives cost about 2x more, so the business just wouldn't have worked at the beginning to with them. We're also digging in to the failure stat comparison between these types of drives and hope to publish a follow-up post!

"Thanks for a very informative post."

=> You're welcome ;-)
Reply ·   3 · Like · Follow Post · November 12, 2013 at 3:26pm

Phillip Remaker ·   Follow · San Jose, California

The problem, of course, if that you will be reporting how good they WERE, 2 to 5 years ago. There is no guarantee that the new drives are manufactured by the same process as the ones that are field tested and proven. For example, any Thailand manufactured drive will be built in completely rebuilt plants.
Reply ·   1 · Like · November 19, 2013 at 1:29am

Masen Yaffee · President at New Directions In Computing

Very interesting study. Thanks for posting your findings! I have some problems with the logic behind some of the conclusions, though. If I read the first chart correctly, over 1/2 of the total number of drives in the study were purchased in 2012 and 2013. In other words, the majority of drives in the study are less than 2 years old. It would therefore seem that the data for failure rates is highly skewed, certainly for 2-5 failure calculation, which represent less than half the total drives in the study. The fifth chart claims that 80% of drives last four years. How would you know that if more than 50% of them are less than 2 years old? Still, thank you for sharing your data. It would be really interesting if you did a related article that compared failure rates among different drive vendors and also initial failure rates of drives made several years ago versus drives made today to see whether drive manufacturing is getting better or worse.
Reply ·   2 · Like · Follow Post · November 13, 2013 at 12:19pm

Gerard van Westen · PostDoc at European Bioinformatics Institute (EMBL-EBI)

I know this is potentially a big no go area, but I would be very interested to see if there is any correlation between manufacturer and failure rate .. There are some unconfirmed reports from Russia and most manufacturers have been absorbed by others, still any news would be interesting...
Reply ·   2 · Like · Follow Post · November 12, 2013 at 12:21pm

Yevgeniy Pusin ·   Follow · Top Commenter · Social Marketing at Backblaze Online Backup

Hi Gerard! We're looking to doing a more detailed manufacturer-related post, but we need to be sure we have enough data points to do so. Once we do, we'll be excited to do something like that as well! You should know, there's no "no-go" for us ;-)
Reply ·   5 · Like · November 12, 2013 at 1:30pm

Kien Tran ·   Follow · Pianist at St. Vincent de Paul Catholic Church

Yevgeniy Pusin I can't wait! I've talked to people about how every drive manufacturer is both the least and most reliable out there, and it'd be great to have some large scale data to compare!
Reply ·   2 · Like · November 12, 2013 at 3:00pm

Gerard van Westen · PostDoc at European Bioinformatics Institute (EMBL-EBI)

Yevgeniy Pusin That's great! Would be very much interested (already following the blog so I'll see the post coming by)..
Reply · Like · November 13, 2013 at 4:16pm

John Bolhuis · Redwood City, California

I have seen your cart full of dead hard drives. It's quite impressive. I'm thinking of getting an old VAX or a system/36 to put up on blocks on my side of the fence just to add more character to the place. ;-)
sincerely, your colo neighbor

Reply ·   2 · Like · Follow Post · November 12, 2013 at 7:19pm

Stuart Saunders

Brian, Gleb, whomsoever;
Pls give us some really useful info. Which you have.

Seagate vs WD vs Hitachi vs ……………………………..

Reply ·   2 · Like · Follow Post · November 12, 2013 at 1:25pm

> **Yevgeniy Pusin** ·   Follow ·   Top Commenter · Social Marketing at Backblaze Online Backup
>
> Oh, is that what you want? :) We'd love to! Currently looking in to whether or not we have enough data to do that. Want to make sure we have a large enough data set for the comparisons to make sense!
>
> Reply ·   7 · Like · November 12, 2013 at 1:29pm

> **Nagy Attila** · Budapest, Hungary
>
> Yevgeniy Pusin In the past 20 years I've constantly seen the debat that "WD drives are BAD", "No seagates are BAD", "No Maxtor drivers are BAD" etc etc. I do believe that this is like with cars: there aren't really good and bad manufacturers, but there are good and bad models. Sometimes even batches can have a big impact: we've experienced that drives that where manufactured in the same batch died about the same time, while drives from the same model but manufactured at a different time had no problem at all.
>
> Reply · Like · November 13, 2013 at 4:53am

> **Daniel Armstrong** · Indian Hills Community College
>
> My experience: I have a (1) Seagate ST3120814A with 5 years of spinning time logged in S.M.A.R.T., it still passes SpinRite, scandisk/chkdisk, speed benchmarks, Etc. With flying colors, and has no reallocated sectors.
>
> I also have several failed WD200 (20GB) and 400 drives from computers I have worked on. They died around the time that the 120s became $1/gig.
>
> That said my current desktop has a 1TB Western Digital Blue that is working fine so far. I am hoping for the best.
>
> Reply · Like · November 13, 2013 at 3:55pm

Dallas Hinton

Most valuable information, thanks! (I'm already a customer of yours!). I'd be curious about failure rates crossed with Drive brands (if you dared <g>).

Reply ·   2 · Like · Follow Post · November 12, 2013 at 11:22am

> **Gleb Budman** ·   Follow ·   Top Commenter · Backblaze
>
> Glad to have you! We're digging in to our data to see if we have it detailed enough to do this.
>
> Reply ·   2 · Like · November 12, 2013 at 11:44am

> **Greg Price**
>
> My experience is that it will correlate to model, batch and firmware version rather than brand alone, but the failure mode and time wasted due to "ungraceful" failure modes on some has lead me to avoid particular vendors.
>
> Reply · Like · November 13, 2013 at 12:24am

Marc Runkel

Thanks for this.. Very well written and informative.

Reply ·   2 · Like · Follow Post · November 12, 2013 at 10:24am

> **Gleb Budman** ·   Follow ·   Top Commenter · Backblaze
>
> Glad you liked.
>
> Reply · Like · November 12, 2013 at 10:58am

View 37 more

Facebook social plugin

« Backblaze Stores 75 Petabytes of Data
1/4th as Much as Facebook - Restoring Data From The NSA »