Introduction to Big Data

APACHE HADOOP

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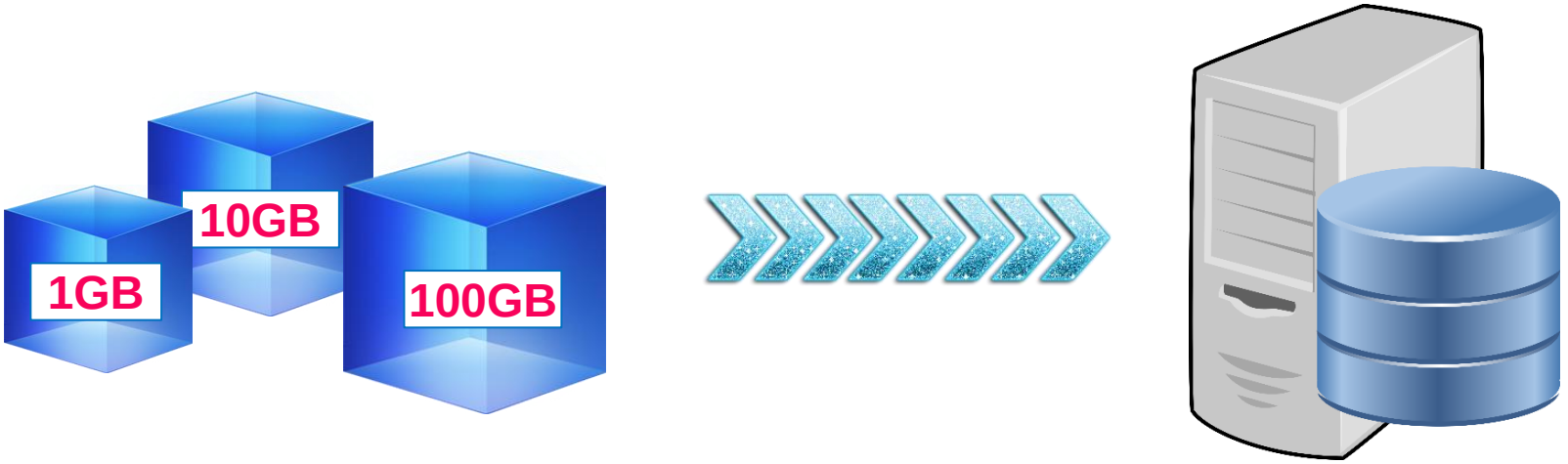
Outline

- An introduction to Apache Hadoop
- When to use and not to use Hadoop
- Hadoop installation
- Hadoop: Now and Future

Imagine a scenario where…



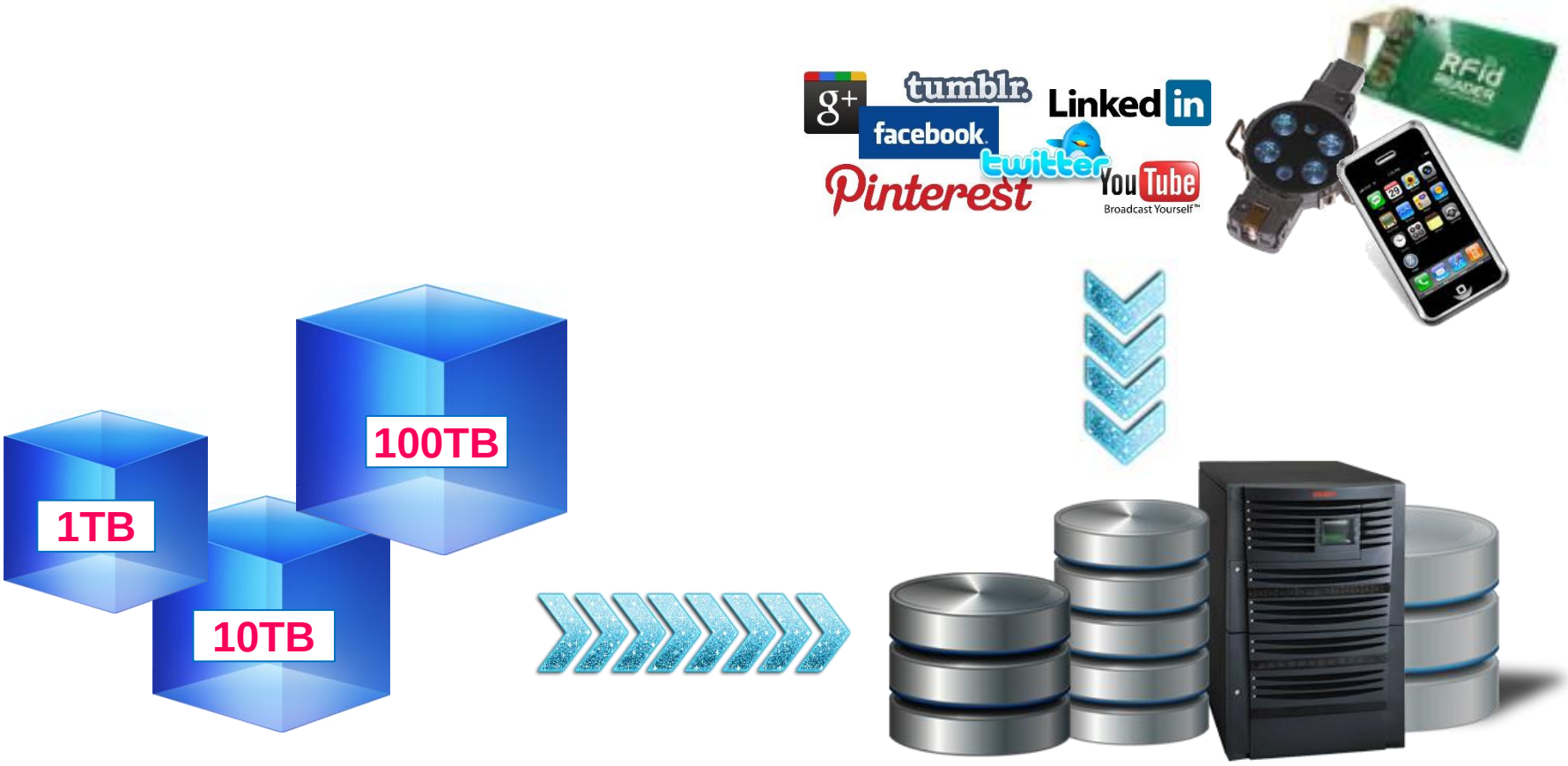
You have 1GB of data to process…. No problem!

Your company starts growing very quickly, and that data arises to 10GB

And then 100GB….

You start to reach the limits of your current desktop computer.

Imagine a scenario where…



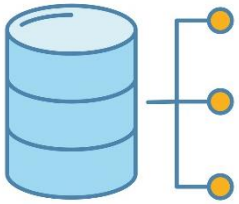
Therefore, you scale-up by investing in a larger computer, but…

the data increases quickly in a few months

it is required to feed the application with unstructured data

Imagine a scenario where…

You may want to



Derive information from data of various types, not limited to relation data only.

Obtain the derivation as soon as possible.

may be your answer!!!

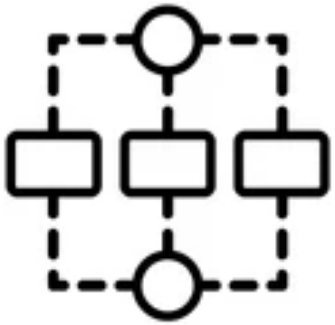
What is Hadoop?

Triển khai trên một cluster gồm hàng ngàn node, mỗi node lưu trữ dữ liệu phân tán

Written in Java

ASF project

Distributed storage



Massive parallel processing

Reliable replication

MAPREDUCE (Processing using different languages)

HIVE & DRILL (Analytical SQL-on-Hadoop)

MAHOUT & SPARK MLlib (Machine learning)

PIG (Scripting)

HBASE (NoSQL Database)

ZOOKEEPER & AMBARI (Management & Coordination)

Apache Ambari

SPARK (In-Memory, Data Flow Engine)

KAFKA & STORM (Streaming)

SOLR & LUCENE (Searching & Indexing)

OOZIE (Scheduling)

Resource Management

YARN

Storage

HDFS

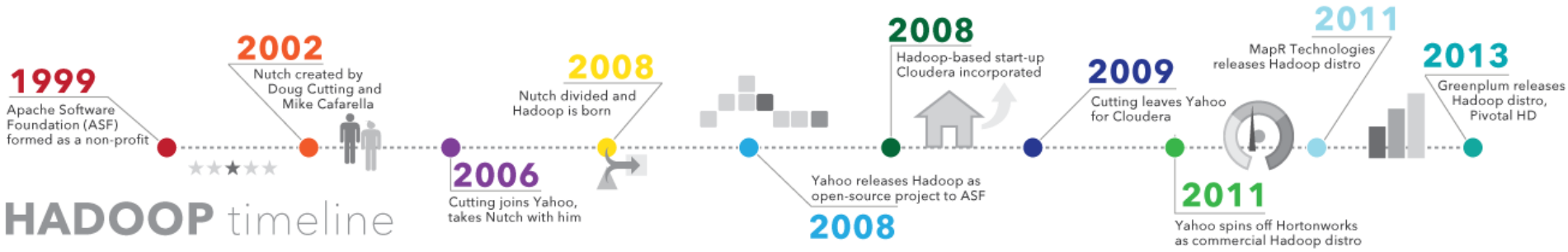
Flume

Unstructured/ Semi-structured Data

Sqoop

Structured Data

A brief history of Hadoop

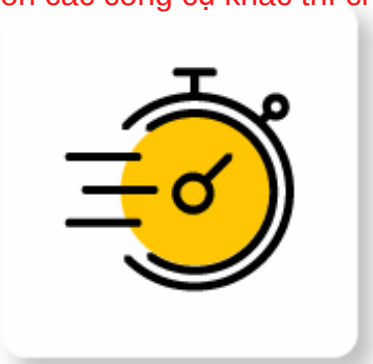


- 2002 – Dough Cutting and Mike Caferella created the Nutch project.
- 2006 – Cutting joined Yahoo and the Nutch project was divided.
  - The web crawler portion remained as Nutch.
  - The distributed computing and processing portion became Hadoop, which was later released as an open-source project.
- 2008 – Yahoo released Hadoop as an open-source project.
- Today, Hadoop's framework and ecosystem of technologies are managed and maintained by ASF

Source: SAS

Hadoop framework: Benefits

nhanh hơn khi xử lý thủ công
còn các công cụ khác thì chưa chắc



Fast

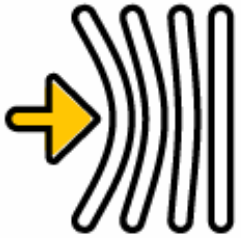
Flexible

Scalable

Hiệu quả về mặt chi phí - tiền bạc

Cost-effective

High throughput



Resilient to failure

khả năng thích nghi phục hồi sau khi xảy ra lỗi

Image credit: Appinventiv

Hadoop framework: Benefits

chia nhỏ công việc ra và xử lý song song -> fast hơn xử lý tuần tự

- Fast: Hadoop makes data processing hassle-free and faster.
  - It has been found that Hadoop can process terabytes of unstructured data in just a few minutes, while petabytes in hours.
- Flexible: Hadoop helps gather data from different sources, of various types, and get valuable insights for many purposes.
  - Data sources: social media, emails, etc.)
  - Data types: structured, semi-structured, or unstructured.
  - Purposes: log processing, market analysis, fraud detection, etc..
- Scalable: Businesses can store and distribute large data sets from hundreds of servers that operate parallelly.

lưu trữ theo hình thức chung và thực hiện song song

Source: Appinventiv

Hadoop framework: Benefits

thiết bị có cấu hình phổ thông

- Cost-effective: Hadoop runs on commodity hardware.
  - One can easily increase nodes without suffering from any downtime of pre-planning requirements.

Tăng số lượng nodes - nhiều máy tính hơn -> để cải tiến và xử lý tính toán, lưu trữ dữ liệu -> việc này không tốn quá nhiều chi phí

- High throughput: More jobs can be done in less time.
  - A small job is split into multiple chunks of data in parallel, which are easier to handle.
- Resilient: It is possible to recover data whenever any node goes down.
  - It stores replicas of every block at different nodes in the cluster.

Có cơ chếp phát hiện node lỗi và tạo bản sao mới để đảm bảo luôn có một số lượng bản sao nhất định -> tính phục hồi tốt

Source: Appinventiv

Hadoop framework: Limitations

Issues with small files

Iterative processing

Low security

Higher vulnerability

Support only Batch processing

Image credit: Appinventiv

Hadoop framework: Limitations

block in HDFS is 128 MB lớn hơn rất nhiều các file trong máy.
HDFS chỉ phù hợp cho dữ liệu ở quy mô lớn, và chia các block ở dung lượng từ 128 - 256 MB

- Issues with small files: Hadoop lacks the potential to support random reading of small files efficiently and effectively.
  - A small file is comparatively smaller than the HDFS block size.
  - A vast number of small files may overload the HDFS namespace.
- Iterative processing: Hadoop is an unfit choice for machine learning or iterative processing-based solutions.
  - The data flow in Hadoop framework is in the form of a chain, such that the output of one becomes the input of another stage.

Input -> Map - > Reduce -> Output: chỉ đi một đường, không phù hợp cho các tác vụ có quy trình lặp
Có cách modify nhưng không phải cấu hình gốc
-> chạy 1 lần đầu ra sẽ là đầu vào và trick để workflow có thể chạy nhiều lần.

Thay vì xử lý vấn đề này trong Hadoop thì dùng Spark

Source: Appinventiv

Hadoop framework: Limitations

Có thể liên hệ bên thứ 3 để cải thiện độ bảo mật bởi Hadoop chỉ thu thập và xử lý dữ liệu

- Low security: Security model is disabled by default.
  - Hadoop does not offer encryption at the storage and network levels.
- Higher vulnerability: Cybercriminals may easily get access to Hadoop-based solutions.

Nói về khả năng bị tấn công

  - Java is a popular, yet heavily exploited programming language.
- Support only Batch processing: MapReduce fails to take advantage of memory to the maximum.

Chỉ hỗ trợ xử lý dữ liệu tĩnh, trong quá trình tính toán không tiếp nhận dữ liệu mới.

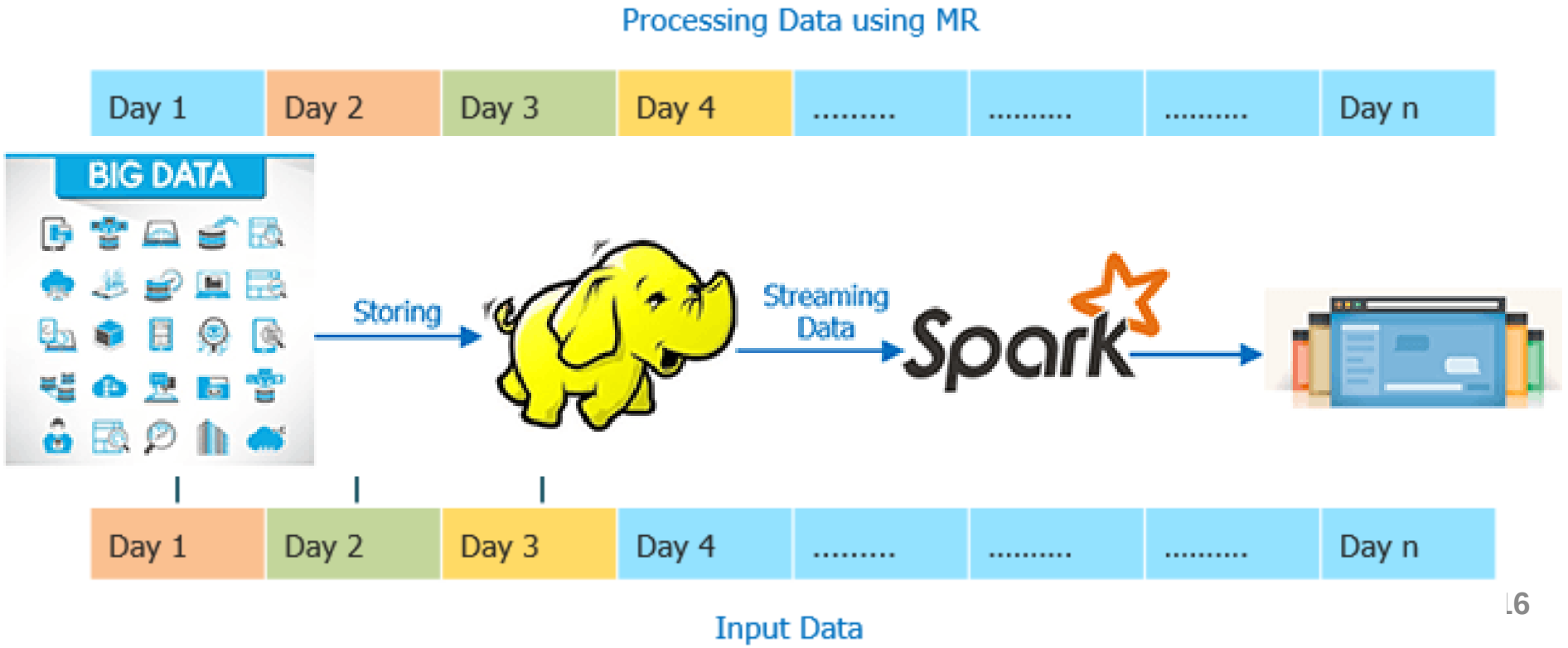
Source: Appinventiv

When to use Hadoop?

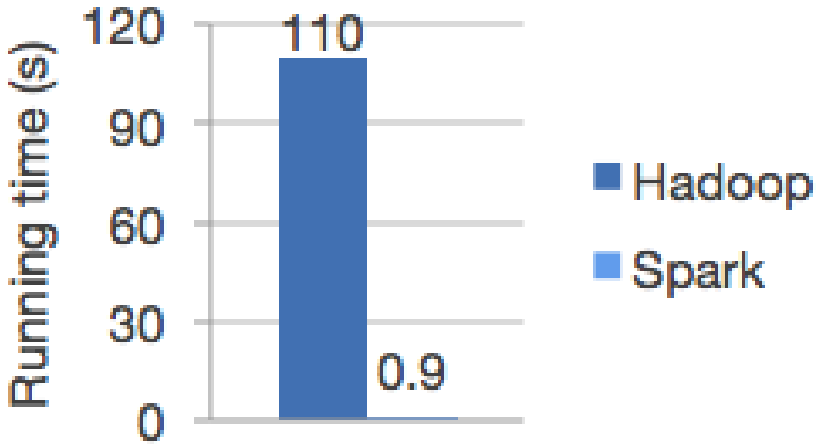
When not to use Hadoop?

Không phù hợp cho các ứng dụng phân tích theo thowifp gian thực.

- Real-time analytics: Results are expected to come quickly.
  - Hadoop works on batch processing → response time is high
  - Alternative: store the Big data in HDFS and mount Spark over it to make the processing real time

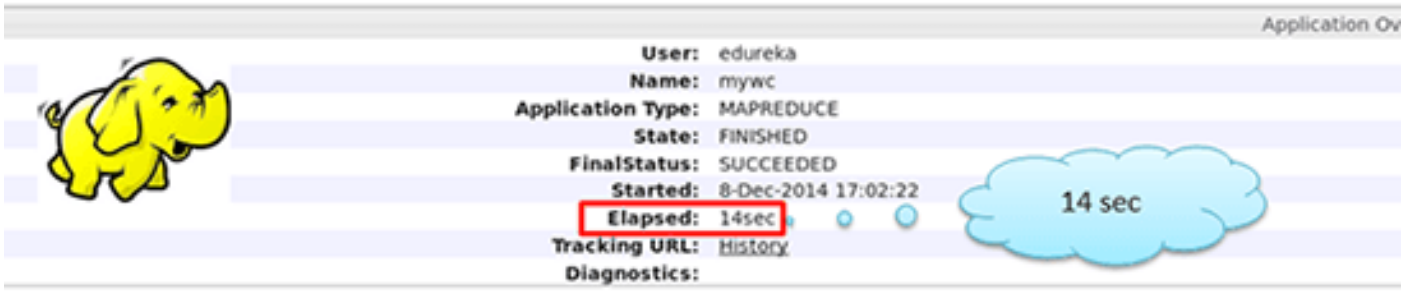


Hadoop vs. Spark: Performance



Spark runs programs up to 100x faster than Hadoop MapReduce in memory, or 10x faster on disk.

A simple example of line processing in Hadoop and Spark



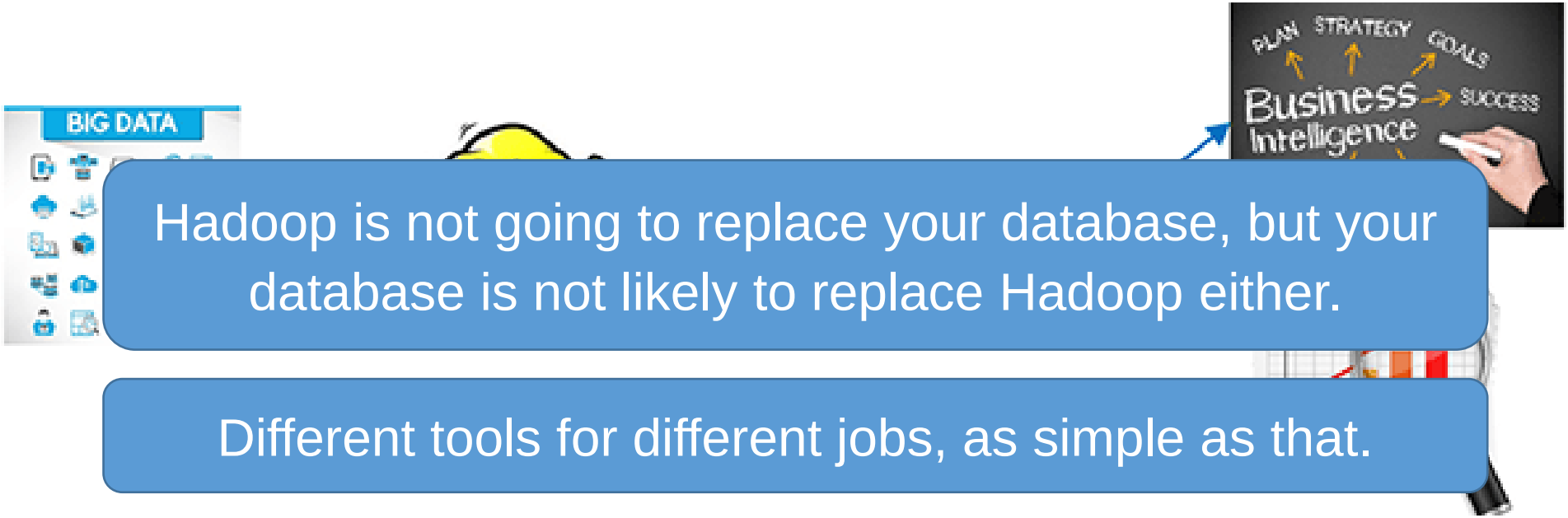
Logistic regression in Hadoop and Spark


```
14/12/08 04:10:06 INFO spark.SparkHadoopWriter: attempt_201412080410_0005_m_000000_5: Committed
14/12/08 04:10:06 INFO scheduler.TaskSetManager: Finished task 0.0 in stage 5.0 (TID 5) in 296 ms on localhost (1/1)
14/12/08 04:10:06 INFO scheduler.TaskSchedulerImpl: Removed TaskSet 5.0, whose tasks have all completed, from pool
14/12/08 04:10:06 INFO scheduler.DAGScheduler: Stage 5 (saveAsTextFile at <console>:14) finished in 0.279 s
14/12/08 04:10:06 INFO spark.SparkContext: Job finished: saveAsTextFile at <console>:14, took 0.626043309 s
14/12/08 04:10:06 INFO executor.Executor: Finished task 0.0 in stage 5.0 (TID 5). 826 bytes result sent to driver
wordCounts: Unit = ()
```

When not to use Hadoop?

Không hỗ trợ tính tương tác cho người dùng.

- An alternative to existing data processing infrastructure
  - Data can be stored in HDFS, processed and transformed into structured manageable data.
  - Formatted data is then sent to RDMBS for BI, reporting, etc.

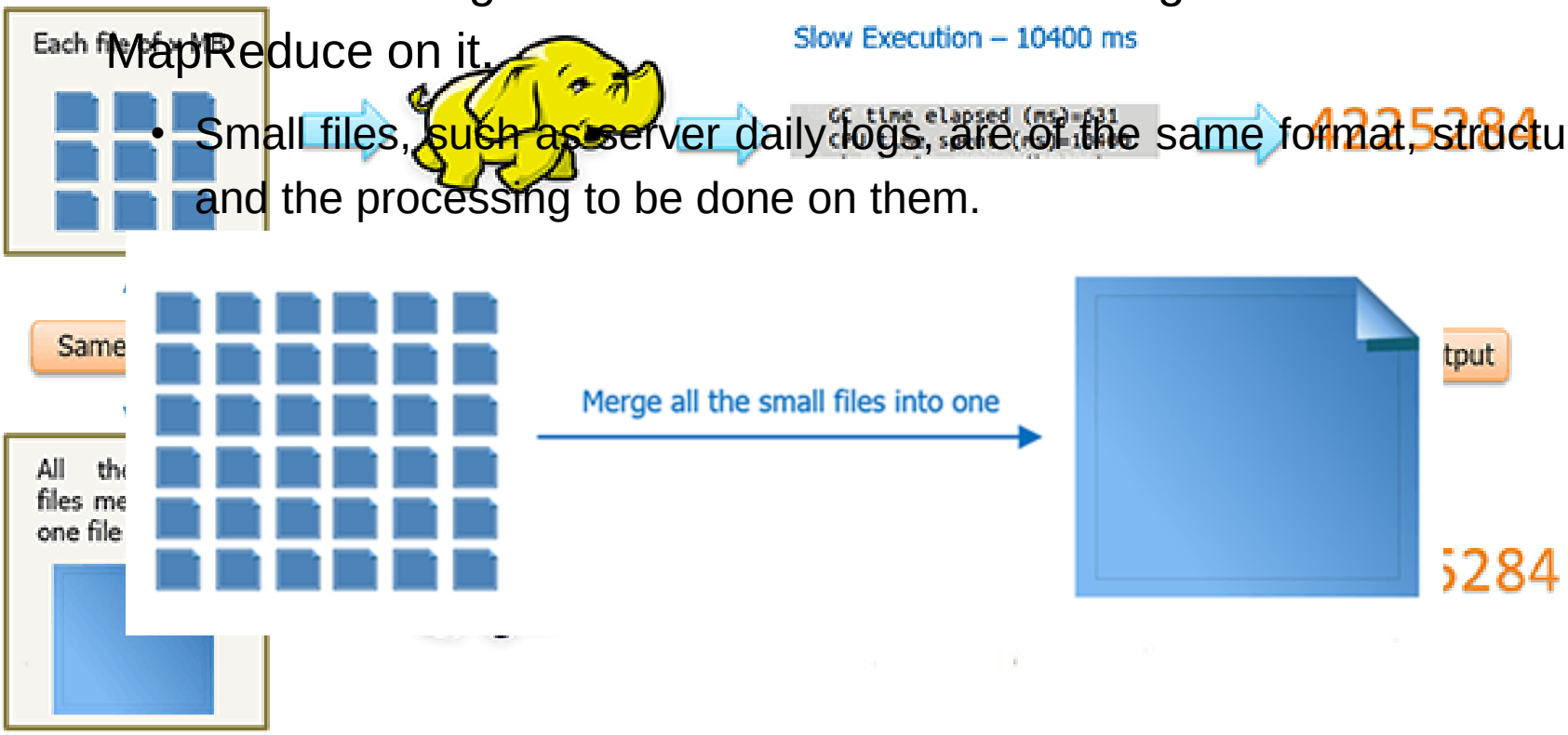


Hadoop is not going to replace your database, but your database is not likely to replace Hadoop either.

Different tools for different jobs, as simple as that.

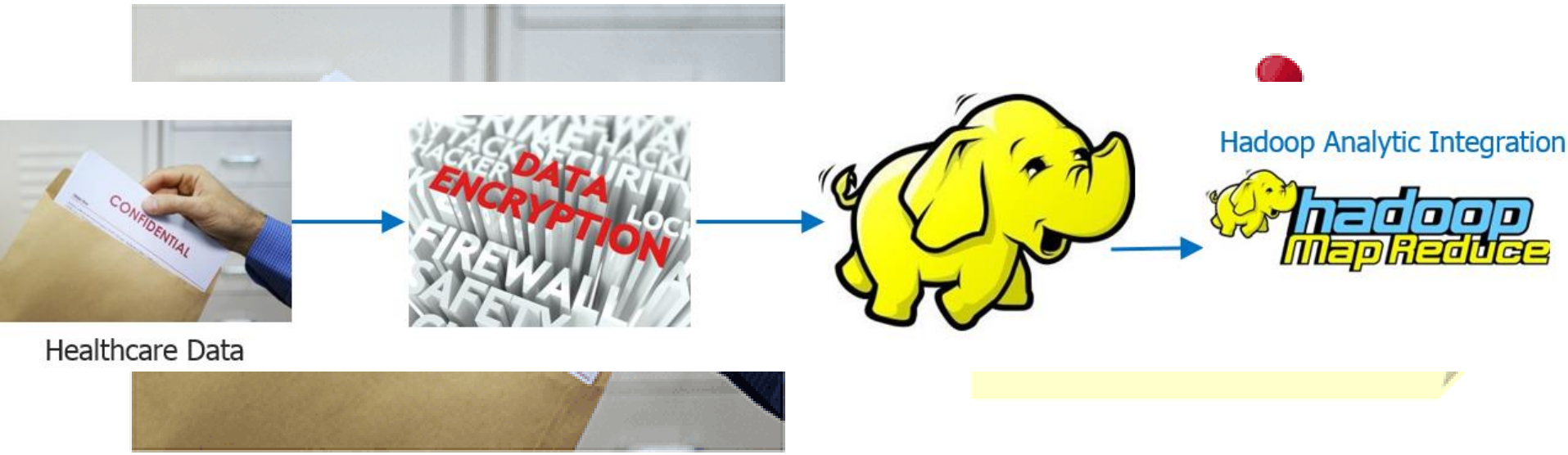
When not to use Hadoop?

- There are multiple smaller datasets.
  - Hadoop may be costlier than other tools (e.g., MS Excel, RDBMS, etc.) on small-structured datasets.
  - Alternative: merge all small files into one big file and then run MapReduce on it.
  - Small files, such as server daily logs, are of the same format, structure, and the processing to be done on them.



When not to use Hadoop?

- Security is the primary concern
  - Enterprises dealing with sensitive data are not able to move towards implementing Big data projects and Hadoop quickly.
  - Encrypt the data while moving to Hadoop, then use it for further processing to get relevant insights.

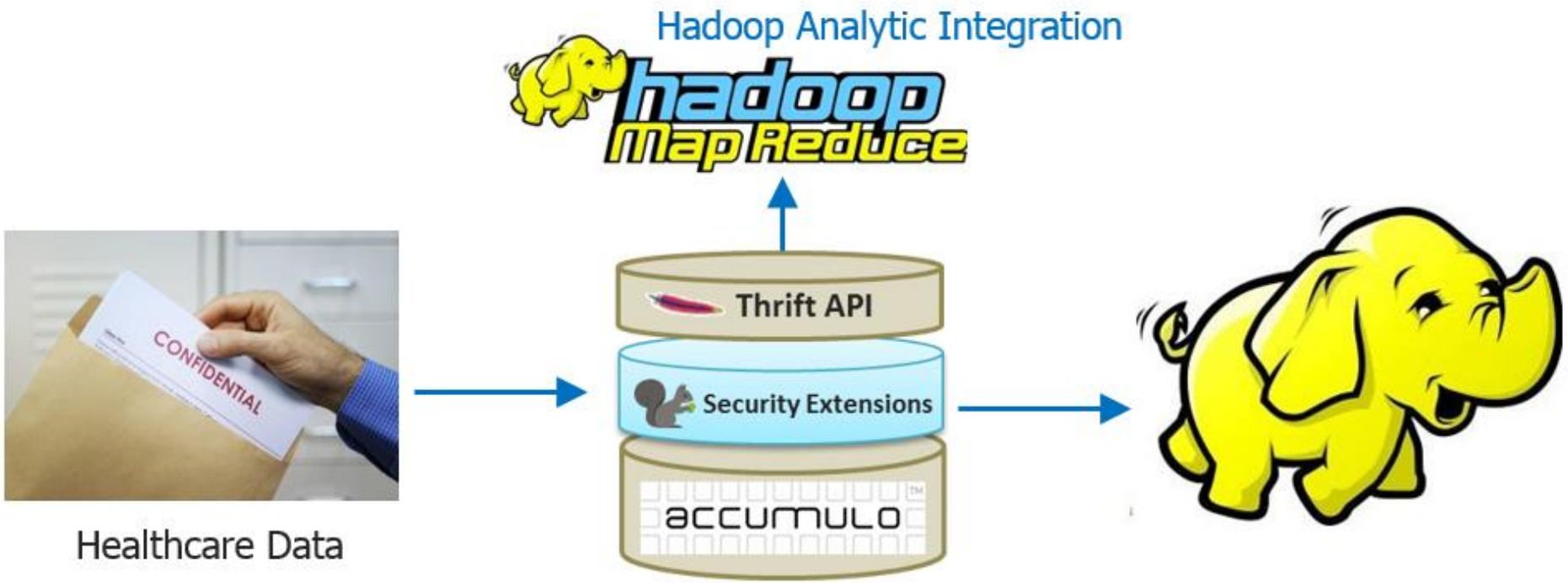


Healthcare Data

"Example Health-care data used by Insurance companies to calculate premium"

When not to use Hadoop?

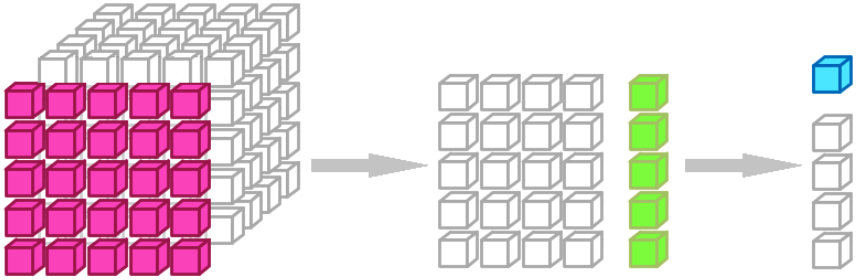
- Security is the primary concern
  - Alternative: use Apache Accumulo on top of Hadoop
  - Accumulo: sorted, distributed key/value store that provides robust, scalable data storage and retrieval; cell-based access control.



In summary, what is Hadoop not for?

- It is good for Big data but not for OLTP or OLAP/DSS.

Hadoop is not a replacement for existing RDBMS technology but complements them.



- Process transactions (random access)
- Process lots of small files
- Works that cannot be parallelized
- Low latency data access
- Intensive calculations with little data

Mỗi một node là một máy tính bình thường
nên có thể quá yếu để tính toán
-> scale để có thể tính toán trên dữ liệu nhỏ này.

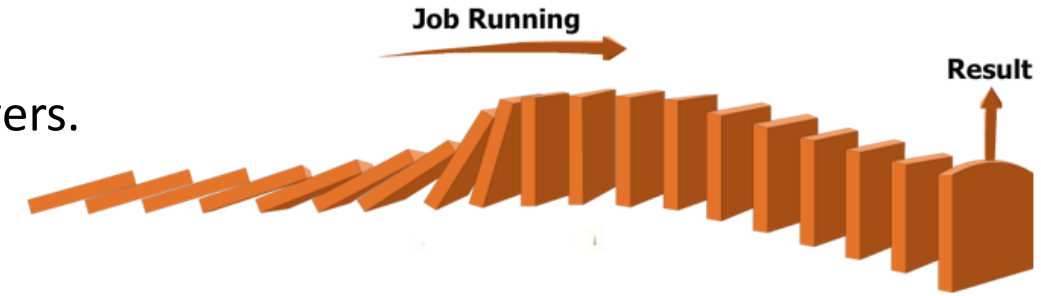
When to use Hadoop?

- Data size and data diversity

The data is huge in size, i.e., several terabytes and petabytes.

Data of different types: structured, semi-structured and unstructured.

You are not in a hurry for answers.



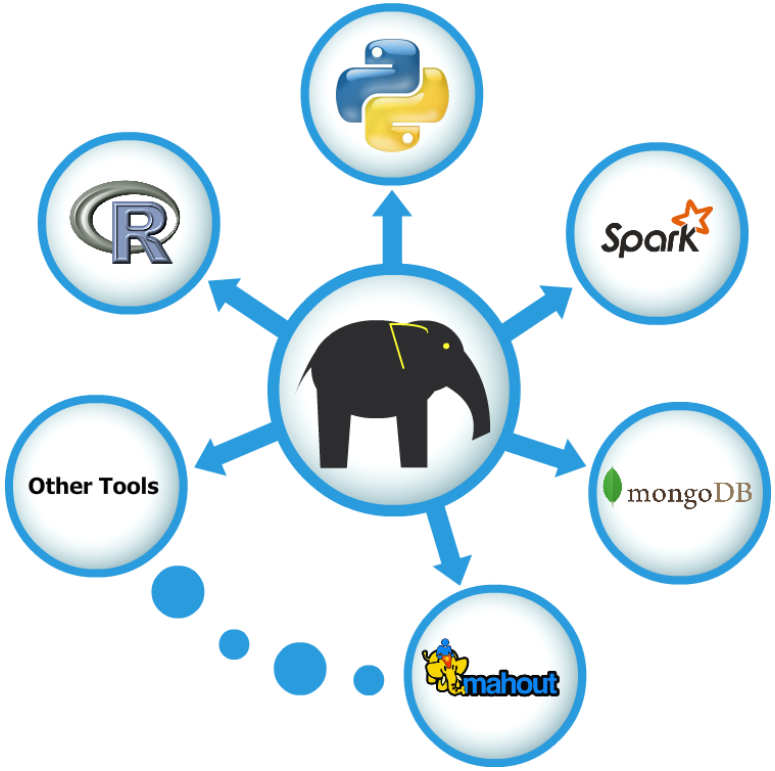
When to use Hadoop?

- Future planning
  - Build a small or medium cluster for the data available at present and scale up the cluster in future.

When to use Hadoop?

- Multiple frameworks for Big data
  - Can be integrated with multiple analytic tools to get the best out of it

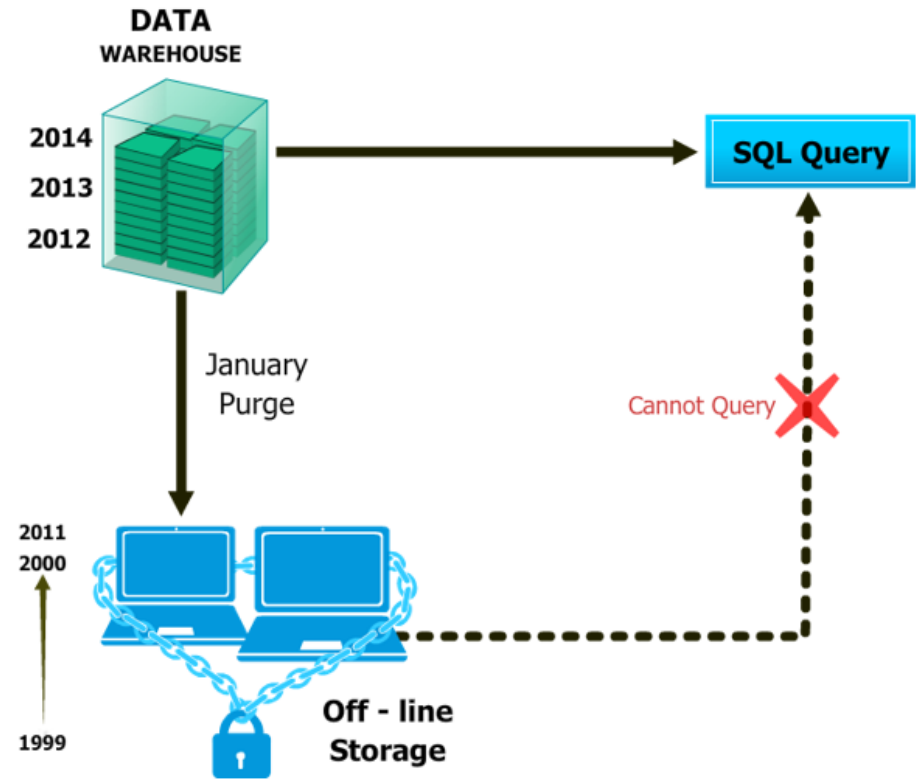
- **Mahout** for Machine-Learning
- **R and Python** for analytics and visualization
- **Spark** for real time processing
- **MongoDB and Hbase** for NoSQL database
- **Pentaho** for BI, etc.

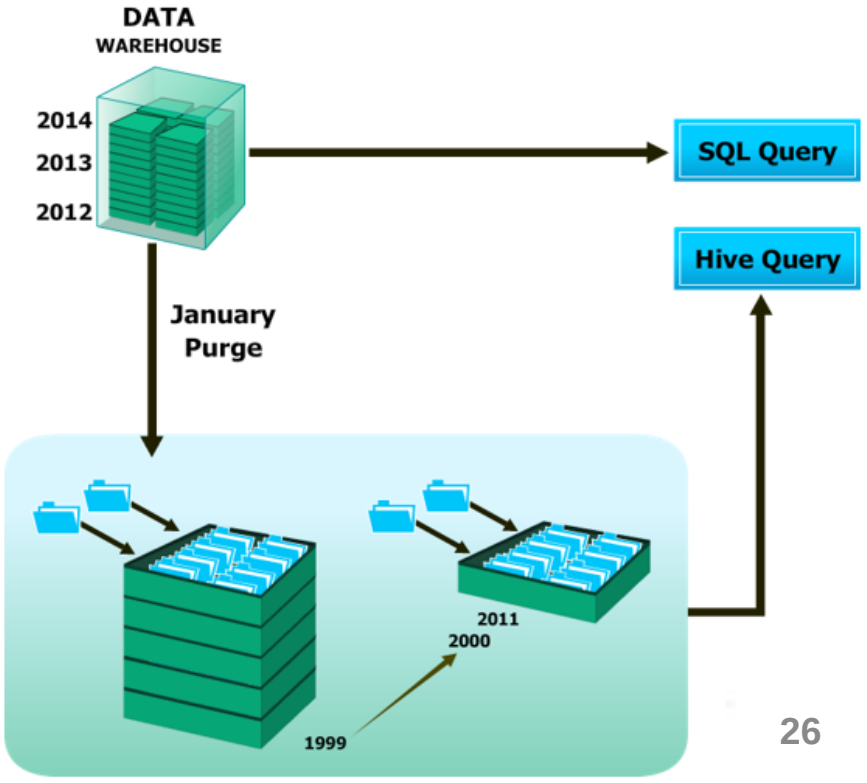


When to use Hadoop?

Tin cậy nó nằm trong hệ thống của chúng ta mà không bị mất mát.

- Lifetime data availability
  - Scalability: the stored data can be live and running forever, the cluster size can be increased unlimitedly by adding nodes to it.





Keys to successfully adopting Hadoop

Business users and analysts have access to as much data as possible

Regulatory requirements like data privacy must still be respected.

Results are accessible through standard tools in an organization

Cần trình bày với đối tác, cấp trên là những người không có chuyên môn
-> nên trực quan hóa để có thể nhiều người hiểu được

Hadoop developers should expose their logic so that results are easily consumed and reusable.

Governance requirements for the data stored in Hadoop

Data audit for both RDBMS and Hadoop are possible.

Keys to successfully adopting Hadoop

Xác định mục tiêu phân tích rõ ràng chứ không đi theo một bài toán mở.
-> cần biết mục tiêu, phục vụ cho vấn đề j, và lợi ích đem lại.

Should not try to find an open-ended problem

This kind of problem has neither clearly defined milestones nor measurable business value.

Working with business's leaders

Businesses want to see value from their IT investments, and with Hadoop it may come in a variety of ways.

Examine the perspectives of people and processes that are adopting Hadoop in the organization

Adopters make effort to support data science by fostering experimentation and data exploration

Hadoop case studies

Hadoop in action

- There have several enterprises implementing Hadoop.

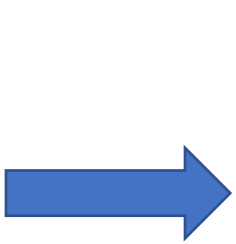
Hadoop case studies in enterprise

中国移动通信
CHINA MOBILE

10x
The Data

1/5
The Cost

The New York Times



4TB in 1.5TB

24Hours

Hadoop case studies in enterprise

NETFLIX

Recommendation engines and new content decisions
Hadoop, Hive and Pig together with traditional BI

U.S. XPRESS

Collect and store 100s of data points from thousands of trucks, plus lots of geo data in a Hadoop cluster

Product recommendations, in-store shopping experience of customers
Hadoop and NoSQL technologies

More at the following link

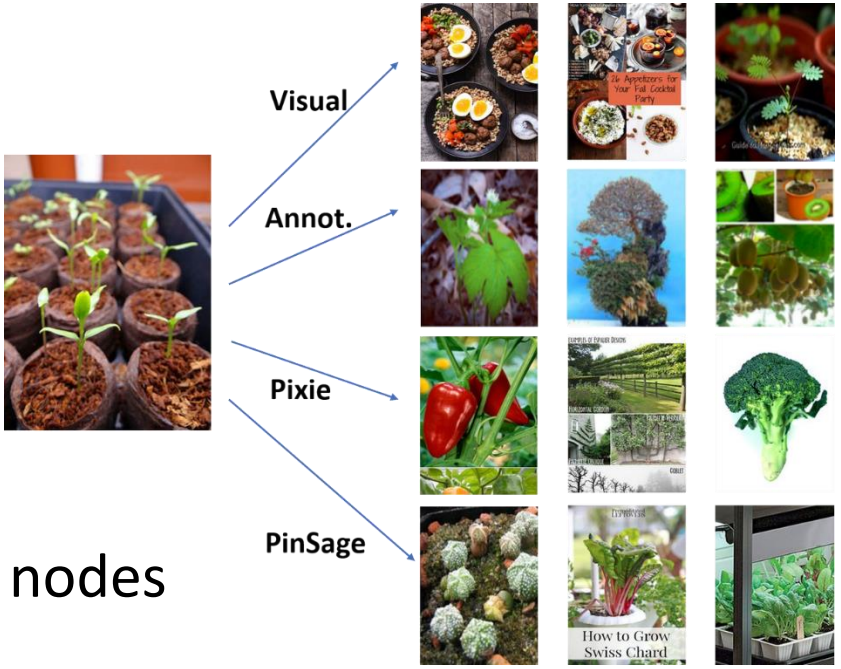
Hadoop case studies in enterprise

About **200 million** text pages

IBM Watson

Use Hadoop to distribute the workload for loading the information into memory

Recommender system of pins and boards using GCN



Hadoop2 cluster with
378 d2.8xlarge Amazon AWS nodes

Hadoop installation

The installation process

Image credit: Medium

Installation modes

- Hadoop cluster can be set up in one of the following three supported modes:

Local (Standalone) mode

Pseudo-distributed mode

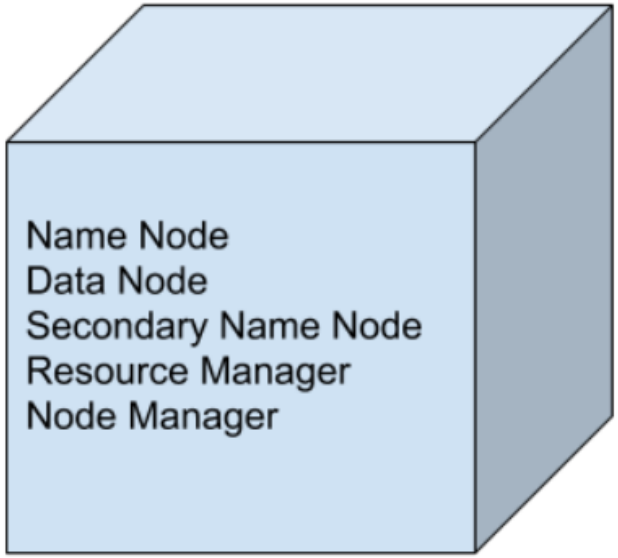
Fully-distributed mode

Local (Standalone) mode

- Hadoop is by default configured to run all the processes in a single JVM (Java Virtual Machines).
- This is useful for learning, testing, and debugging.
- There is no need to configure the xml files—hdfs-site.xml, mapred-site.xml, core-site.xml for Hadoop environment.

Pseudo-distributed mode

- Use only a single node to simulate the cluster.
- All the processes run independently on separate JVMs.

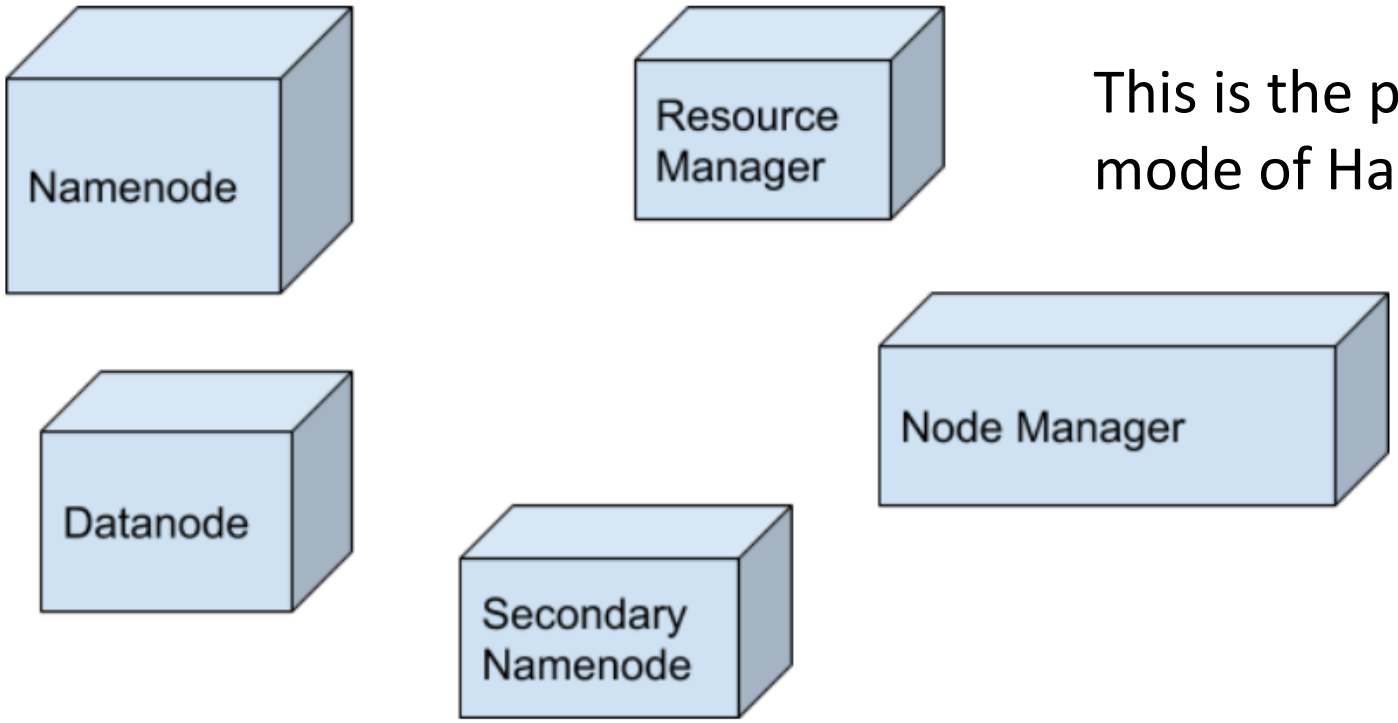


- This is both for development and debugging purposes.
- The configuration files must be specified properly.

Image credit: GeeksforGeeks

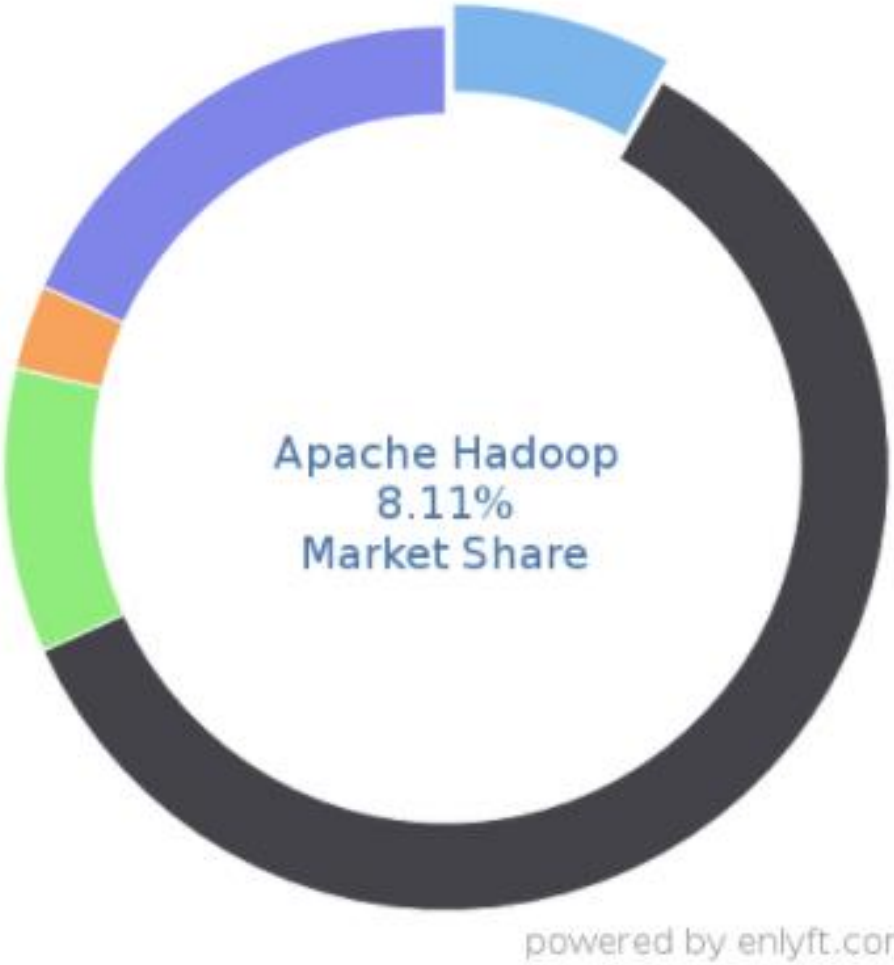
Fully-distributed mode

- Hadoop runs on the cluster of machines, each of which plays the role of master daemon or slave daemons.
- The data is distributed across different nodes.



This is the production mode of Hadoop.

Hadoop: Now and Future



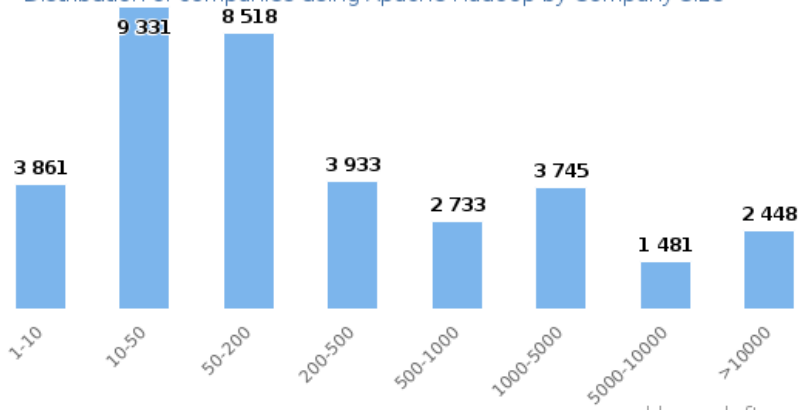
Big Data

Apache Hadoop (8.11%)
Snowplow (60.13%)
Informatica (10.41%)
Teradata (3.10%)
View other alternative products

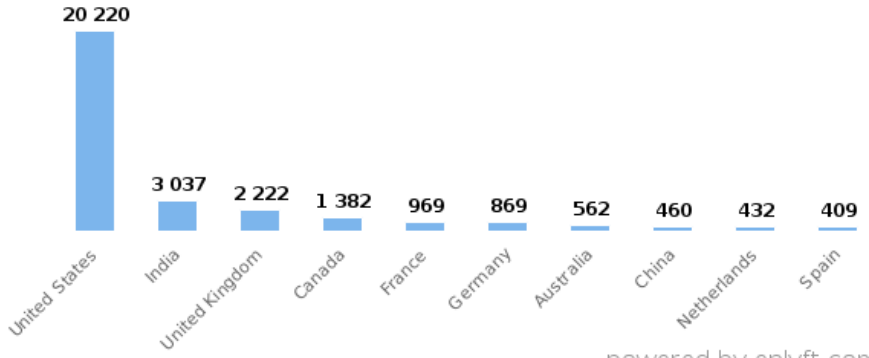
37,031

Companies using Apache Hadoop

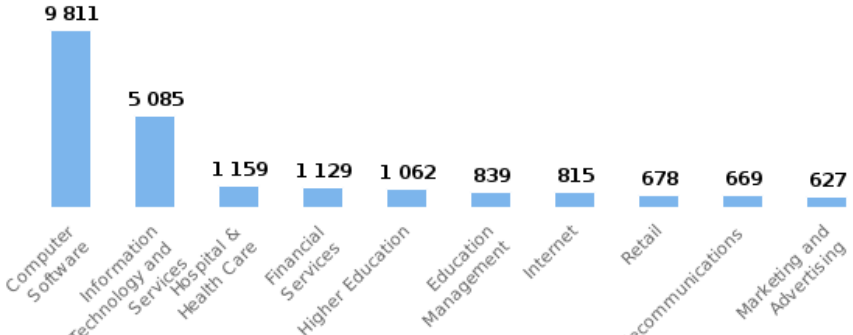
Distribution of companies using Apache Hadoop by Company Size



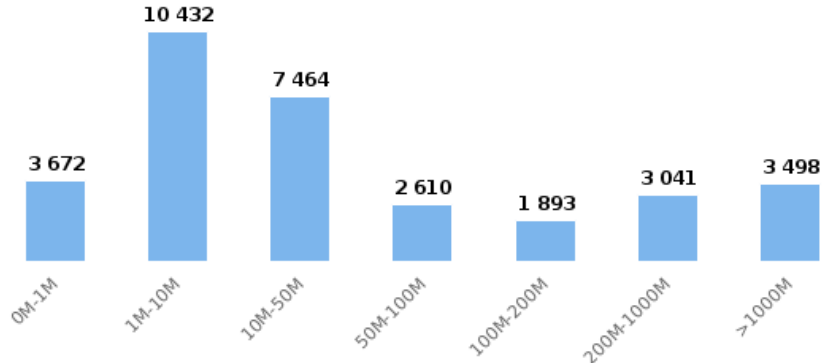
Distribution of companies using Apache Hadoop by Country



Distribution of companies using Apache Hadoop by Industry



Distribution of companies using Apache Hadoop by Revenue



Top Hadoop Technology companies

Where to learn Hadoop?


...the end.