

<http://arnaud-nauwynck.github.io>

Big Data

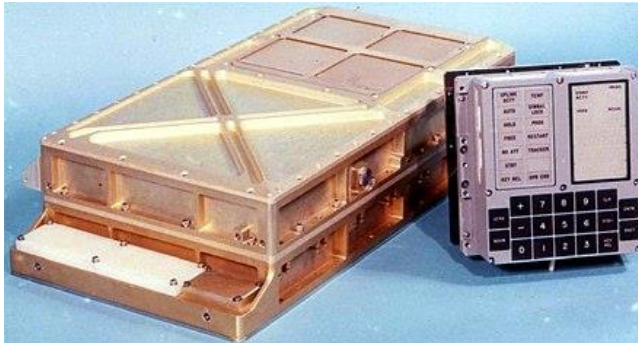
History, Hardware-Software evolution
To
Distributed Computing

arnaud.nauwynck@gmail.com

Big Data ...

Big? is Time-relative

cell phone (in 2021) $\geq 1000x$ "more"



than Appolo moon
guidance computer (1968)

Moore's Laws

Moore's Law: The number of transistors on microchips doubles every two years

Moore's law describes the empirical regularity that the number of transistors on integrated circuits doubles approximately every two years. This advancement is important for other aspects of technological progress in computing – such as processing speed or the price of computers.

Our World
in Data

Transistor count

50,000,000,000

10,000,000,000

5,000,000,000

1,000,000,000

500,000,000

100,000,000

50,000,000

10,000,000

5,000,000

1,000,000

500,000

100,000

50,000

10,000

5,000

1,000

Year in which the microchip was first introduced

Data source: Wikipedia (wikipedia.org/wiki/Transistor_count)

OurWorldinData.org – Research and data to make progress against the world's largest problems.

Licensed under CC-BY by the authors Hannah Ritchie and Max Roser.



Gordon Moore in 1965

MOSFET scaling (process nodes)

10 μm – 1971

6 μm – 1974

3 μm – 1977

1.5 μm – 1981

1 μm – 1984

800 nm – 1987

600 nm – 1990

350 nm – 1993

250 nm – 1996

180 nm – 1999

130 nm – 2001

90 nm – 2003

65 nm – 2005

45 nm – 2007

32 nm – 2009

22 nm – 2012

14 nm – 2014

10 nm – 2016

7 nm – 2018

5 nm – 2020

Future

3 nm ~ 2022

Kryder's « Law »

density & capability of hard drive storage ~ *2 every 13 months



HDD: 2To in 2011



HDD: 10To in 2021 (~300 euros)

Seagate NAS HDD IronWolf - disque dur 10 To

Visiter la boutique Seagate

★★★★★ 236 évaluations

287,39 € Prix conseillé: 359,95 € -20%

Tous les prix incluent la TVA.

Payez en 4 fois sans frais Voir conditions

Neufs (24) à partir de 287,39 € & Livraison GRATUITE

Capacité du

10 To

stockage

numérique

Compatibilité du

Nas

périphérique

Interface du

Serial ATA

disque dur

Marque

Seagate

✓ Voir plus

À propos de cet article

- Seagate NAS HDD IronWolf. Taille du disque dur: 3.5"
- Capacité disque dur: 10000 Go
- Vitesse de rotation du disque dur: 7200 tr/min
- Puissance d'exploitation moyenne (W): 7.8 W
- Fonctionnement (température signalée par le variateur, ° C): 65

✓ Voir plus de détails



Samsung 970 EVO Plus MZ-V7S2T0BW |
Disque SSD Interne NVMe M.2, 2 To, Jusqu'à 3
500Mo/s en lecture séquentielle

Visiter la boutique Samsung

★★★★★ 42 724 évaluations

254,90 €

Tous les prix incluent la TVA.

Payez en 4 fois sans frais Voir conditions

Neufs & occasions (36) 236,13 € Livraison GRATUITE en France métropolitaine.

Capacité: 2 To

1 To 2 To 250 Go 500 Go 512 Go

Style: 970 EVO plus

970 EVO 970 EVO plus 970 Pro 980 980 Pro

980 Pro avec dissipateur

Nom du motif: 3 500 Mo/s

3 500 Mo/s 7 000 Mo/s

SSD: 2To in 2021 (~250 euros)

Density...



48 * HDD disks in 2U blade



32 * SSD (E.1 EDSFF) in 1U blade
... 500 Tera / 1 Peta !! ... 200 000 euros

SCM: Storage Class Memory

persistent + fast

Compromise NDRAM <-> SSD

3D XPoint™ Technology: An Innovative, High-Density Design

Cross Point Structure

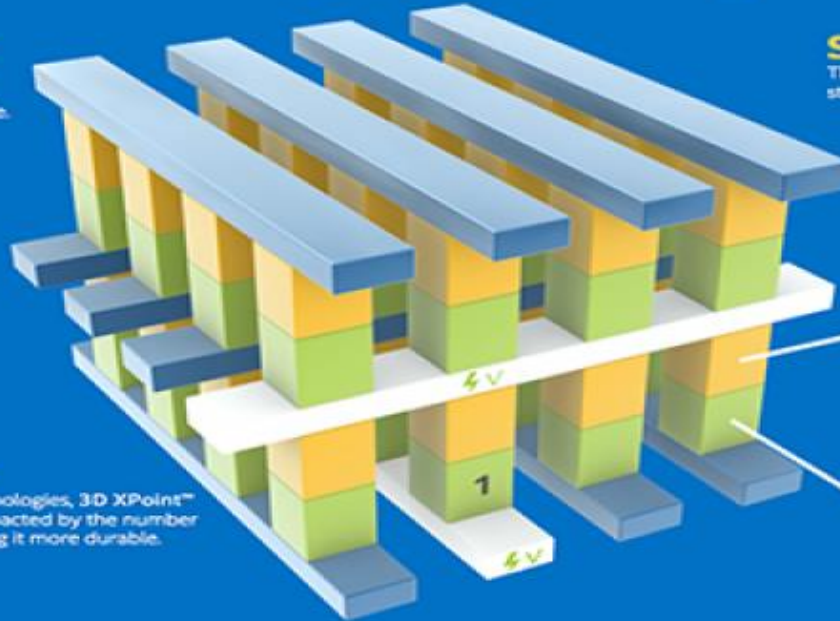
Perpendicular wires connect submicroscopic columns. An individual memory cell can be addressed by selecting its top and bottom wire.

Non-Volatile

3D XPoint™ Technology is non-volatile—which means your data doesn't go away when your power goes away—making it a great choice for storage.

High Endurance

Unlike other storage memory technologies, 3D XPoint™ Technology is not significantly impacted by the number of write cycles it can endure, making it more durable.



Stackable

These thin layers of memory can be stacked to further boost density.

Selector

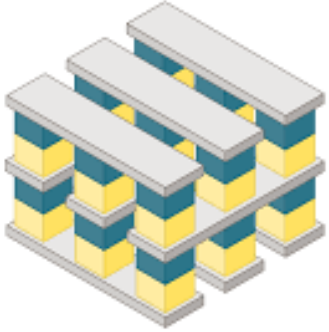
Whereas DRAM requires a transistor at each memory cell—making it big and expensive—the amount of voltage sent to each 3D XPoint™ Technology selector enables its memory cell to be written to or read without requiring a transistor.

Memory Cell

Each memory cell can store a single bit of data.

3D - Intel Optane

No transistors ... changed of state (resistance)
in 3D stacks



10x faster (*more expensive) than SSD

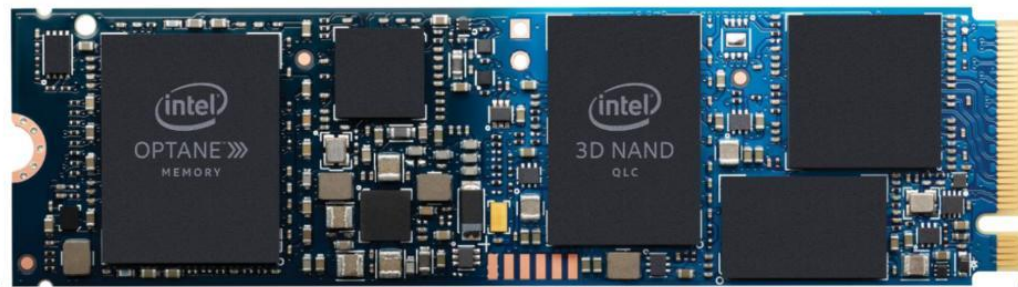
Slower (cheaper) than DDR4 RAM

⇒ For server up to 3To fast & persistent memory...

⇒ ~ 12 000 \$ / 1 To

NAND (SSD) + Optane as Cache

INTEL® OPTANE™ MEMORY H10 WITH SOLID STATE STORAGE



Single device fits in small spaces with its versatile M.2 form factor designed for mobile device and desktops

INTEL® OPTANE™ TECHNOLOGY

- Accelerate your PC with breakthrough responsiveness so you can search and find files faster, and launch applications quicker
- Conquer storage-demanding applications with smart software that automatically learns your computing behaviors to accelerate frequent tasks

INTEL® QLC 3D NAND TECHNOLOGY

- Get up to 1TB of storage capacity with an Intel® QLC 3D NAND SSD into a smaller footprint
- Transfer data at PCIe* speeds, unleashing the full power of QLC, and getting from data to productivity faster

Memory & Disk Technologies Disruptions

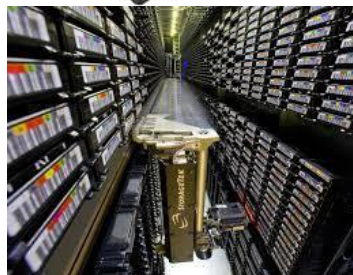
RAM



HDD



Tape



~2015
Switch HDD / SSD

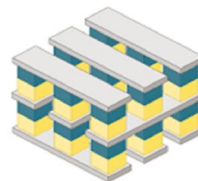
SSD (since 1991)



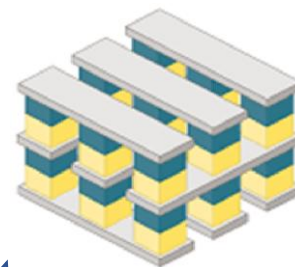
future
switch??



SCM - 3D Xpoint

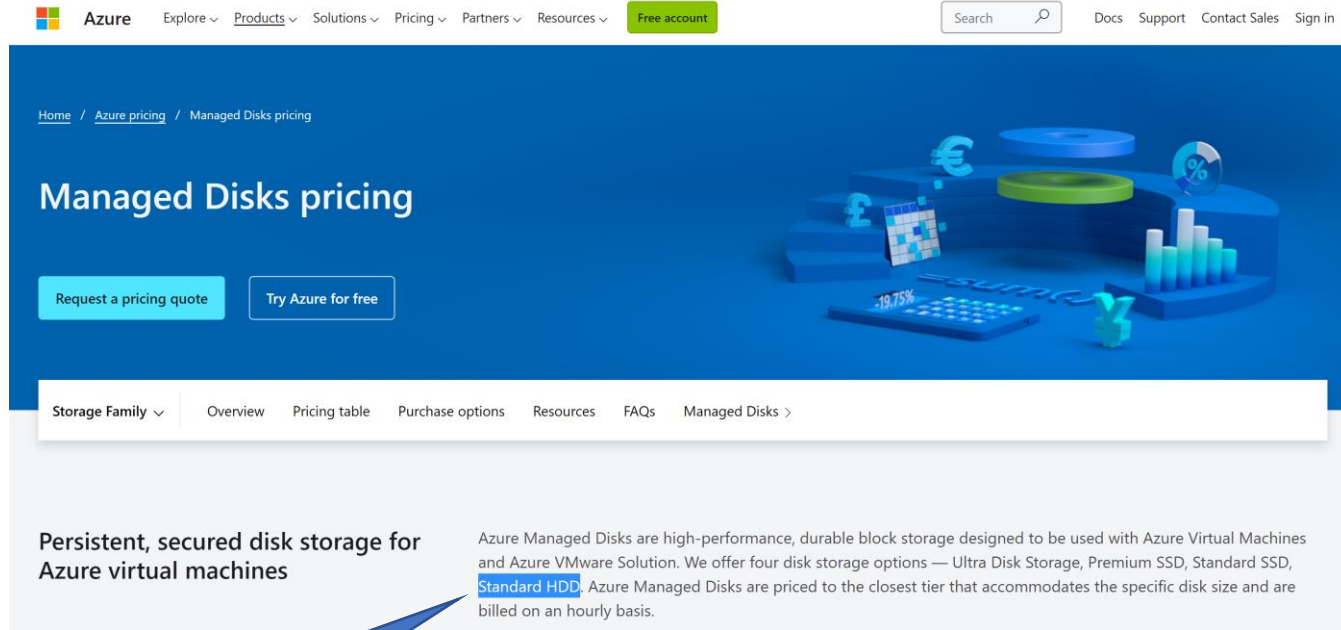


(since 2017)



Next switch ??
> 2022

Example HDD -> SSD



Azure Explore Products Solutions Pricing Partners Resources Free account

Home / Azure pricing / Managed Disks pricing

Managed Disks pricing

Request a pricing quote Try Azure for free

Storage Family Overview Pricing table Purchase options Resources FAQs Managed Disks >

Persistent, secured disk storage for Azure virtual machines

Azure Managed Disks are high-performance, durable block storage designed to be used with Azure Virtual Machines and Azure VMware Solution. We offer four disk storage options — Ultra Disk Storage, Premium SSD, Standard SSD, Standard HDD. Azure Managed Disks are priced to the closest tier that accommodates the specific disk size and are billed on an hourly basis.

???

No more HDD
Hardwares in
Azure DataCenters

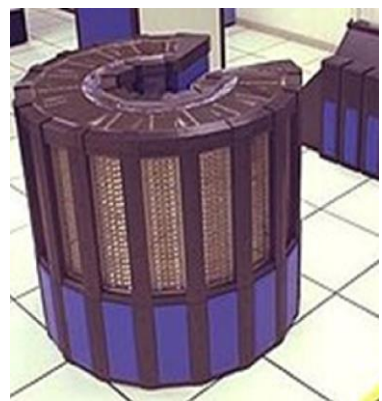
!!!!



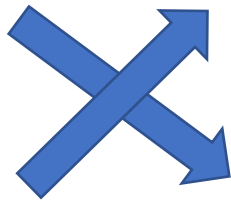
HDD are emulated « throttled »
From SSD
For lower perf ... lower billed

Vertical -> Horizontal Scaling

Disruptions of DataCenters



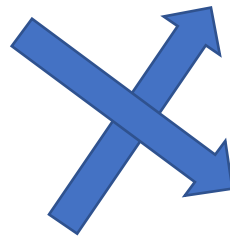
Hardwares:
Super-Computer
« Crays »



1980 : PC

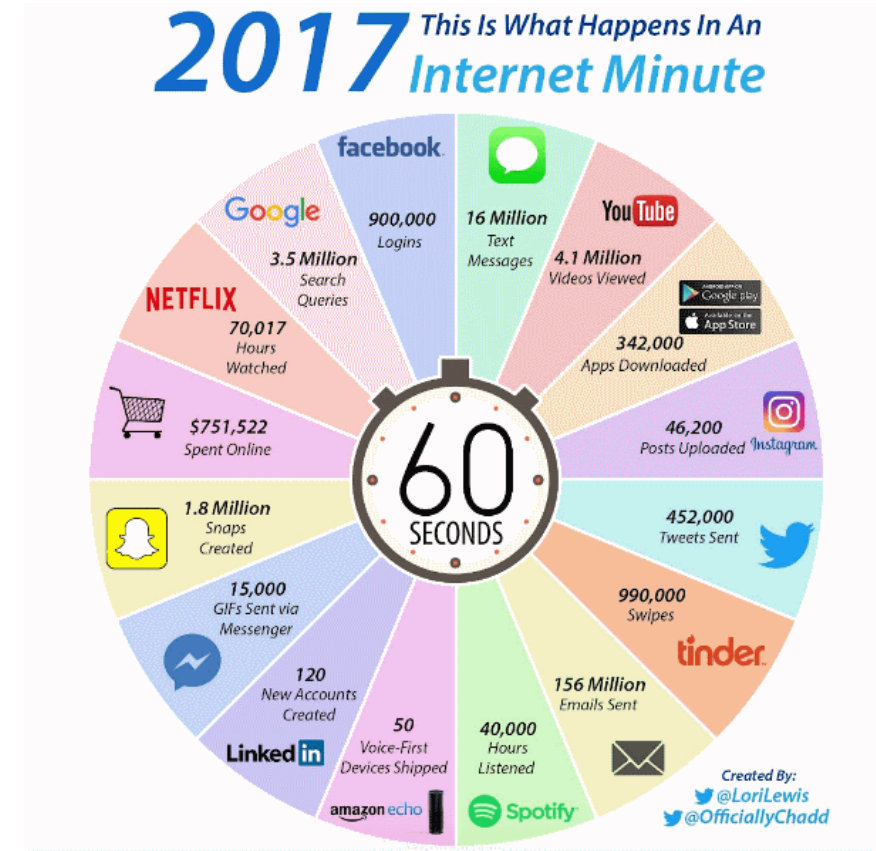
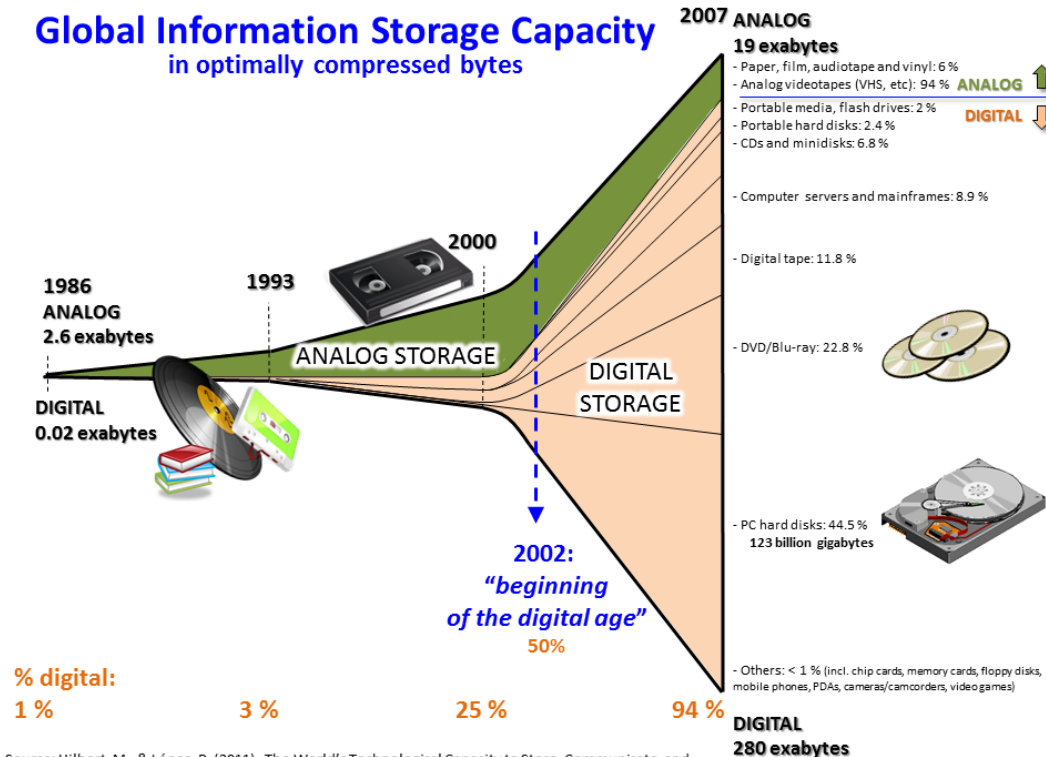


Hardwares:
Distributed (DataCenters)



« Blade » commodity hardwares

Data, Data, Data = DataCenters





how many petabytes of data does google have



All



News



Images



Shopping



Videos



More

Tools

About 971,000 results (0.49 seconds)

1,200 petabytes

Science Focus estimates that Google, Amazon, Microsoft and Facebook collectively store **at least 1,200 petabytes**. (That's not even including well-known storage sites like Dropbox.) A thousand gigabytes equals a terabyte - or 1 million megabytes. Jul 29, 2019

<https://starry.com> › [blog](#) › [inside-the-internet](#) › [how-big-is...](#) ⋮

[How Big Is The Internet? Hint: Probably A Lot Bigger Than ...](#)

1 Peta = 1000 Teras

= 1,125,899,906,842,624 Bytes

Not Only for



Example at French Bank «SG » : 3 Petas in 2020
for storing Vars / Risks / market params / trades

« Small » Cluster : 6 racks

~ 90 servers * { 256 RAM + 42 cores + 8 disks }

HOW BIG IS A PETABYTE?

11,000 4k movies



It would take you over 2.5 years of nonstop binge watching to get through a petabyte's worth of 4k movies



20+ PB of data
in the Library of Congress



If you took a petabyte's worth of
1GB flash drives and lined them up
end to end, they would stretch over

92 football fields



4,000 digital photos
every day for the rest of your life

Sources: Lifewire.com,
Blogs.loc.gov, cobaltiron.com

cobalt IRON

Softwares for BigData ?

No more traditionnal
Oracle DB + single Jdbc client ...

Definition of BigData

= NO FIT in a Single Server
(even 10Million\$, Huge with SAN)

3 Vs

Volume, Velocity, Variety

(5vs : + veracity, value)

3 Vs

Volume, Velocity, Variety

> Peta
bytes

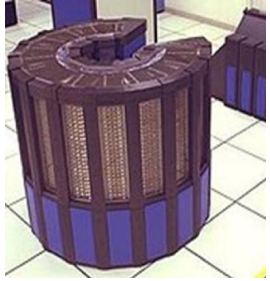
The diagram illustrates the three Vs of Big Data. At the top, the text '3 Vs' is followed by 'Volume, Velocity, Variety'. Below each term is a blue speech bubble pointing to it. The 'Volume' bubble contains '> Peta bytes'. The 'Velocity' bubble contains '<= 1 h / day to process'. The 'Variety' bubble contains '>= Millions files (Parquet..)'.

<= 1 h / day
to process

>= Millions files
(Parquet..)

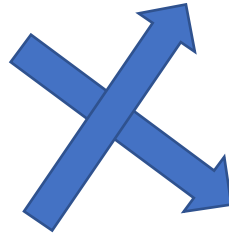
Softwares Disruption

Distributed & Fault Tolerance



Software: **MPI**
Message
Passing
Interface
(1 OS, 1 process, N Threads)

↑
1995



Software: **MapReduce**
Distributed computing
... Fault Tolerant

↑
2004

MapReduce Google paper : 2004 (end of use ~2014)

MapReduce: Simplified Data Processing on Large Clusters

Jeffrey Dean and Sanjay Ghemawat

jeff@google.com, sanjay@google.com

Google, Inc.

Abstract

MapReduce is a programming model and an associated implementation for processing and generating large data sets. Users specify a *map* function that processes a key/value pair to generate a set of intermediate key/value pairs, and a *reduce* function that merges all intermediate values associated with the same intermediate key. Many real world tasks are expressible in this model, as shown in the paper.

Programs written in this functional style are automati-

cally straightforward. However, the input data is usually large and the computations have to be distributed across hundreds or thousands of machines in order to finish in a reasonable amount of time. The issues of how to parallelize the computation, distribute the data, and handle failures conspire to obscure the original simple computation with large amounts of complex code to deal with these issues.

As a reaction to this complexity, we designed a new

programming model that is simpler and more expressive

MapReduce @Yahoo = Hadoop .. 2006

Constraint

=>

Architecture

Choice

Commodity Hardwares (datacenters):

Only HDD + RAM

Data Locality : co-host Storage near Compute

use RAM to cache

avoid network



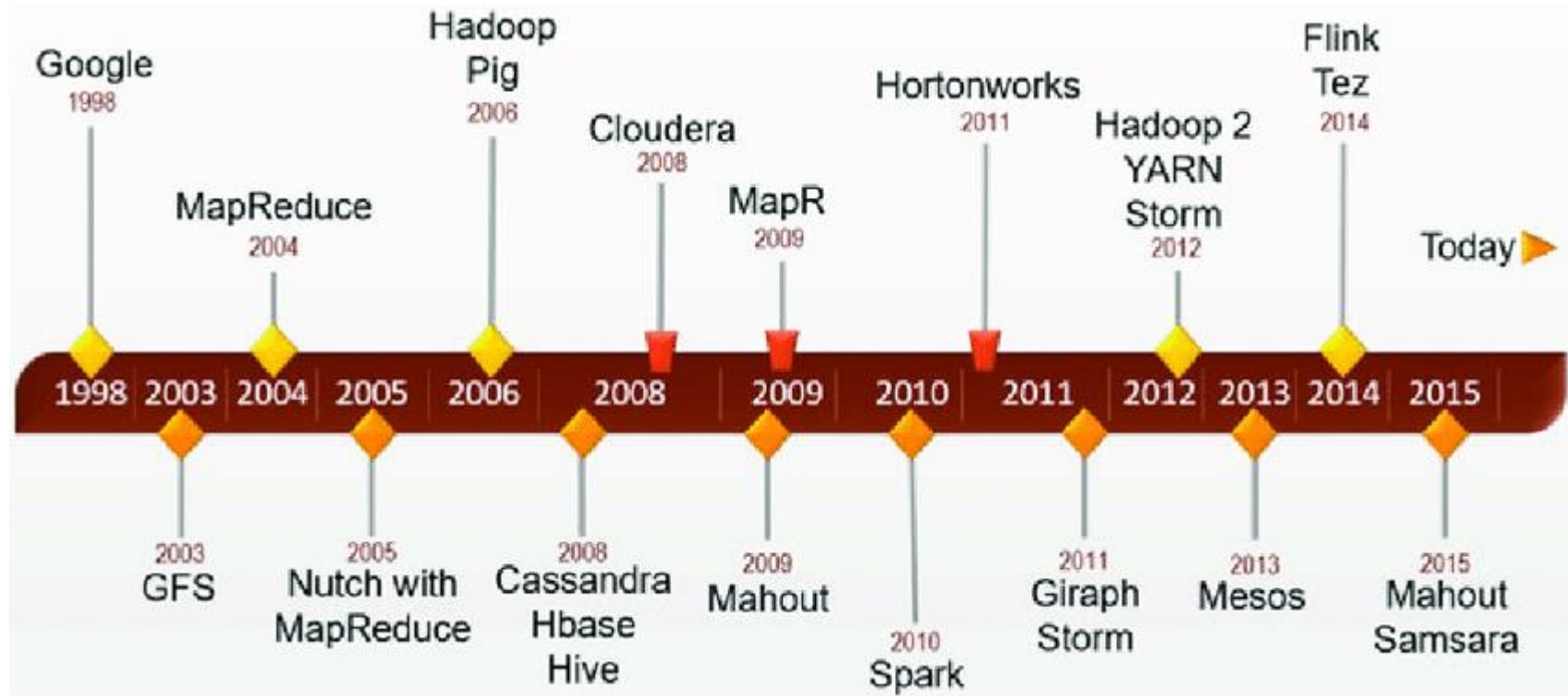
2006

Think different?

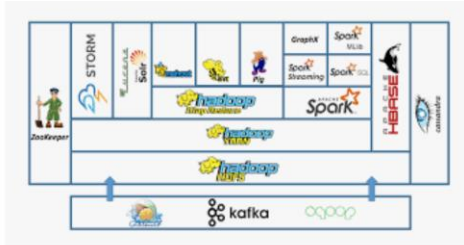
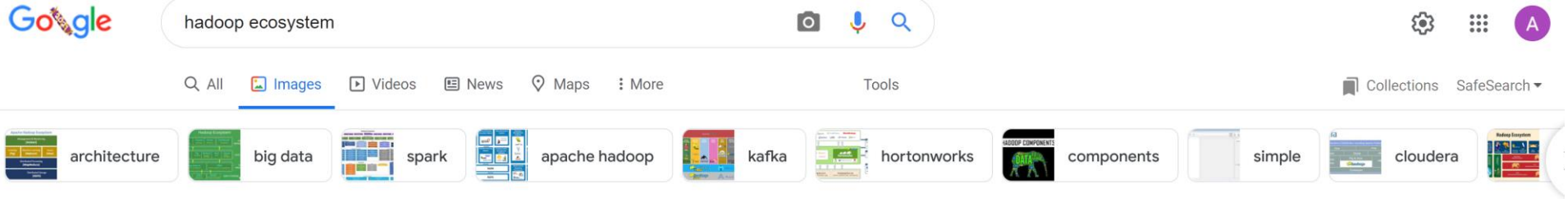


2020

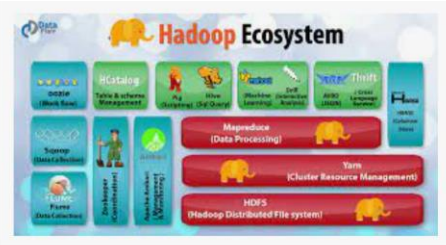
Hadoop + Community + Companies + Specific Tool 1 + Specific Tool 2+ ...



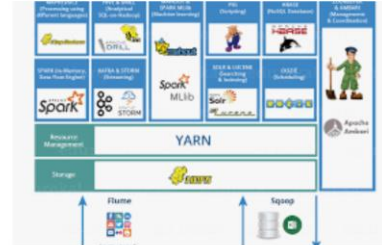
Hadoop Ecosystem « Explosion »



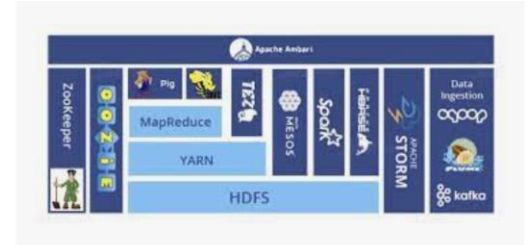
Hadoop pour les nuls - Présentation de ...
ledatascientist.com



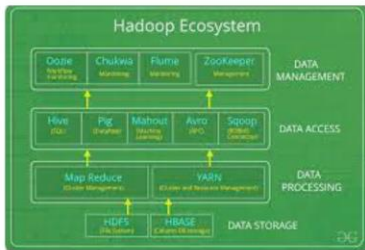
Hadoop Ecosystem and Their Components ...
data-flair.training



Hadoop Ecosystem | Hadoop Tools for ...
edureka.co



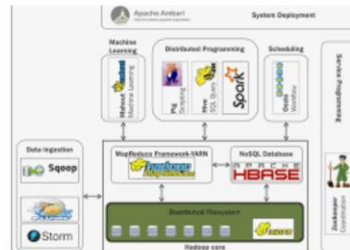
Hadoop Ecosystem. Before talking about ...
medium.datadriveninvestor.com



Hadoop Ecosystem - GeeksforGeeks
geeksforgeeks.org



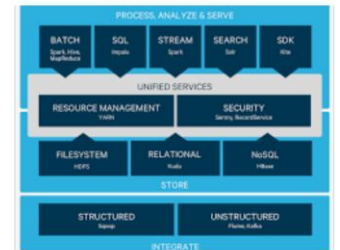
Apache Hadoop Ecosystem | Download ...
researchgate.net



The Hadoop ecosystem | Hadoop Essentials
subscription.packtpub.com



Overview of the Hadoop ecosystem ...
oreilly.com



Apache Hadoop open source ecosystem...
cloudera.com



At The end, Only 1 will remain
(French TV Game: Koh-Lanta)





Spark
Spark Sql / Mlib / ..
Spark Streaming

1 System
N library extensions
2 Modes (Batch / Streaming)

