Introduction

- Large Volume of Data Stored in Enterprise Storage
  - Walmart: > 1 million transactions/hour
  - Bank: > 100 TB customer data
  - Emails, home dirs, databases, etc.

- Big Data Analytics
  - Widely used: distributed pattern matching, machine learning, statistics analysis, etc.
  - Active community: Hadoop, Spark, Tachyon, etc.

- Emerging Requirements
  - Run analytics on data stored in enterprise storage (NetApp FAS Systems)

Motivation

<table>
<thead>
<tr>
<th>Batch MapReduce</th>
<th>Interactive Text</th>
<th>Online HBase</th>
<th>In-Memory Spark</th>
<th>Graph Graph</th>
</tr>
</thead>
<tbody>
<tr>
<td>FileSystem.java</td>
<td>S3-­‐FS.java</td>
<td>HDFS.java</td>
<td>NFS.java</td>
<td></td>
</tr>
</tbody>
</table>

There is no native NFS integration with Hadoop!

Current Approaches

1. Copy from NFS into HDFS
   - Need to ingest into HDFS
   - Need to maintain multiple copies
   - Need to periodically synchronize

2. Mount with Linux NFS Client
   - Optimized for small random I/O
   - Not integrated with Hadoop scheduler

Mambo: Hadoop NFS Connector

Benefits

- Designed for large streaming I/O
- Tight integration with Hadoop
  - Commit data to disk only when a task succeeds
  - Intelligent prefetching for streaming reads; aware of task sizes
  - Single copy of data stored in NFS
- Allows NFS to be on the same level as others
  - RedHat ClusterFS, Ceph, Amazon S3, and others
- Drop in replacement
- Supports multiple NFS controllers

Easy to Use

- Just modify configuration
  ```xml
  <property>
    <name>fs.defaultFS</name>
    <value>hdfs://namenode:54310/</value>
  </property>
  ```

  Changes to
  ```xml
  <property>
    <name>fs.defaultFS</name>
    <value>nfs://nfsserver:2049/</value>
  </property>
  ```

Implementation

- Implemented NFSv3 protocol
  - 14 of 22 procedures
- Implemented MOUNT protocol
  - 5 of 8 procedures
- 1 MB I/O
- 64 prefetching threads

Evaluation

- NIFS connector vs. Linux NFS driver
  - Read/write a 10 GB file
  - 10 Gb/s link

- DFSIO (standard HDFS benchmark)

Summary

- Built NFSv3 connector
  - Allows Hadoop to natively use NFS
  - Uses a single copy of data
  - Easy to use
  - Good performance
  - Works for Hadoop and Spark

Acknowledgements

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- Try it from Github !!!