Inspire…Educate…Transform.

Engineering Big Data

Ingesting & Organizing Big Data

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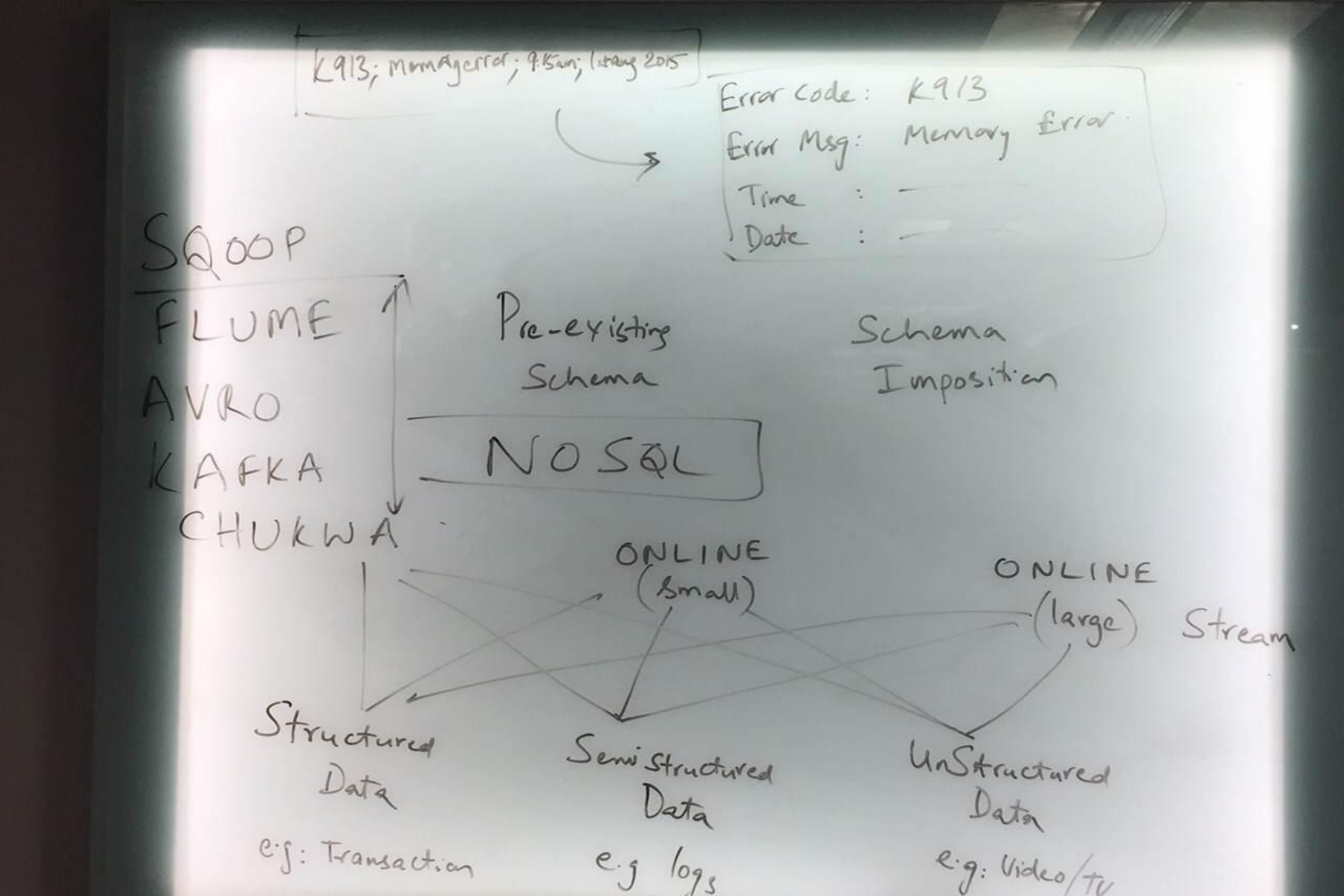
CEO, Quadratyx

August 1, 2015

Wake-Up Quiz


K913; MemoryError; 9:15am; 1st Aug 2015
Error Code: K913
Error Msg: Memory Error
Time :
Date :
SQOOP
FLUME
AVRO
KAFKA
CHUKWA
Pre-existing Schema
Schema Imposition
NOSQL
ONLINE (small)
ONLINE (large)
Stream
Structured Data
e.g: Transaction
Semi Structured Data
e.g logs
UnStructured Data
e.g: Video/TV

HDFS CAN *STORE* BIG BYTES, FILES RELIABLY, AT VERY LOW COST.

BUT IT CANNOT *BRING IN (INGEST)* DATA BY ITSELF.

Eco-system components for Ingestion: Flume, Chukwa, Avro, Kafka

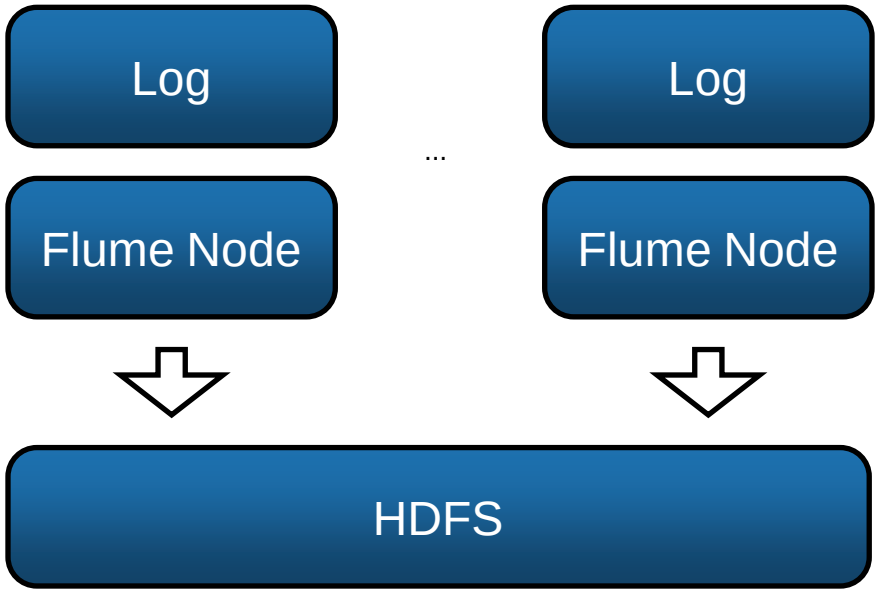
HDFS ALSO DOES NOT *ORGANIZE* DATA FOR EASY QUERYING.

No-SQL Data Stores


FLUME

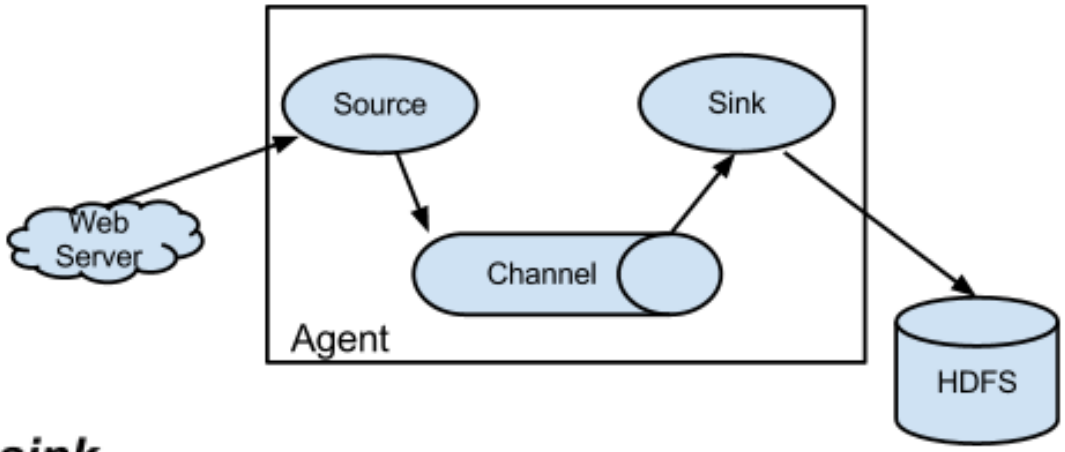
From http://flume.apache.org

Flume is a distributed, reliable, and available service for efficiently collecting, aggregating, and moving large amounts of log data.

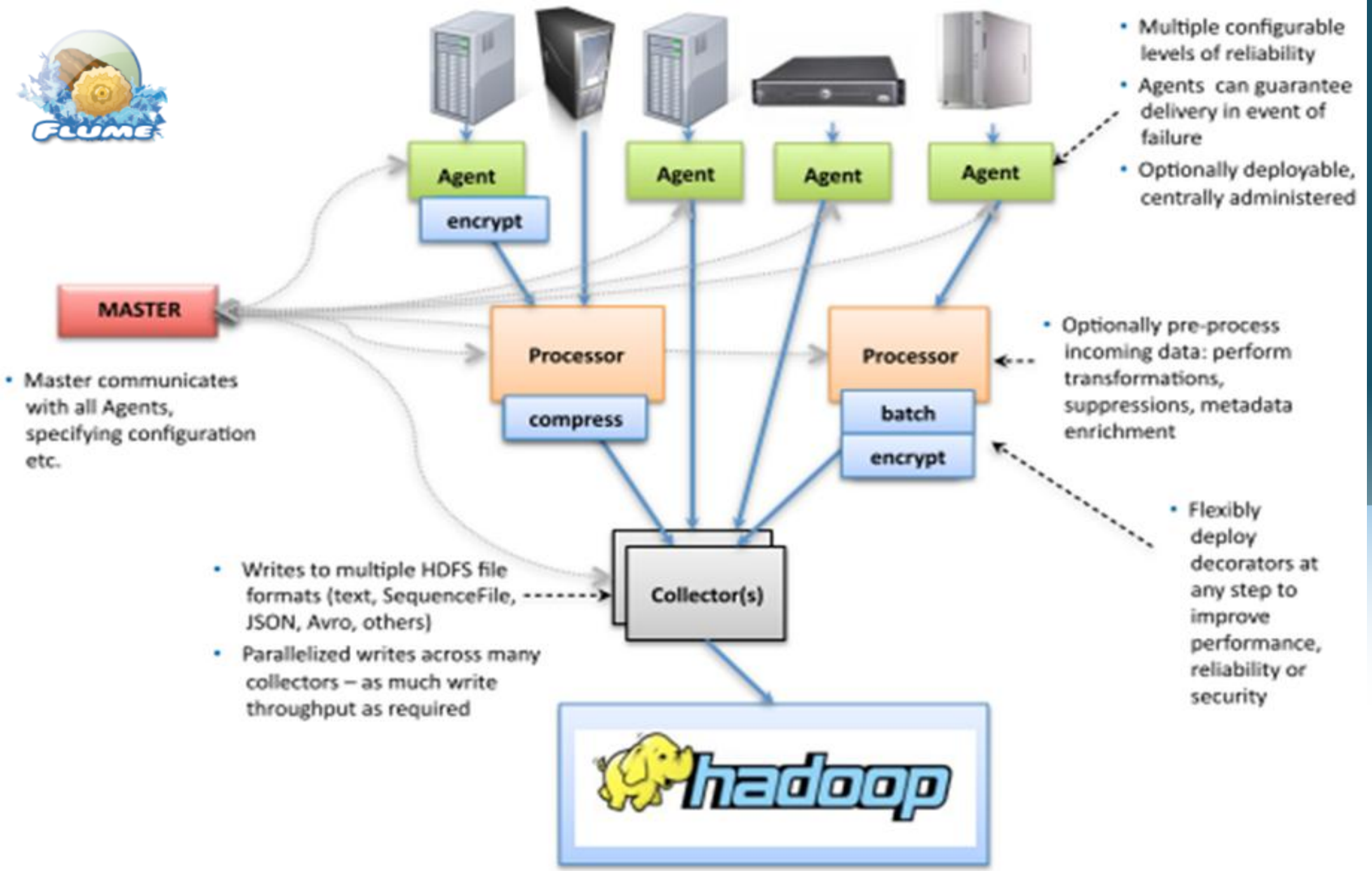


- Simple and flexible architecture
- Streaming data flows
- Tunable reliability
- Many failover and recovery mechanisms.
- Extensible data model
- Allows online analytic applications

Flume Nodes



- **Each Flume node has a *source* and a *sink***
- **Source**
  - Tells the node where to receive data from
- **Sink**
  - Tells the node where to send data to
- **Sink can have one or more *decorators***
  - Perform simple processing on data as it passes though, such as
    - Compression
    - Encryption
    - `awk`, `grep`-like functionality


Agent
encrypt
Agent
Agent
Agent
MASTER
Processor
compress
Processor
batch
encrypt
Collector(s)
hadoop
Multiple configurable levels of reliability
Agents can guarantee delivery in event of failure
Optionally deployable, centrally administered
Master communicates with all Agents, specifying configuration etc.
Optionally pre-process incoming data: perform transformations, suppressions, metadata enrichment
Writes to multiple HDFS file formats (text, SequenceFile, JSON, Avro, others)
Parallelized writes across many collectors – as much write throughput as required
Flexibly deploy decorators at any step to improve performance, reliability or security

Avro

- Avro is a **serialization framework** developed within Apache's Hadoop project.

- Avro provides good way to **convert unstructured and semi-structured data into a structured way** using schemas

Sample Avro schema

Schema description:

```
 {
 "name": "User",
 "type": "record",
 "fields": [
   {"name": "FirstName", "type": "string", "doc": "First Name"},
   {"name": "LastName", "type": "string"},
   {"name": "isActive", "type": "boolean", "default": true},
   {"name": "Account", "type": "int", "default": 0} ]
}
```

Avro Details

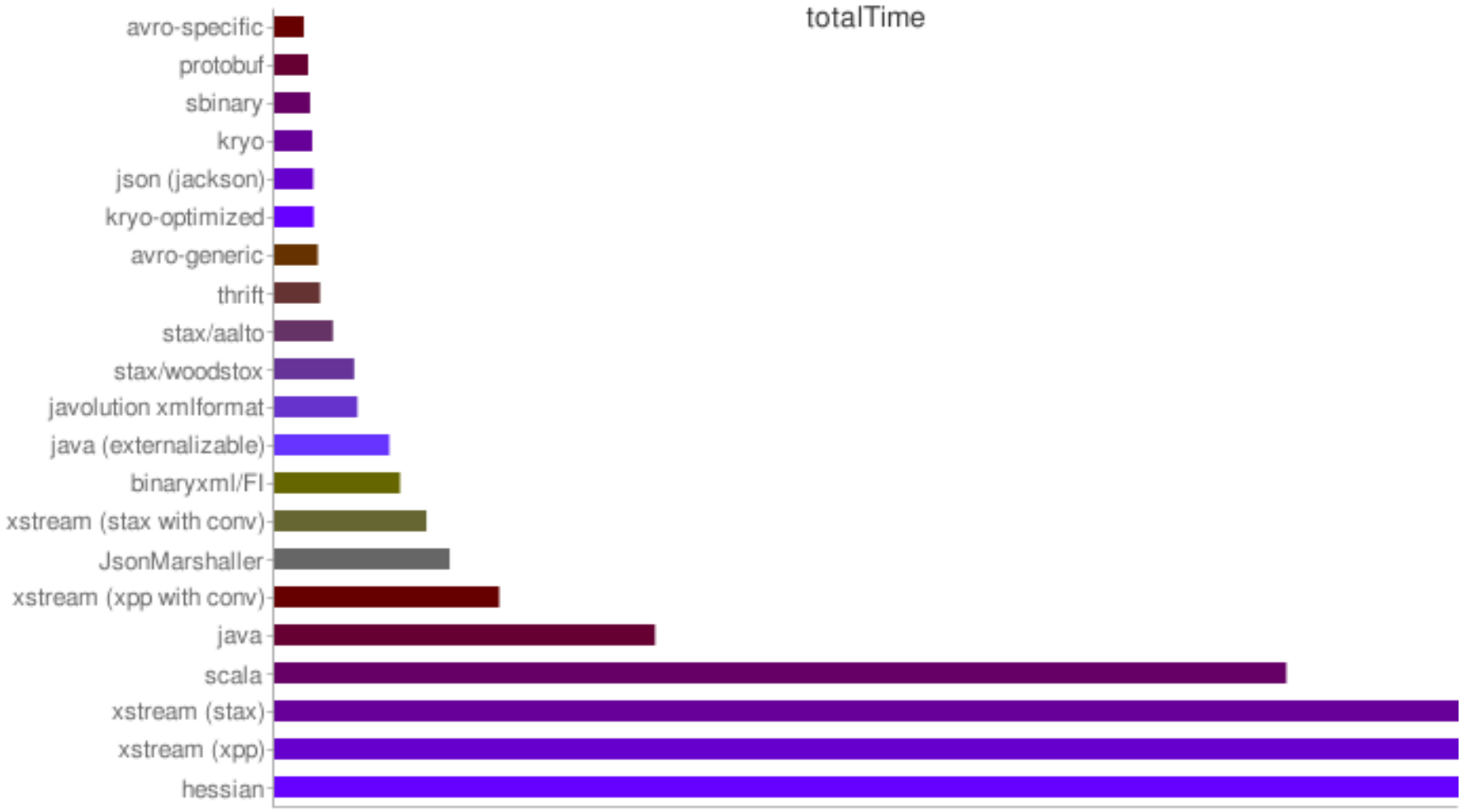
- Data serialization system
- Uses JSON based schemas
- Uses RPC calls to send data
- Schema's sent during data exchange
- Integrated with many languages
- Fast binary data format or encode with JSON

Avro API's exist for the following languages

- Java
- C#
- C
- C++
- Python
- Ruby

Other Serialization Methods, Avro example & analysis links

https://martin.kleppmann.com/2012/12/05/schema-evolution-in-avro-protocol-buffers-thrift.html
http://devres.zoomquiet.io/data/20091111011019/index.html



Hindu mythology has various account of World Tortoises, besides a World Serpent (Shesha), Kurmaraja and world-elephants.

The most widespread name given to the tortoise is Kurma or Kurmaraja. The Shatapatha Brahmana identifies the earth as its lower shell, the atmosphere as its body and the vault of heaven as its upper shell.

The name *Akūpāra* (the Sanskrit for "unbounded") is mentioned in the Bhagavata Purana.[*citation needed*]

An alleged tortoise *Chukwa* supporting Mount Meru is reported by Leveson Venables Vernon-Harcourt in 1838.[2] Vernon-Harcourt claims that this *Chukwa* was introduced to bishop Heber "in the Vidalaya school in Benares [by] an astronomical lecturer" (sic; *vidyalaya* is the Sanskrit for "school"). *Chukwa* along with *Maha-padma* (spelled "Maha-pudma") as the name of a world-elephant mentioned in the Ramayana has subsequently made it into *Brewer's Dictionary of Phrase and Fable* and was further repeated by reference to that work.

The concept of World-Tortoise and World-Elephant was conflated in popular or rhetorical references to Hindu mythology.[*dubious – discuss*] The combination of tortoise and elephant is present in John Locke's 1690 tract *An Essay Concerning Human Understanding*, which references an "Indian who said the world was on an elephant which was on a tortoise ". It is repeated in Bertrand Russell's 1927 *Why I Am Not A Christian* in the reference to "the Hindu's view, that the world rested upon an elephant and the elephant rested upon a tortoise". A whimsical allusion to such a supposed "tortoise-and-elephant" version of the myth appears in Wilfrid Sellars' 1956 *Empiricism and the Philosophy of Mind*:

> authoritative nonverbal episodes... would constitute the tortoise on which stands the elephant on which rests the edifice of empirical knowledge.

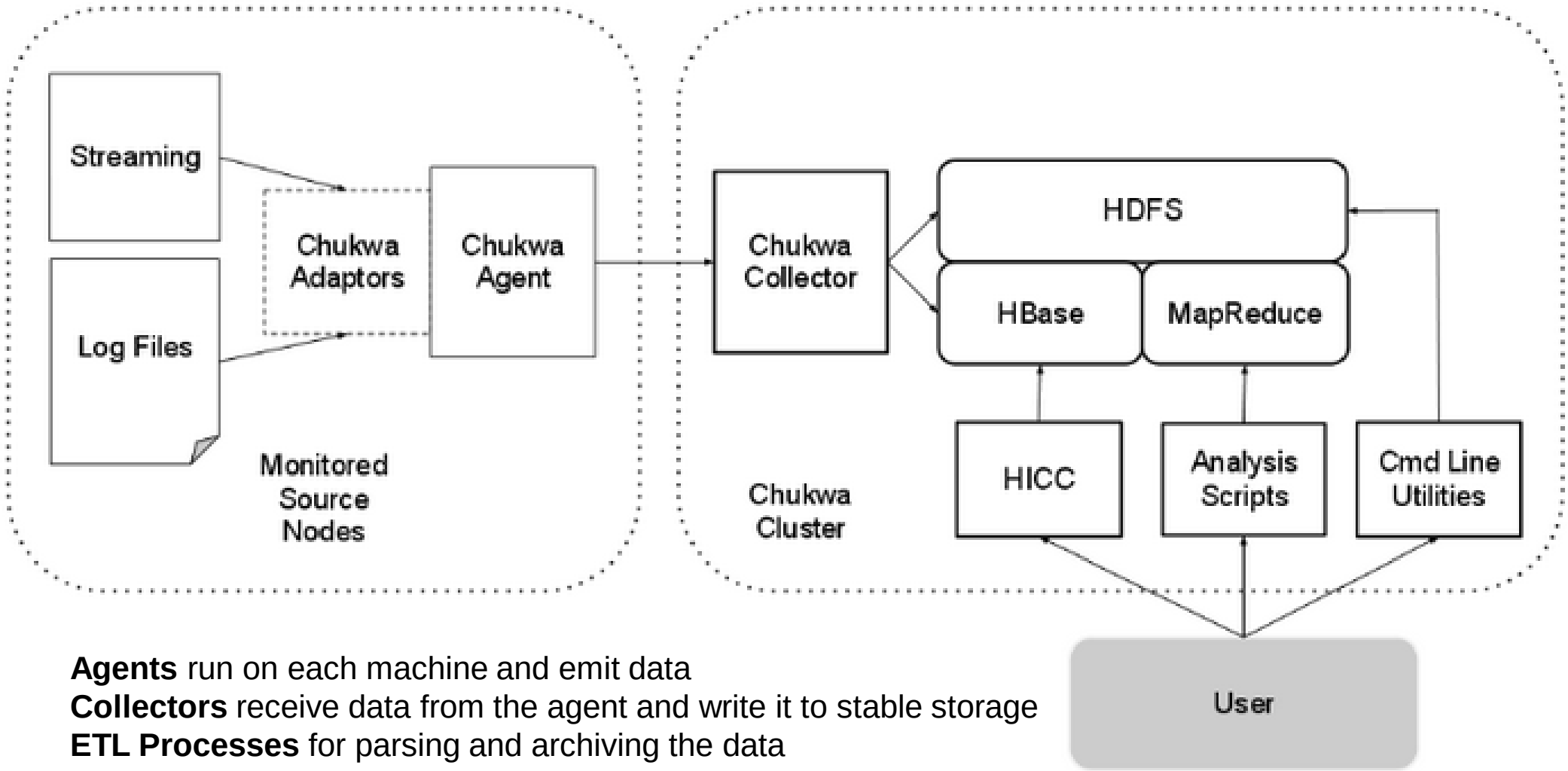
Chukwa

- A scalable log collector

- Some log analyses
  - Anomaly detection via machine learning
  - Profiling to find inefficiencies
  - Hardware failure rate monitoring
  - Accounting and utilization tracking
  - Log collection & archiving for developers.
  - Summarization/archiving of metrics data
    - Upload to SQL database for visualization

- Major motivation for Chukwa was storing and analyzing Hadoop logs.

Chukwa Architecture

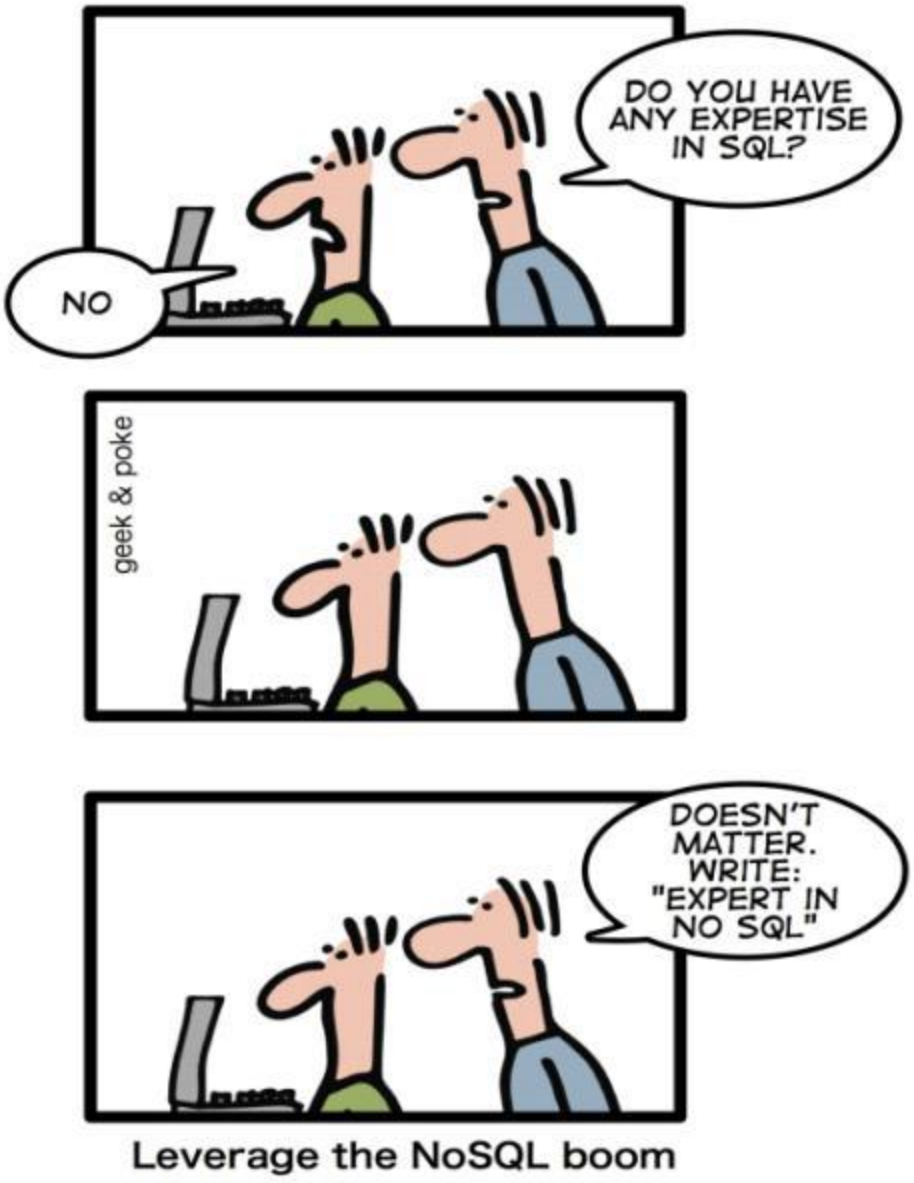


Agents run on each machine and emit data
Collectors receive data from the agent and write it to stable storage
ETL Processes for parsing and archiving the data
Data Analytics Scripts for aggregate Hadoop cluster health.
HICC, the Hadoop Infrastructure Care Center; a web-portal style interface for displaying data.

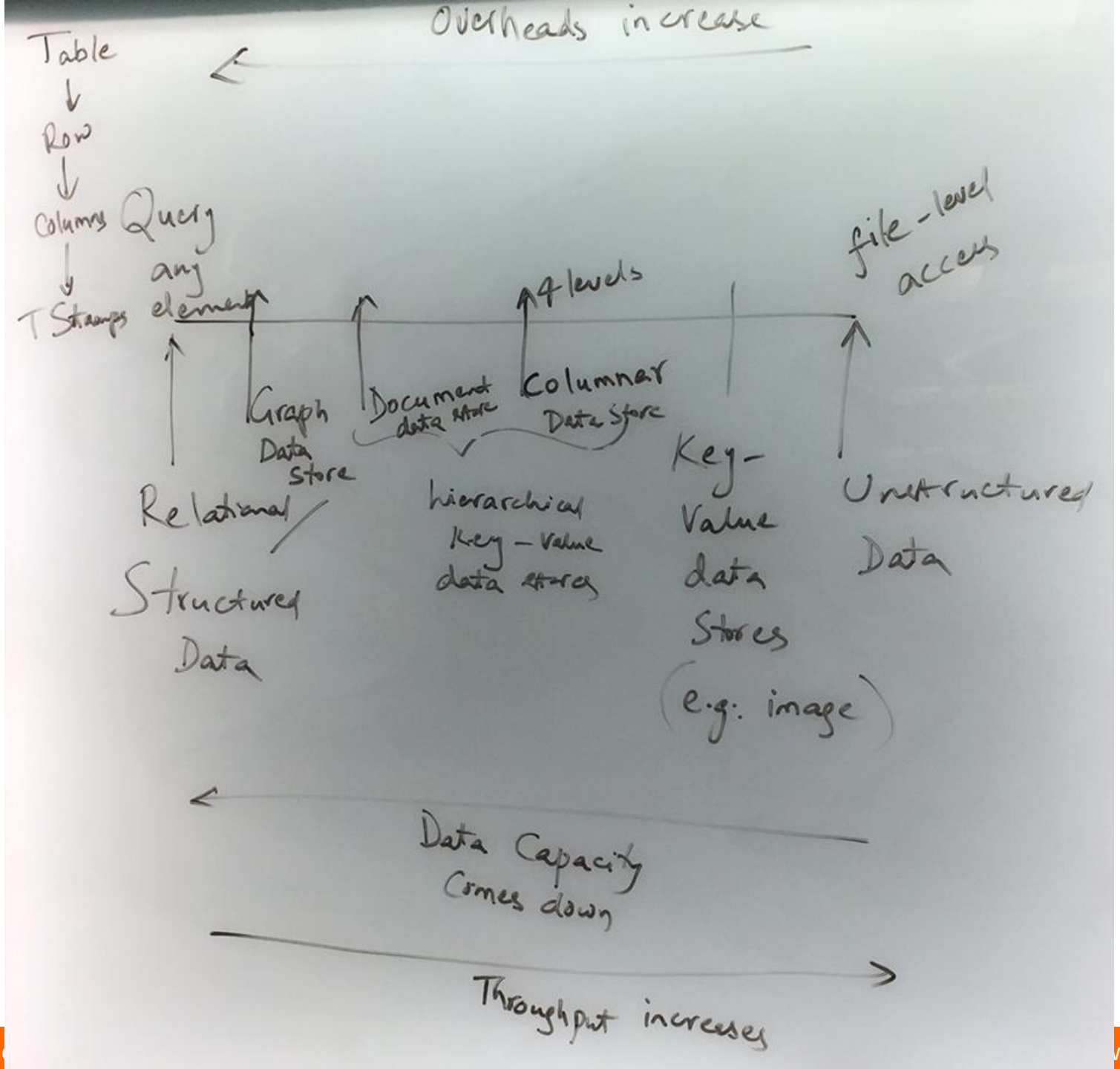
Chukwa goals

- How many nodes? How much data?
  - Scale to thousands of nodes. Hundreds of KB/sec/node on average, bursts above that OK
- What data sources and delivery semantics?
  - Console Logs and Metrics. Reliable delivery (as much as possible.) Minutes of delay are OK.
- Processing expressiveness?
  - MapReduce
- Storage?
  - Should be able to store data indefinitely. Support petabytes of stored data.

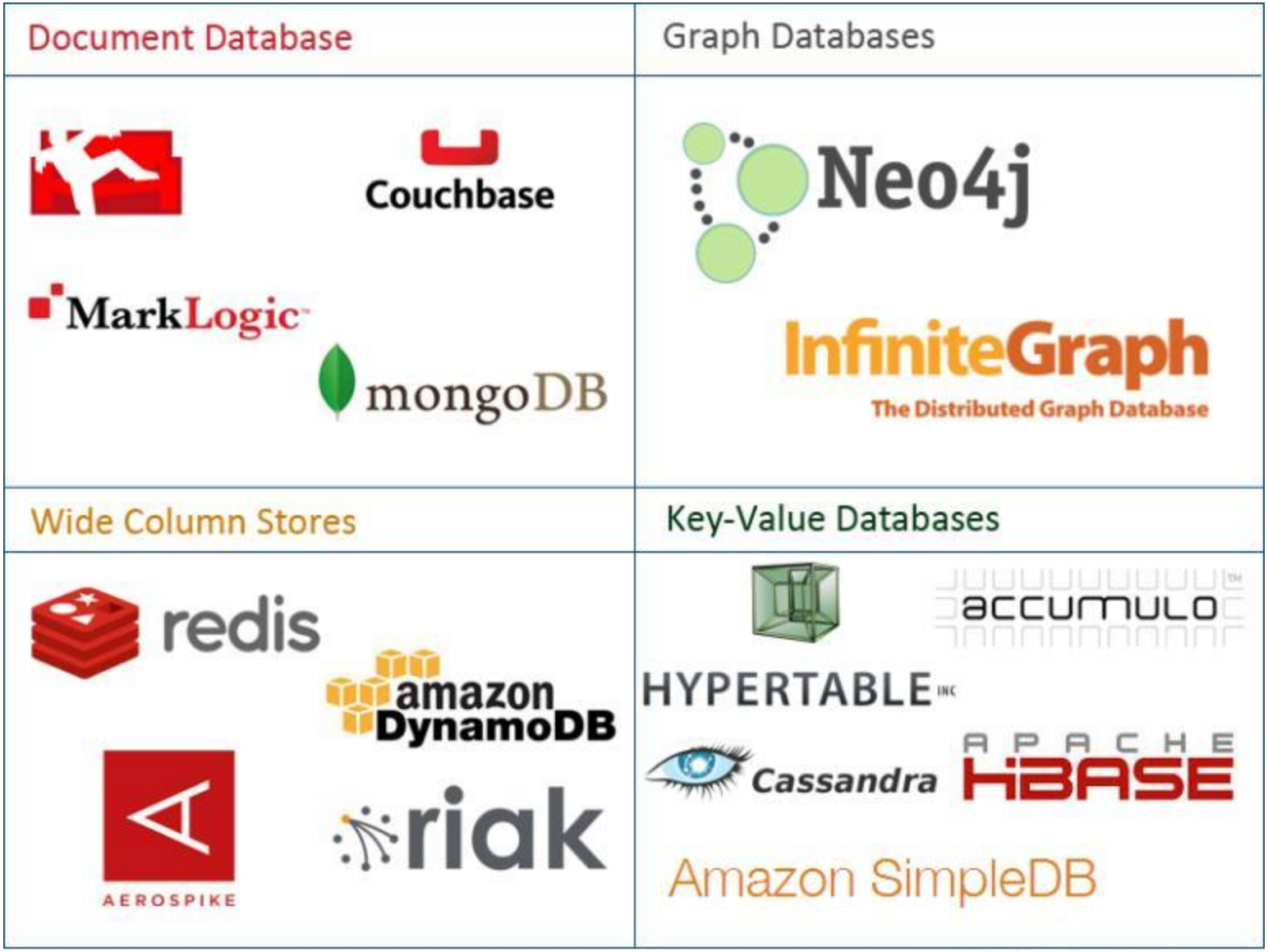
HOW TO WRITE A CV



NOSQL


Overheads increase
Table
Row
Columns
Strings
Query any element
4 levels
file-level access
Graph Data Store
Document data store
Columnar Data Store
Relational
Structured Data
hierarchical key-value data stores
Key-Value data Stores
(e.g. image)
Unstructured Data
Data Capacity comes down
Throughput increases

http://nosql-database.org/ Lists 150 No-SQL databases today.

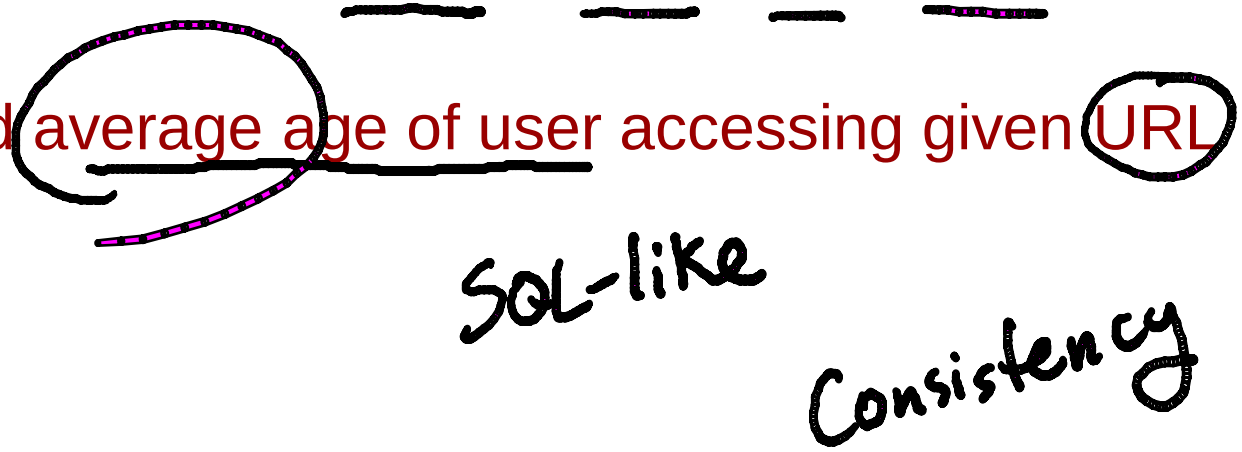


Example #1: Web log analysis

Each record: UserID, URL, timestamp, additional-info

Separate records: UserID, name, age, gender, …

Task: Find average age of user accessing given URL



Example #2: Social-network graph

Each record: $UserID_1$, $UserID_2$

Separate records: UserID, name, age, gender, …

Task: Find all friends of friends of friends of … friends of given user

Example #3: Wikipedia pages

Large collection of documents

Combination of structured and unstructured data

Task: Retrieve introductory paragraph of all pages about U.S. presidents before 1900

NoSQL Distinguishing Characteristics

- Large data volumes
  - Google's "big data"
- Scalable replication and distribution
  - Potentially thousands of machines
  - Potentially distributed around the world
- Queries need to return answers quickly
- Mostly query, few updates
- Asynchronous Inserts & Updates
- Schema-less

Transactions – ACID Properties

- **A**tomic – All of the work in a transaction completes (commit) or none of it completes
- **C**onsistent – A transaction transforms the database from one consistent state to another consistent state. Consistency is defined in terms of constraints.
- **I**solated – The results of any changes made during a transaction are not visible until the transaction has committed.
- **D**urable – The results of a committed transaction survive failures

NoSQL Theory

- Usually do not require a fixed table schema nor do they use the concept of joins
- All NoSQL offerings relax one or more of the ACID properties: Atomicity, consistency, isolation, durability
  - BASE (**B**asically **A**vailable, **S**oft state, **E**ventual consistency)

The NoSQL movement

- Three major papers were the seeds of the NoSQL movement:
  - BigTable (Google)
  - Dynamo (Amazon)
    - Gossip protocol (discovery and error detection)
    - Distributed key-value data store
    - Eventual consistency
  - CAP Theorem

CAP Theorem

It is impossible for a distributed computer system to simultaneously provide all three of the following guarantees:

- ***Consistency:*** all nodes see the same data at the same time
- ***Availability:*** a guarantee that every request receives a response on whether it was successful or failed
- ***Partition tolerance:*** the system continues to operate despite arbitrary message loss or failure of part of the system

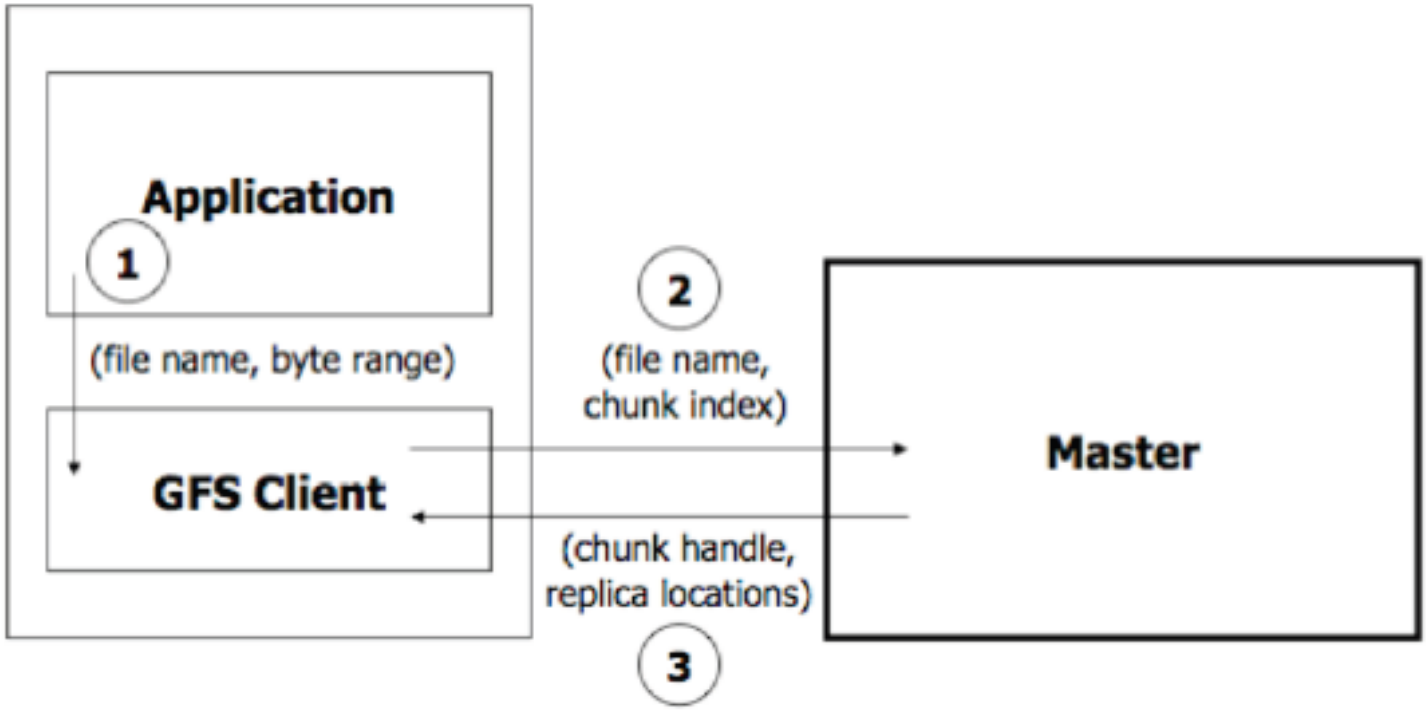
According to the theorem, a distributed system can satisfy any two of these guarantees at the same time, but not all three.

Appendix

SEQUENCE OF OPERATIONS DURING FILE READ AND FILE WRITE, IN GFS AND HDFS

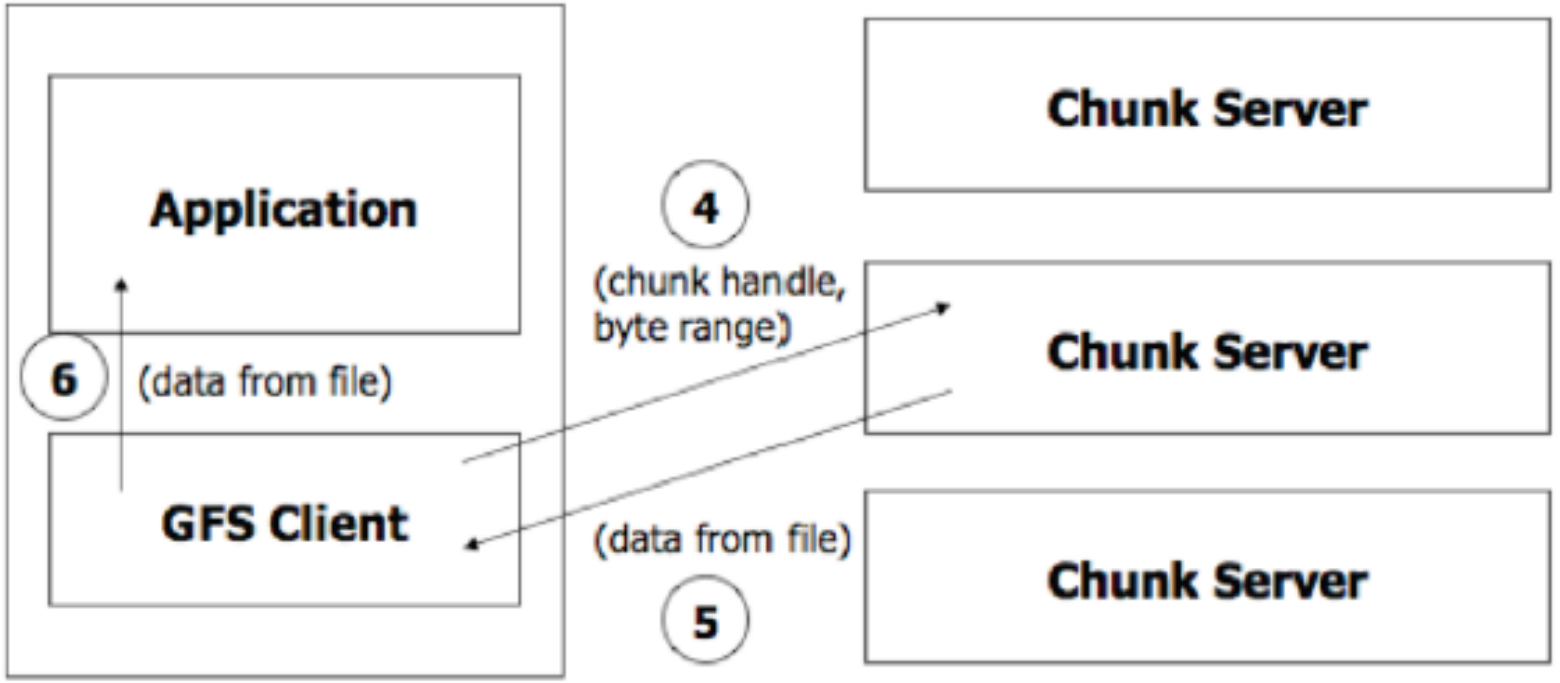
GFS Read Algorithm

1. Application originates the read request
2. GFS client translates request and sends it to master
3. Master responds with chunk handle and replica locations

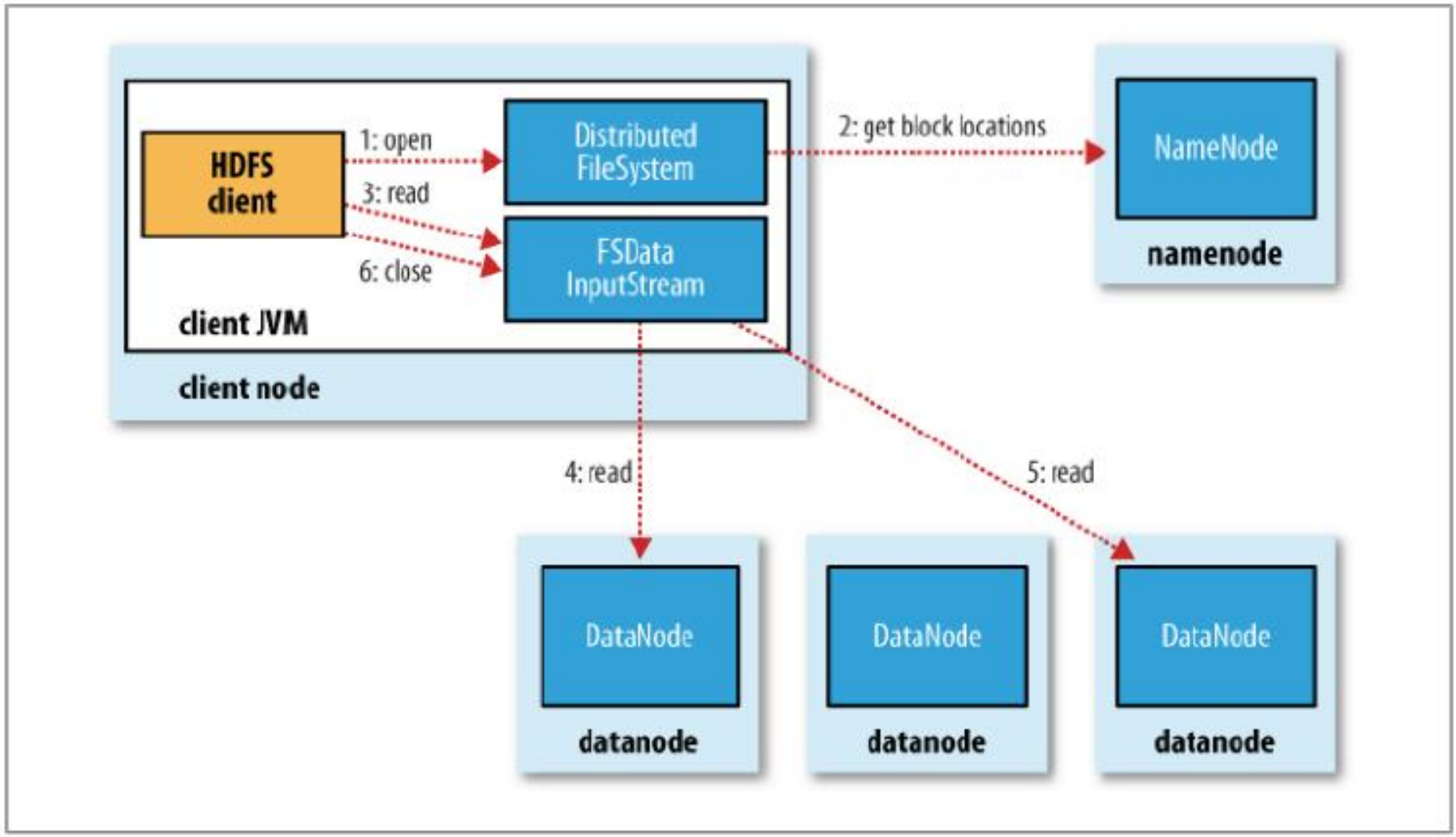


Read Algorithm (contd.)

4. Client picks a location and sends the request
5. Chunkserver sends requested data to the client
6. Client forwards the data to the application

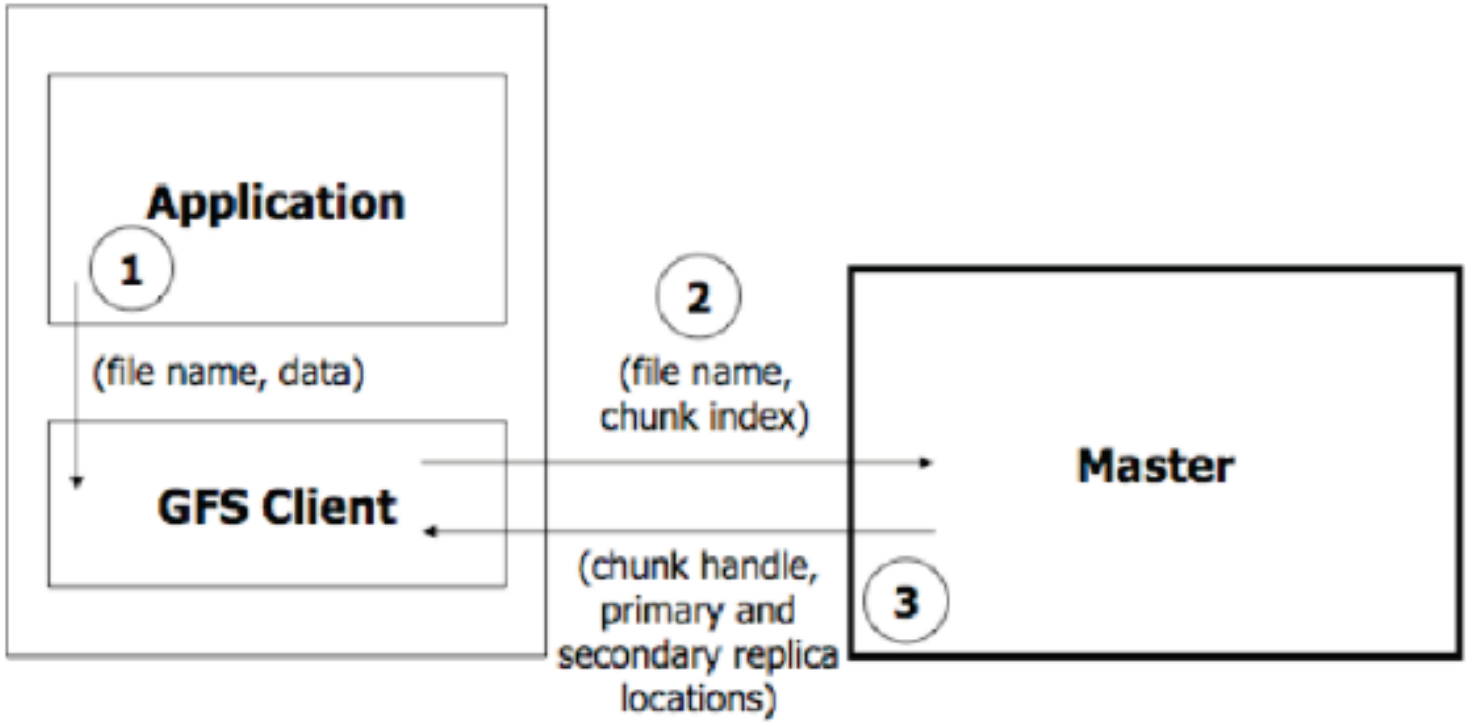


HDFS: Anatomy of a File Read



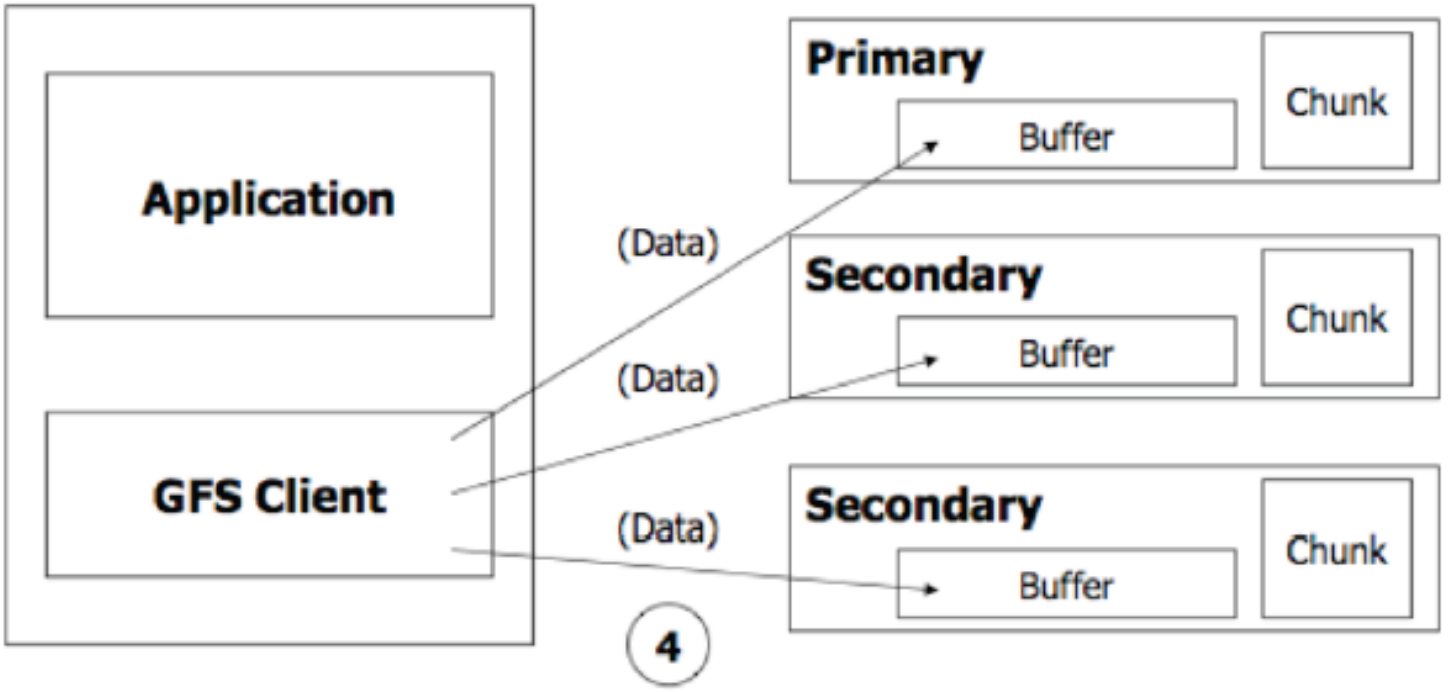
GFS Write Algorithms

1. Application originates the request
2. GFS client translates request and sends it to master
3. Master responds with chunk handle and replica locations



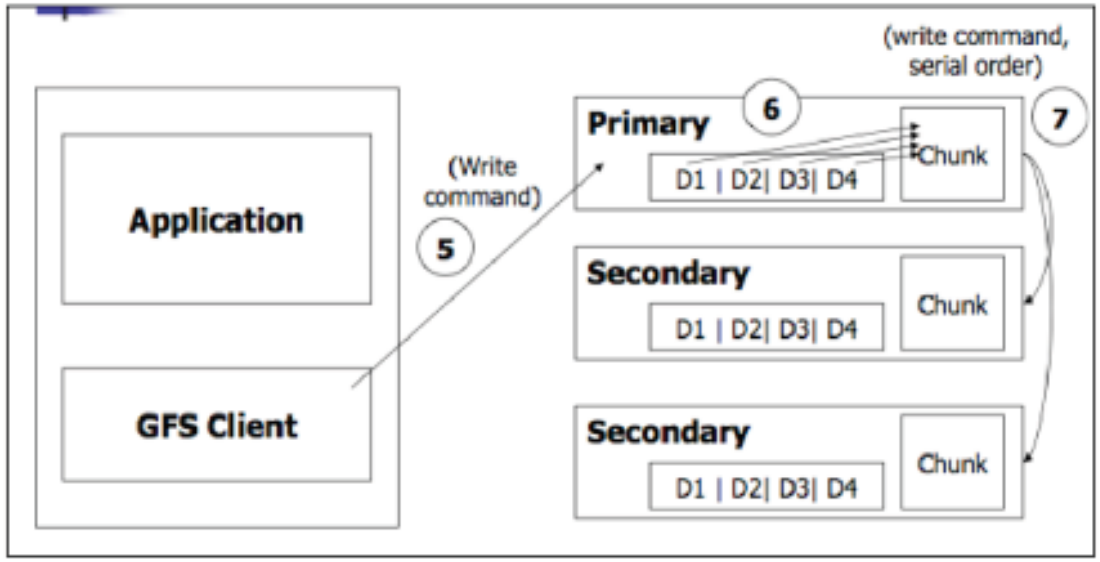
Write Algorithm (contd.)

4. Client pushes write data to all locations. Data is stored in chunkserver's internal buffers



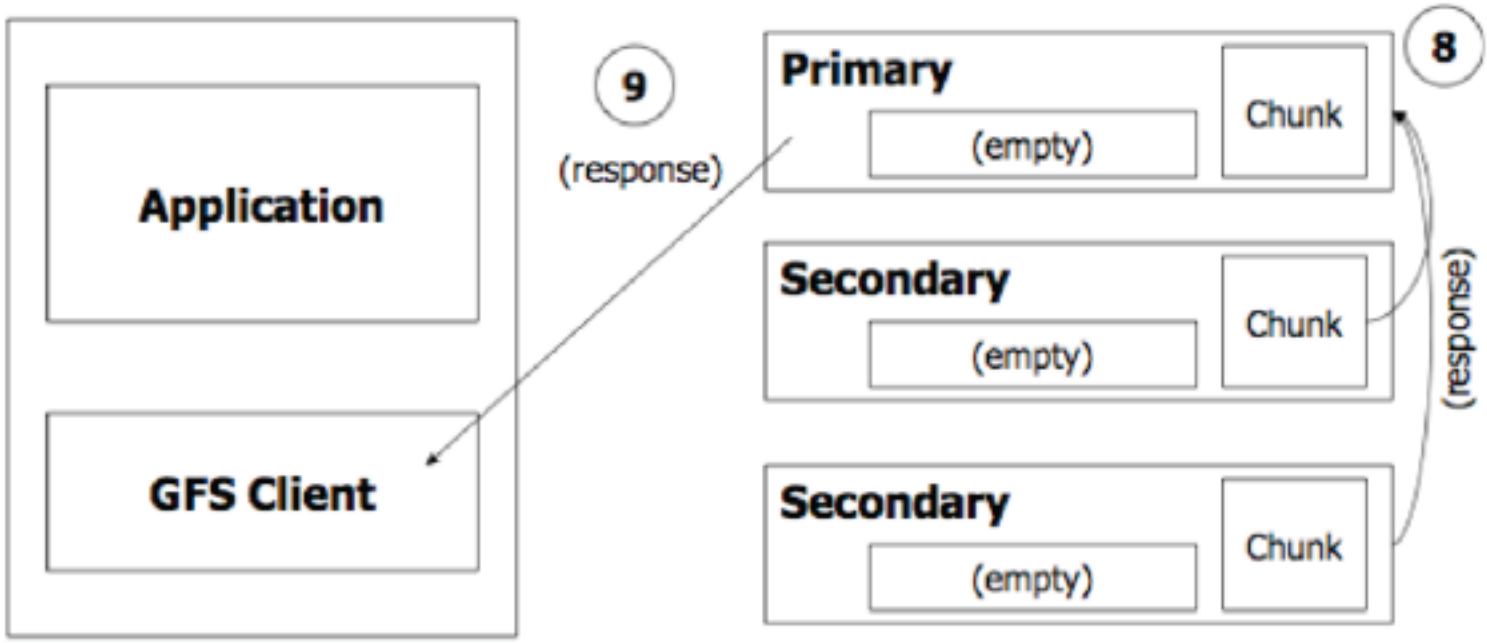
Write Algorithm (contd.)

5. Client sends write command to primary
6. Primary determines serial order for data instances in its buffer and writes the instances in that order to the chunk
7. Primary sends the serial order to the secondaries and tells them to perform the write

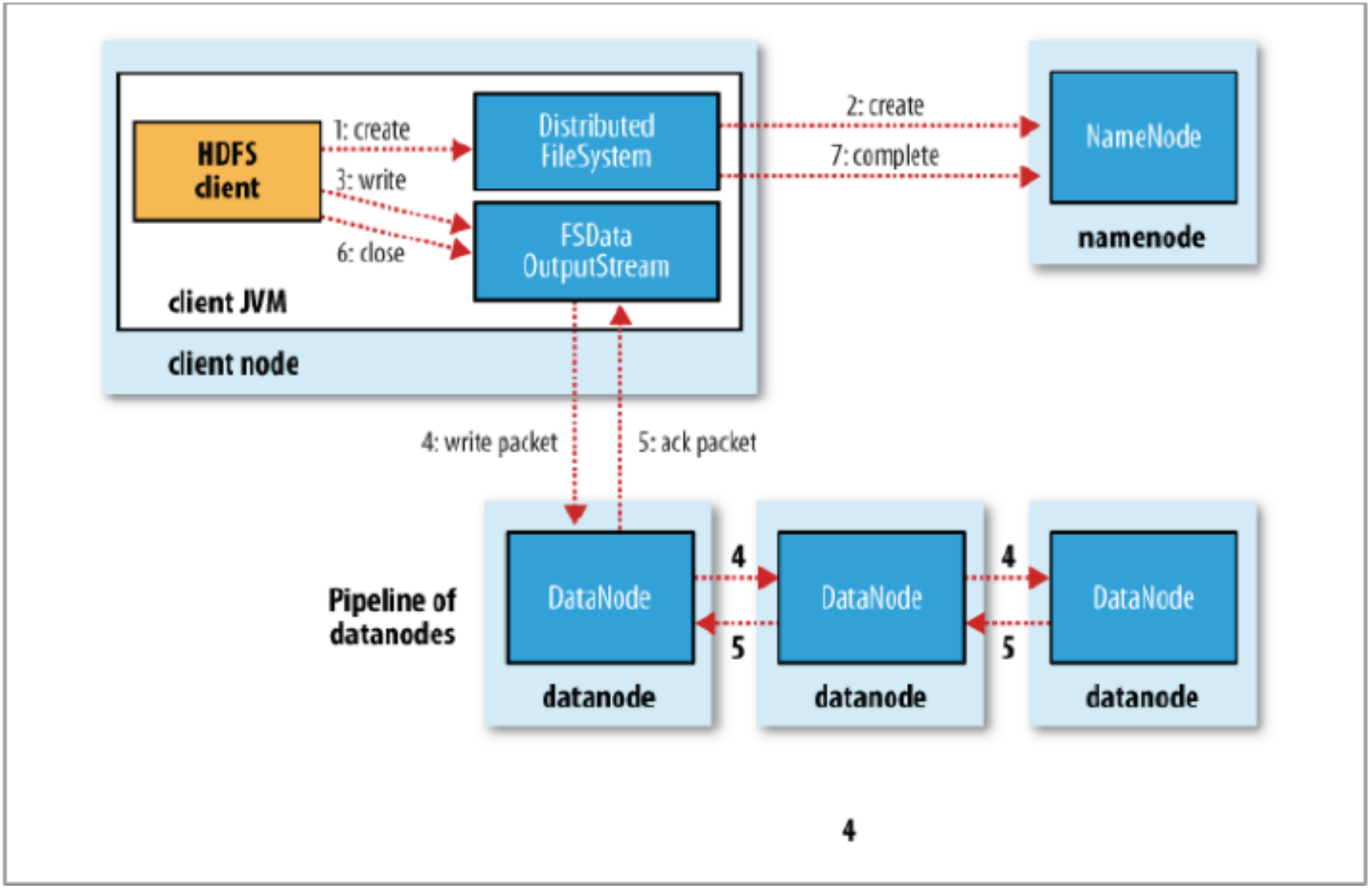


Write Algorithm (contd.)

8. Secondaries respond back to primary
9. Primary responds back to the client



HDFS: Anatomy of a File Write



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