



Optimistic Concurrency Control in a Distributed NameNode Architecture for Hadoop Distributed File System

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September 5, 2014, Stockholm

Qi Qi

Dedication

*To my father, a man of integrity, who
supports all my adventurous decisions so
that I can live outside of the box.*

Resumo

[To be added] Portuguese Abstract

Abstract

The *Hadoop Distributed File System* (HDFS) is the storage layer for Apache Hadoop ecosystem, persisting large data sets across multiple machines. However, the overall storage capacity is limited since the metadata is stored in-memory on a single server, called the *NameNode*. The heap size of the *NameNode* restricts the number of data files and addressable blocks persisted in the file system.

The *Hadoop Open Platform-as-a-service* (Hop) is an open platform-as-a-Service (PaaS) support of the Hadoop ecosystem on existing cloud platforms including Amazon Web Service and OpenStack. The storage layer of Hop, called the Hop-HDFS, is a highly available implementation of HDFS, based on storing the metadata in a distributed, in-memory, replicated database, called the *MySQL Cluster*. It aims to overcome the *NameNode*'s limitation while maintaining the strong consistency semantics of HDFS so that applications written for HDFS can run on Hop-HDFS without modifications.

Precedent thesis works have contributed for a transaction model for Hop-HDFS. From system-level coarse grained locking to row-level fine grained locking, the strong consistency semantics have been ensured in Hop-HDFS, but the overall performance is restricted compared to the original HDFS.

In this thesis, we first analyze the limitation of HDFS *NameNode* implementation and provide an overview of Hop-HDFS illustrating how we overcome those problems. Then we give a systematic assessment on precedent works for Hop-HDFS comparing to HDFS, and also analyze the restriction when using pessimistic locking mechanisms to ensure the strong consistency semantics. Finally, as a proof of concept, we demonstrate how to improve the performance by designing a new model based on optimistic concurrency control with snapshot isolation. The evaluation shows the significant improvement of this new model, and its correctness has been validated by 300+ unit tests passing from Apache HDFS.

Palavras Chave

Keywords

Palavras Chave [To be corrected by native Portuguese speaker]

HDFS

MySQL Cluster

Controle de Concorrência

Snapshot Isolation

Transação

Vazão

Keywords

HDFS

MySQL Cluster

Concurrency Control

Snapshot Isolation

Transaction

Throughput

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DDD

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2.2 *B*

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CCC

2.4 *D*

DDD

II Assessment in Hop-HDFS

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Limitation on Pessimistic Locking Mechanism

3.1 *A*

AAA

3.2 *B*

BBB

3.2.1 **B1**

BBB1

3.2.2 **B2**

BBB2

3.3 *C*

CCC

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Systematic Assessment of Hop-HDFS Performance

Neque porro quisquam est qui dolorem ipsum quia dolor sit amet, consectetur, adipisci velit...

– Cerico

4.1 *A*

AAA

4.2 *B*

BBB

4.2.1 **B1**

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Bibliography

Shvachko, K. V. (2010). Hdfs scalability: The limits to growth. *login* 35(2), 6–16.



Appendices



Apache HDFS Unit Tests Passing List

