



Importance of magnetic storage innovation in an era of explosive Cloud and AI data growth



Lawrence Ying <lyying@google.com>

Sr Tech Lead, Google Platforms

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Agenda

- Common fallacy: HDDs will soon be replaced by SSDs
- Common fallacy: WORN data dominate storage in Cloud
- Storing the world's information

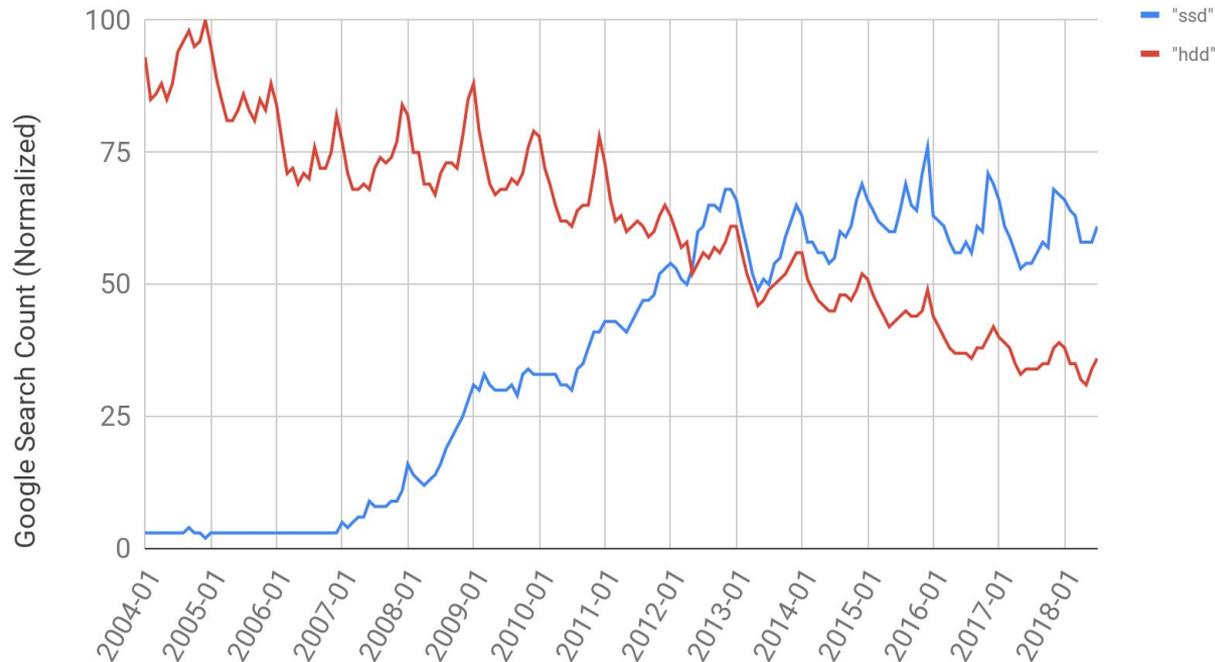
Agenda

- ~~Common fallacy: HDDs will soon be replaced by SSDs~~
Dominance of HDDs for Cloud bulk storage
- ~~Common fallacy: WORN data dominate storage in Cloud~~
Cloud's hunger for both Bytes and IOPS
- Storing the world's information

Common fallacy:
HDDs will soon be replaced by SSDs

Everyone is talking about SSDs

"ssd" vs "hdd" - Google Search interest over time

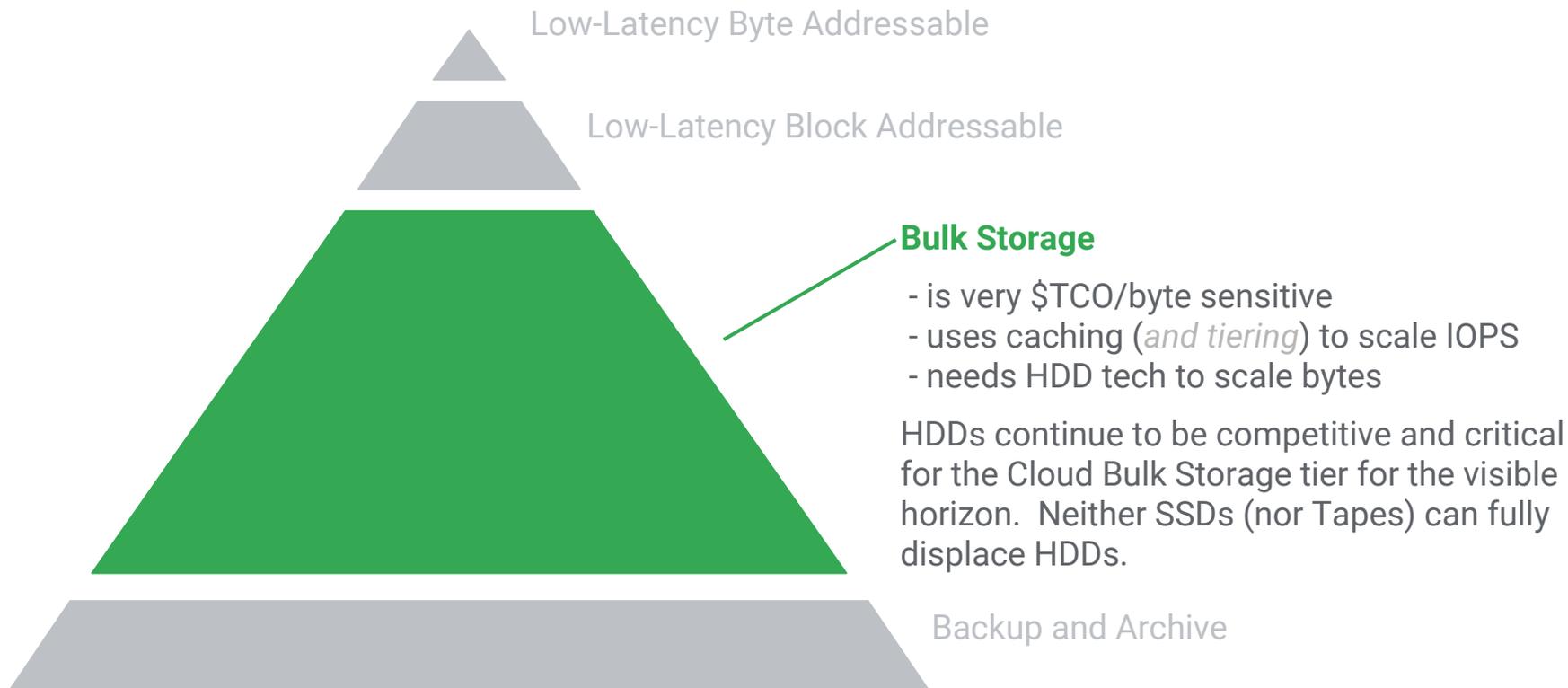


<http://trends.google.com/trends/explore?date=all&q=ssd,hdd>

SSDs are quickly replacing HDDs for the general public.

But what about Cloud?

Common Cloud storage tiers



(image here for illustration purpose only)

Options for Bulk storage tier

	SSD	HDD	Tape
\$(Capex) / Unit <i>(Lower is better)</i>	\$\$	\$\$	\$
Byte / Unit	#	##	##
IOPS / Unit	#####	####	#
Byte/\$ CAGR	~X%	~X%	~X%
Overall Byte/\$	Bad	Good	(IOPS not usable)

Key takeaway

HDDs continue to be competitive and critical for the Cloud Bulk Storage tier for the visible horizon.

Common fallacy:
WORN* data dominate storage in Cloud

* WORN = Write-Once-Read-Never

Need for IOPS, in addition to bytes

The world's information stored continues to grow exponentially.
But what about the need to access this stored information?

As it turns out, the “data access density” (IOPS per Byte) may not be getting colder.

Online virtual communities driving data accesses

Thanks to Cloud, people are more social than ever before, resulting in more data accesses.

Rank	Name	Active User Count
1	Facebook (Messenger)	2.2 Billion
2	YouTube	1.9 Billion
3	WhatsApp	1.5 Billion
4	Instagram	1 Billion
5	WeChat	1 Billion

https://en.wikipedia.org/wiki/List_of_virtual_communities_with_more_than_100_million_active_users

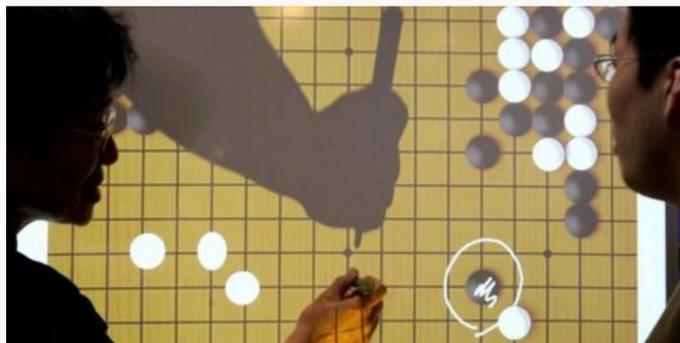
Artificial intelligence driving data accesses

Thanks to AI (artificial intelligence), the need to access (train over) older data is also becoming more common-place.



Google's AI just cracked the game that supposedly no computer could beat

By Mike Murphy | January 27, 2016



Going up. (Reuters/Kiyoshi Ota)



8 million
miles driven by Waymo
self-driving cars since 2009.

All 8 million miles worth of data
are used to train (teach)
self-driving cars how to navigate
safely and comfortably through
all situations.



Translate

Live OCR (optical character recognition) and language translation are now more accurate than ever, thanks to AI training on large data set.



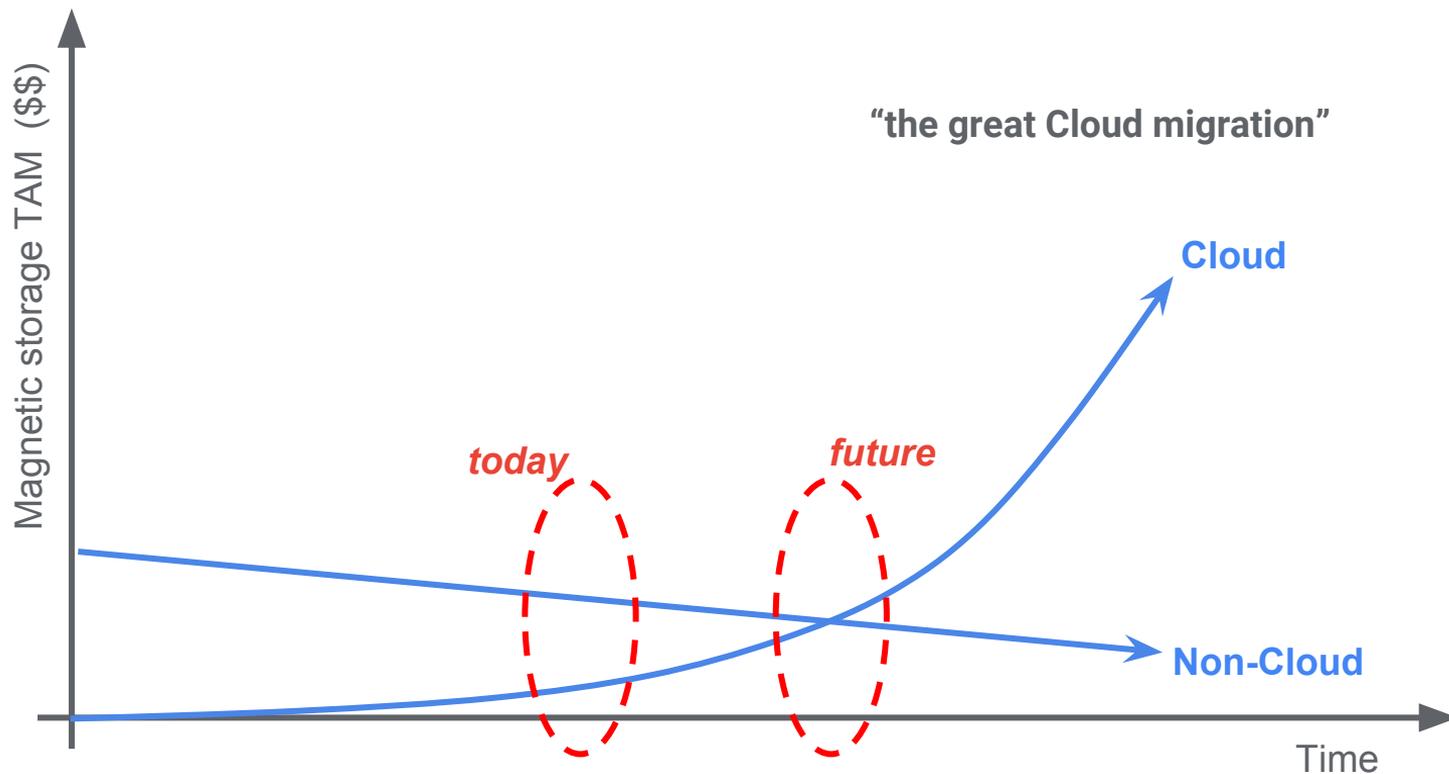
Key takeaway

1. The obvious: We want cheaper bytes!!
2. The less obvious: In addition, we need both
 - HDD IOPS and
 - Tape throughputto increase (cost-optimally) as their capacities increase, in the long-run.
3. Also: We need low-latency storage (such as MRAM) to reach cheaper \$/byte to make caching and tiering more economical (which helps absorb IOPS for the Bulk storage tier).

Storing the world's information

In 5~10 years, the majority of the world's information will be stored in the Cloud.

Magnetic storage TAM (total available market)

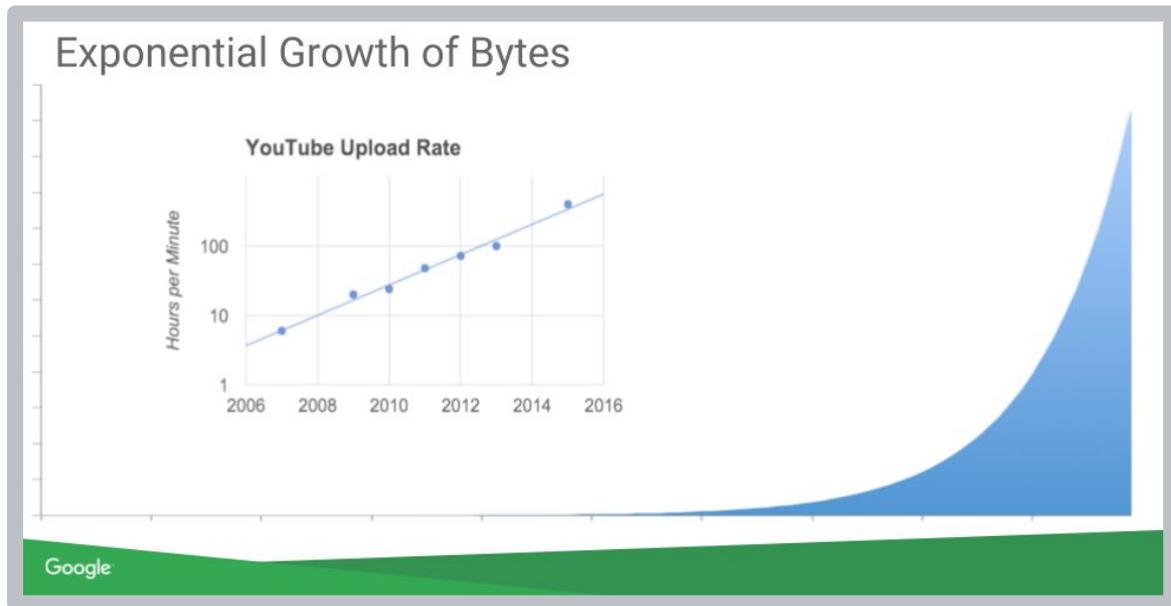


(image here for illustration purpose only)

Cloud continues to grow exponentially



Cloud's hunger for storage bytes is *much greater* than the technology improvement rate of magnetic storage media.



"Disks for Data Center", OCP Summit TechTalk, Aug 2016

More users moving storage into Cloud



The Cloud growth consists of an expanding user base...

Google Drive will hit a billion users this week



Frederic Lardinois @frederic / Jul 25, 2018



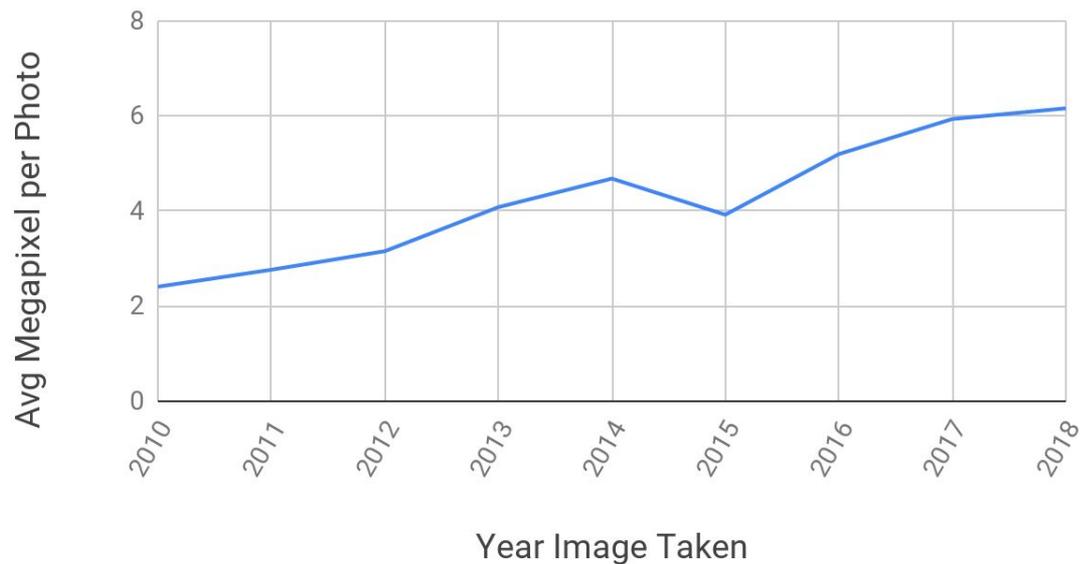
Google 📍 loves to talk about how it has seven products with more than a billion users. Those are its flagship search service, Gmail, Chrome, Google Maps, YouTube, Android and the Google Play Store. Indeed, **Android** 📍 actually has more than 2 billion users now. Later this week, we will be able to add an eighth service to this list: Google Drive, the company's online file storage service that [launched back in 2012](#).

More data per user as well



... coupled with an increasing storage need per user.

Google Photos - User Uploaded Image Resolution

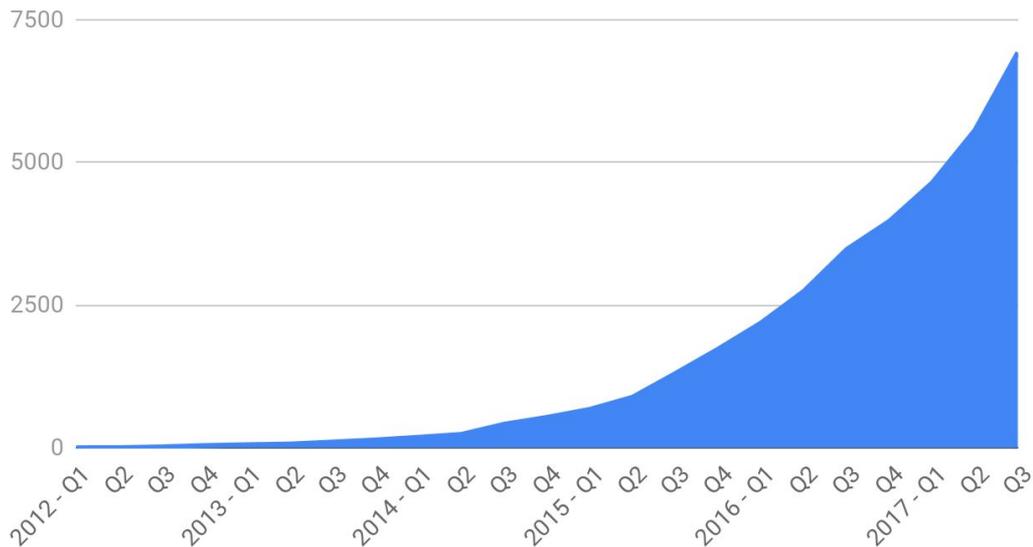


And the growth of artificial intelligence



And a lot of data
are never truly
cold!!

Google source code directories containing Brain/AI Model



Information has the greatest value when it is ***accessible and useful***.

Thanks to Cloud and AI,
the world's hunger for storage is growing faster than ever before.

We need your help to accelerate innovation in magnetic storage technologies,
to be able to handle Cloud and AI's explosive storage needs.

Together, we can
organize the world's information
and make it universally accessible and useful !!

A wide-angle, high-angle photograph of a large server room. The room is filled with rows of server racks, each illuminated with a soft blue light. The racks are arranged in a grid pattern, and the floor is a light-colored tile. The ceiling is high and features a complex network of pipes and cables. The overall atmosphere is clean, organized, and technologically advanced.

Thank You