Chapter3

Understanding Big Data Technology Foundations

Big Data Stack

Basanta Joshi, PhD

Asst. Prof., Depart of Electronics and Computer Engineering

Program Coordinator, MSc in Information and Communication Engineering

Member, Laboratory for ICT Research and Development (LICT)

Member, Research Management Cell (RMC)

Institute of Engineering

basanta@ioe.edu.np

http://www.basantajoshi.com.np

https://scholar.google.com/citations?user=iocLiGcAAAAJ

https://www.researchgate.net/profile/Basanta_Joshi2

Big data Stack

VISUALIZATION LAYER AND API'S	Java, HTML5, D3, RESTful API
ANALYTICAL TOOLS	pentaho, mahout, R
ANALYSIS LAYER	Java, Spark (Lightning-Fast Cluster Computing), HIVE, cloudera IMPALA
PROCESSING LAYER	hadoop MapReduce, Bidoop Motor de Eventos, Bidoop Motor de Workflow
STORAGE LAYER	hadoop HDFS, HIVE, APACHE HBASE, mongoDB
REAL TIME EVENT ENGINE	Bidoop Motor de Eventos
INTEGRATION LAYER (ETL)	FLUME, chukwa, AVRO, sqoop
SOURCES	Logs, XML

CAPA DE GESTIÓN

Chef

HERRAMIENTAS ADMINISTRACIÓN

OOZIE

HERRAMIENTAS MONITORIZACIÓN

Ganglia

Nagios

HERRAMIENTAS DIAGNÓSTICO

Pacemaker

Zoo Keeper

What We Need?

- Store
- Join
- Index
- Analytics
- Aggregate
- Visualize

Challenge

The challenge in big data analytics is to

- dig deeply
- quickly (real time?)
- and widely

"ilities" or NFR?

- Availability
- Scalability
- Security
- Performance
- ...

Solution?

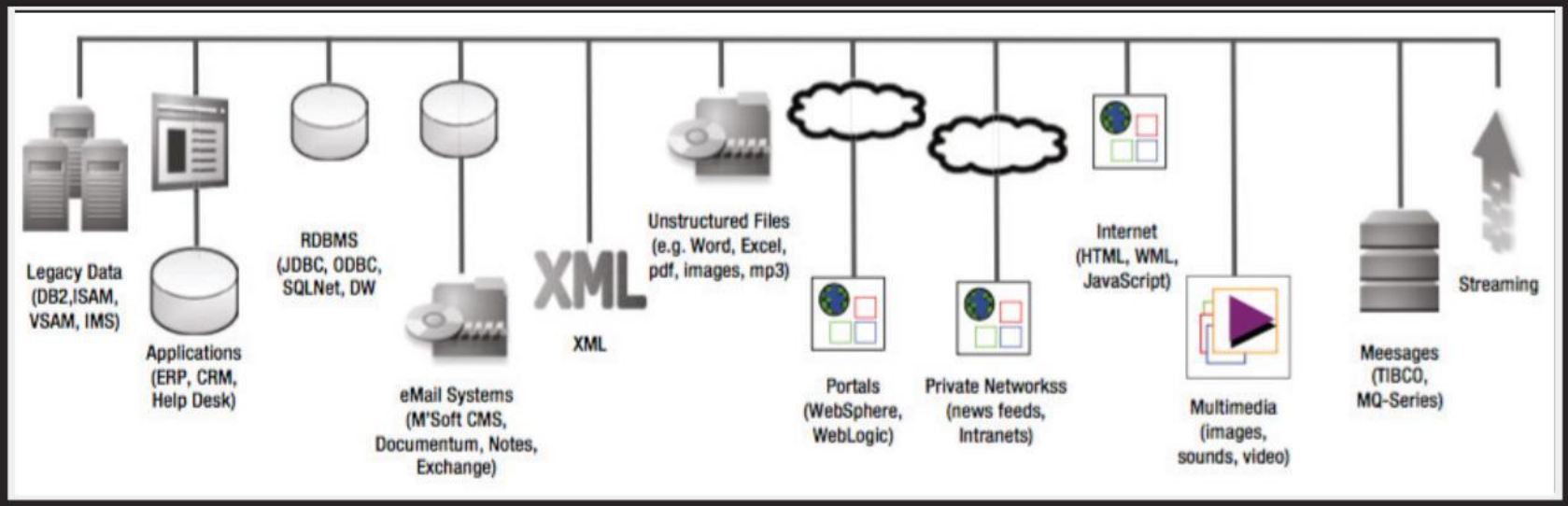
Big Data Tech Stack

What're essential components?

Data Sources

Multiple internal & external data sources

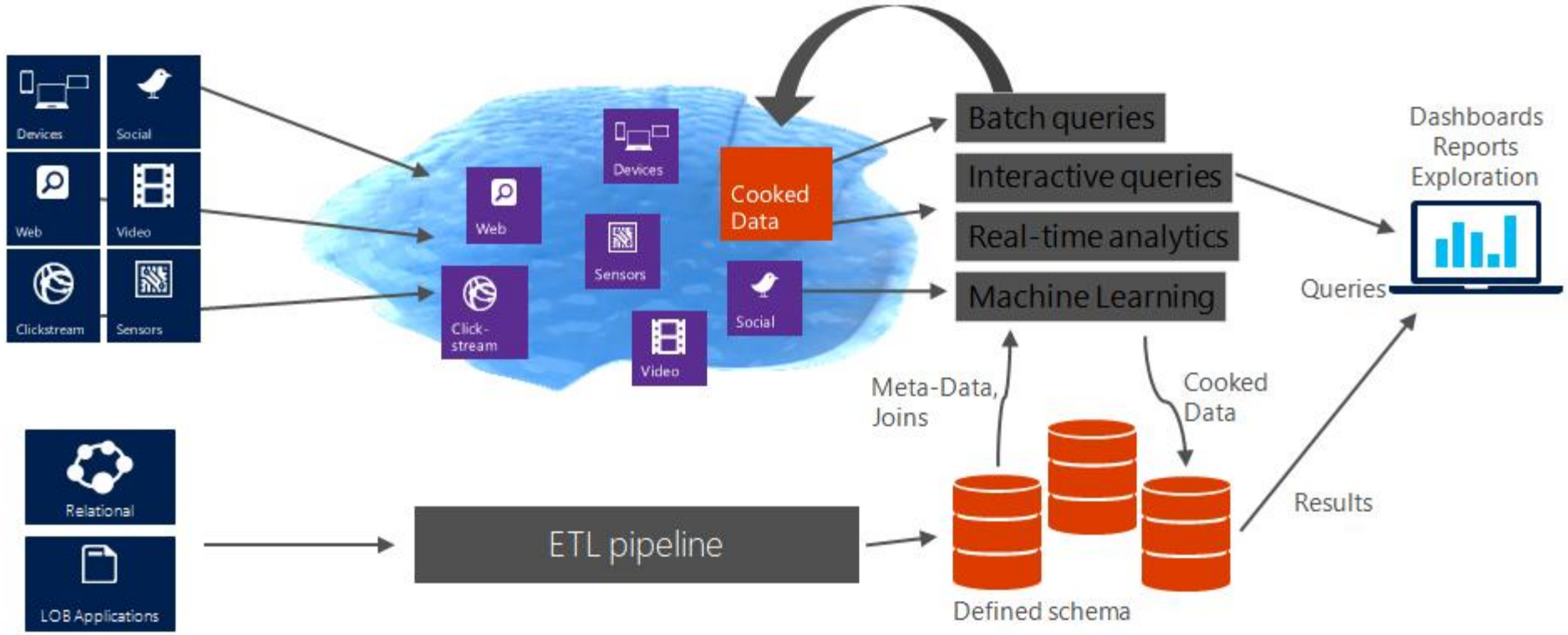
Creates a data lake


Legacy Data
(DB2,ISAM,
VSAM, IMS)
Applications
(ERP, CRM,
Help Desk)
RDBMS
(JDBC, ODBC,
SQLNet, DW
eMail Systems
(M'Soft CMS,
Documentum, Notes,
Exchange)
XML
XML
Unstructured Files
(e.g. Word, Excel,
pdf, images, mp3)
Portals
(WebSphere,
WebLogic)
Private Networkss
(news feeds,
Intranets)
Internet
(HTML, WML,
JavaScript)
Multimedia
(images,
sounds, video)
Meesages
(TIBCO,
MQ-Series)
Streaming

Legacy Data Sources
HTTP/HTTPS web services
RDBMS
FTP
JMS/MQ based services
Text/flat file/csv logs
XML data sources
IM Protocol requests

New Age Data Sources
High Volume Sources
1. Switching devices data
2. Access point data messages
3. Call data record due to exponential growth in user base
4. Feeds from social networking sites
Variety of Sources
1. Image and video feeds from social Networking sites
2. Transaction data
3. GPS data
4. Call center voice feeds
5. E-mail
6. SMS
High Velocity Sources
1. Call data records
2. Social networking site conversations
3. GPS data
4. Call center - voice-to-text feeds

The data lake and warehouse



Different

Volume, Variety, Velocity

Aim is to create a funnel after proper validation and cleaning

Ingestion Layer

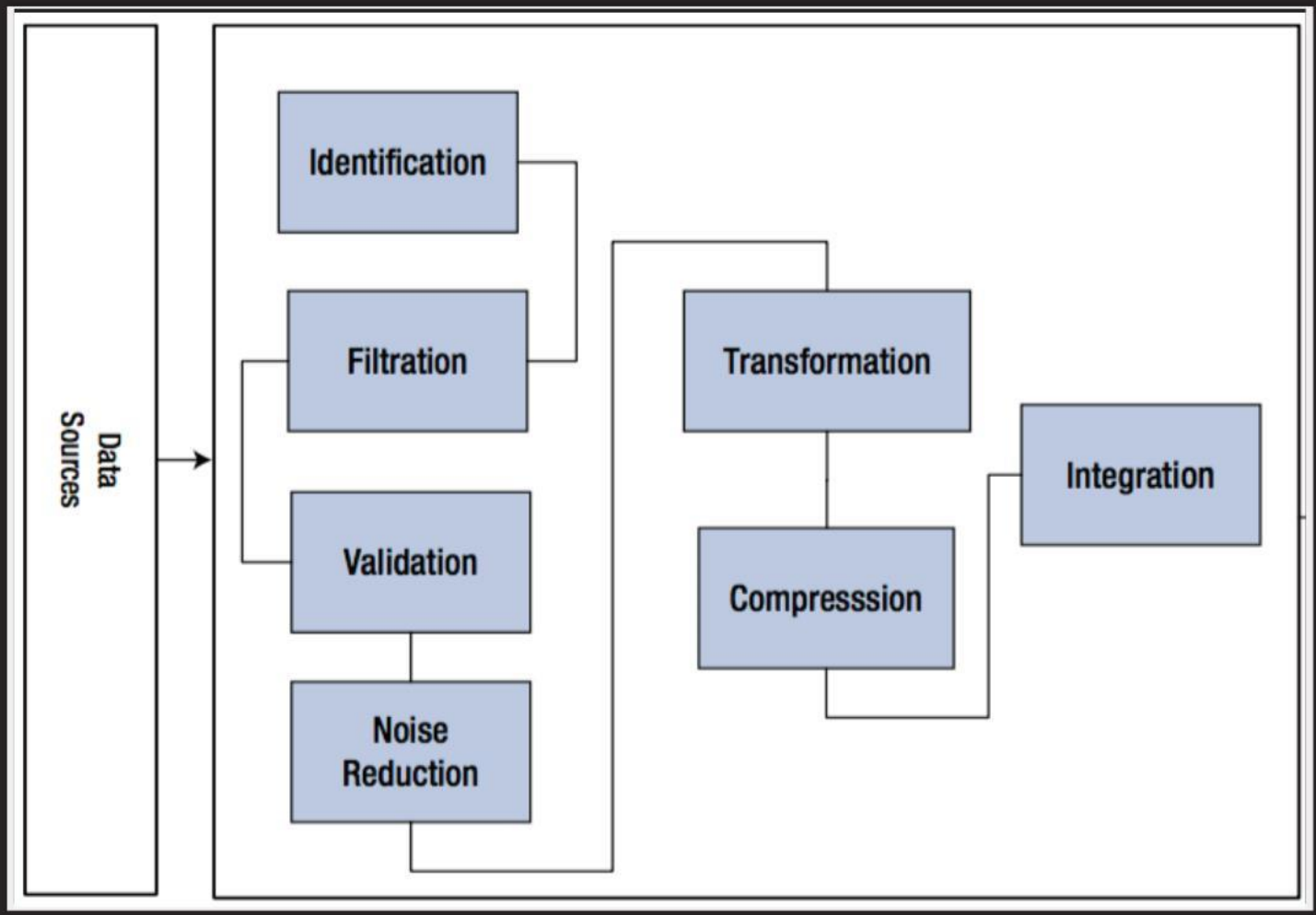
Signal-to-Noise ratio

10:90

separate the noise from relevant info

It has capability to

- Validate
- Cleanse
- Transform
- Reduce
- Integrate


Data Sources
Identification
Filtration
Validation
Noise Reduction
Transformation
Compresssion
Integration

Distributed Storage Layer

Fault tolerance
Parallelization

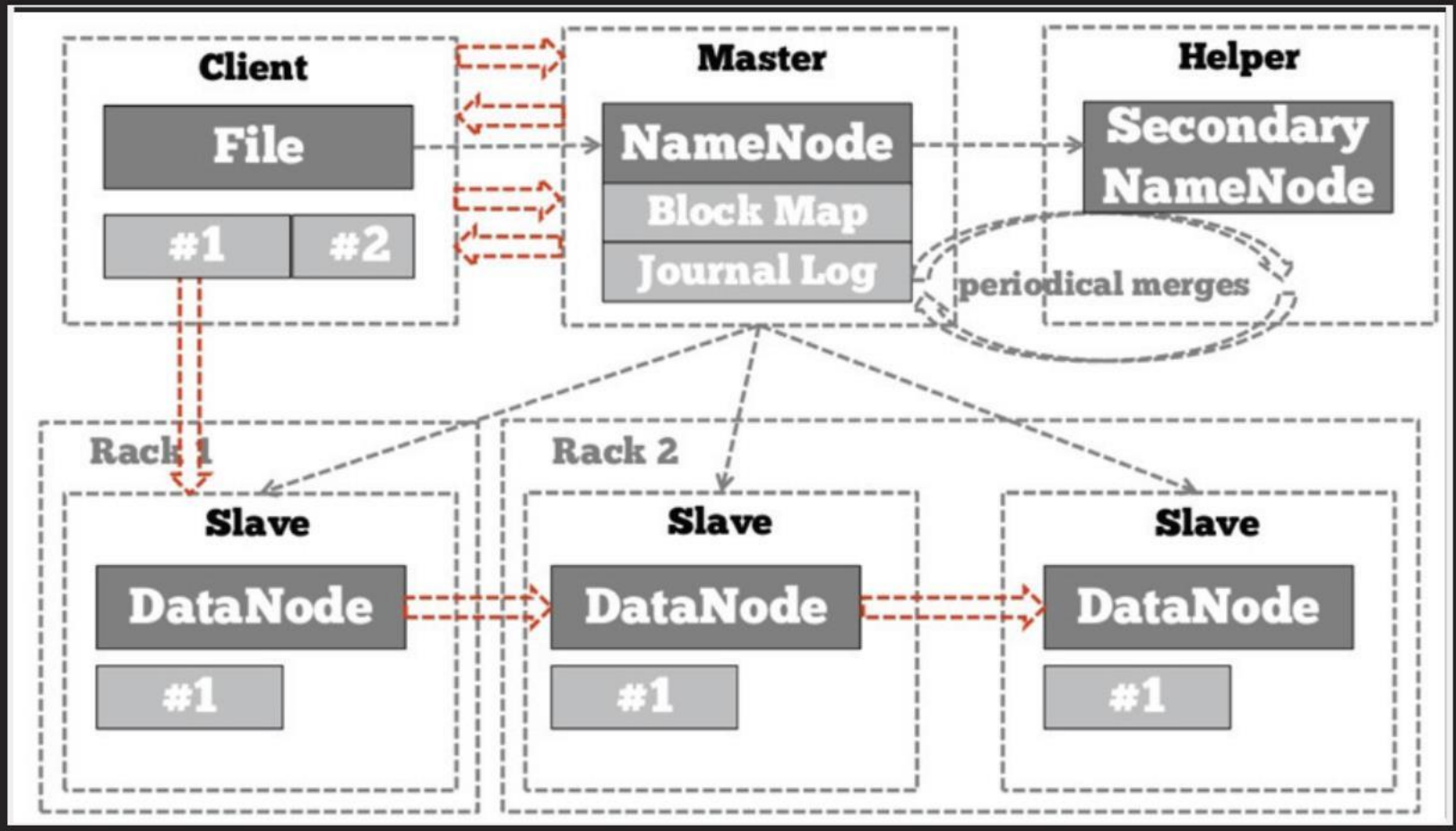
HDFS

massively scalable distributed file system

HDFS


Intended for
• large files
• batch inserts
Write once, read many times

HDFS Architecture

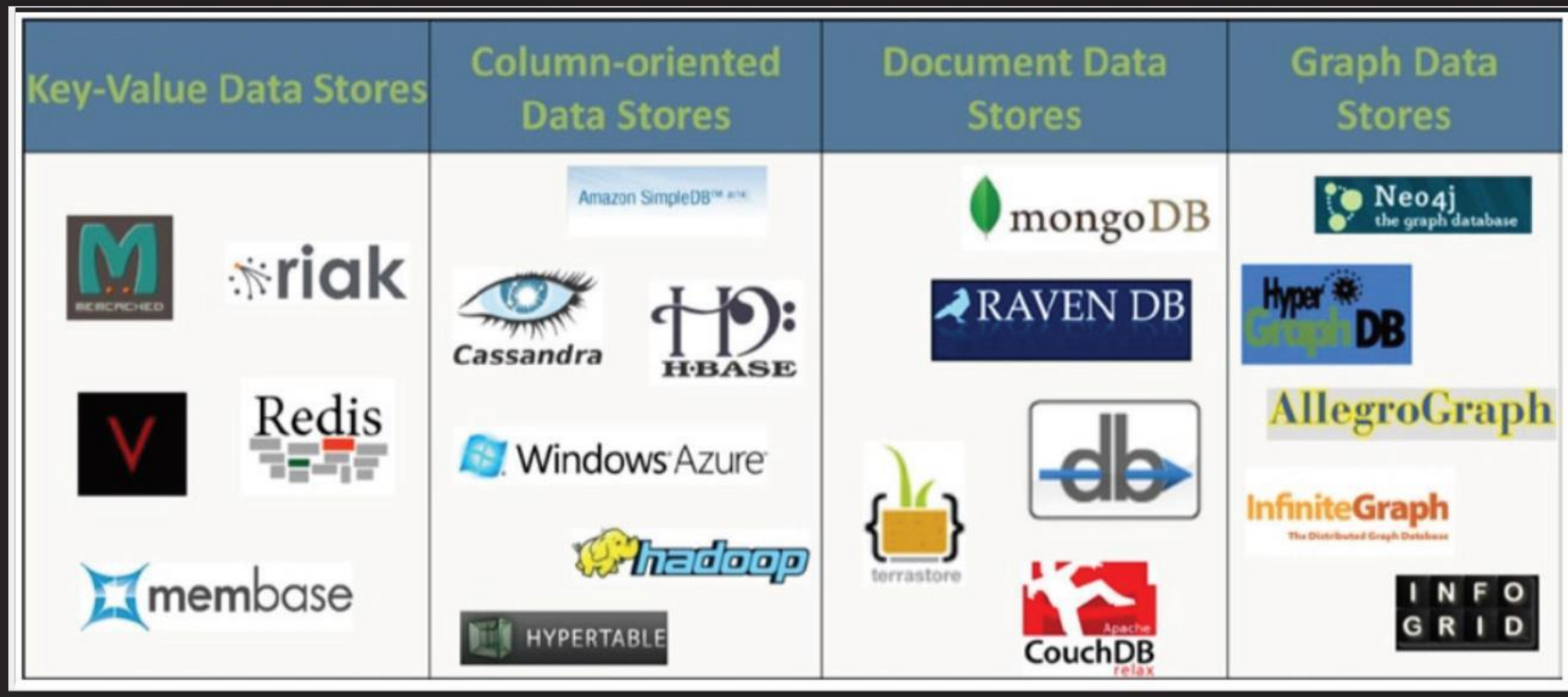


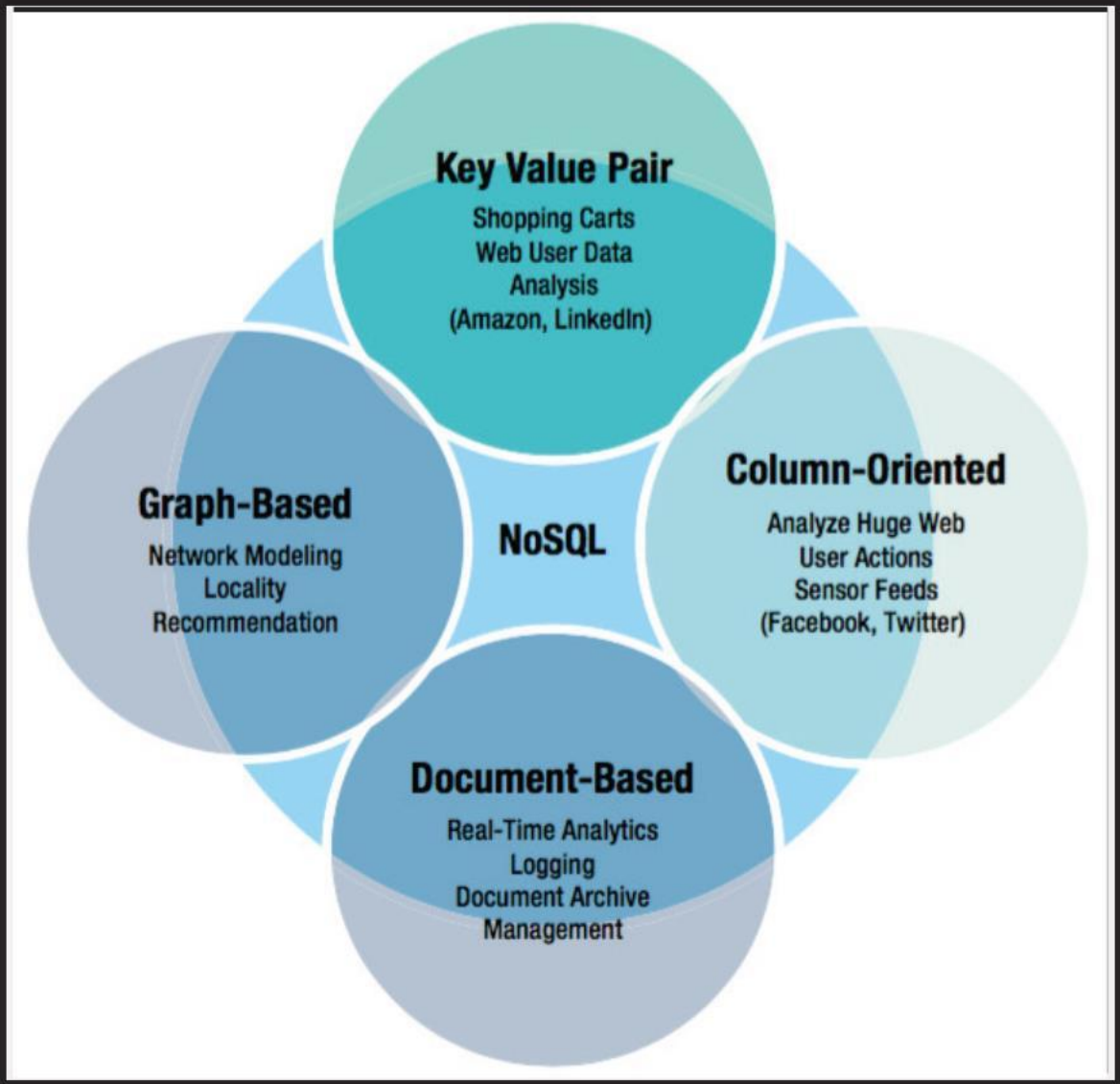
Non-relational, distributed data?

NoSQL

CAP theorem

Consistency, Availability, Partition Tolerance


Key-Value Data Stores
Column-oriented Data Stores
Document Data Stores
Graph Data Stores
memcached
riak
Redis
membase
Amazon SimpleDB
Cassandra
HBASE
Windows Azure
hadoop
HYPERTABLE
mongoDB
RAVEN DB
terrastore
db
Apache CouchDB relax
Neo4j the graph database
HyperGraphDB
AllegroGraph
InfiniteGraph
INFO GRID


Key Value Pair
Shopping Carts
Web User Data
Analysis
(Amazon, LinkedIn)
Graph-Based
Network Modeling
Locality
Recommendation
NoSQL
Column-Oriented
Analyze Huge Web
User Actions
Sensor Feeds
(Facebook, Twitter)
Document-Based
Real-Time Analytics
Logging
Document Archive
Management

Ingestion to DFS

Sqoop, Flume, MapReduce, ETL

Infrastructure & Platform Layer

Computing & Scalability

Hadoop?

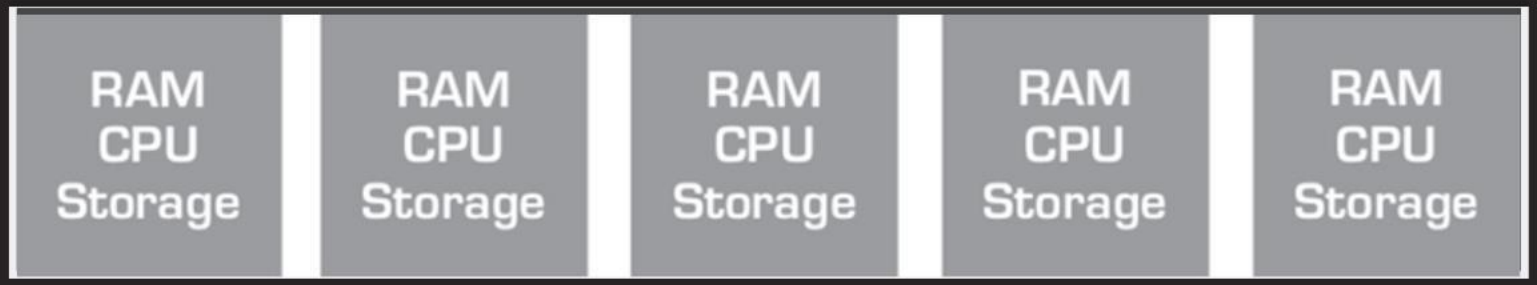
Vertical Scaling

Vertical Scaling

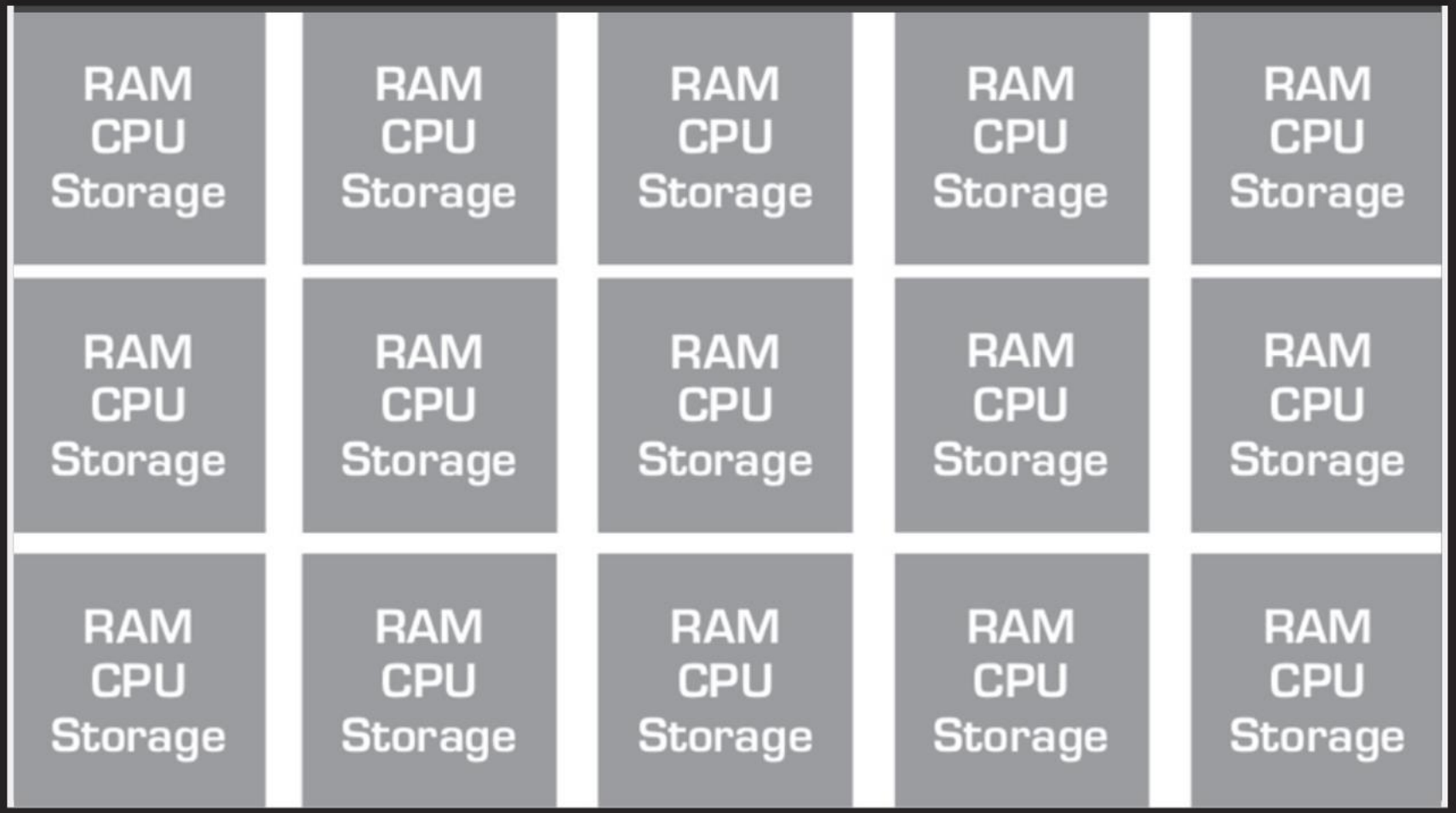
Vertical Scaling

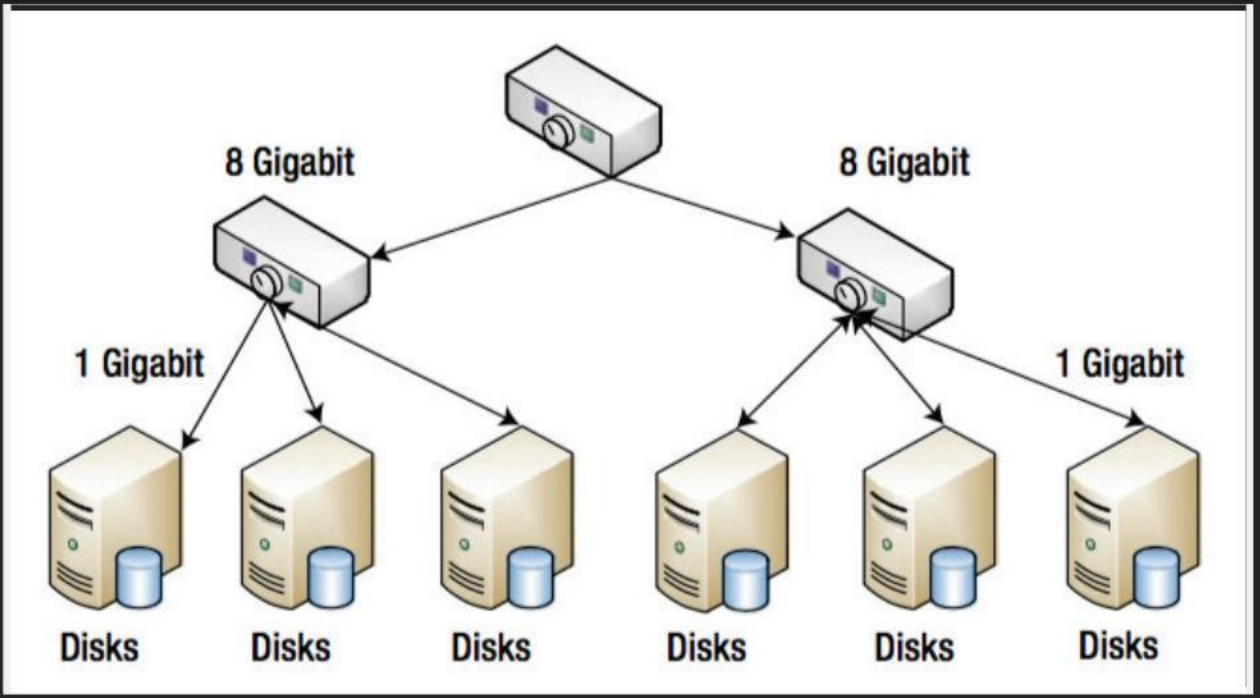
Horizontal Scaling

Horizontal Scaling



Horizontal Scaling

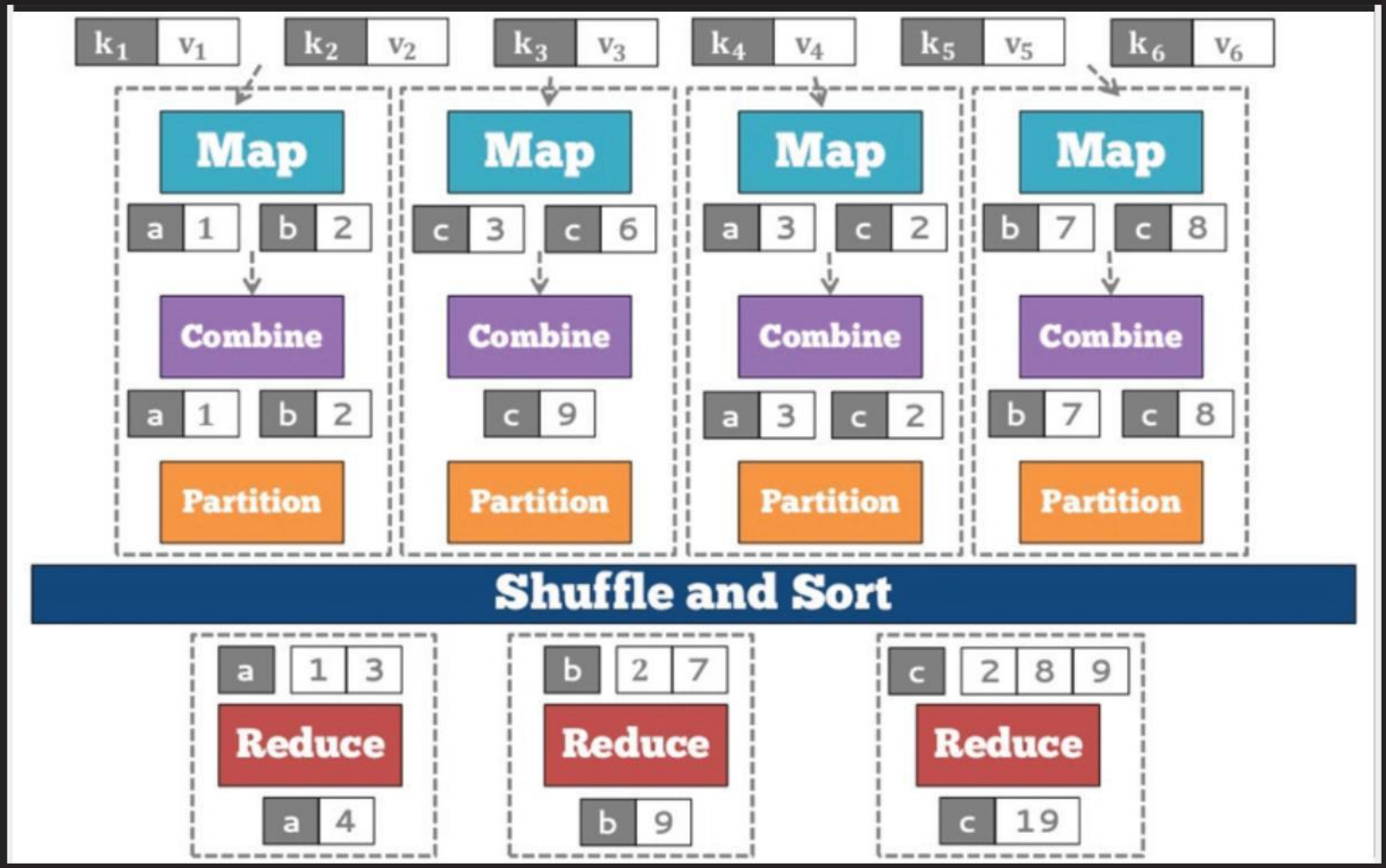


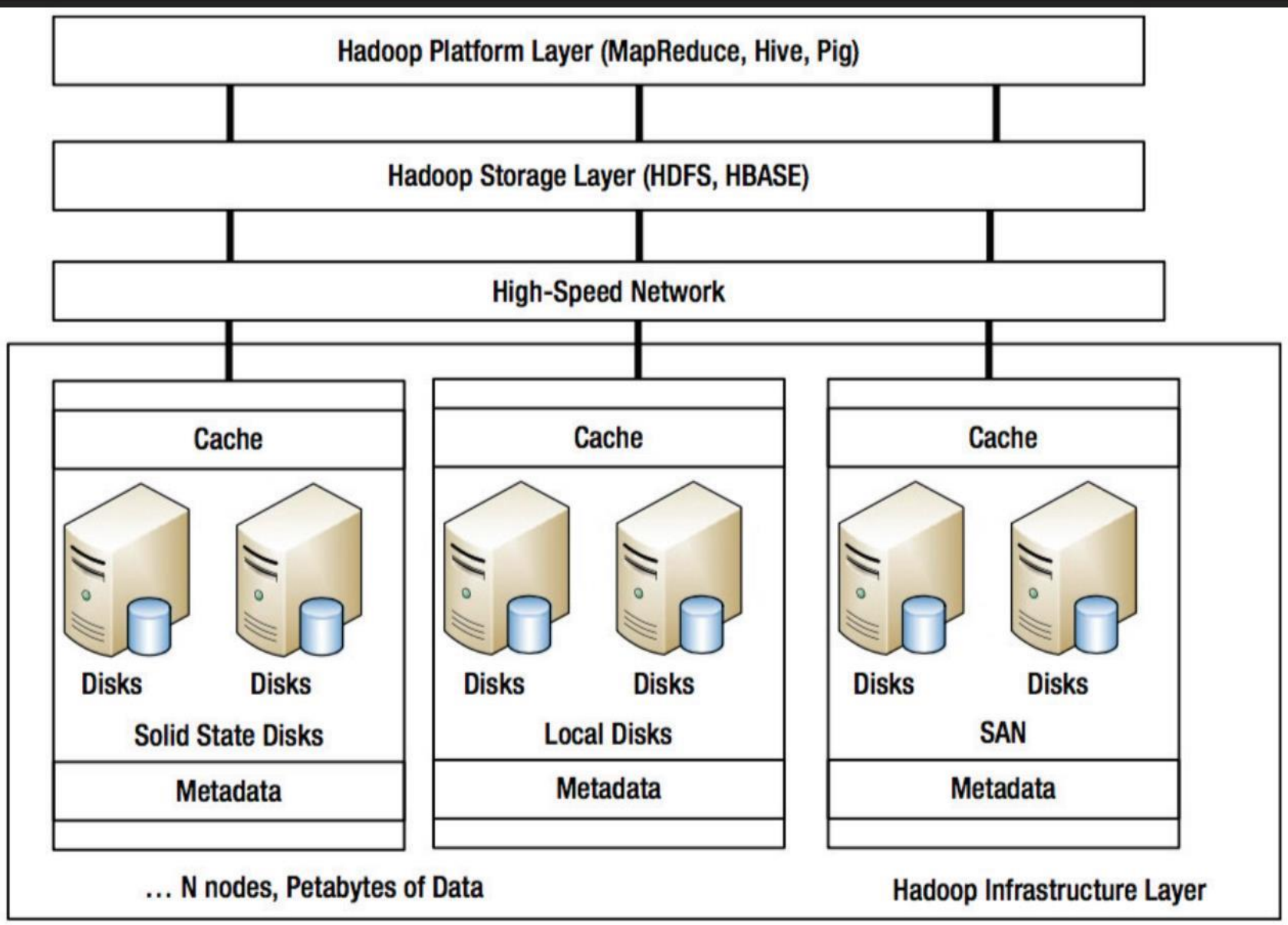

8 Gigabit
8 Gigabit
1 Gigabit
1 Gigabit
Disks
Disks
Disks
Disks
Disks
Disks

MapReduce

is the main computation paradigm

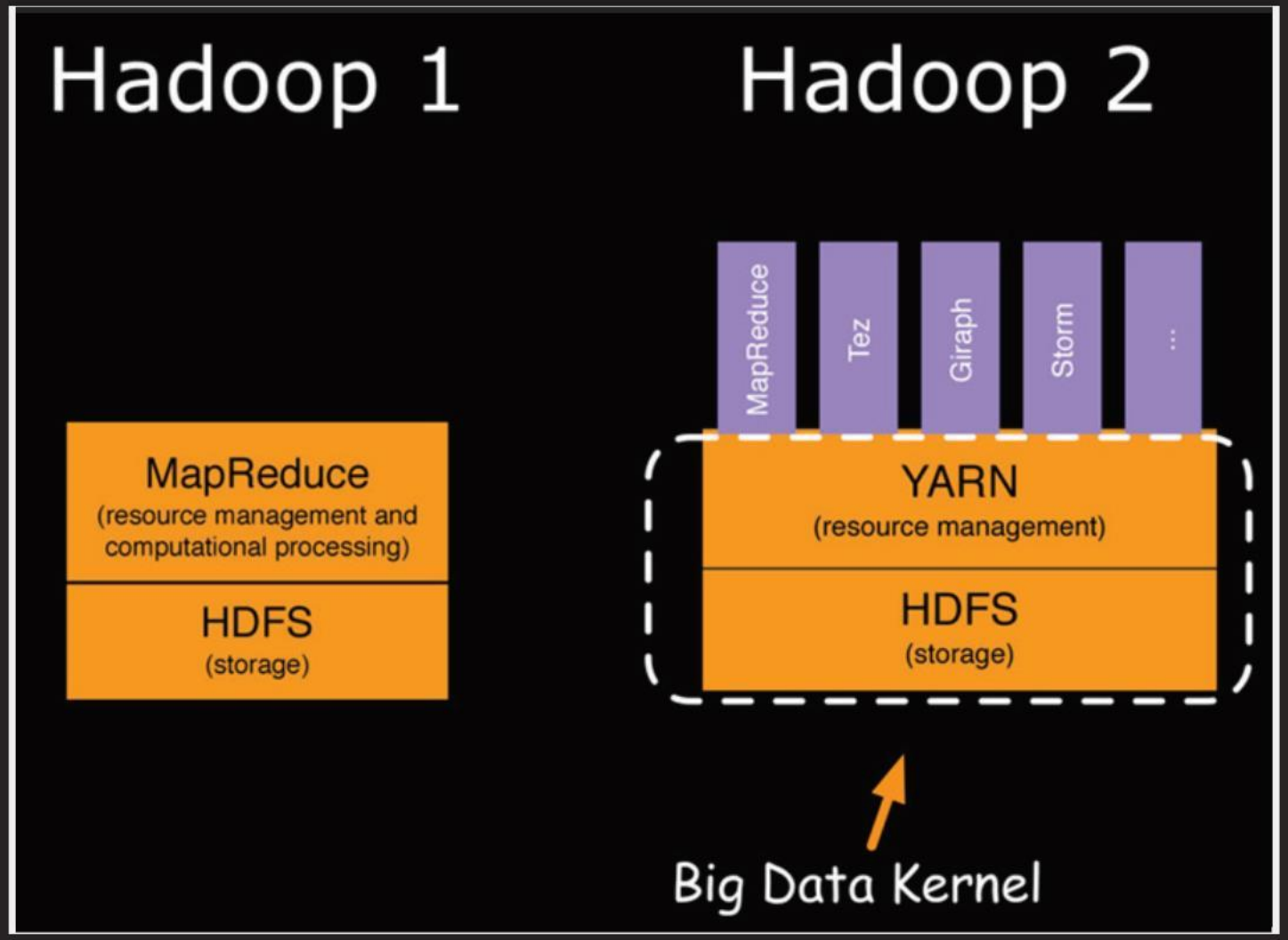
MapReduce


k1 v1
k2 v2
k3 v3
k4 v4
k5 v5
k6 v6
Map
Map
Map
Map
a 1
b 2
c 3
c 6
a 3
c 2
b 7
c 8
Combine
Combine
Combine
Combine
a 1
b 2
c 9
a 3
c 2
b 7
c 8
Partition
Partition
Partition
Partition
Shuffle and Sort
a 1 3
b 2 7
c 2 8 9
Reduce
Reduce
Reduce
a 4
b 9
c 19

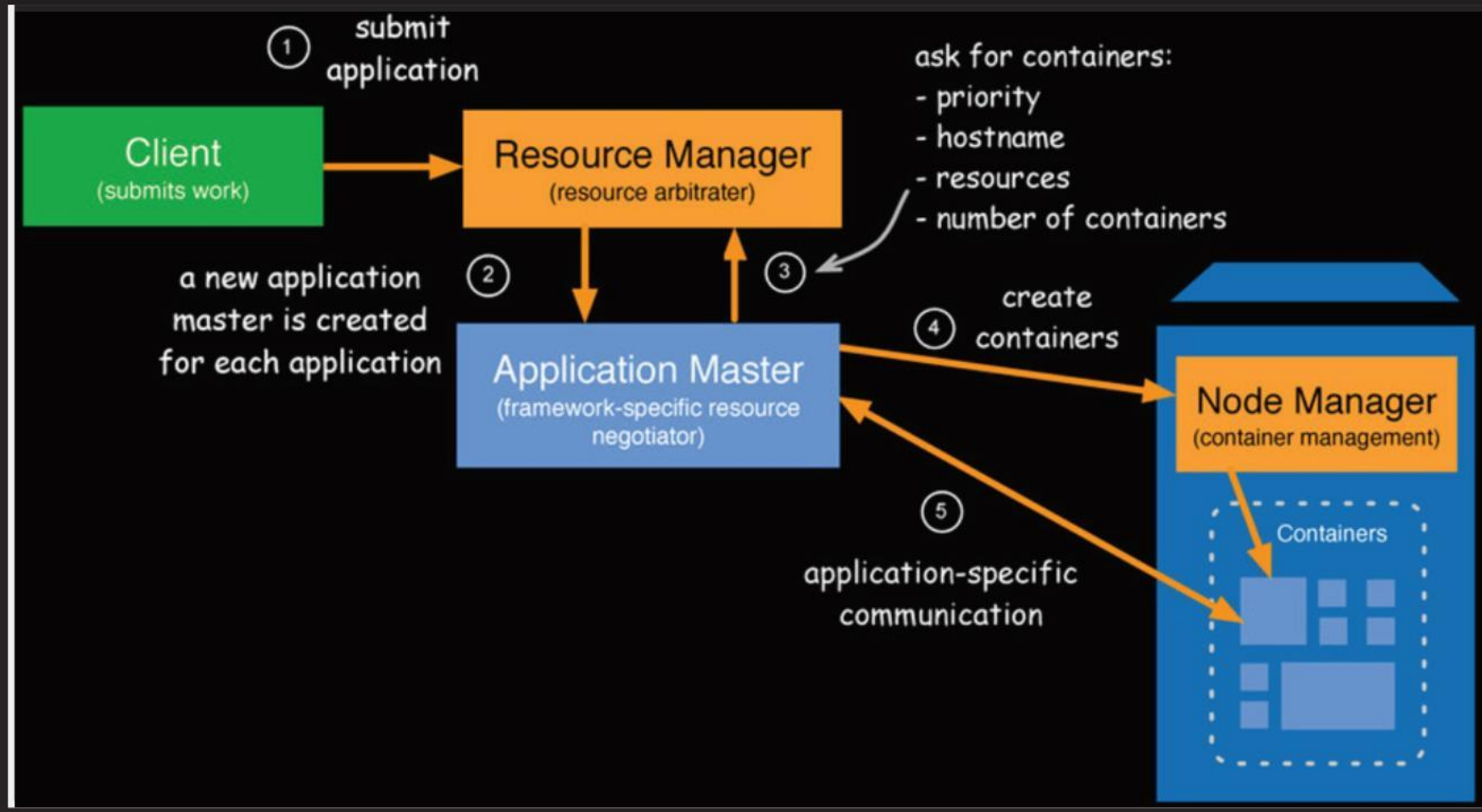

Hadoop Platform Layer (MapReduce, Hive, Pig)
Hadoop Storage Layer (HDFS, HBASE)
High-Speed Network
Cache
Disks
Disks
Solid State Disks
Metadata
Cache
Disks
Disks
Local Disks
Metadata
Cache
Disks
Disks
SAN
Metadata
… N nodes, Petabytes of Data
Hadoop Infrastructure Layer

Hadoop 2

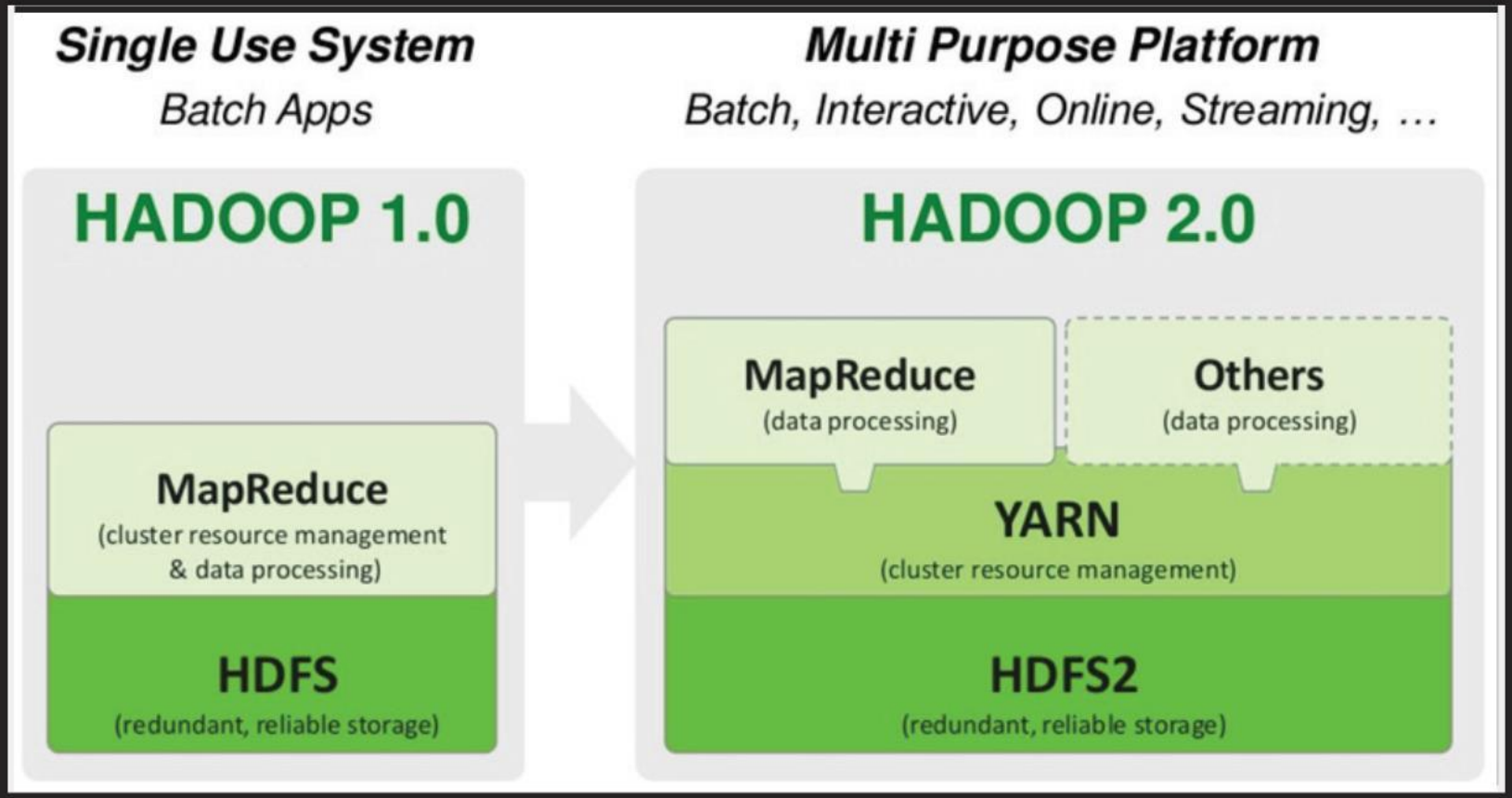
What's new?


Hadoop 1
Hadoop 2
MapReduce
(resource management and computational processing)
HDFS
(storage)
MapReduce
Tez
Giraph
Storm
...
YARN
(resource management)
HDFS
(storage)
Big Data Kernel

What's new?


1
submit application
Client
(submits work)
Resource Manager
(resource arbitrater)
ask for containers:
- priority
- hostname
- resources
- number of containers
2
a new application master is created for each application
3
4
create containers
Application Master
(framework-specific resource negotiator)
Node Manager
(container management)
Containers
5
application-specific communication

H1 vs. H2


Single Use System
Batch Apps
Multi Purpose Platform
Batch, Interactive, Online, Streaming, …
HADOOP 1.0
MapReduce
(cluster resource management & data processing)
HDFS
(redundant, reliable storage)
HADOOP 2.0
MapReduce
(data processing)
Others
(data processing)
YARN
(cluster resource management)
HDFS2
(redundant, reliable storage)

One cluster,
distributed storage,
distributed scheduler,
many types of applications.

Blueprints

- NoSQL with HBase
- Stream Processing with Storm/Spark
- Graph Processing with Giraph
- SQL on Hadoop with Impala
- Columnar Data Formats

Security Layer

Data need to be protected

- Meet compliance requirements
- Individual's privacy

Proper authorization and authentication needed

What can we do?

- Authentication protocol like Kerberos
- Enable file layer encryption
- Use SSL, certificates and trusted keys
- Provision with Chef, Puppet or Ansible like tools
- Log all the communication for detecting anomalies
- Monitor whole system

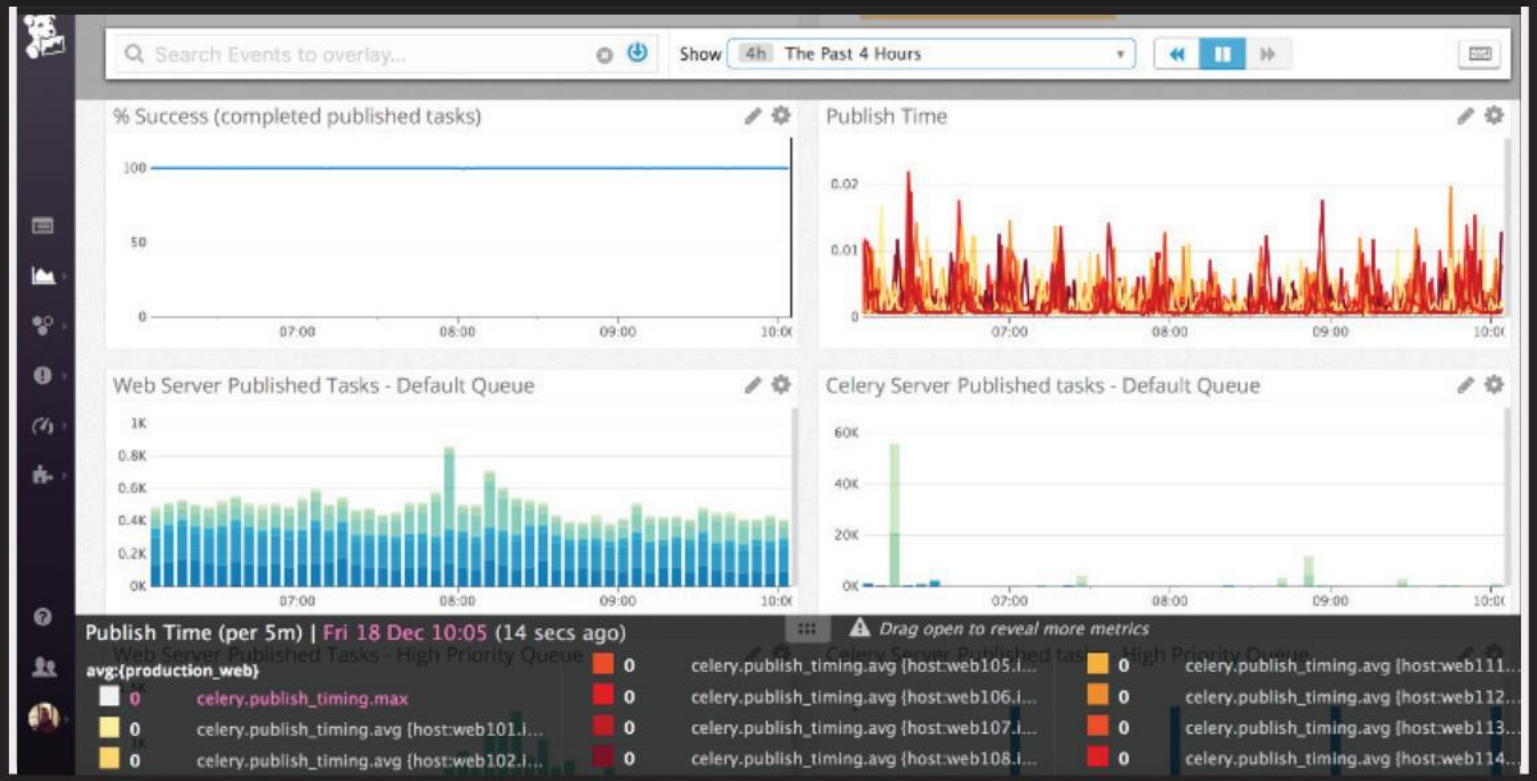
Monitoring Layer

Get a complete picture

of our Big Data tech stack

Satisfy SLAs with min downtime

DataDog


Search Events to overlay...
Show 4h The Past 4 Hours
% Success (completed published tasks)
100
50
0
07:00
08:00
09:00
Publish Time
0.02
0.01
0
Web Server Published Tasks - Default Queue
1K
0.8K
0.6K
0.4K
0.2K
0K
Celery Server Published tasks - Default Queue
60K
40K
20K
0K
Publish Time (per 5m) | Fri 18 Dec 10:05 (14 secs ago)
Drag open to reveal more metrics
avg:{production_web}
0 celery.publish_timing.max
0 celery.publish_timing.avg {host:web101.i...
0 celery.publish_timing.avg {host:web102.i...
0 celery.publish_timing.avg {host:web105.i...
0 celery.publish_timing.avg {host:web106.i...
0 celery.publish_timing.avg {host:web107.i...
0 celery.publish_timing.avg {host:web108.i...
0 celery.publish_timing.avg {host:web111...
0 celery.publish_timing.avg {host:web112...
0 celery.publish_timing.avg {host:web113...
0 celery.publish_timing.avg {host:web114...

New Relic (Overview)

New Relic (Databases)

Analytics Engine

Co-Existence with Traditional BI

- Data warehouse in the traditional way
- Distributed MR processing on big data stores

Mediate data in either direction

i.e use Hive/HBase with Sqoop

Real-time analysis can leverage low-latency NoSQL stores

i.e Cassandra, Vertica, ...

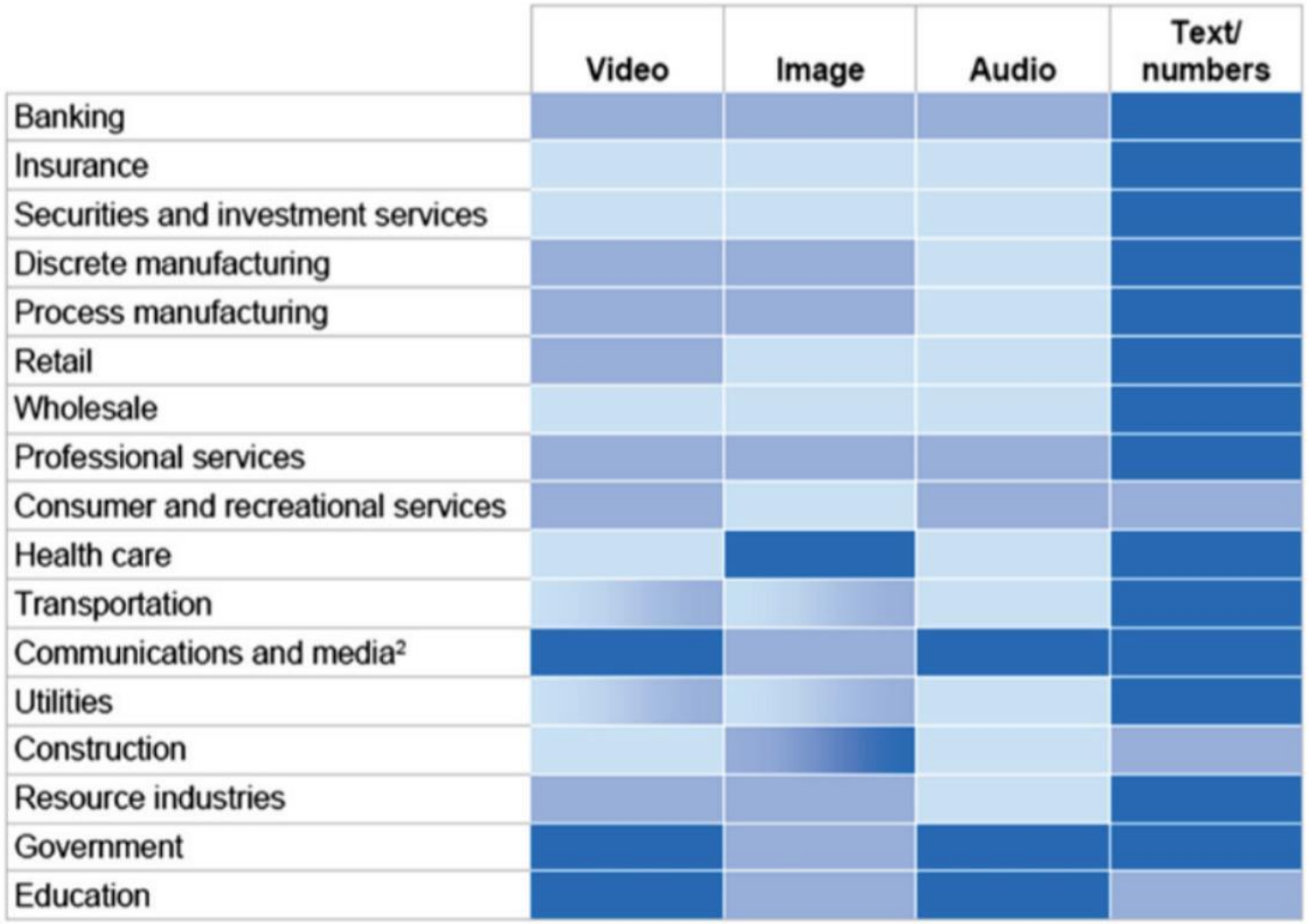
R may be used for complex statistical algorithms

Search Engines

Huge volume and variety of data

“needle in a haystack”

The type of data generated and stored varies by sector[1]

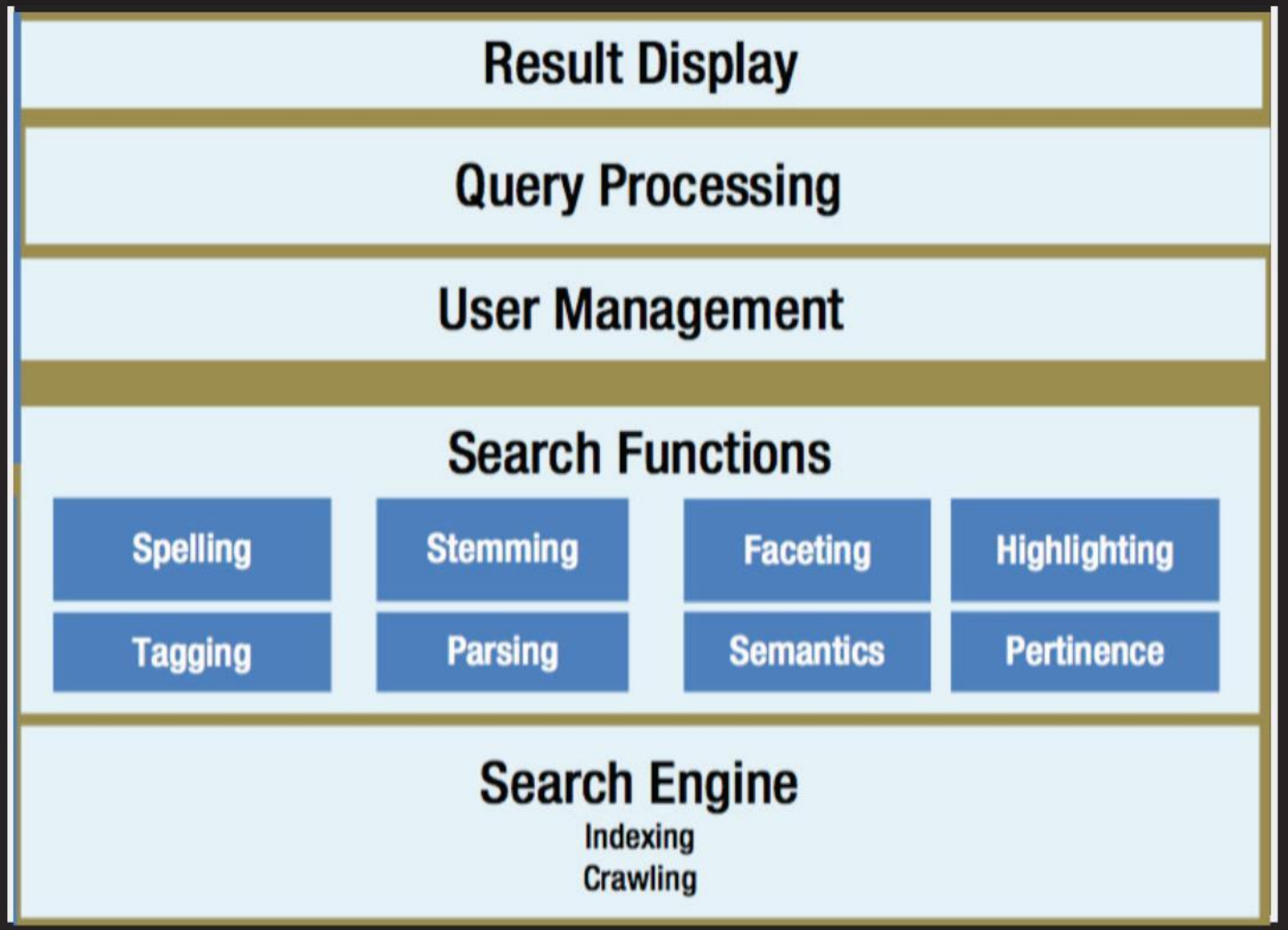


	Video	Image	Audio	Text/ numbers
Banking				
Insurance				
Securities and investment services				
Discrete manufacturing				
Process manufacturing				
Retail				
Wholesale				
Professional services				
Consumer and recreational services				
Health care				
Transportation				
Communications and media[2]				
Utilities				
Construction				
Resource industries				
Government				
Education				

1 We compiled this heat map using units of data (in files or minutes of video) rather than bytes.
2 Video and audio are high in some subsectors.
SOURCE: McKinsey Global Institute analysis

Need blazing fast search mechanism

to index and search for big data analytics


Result Display
Query Processing
User Management
Search Functions
Spelling
Stemming
Faceting
Highlighting
Tagging
Parsing
Semantics
Pertinence
Search Engine
Indexing
Crawling

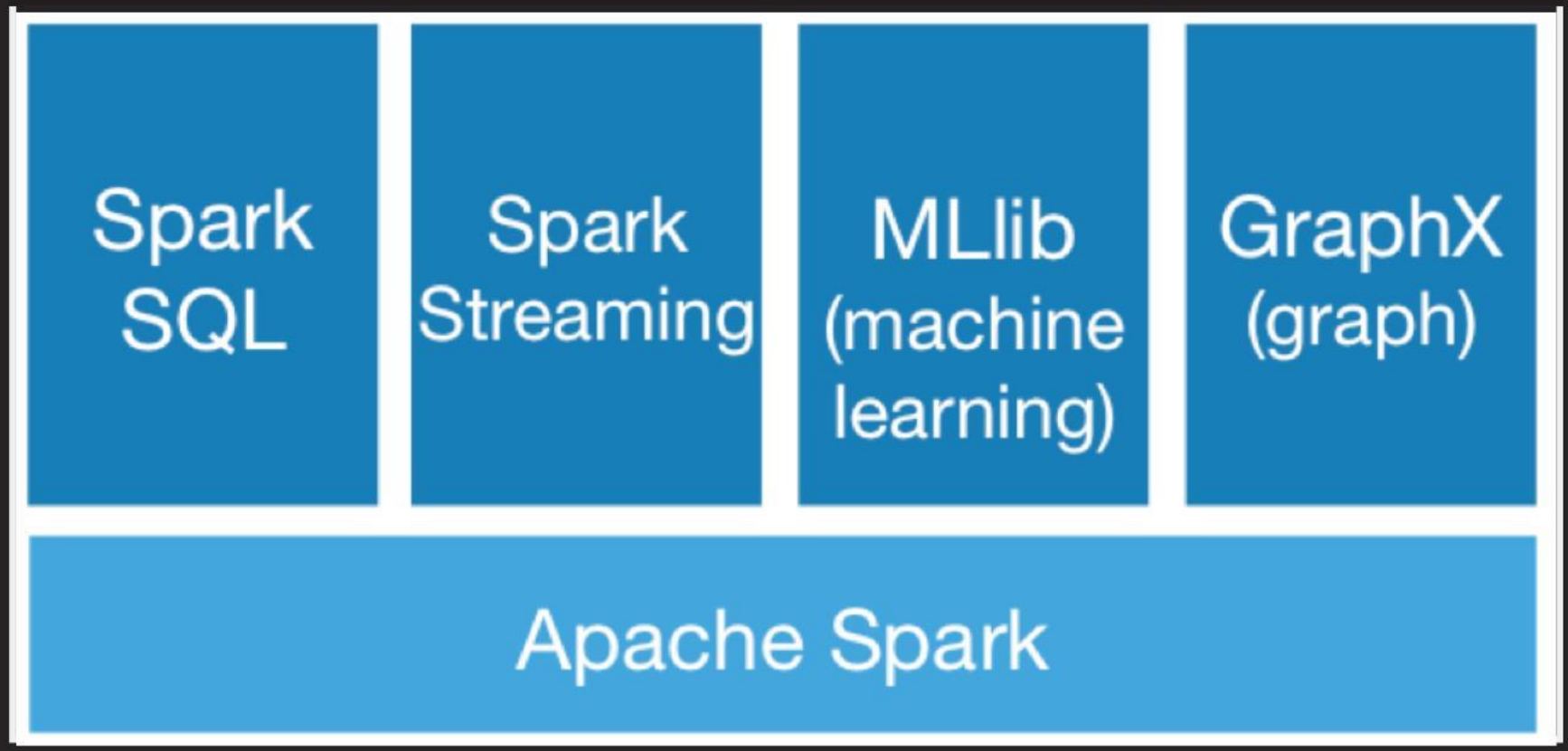
Elastic Search, Solr, ...

Real-time Processing

In memory?

Apache Spark™ is a fast and general engine for large-scale data processing.

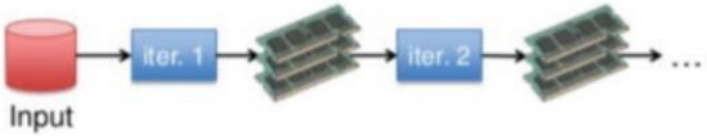
Apache Spark


Spark SQL
Spark Streaming
MLlib (machine learning)
GraphX (graph)
Apache Spark

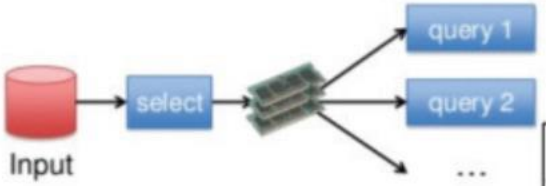

Spark
hadoop
cassandra
MESOS
APACHE
HBASE

Spark In-memory Processing

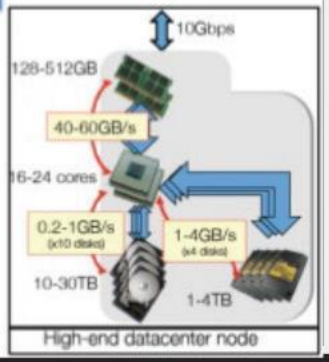
Iterative:



Interactive:



1. Extract a working set
2. Cache it
3. Query it repeatedly

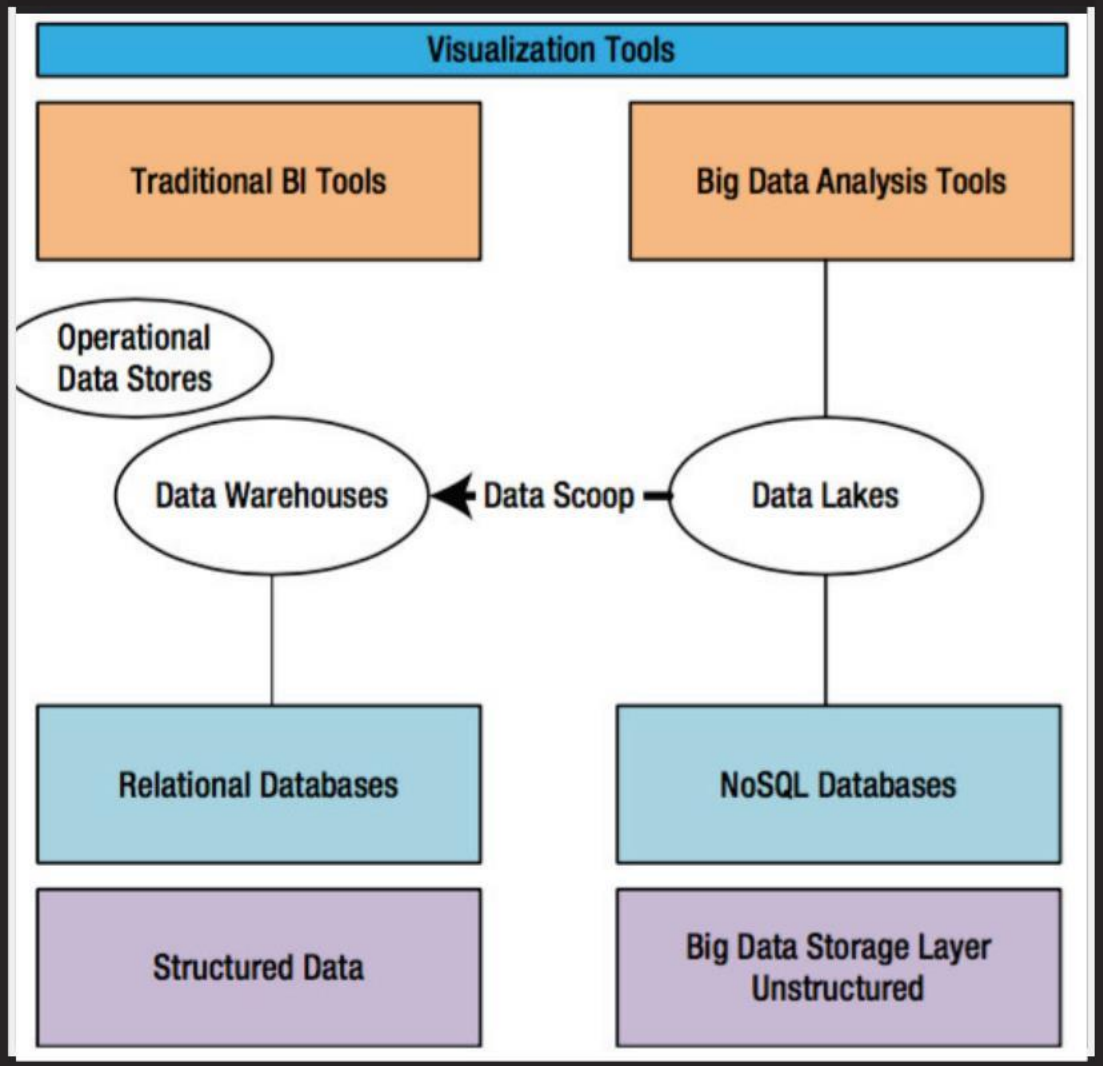


Storm, Kinesis, Flink, ...

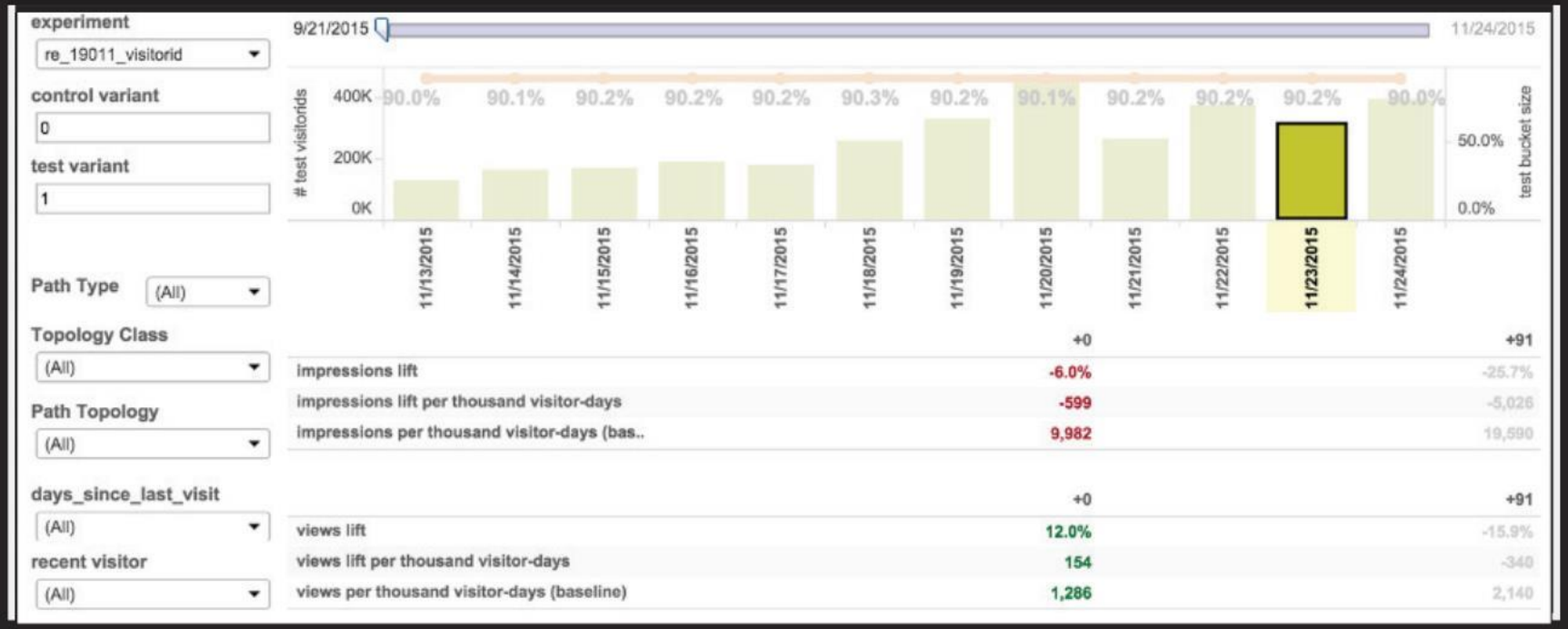
Visualization Layer

Gain insight faster

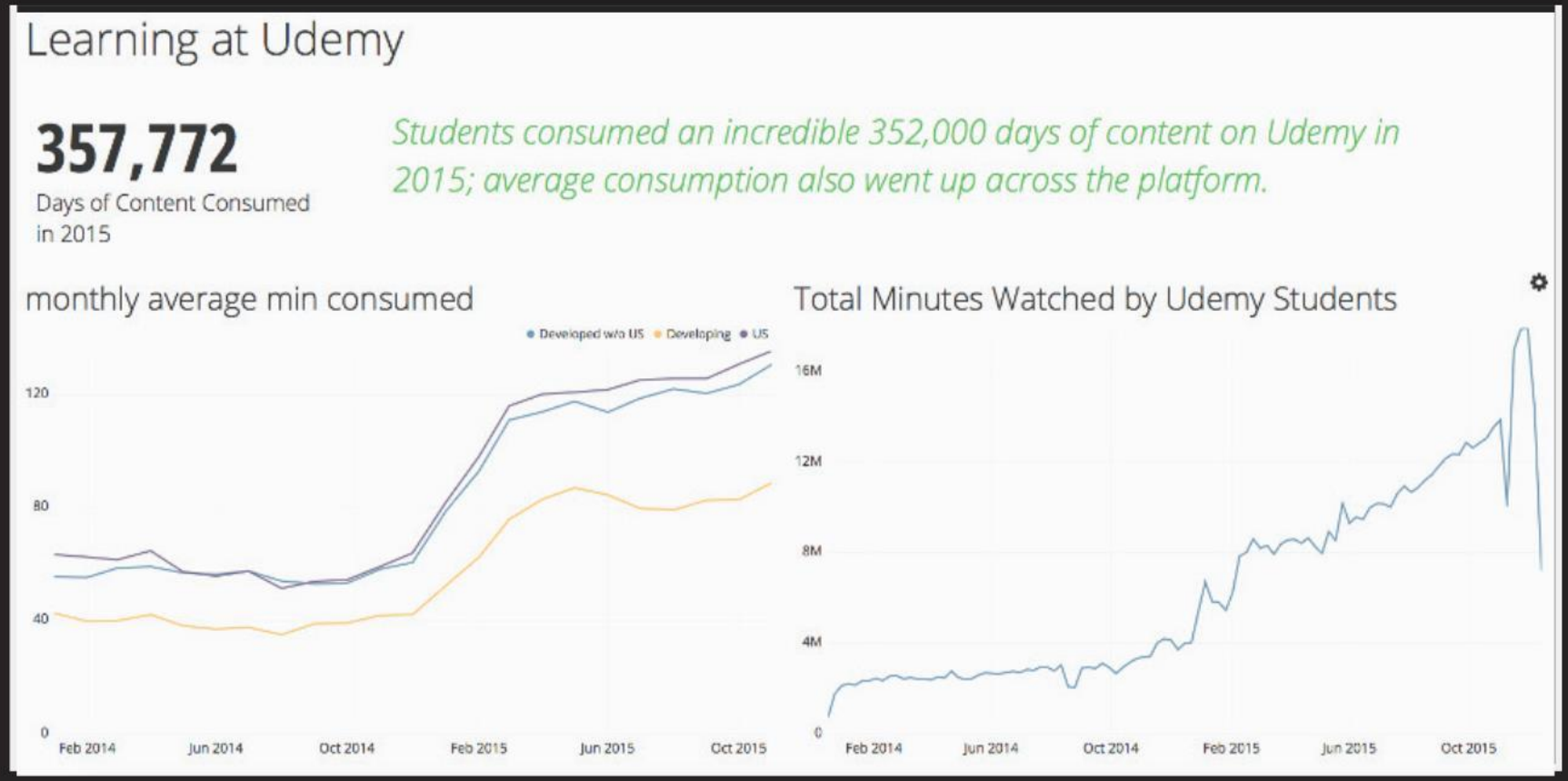
Look at different aspects of data visually


Visualization Tools
Traditional BI Tools
Big Data Analysis Tools
Operational Data Stores
Data Warehouses
Data Scoop
Data Lakes
Relational Databases
NoSQL Databases
Structured Data
Big Data Storage Layer Unstructured

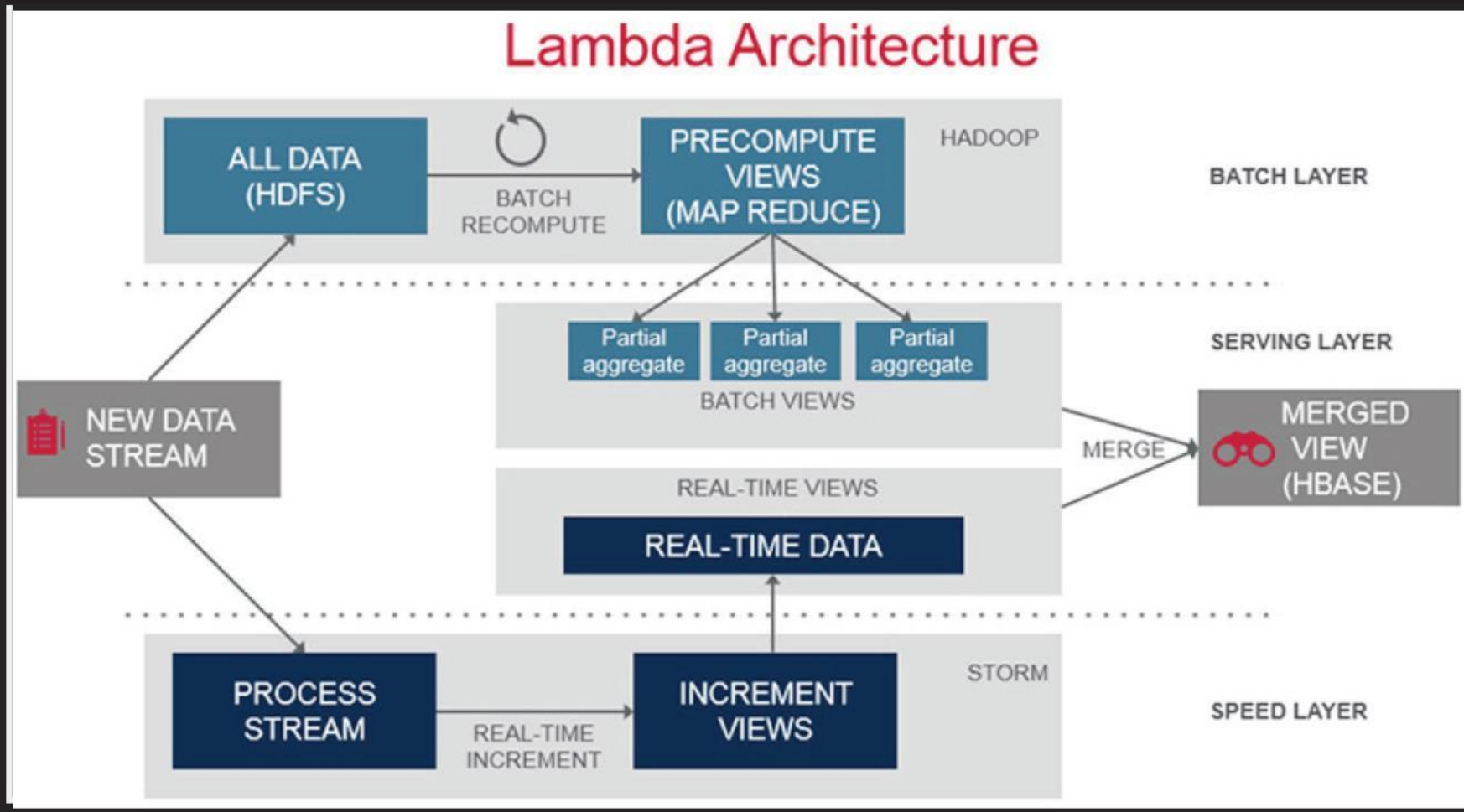
Tableau


experiment
re_19011_visitorid
control variant
0
test variant
1
Path Type
(All)
Topology Class
(All)
Path Topology
(All)
days_since_last_visit
(All)
recent visitor
(All)
9/21/2015
11/24/2015
test visitorids
400K
200K
0K
90.0%
90.1%
90.2%
90.2%
90.2%
90.3%
90.2%
90.1%
90.2%
90.2%
90.2%
90.0%
50.0%
0.0%
test bucket size
11/13/2015
11/14/2015
11/15/2015
11/16/2015
11/17/2015
11/18/2015
11/19/2015
11/20/2015
11/21/2015
11/22/2015
11/23/2015
11/24/2015
+0
+91
impressions lift
-6.0%
-25.7%
impressions lift per thousand visitor-days
-599
-5,026
impressions per thousand visitor-days (bas..
9,982
19,590
+0
+91
views lift
12.0%
-15.9%
views lift per thousand visitor-days
154
-340
views per thousand visitor-days (baseline)
1,286
2,140

ChartIO


Learning at Udemy
357,772
Days of Content Consumed in 2015
Students consumed an incredible 352,000 days of content on Udemy in 2015; average consumption also went up across the platform.
monthly average min consumed
Developed w/o US
Developing
US
120
80
40
0
Feb 2014
Jun 2014
Oct 2014
Feb 2015
Jun 2015
Oct 2015
Total Minutes Watched by Udemy Students
16M
12M
8M
4M
0
Feb 2014
Jun 2014
Oct 2014
Feb 2015
Jun 2015
Oct 2015

Lambda Architecture



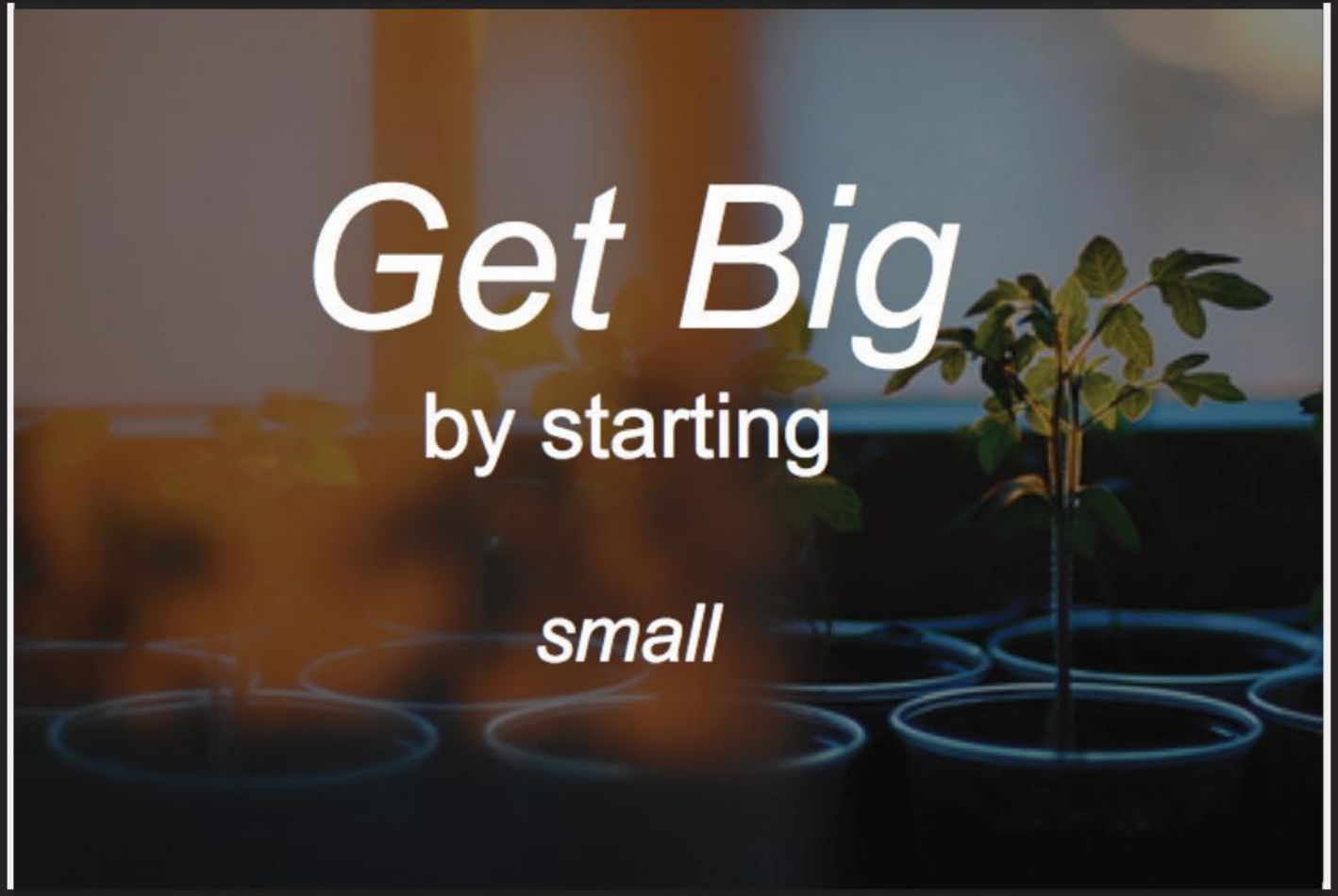
Lambda Architecture / MapR

Don't forget

There is no "One Size Fits All" solution

We need

Continuous Development


Get Big
by starting
small


Focus on
Business Impact.

Thank You :)