Apache Hadoop Goes Realtime at Facebook

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Problem and Context

- Ever increasing data at Facebook
- Launch of *Facebook Messages*
- Other Young Turks at Facebook
- Leaving MySQL and its sharding
- Migration challeneges
- Problem in words: Unpredictable growth, write throughput and latency requirements

Problem and Context (contd.)

- The Usual Suspects
  - Cassandra
  - Other NoSQL
- Other considerations
- Solution: A near realtime Hadoop/HBase that is modified from the vanilla versions to provide scalability, consistency, availability and a compatible data model.

Key contributions

- Making Hadoop and HBase more real-time
- Adapting Hadoop and HBase to Facebook's unique requirements
  - Implementation of RealTime HDFS
  - Implementation of Production HBase
  - Operational Optimizations

Overview

- Problem and Context
- Facebook stands alone
- (Small) Introduction to Hadoop and HBase
- Enter the Hs
- Realtime HDFS
- Production HBase
- Operational Optimization
- The present future

Facebook's unique requirements

- Facebook and the Hadoop ecosystem
  - Offline and sequential

- Requirement Type 1 – Realtime concurrent read access to large stream of realtime data
  - Example: Scribe

- Requirement Type 2 - Dynamically index a rapidly growing data set for fast random lookups
  - Example: *Facebook Messages*

Facebook's unique requirements

- Facebook Messaging:
  - *Unweildly tables*
  - *High Write Throughput*
  - *Data Migration*
- Facebook Insights
  - *Realtime Analytics*
  - *Aggregators*
- Facebook Metrics System
  - *Quick reads*
  - *Automatic Sharding*

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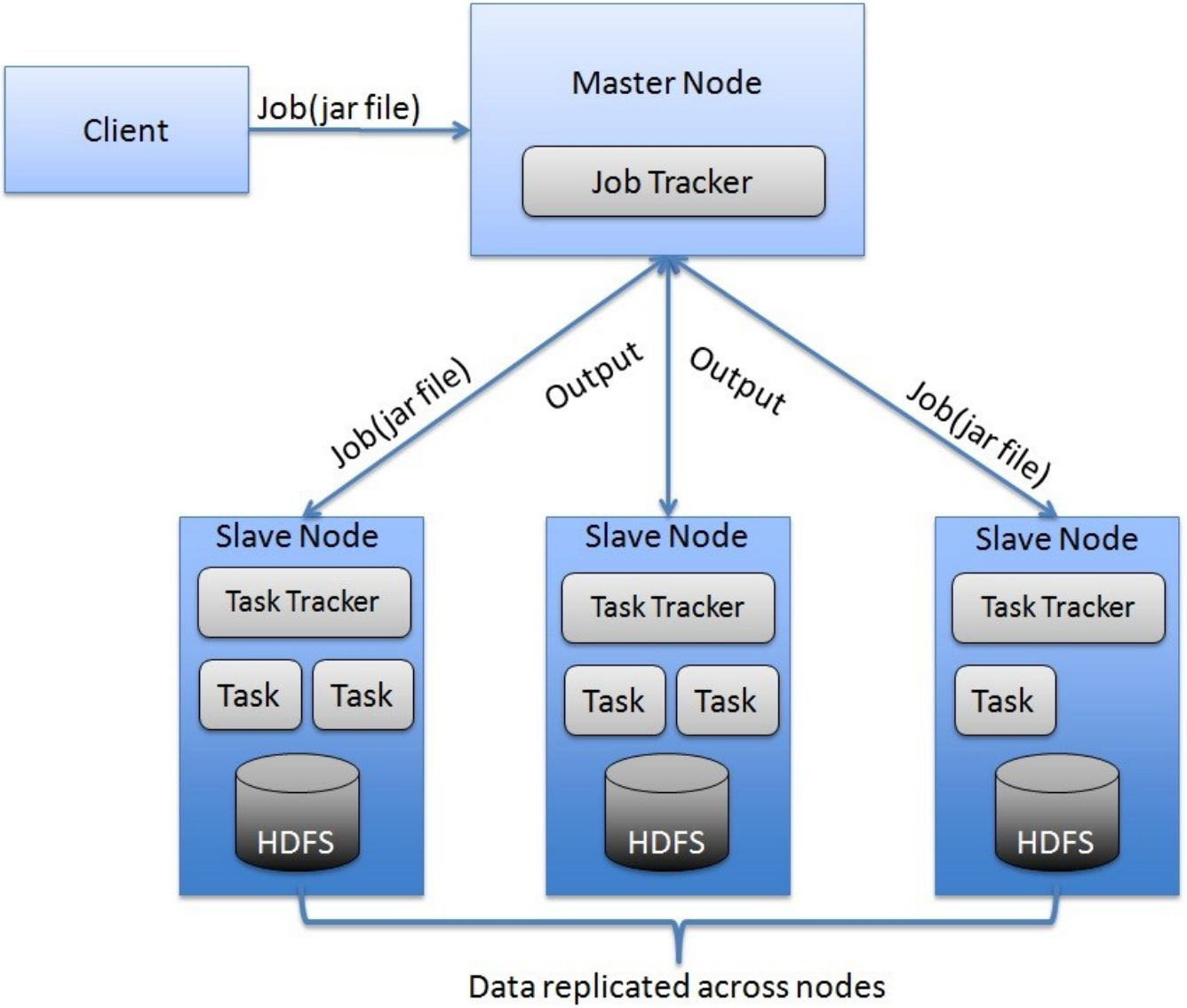
Introduction to Hadoop



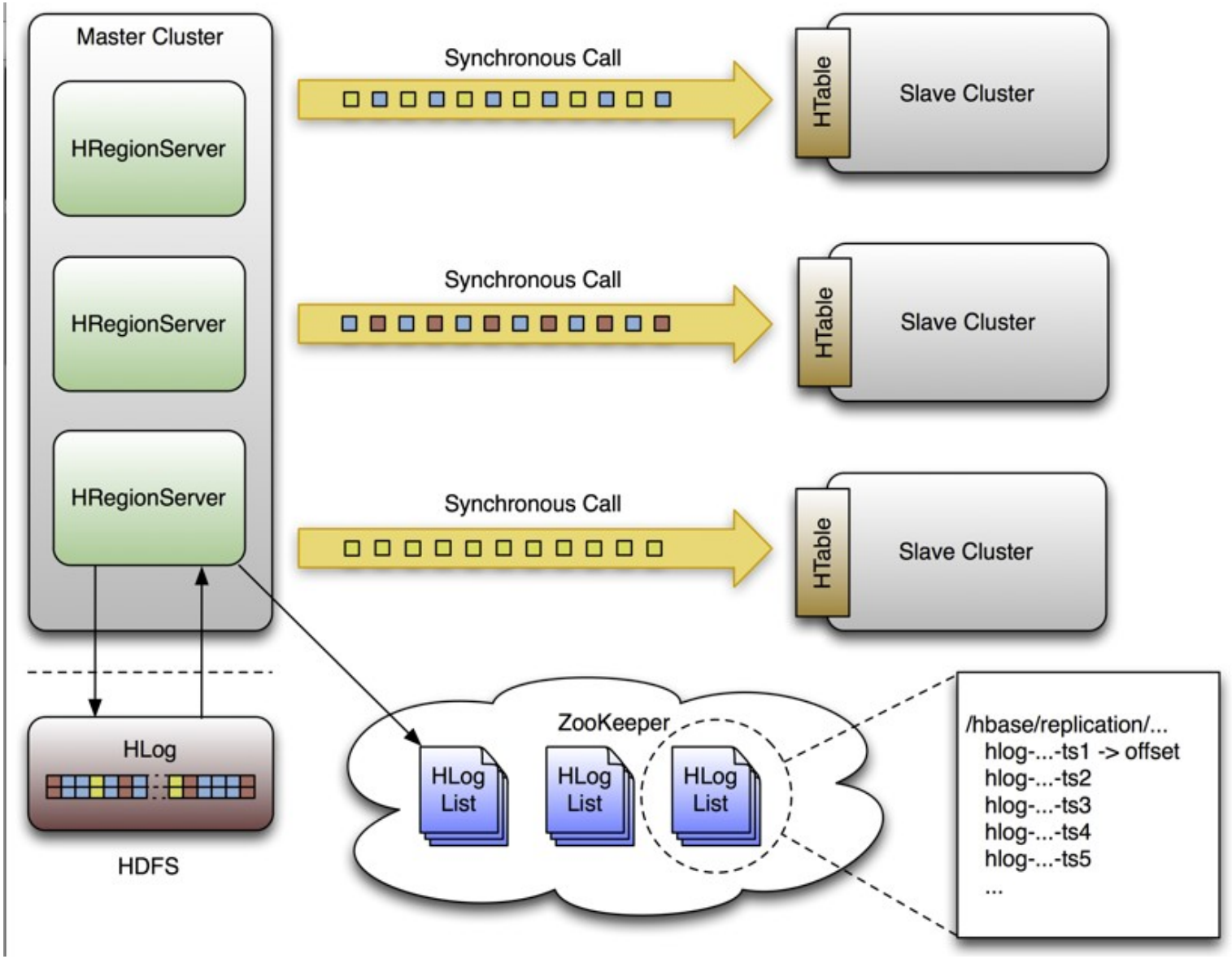
Introduction to HBase

- Hbase: A NoSQL database that utilizes an on-disk column storage format.
- Hbase USP: Provides fast key-based access to a specific cell or data or a range of cells.
- Based on Google's BigTable but extends it
- Has Row atomicity and read-modify-write consistency
- Simplifies a lot of tasks related to distributed databases.
- Tagline: *Random access to web-scale data*

Introduction to Zookeeper

- Zookeeper: A software service for a distributed environment that coordinates and configures different machines in a centralized way.
- A change is not considered successful until it has been written to a quorum
- A leader is elected within the ensemble for conflicts
- In HBase, ZooKeeper coordinates and shares state between the Masters and RegionServers.
- Tagline: *Enables highly reliable distributed coordination*

HBase + Zookeeper



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The Why Hadoop/HBase question

- Scalability
- Range Scans
- Efficient low-latency strong consistency
- Atomic Read-Modify-Write
- Random reads
- Fault Isolation

The Why Hadoop/HBase question

- High write throughput
- Data model
- High Availability

- *Non-requirements*
  - Tolerance of network partitions
  - Individual data centre failure zero downtime
  - Federation comfort

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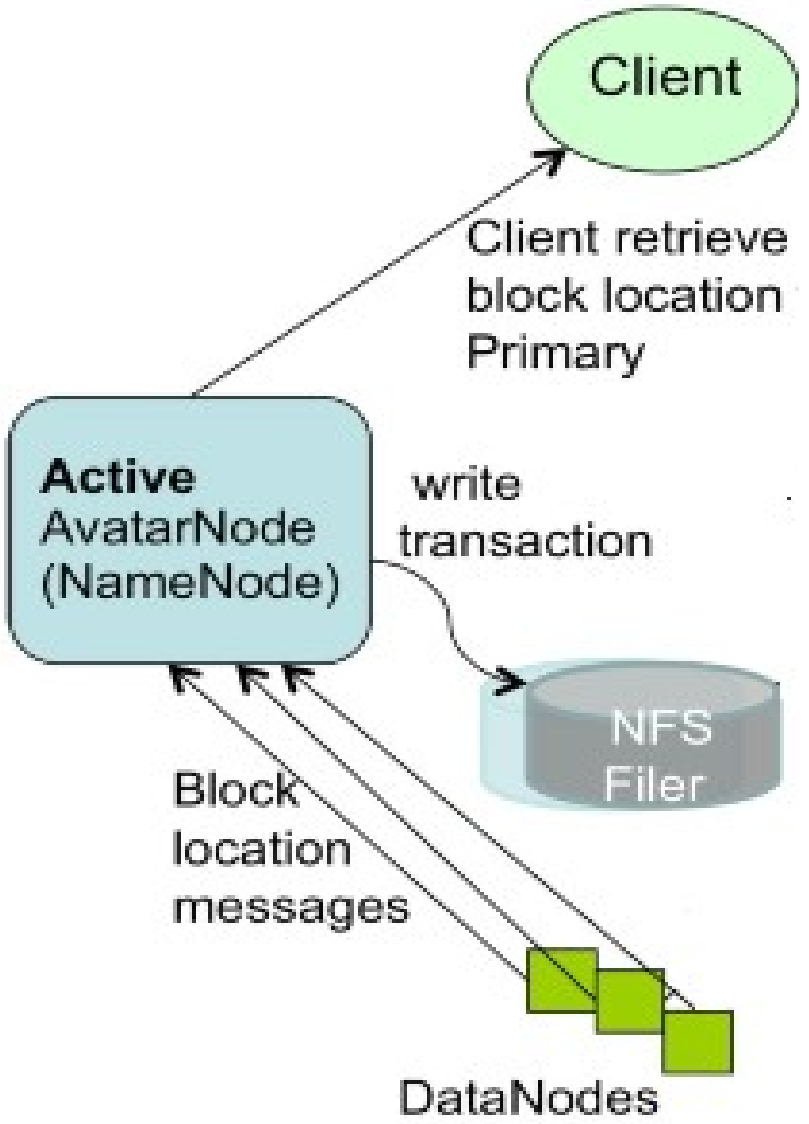
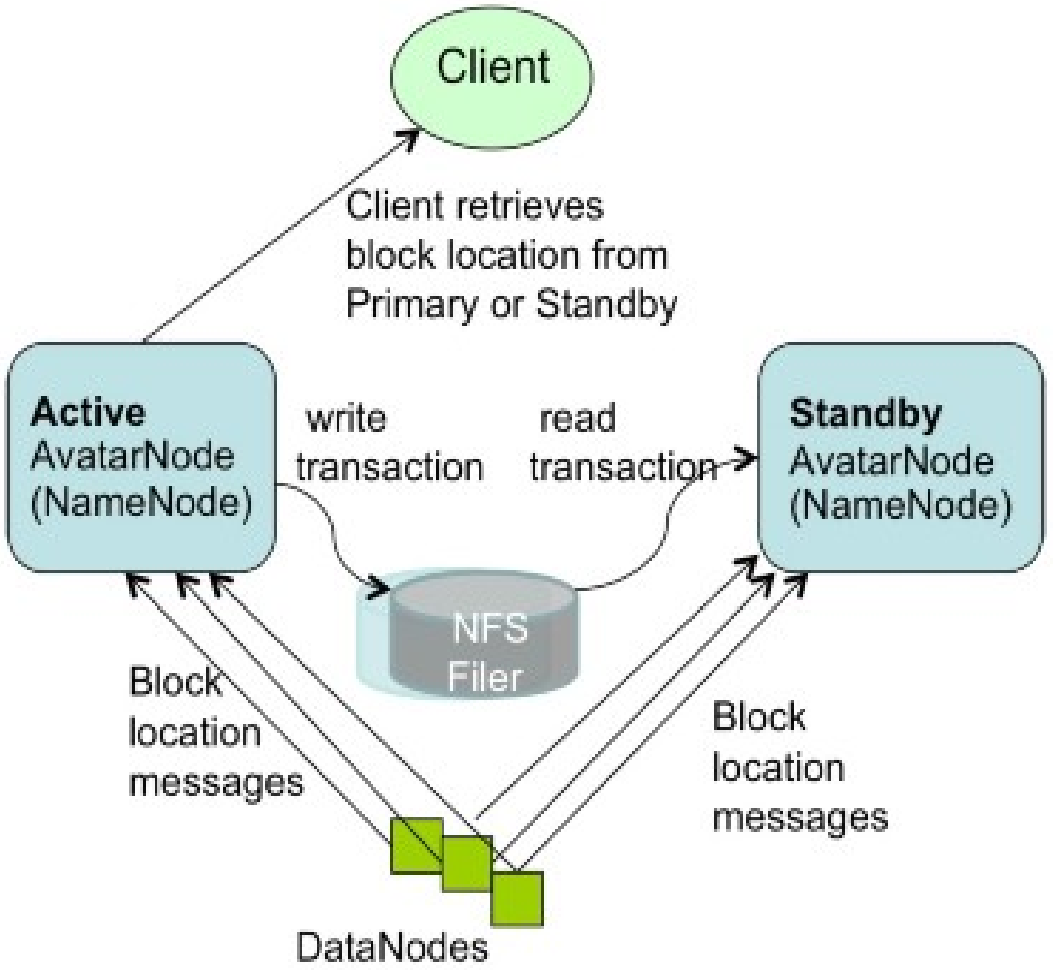
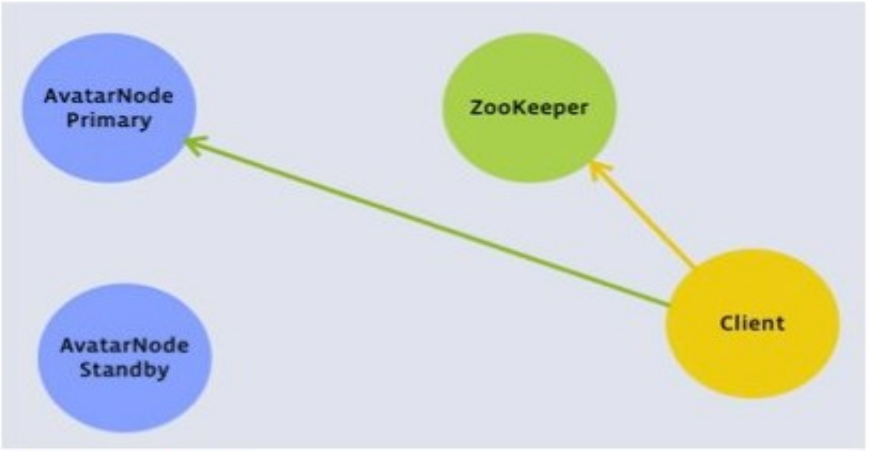
Realtime HDFS - AvatarNode



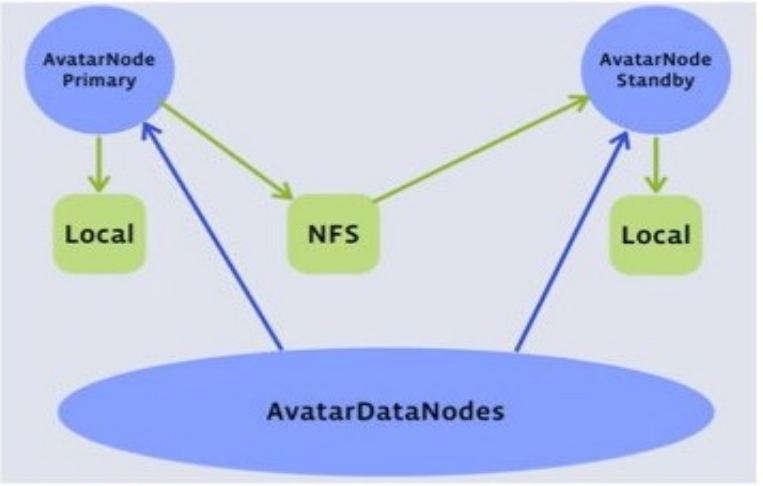
Realtime HDFS - AvatarNode



Realtime HDFS – AvatarNode view



Avatarnode client view



Avatarnode datanode view

Realtime HDFS – Logging

- Enhancements to Transcation logging:
  - Conventional HDFS
  - Change: Let the StandbyNode always know about block ids.
  - Avoidance of partial reads between Active and Standby node

Improved block availability

- **Challenge:** Placement of non-local blocks is not optimal; can be on any rack or within any node therein.
- **Soution:** A new block placement policy which has reduced the probabilty of data loss by orders of magnitude.
  - Define a 'window' of logical racks and logical machines around the original block.

Hadoop performance improvements

- RPC Timeout
  - *Live free or fail fast*
- File Lease recovery
- Local replica awareness
- New tricks:
  - HDFS sync
  - Concurrent readers

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HBase – ACID compliance

- **Requirement:** Row-level atomicity and consistency of ACID compliance
  - *RegionServer failure during log write for row transactions.*
  - *Consistency of replicas*
- **Solution:**
  - WAL edits ~ Write Ahead Log policy
  - Immediate rollback

HBase – Availability Improvements

- Master Rewrite
  - Store transient state in Zookeeper
- Rolling upgrades
  - Handled by reassigning of regions
- Distributed Logsplitting
  - Outsource to Zookeeper

Hbase – Performance Improvement

- Compaction Improvement
  - *put latency dropped from 25 ms to 3 ms!*
- Read Optimization – Skipping certain unnecessary files for certain queries, reducing I/O
  - Using Bloom filters
  - A new special timestamp file selection algorithm

- Ensuring that Regions are local to their data

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Operational Optimizations

- Facebook's HBase testing program
- HBase Verify
- HBCK
- Added metrics for long running operations too!
- Manual split instead of automatic

Operational Optimizations

- Dark Launch
- Dashboard/ODS integration
  - Cross-cluster dashboards for higher analysis
  - Visualize version differences
- Backups
  - Do it using Scribe as an alternate application log
  - Piggyback on the date sent for Hive analytics

Operational Optimizations

- Importing the data
  - **Challenge**: Importing legacy data in HBase from a Hadoop job saturates the production network
  - **Solution:** Use Bulk Import with compression
    - Enhanced by GZIP of the intermediate map output
- Reducing Network I/O:
  - Decreased the periodicity of major compactions
  - Certain column families excluded from logging

The present future

- Apache Hadoop 2.0 was released in 2012
- One addition was YARN
  - A powerful cluster resource management
  - Added the High Availability feature to NameNode by introducing the **Hot/Standby NameNode.**
  - Greater integration with Zookeeper, especially for the ZKFC (Implementation of failover in DAFS)

Thank you and GG!