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@hopshadoop

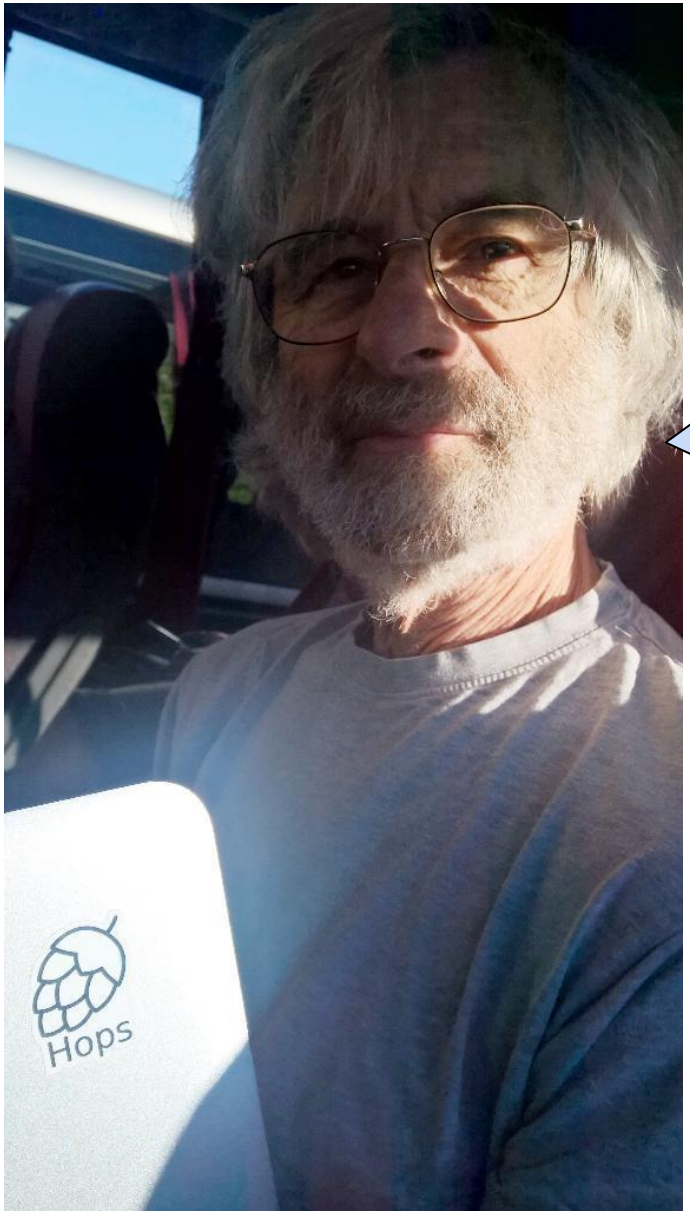
Interactive Flink analytics with HopsWorks and Zeppelin

Jim Dowling

Ermias Gebermeskel

Flink *Forward*

Marketing 101: Celebrity Endorsements



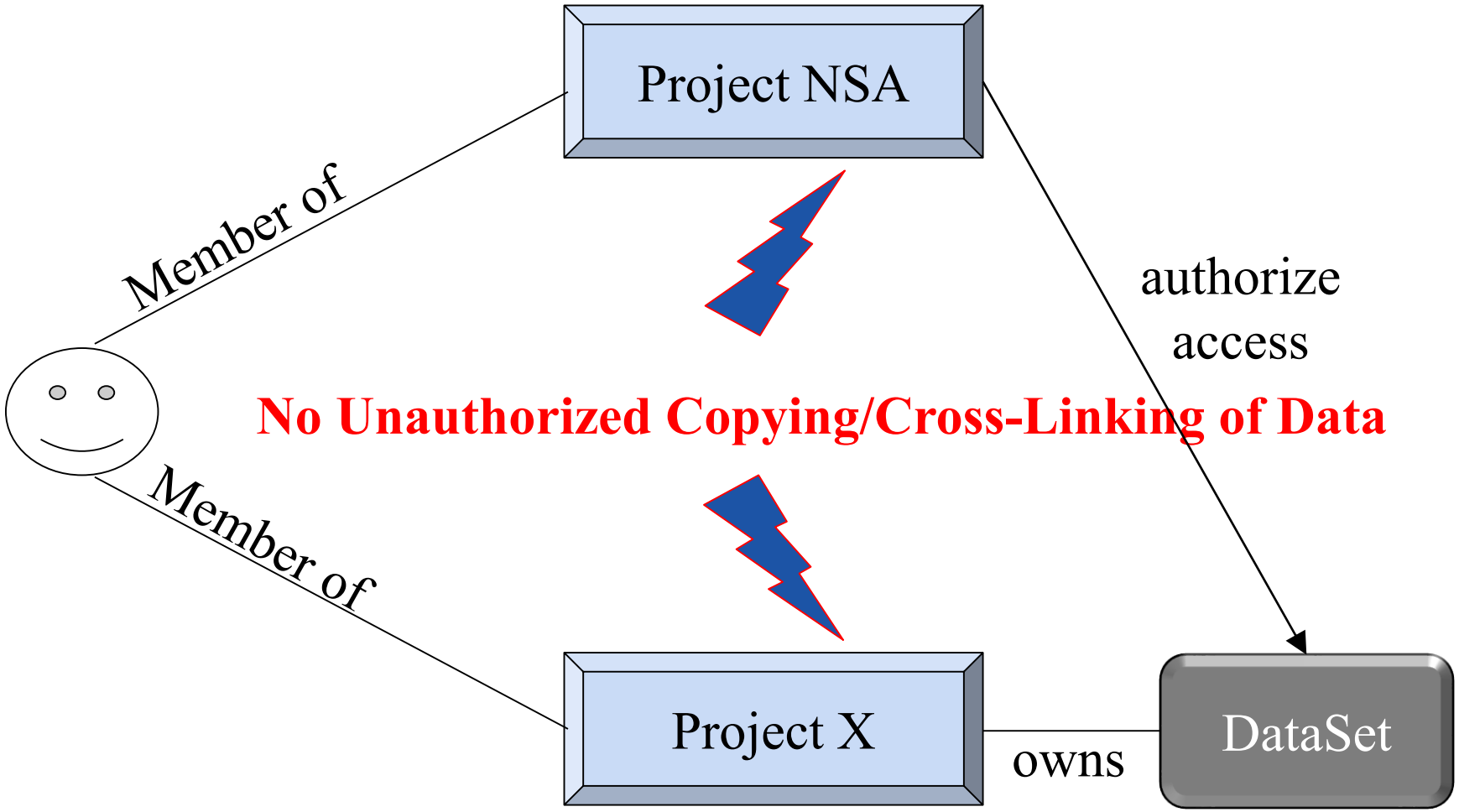
Hi!
I'm Leslie Lamport* and even though you're not using Paxos, I approve this product.

*Turing Award Winner 2014, Father of Distributed Systems

Talk Overview

- Multi-tenancy in Hadoop
- Multi-tenancy in HopsWorks
- Free-Text Search of Hadoop Metadata in HopsWorks
- Zeppelin and Flink in HopsWorks

Goal: Multi-Tenancy and Data Sharing



Access Control in Relational Databases

How do we provide multi-tenancy for users **alice** and **bob** using two databases **db1** and **db2**?

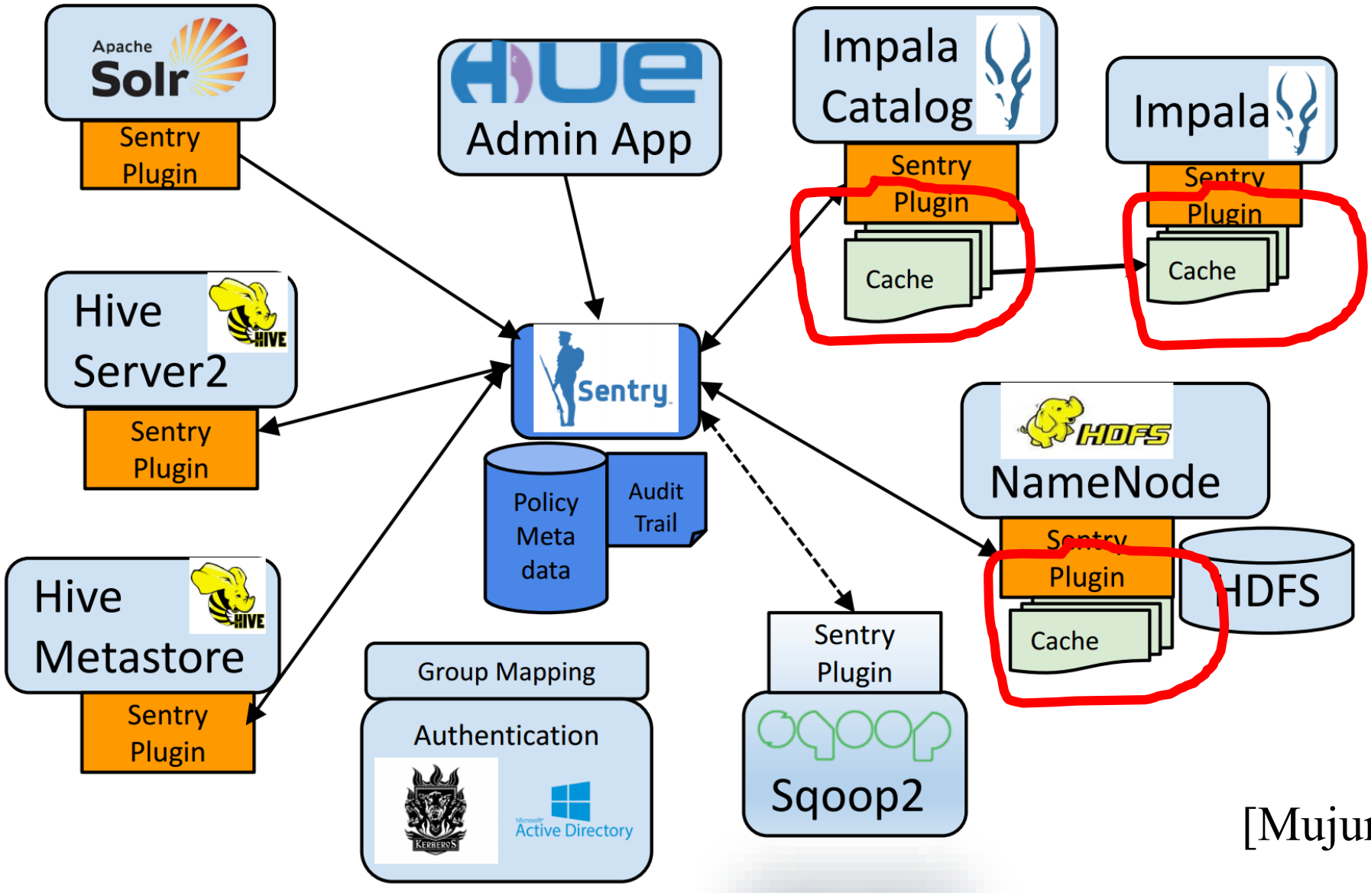
```
grant all privileges on db1.* to 'alice'@'%';
grant all privileges on db2.* to 'bob'@'%';
```

#More fine-grained privileges

```
grant SELECT privileges on db2.sensitiveTable
to 'alice'@'192.168.1.2';
```

What happens to the privileges if I call "drop table db2.sensitiveTable"?

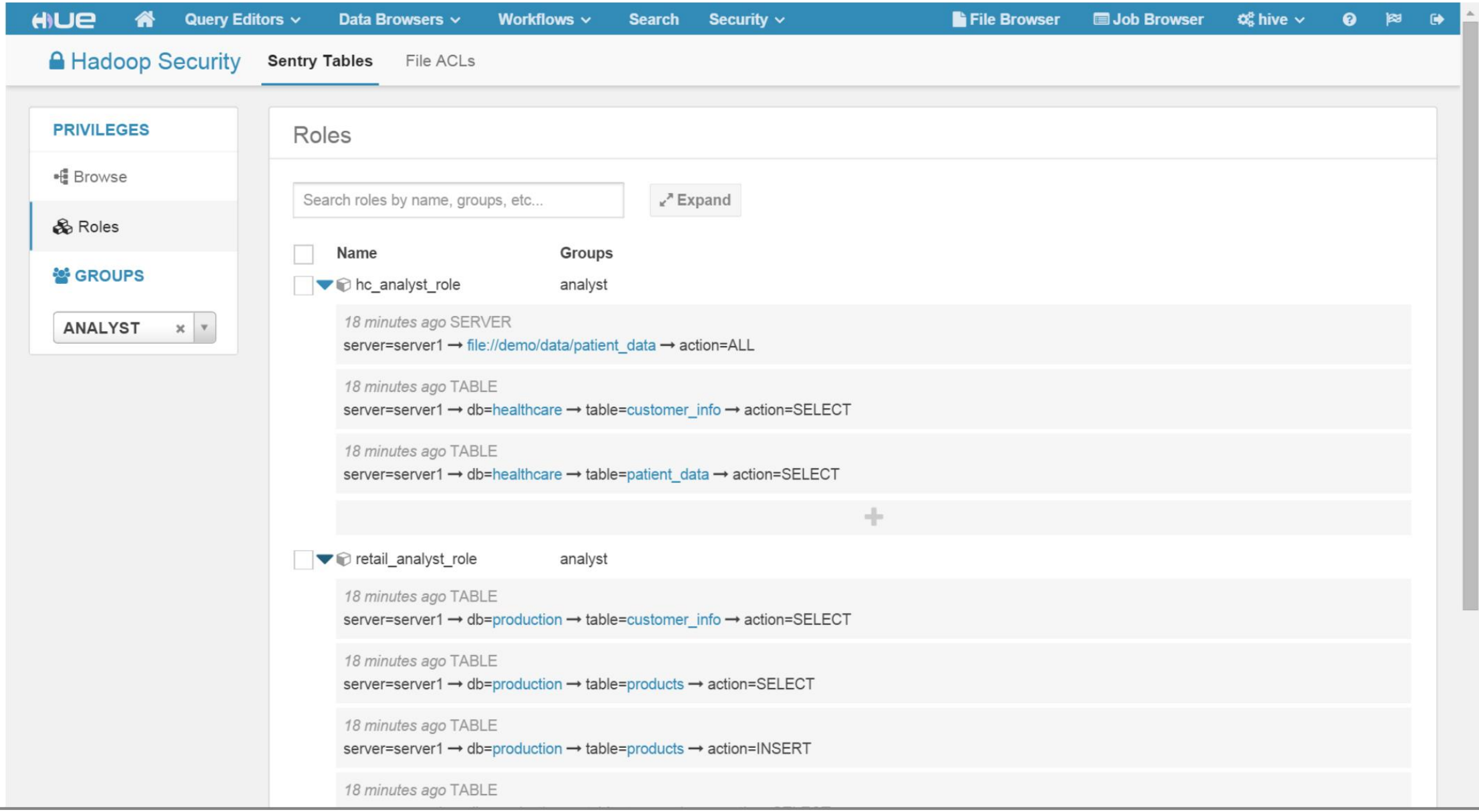
Access Control in Hadoop: Apache Sentry



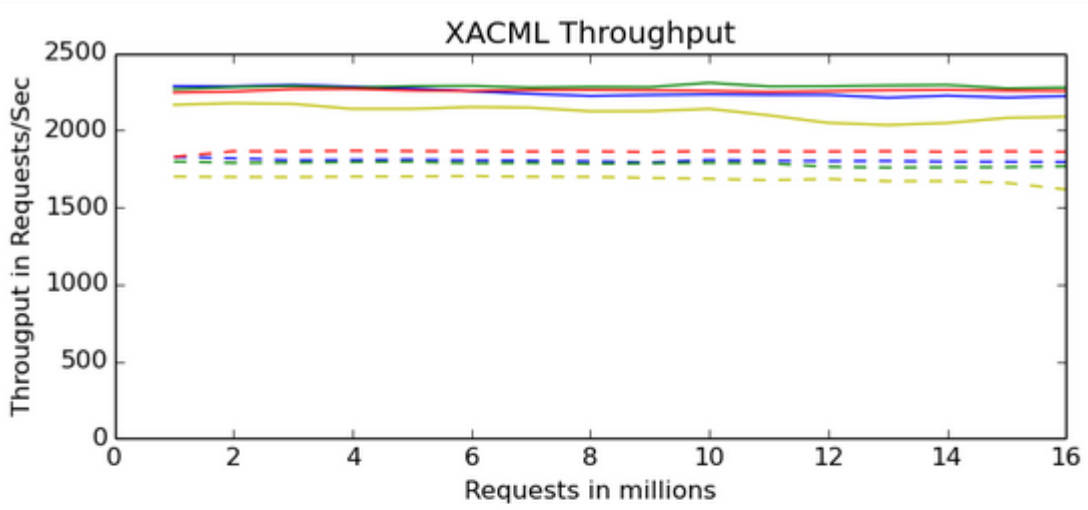
[Mujumdar'15]

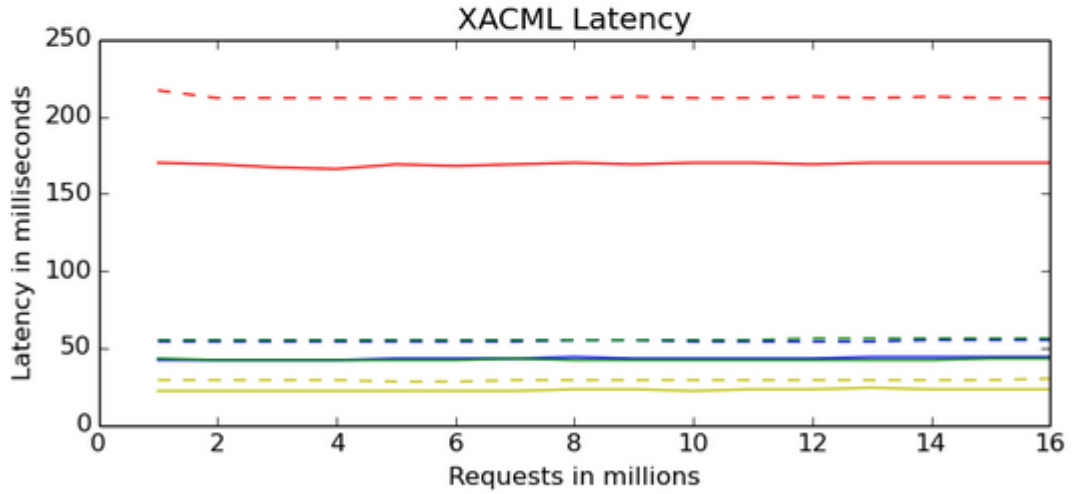
How do you ensure the consistency of the policies and the data?

Policy Editor for Sentry



Performance of Policy Enforcement Points (PEP)





*https://docs.wso2.com/display/IS500/XACML+Performance+in+the+Identity+Server

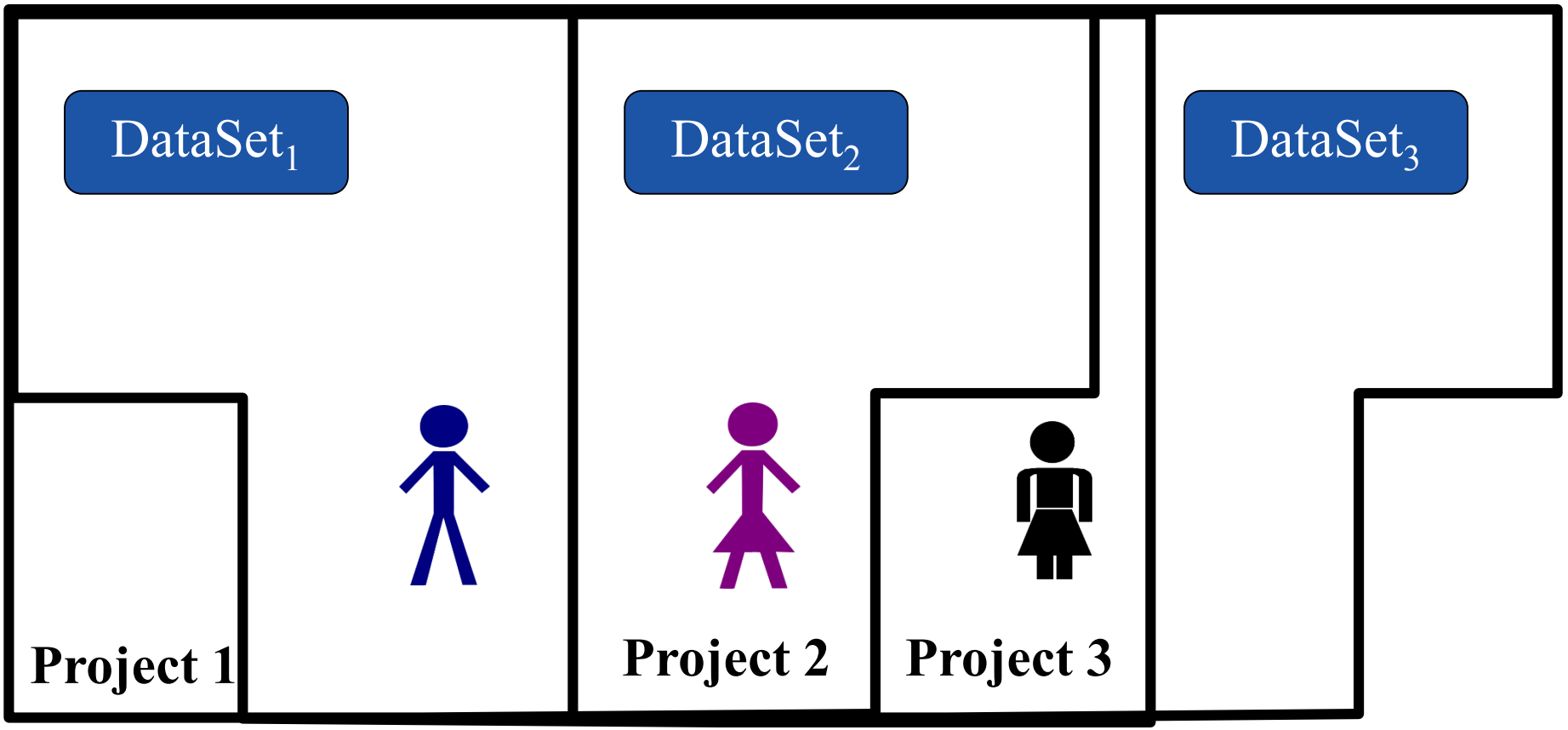
PEPs + Hadoop = Horse-Drawn Sportscar

Policy Enforcement Engines ≈ **O(2,000)** ops/sec

HopsFS Distributed Filesystem ≈ **O(100,000)** ops/sec

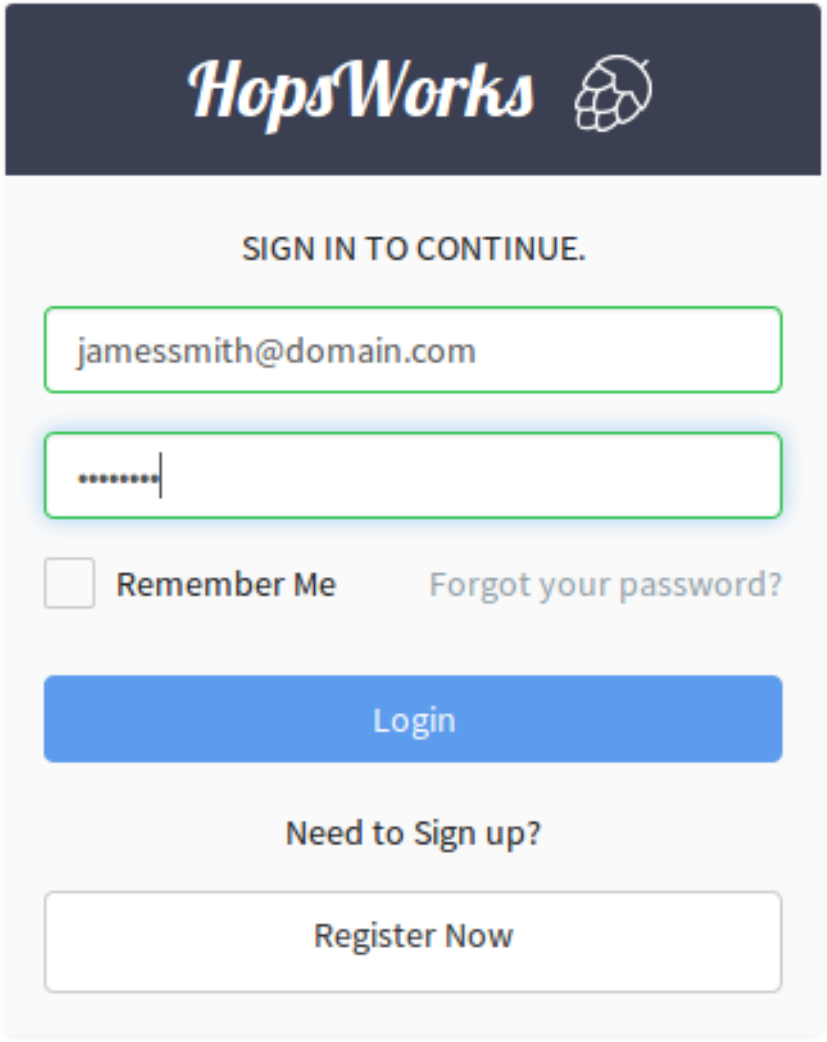
HopsWorks

Users, DataSets, and Projects



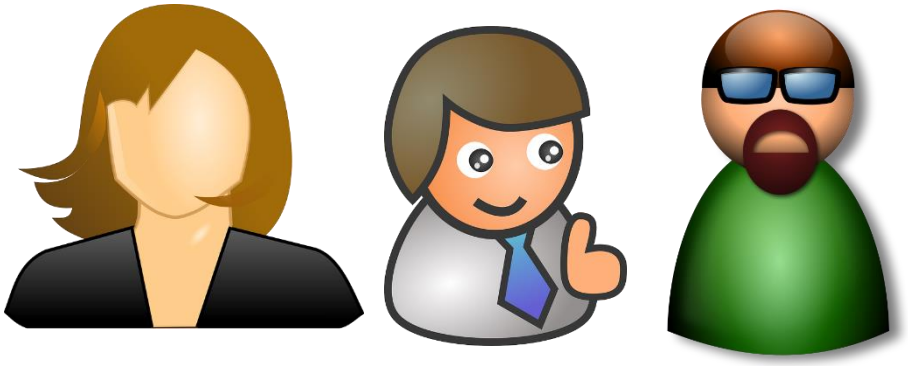
In-Place Data Sharing - not Copying!

User



- Authentication Provider
  - JDBC Realm
  - 2-Factor Authentication
  - LDAP

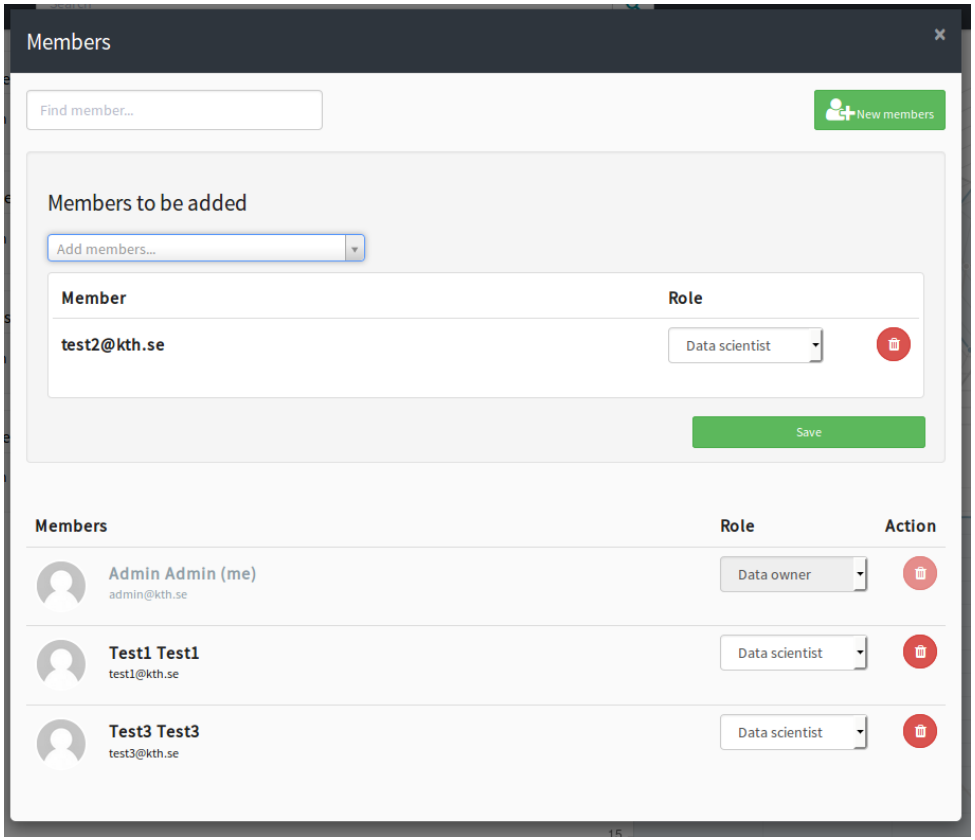
Project



- Members
  - Roles: Owner, Data Scientist

- DataSets
  - Home project
  - Can be shared

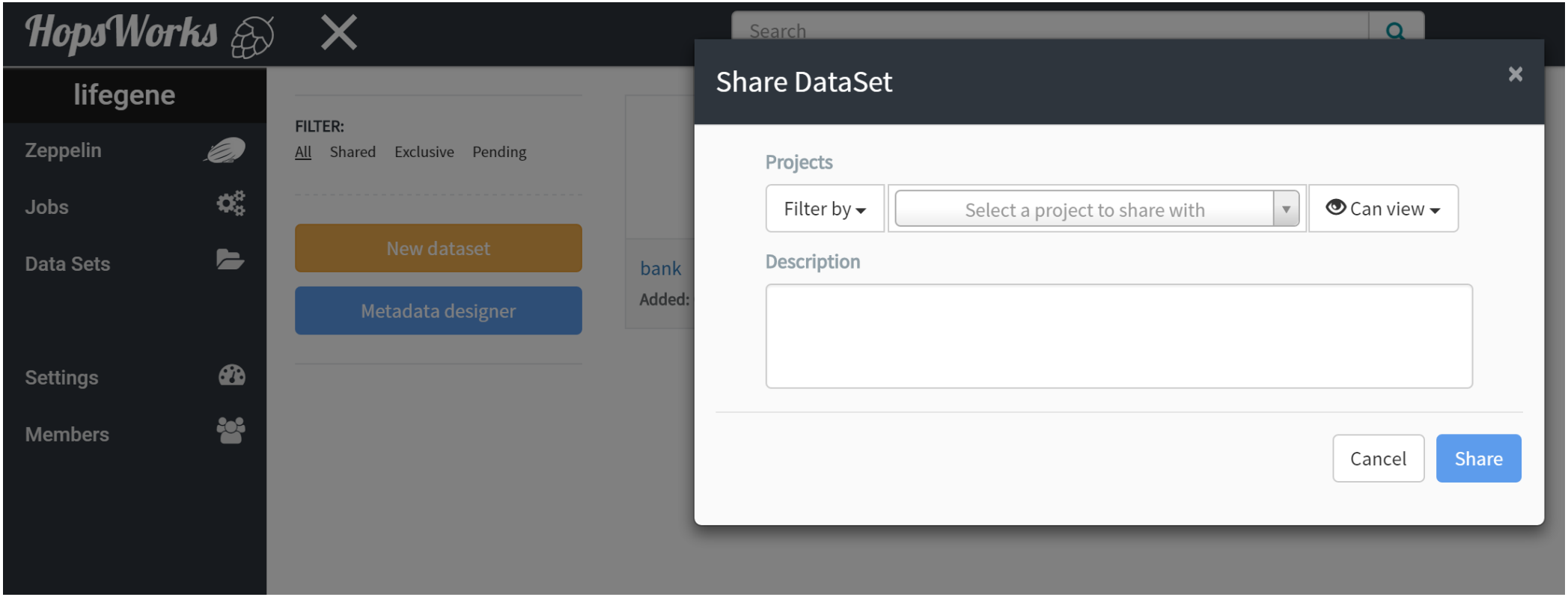
Project Roles



- Owner Privileges
  - Import/Export data
  - Manage Membership
  - Share DataSets
- Data Scientist Privileges
  - Write code
  - Run code
  - Request access to DataSets

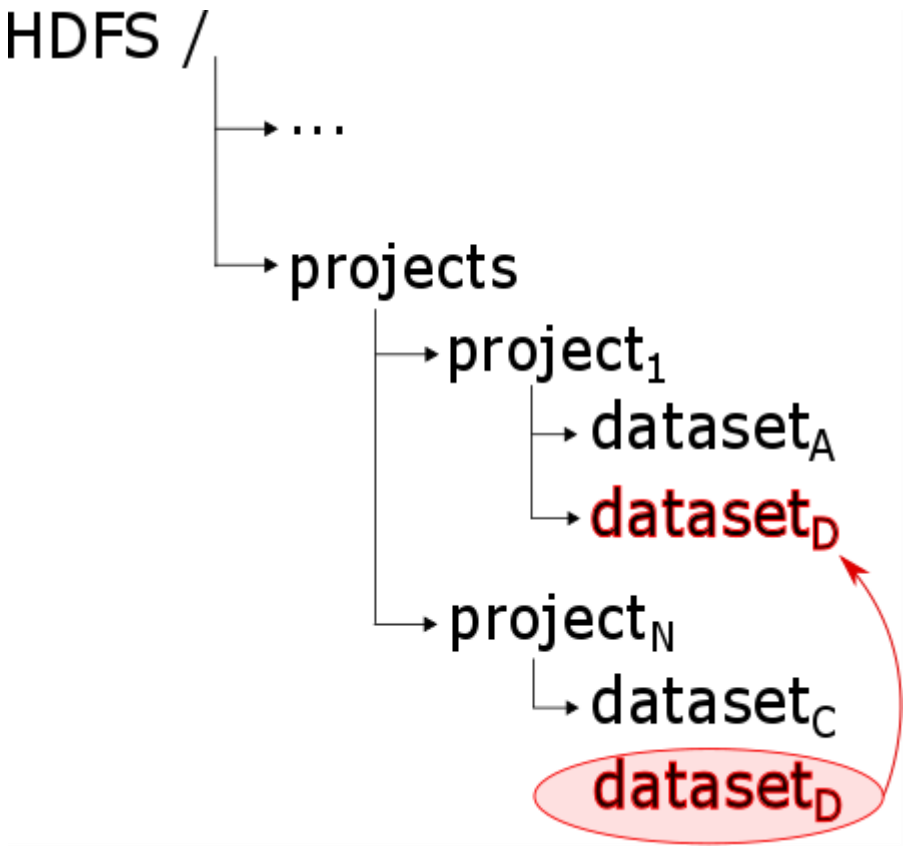
We delegate administration of privileges to users

Sharing DataSets between Projects



The same as Sharing Folders in Dropbox

Delegate Access Control to HDFS

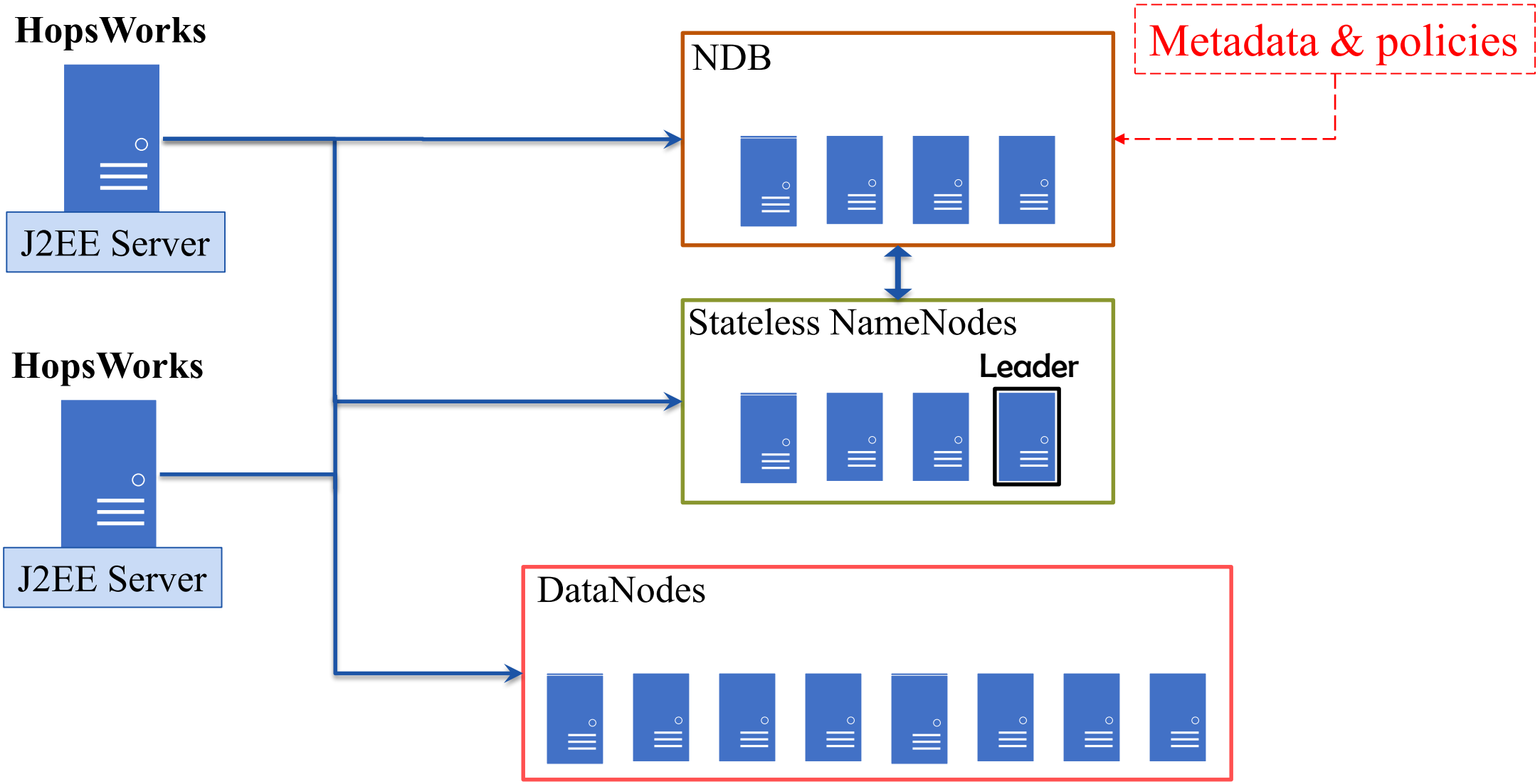


- HDFS enforces access control
- Convention for directories
- Hadoop and HopsWorks use the same Users and Groups in a common DB
- UserId per Project
- GroupId per Project and DataSet

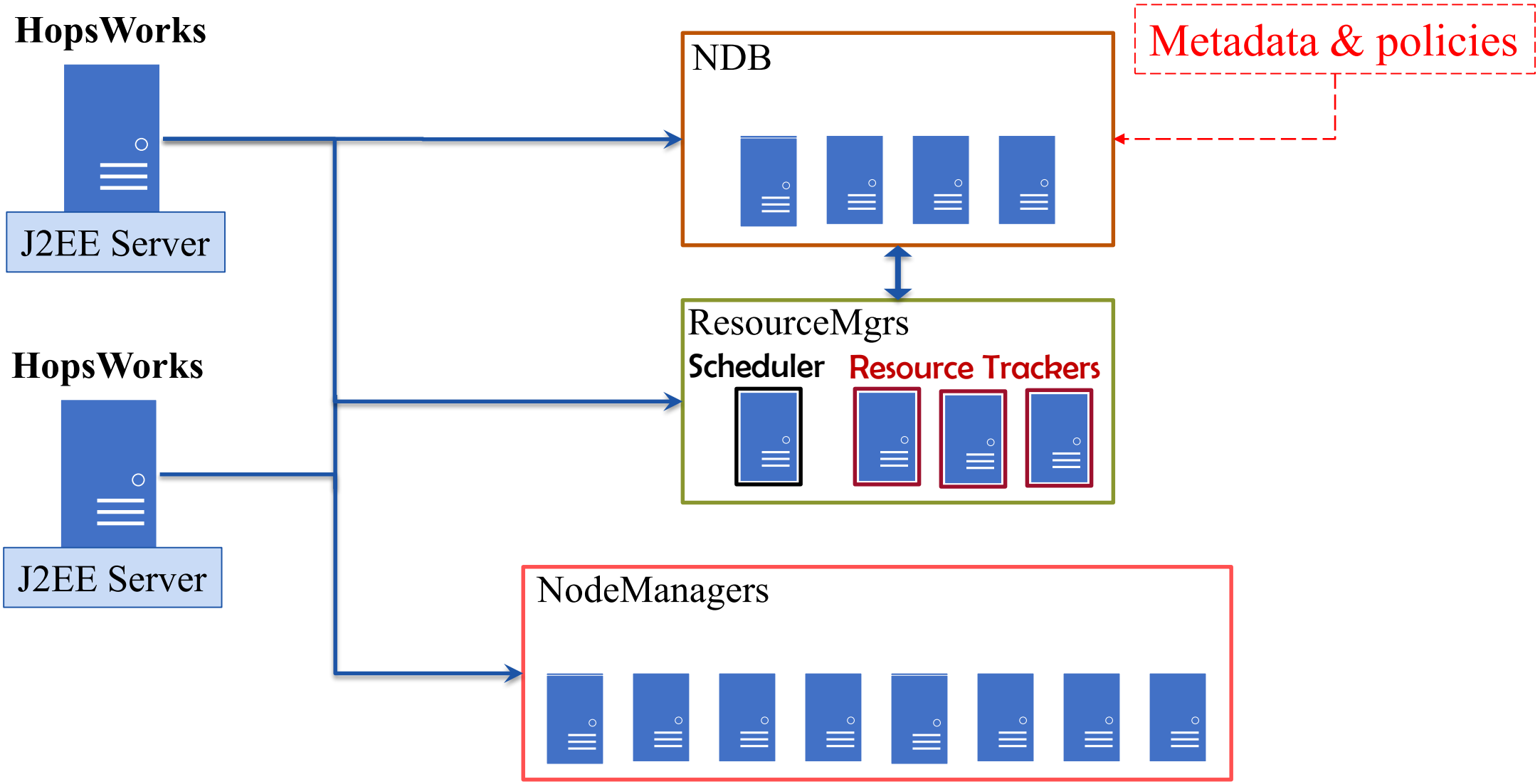
With Hadoop metadata in a DB, we guarantee policy integrity with Foreign Keys

Engine – HopsFS, HopsYARN

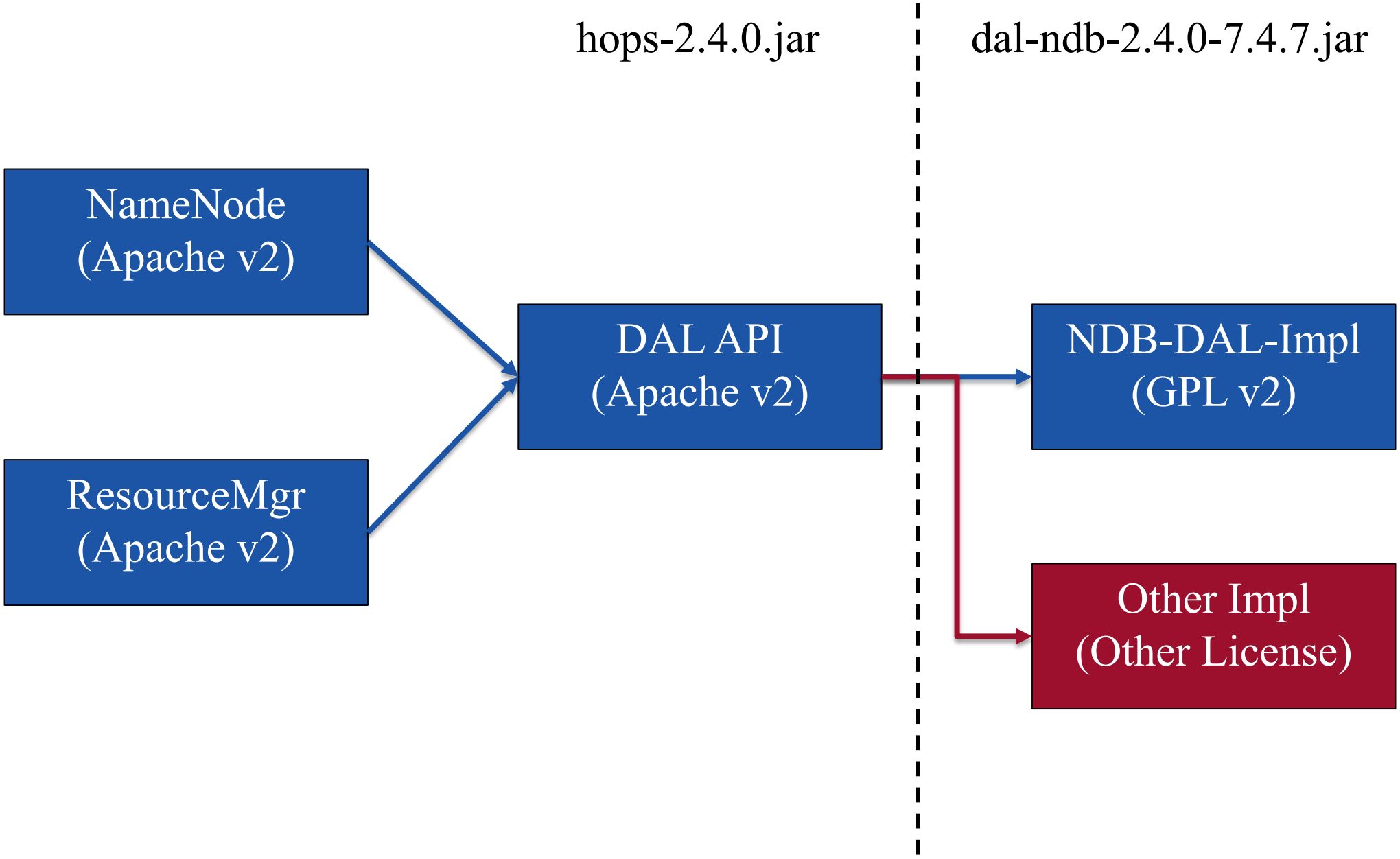
HopsFS


HopsWorks
J2EE Server
HopsWorks
J2EE Server
NDB
Metadata & policies
Stateless NameNodes
Leader
DataNodes

HopsYARN

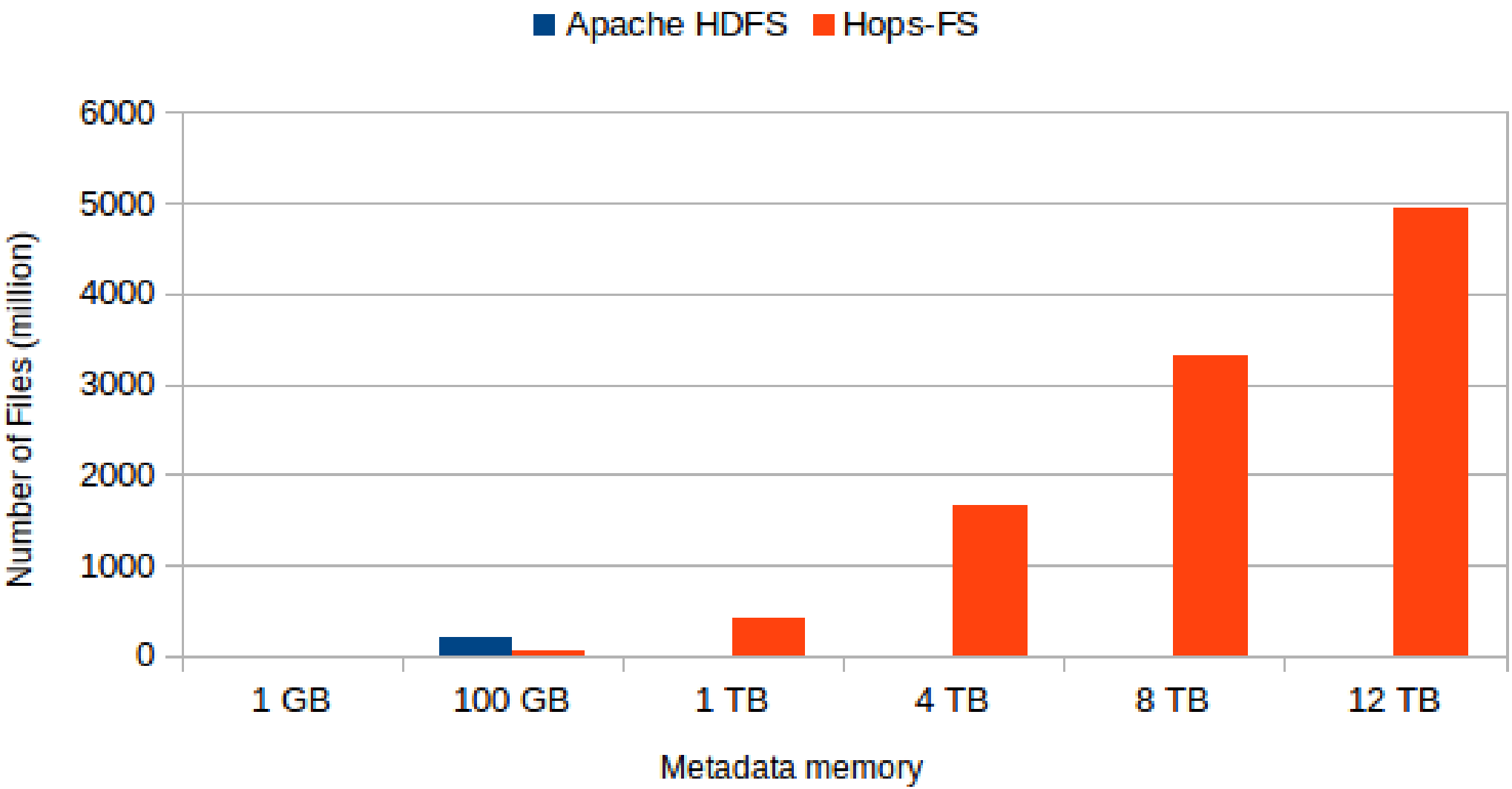

HopsWorks
J2EE Server
HopsWorks
J2EE Server
NDB
Metadata & policies
ResourceMgrs
Scheduler
Resource Trackers
NodeManagers

Data Abstraction Layer (DAL)



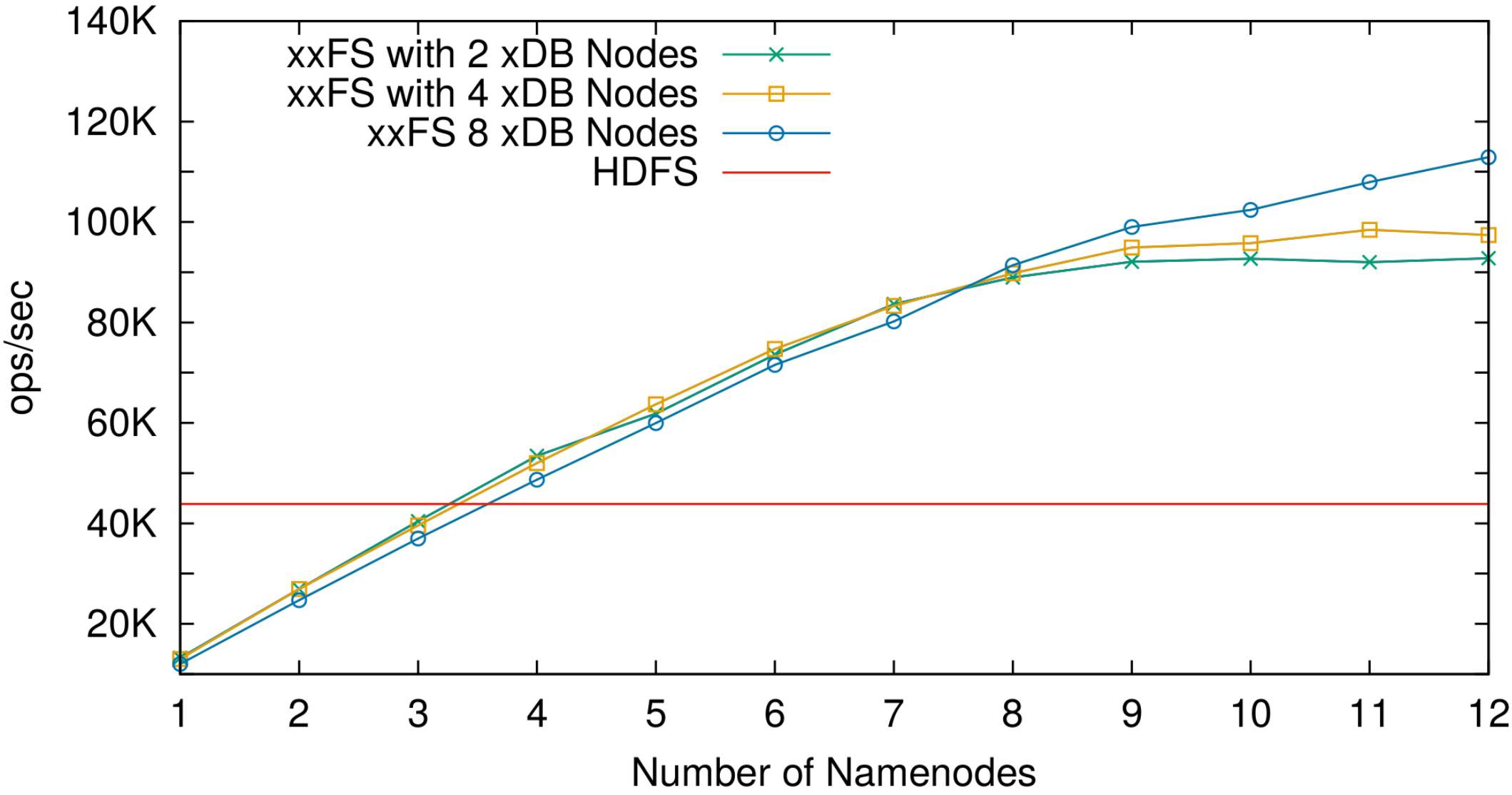
Hops Performance

HopsFS Metadata Scaleout



Assuming 256MB Block Size, 100 GB JVM Heap for Apache Hadoop

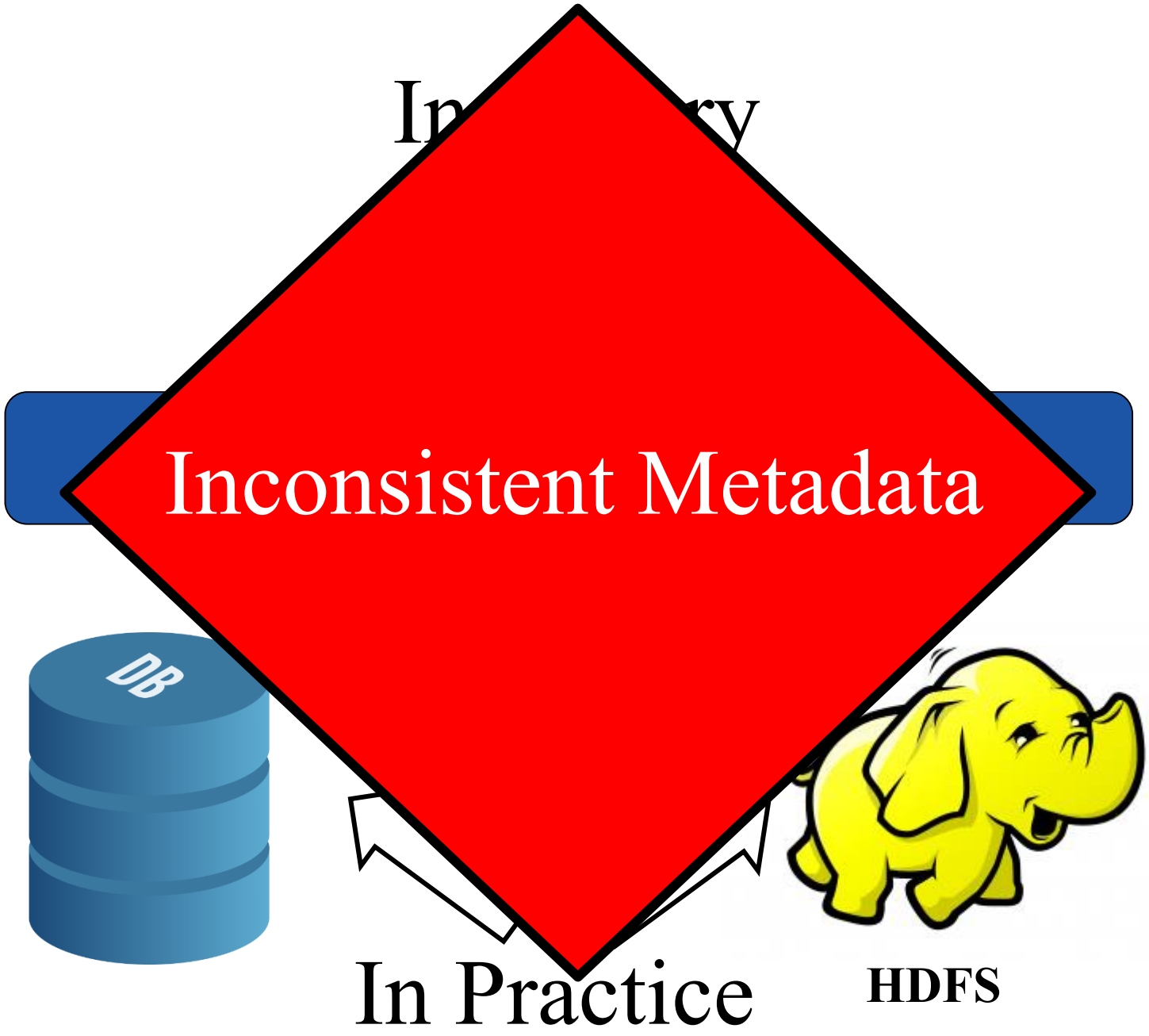
HopsFS Throughput (Real Workload)



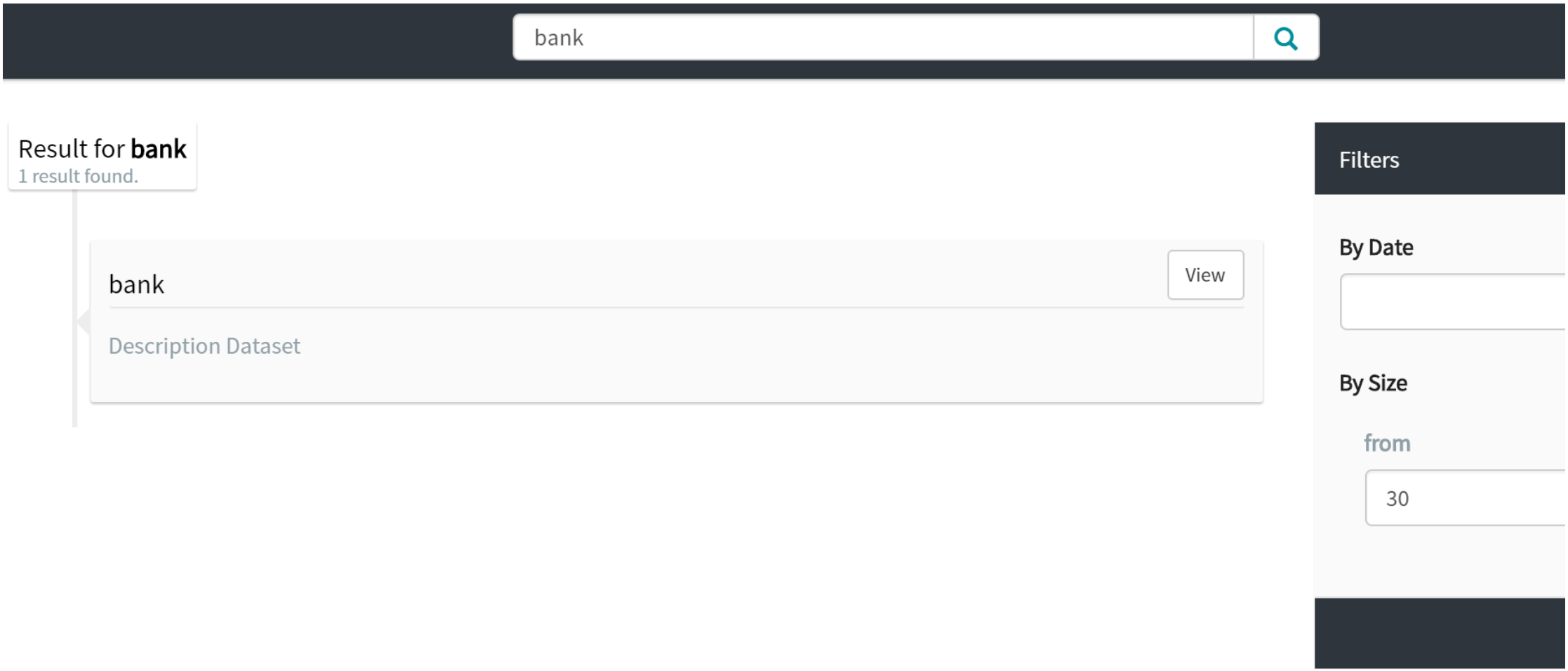
Experiments performed on AWS EC2 with enhanced networking and C3.8xLarge instances

What else can we do with metadata in a DB?

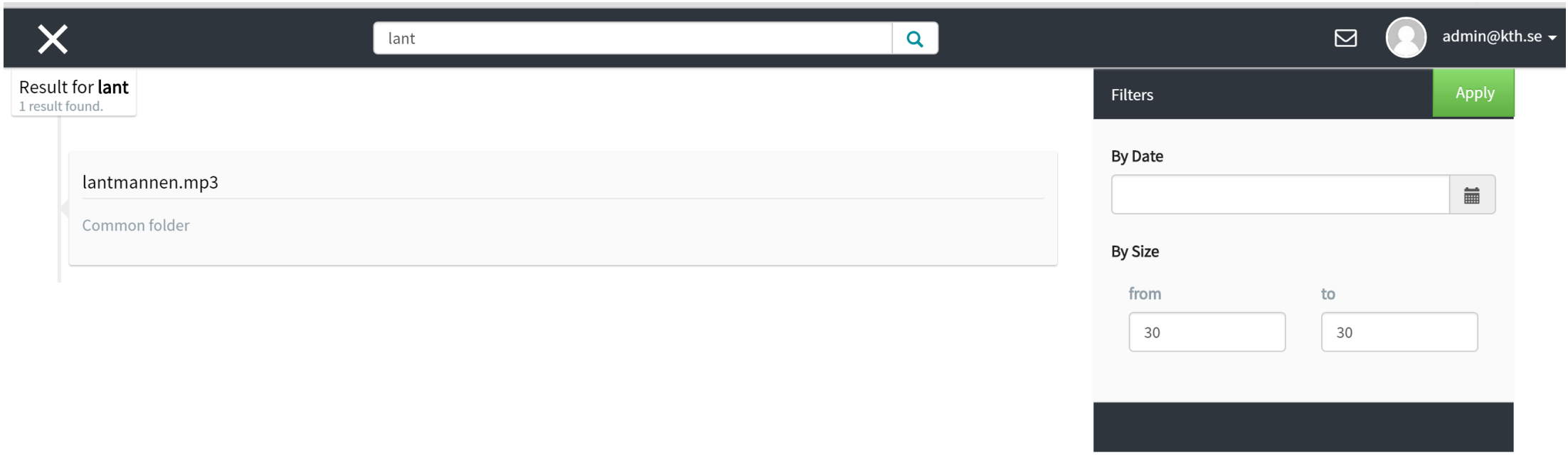
How ACME Inc. handles Free-Text Search



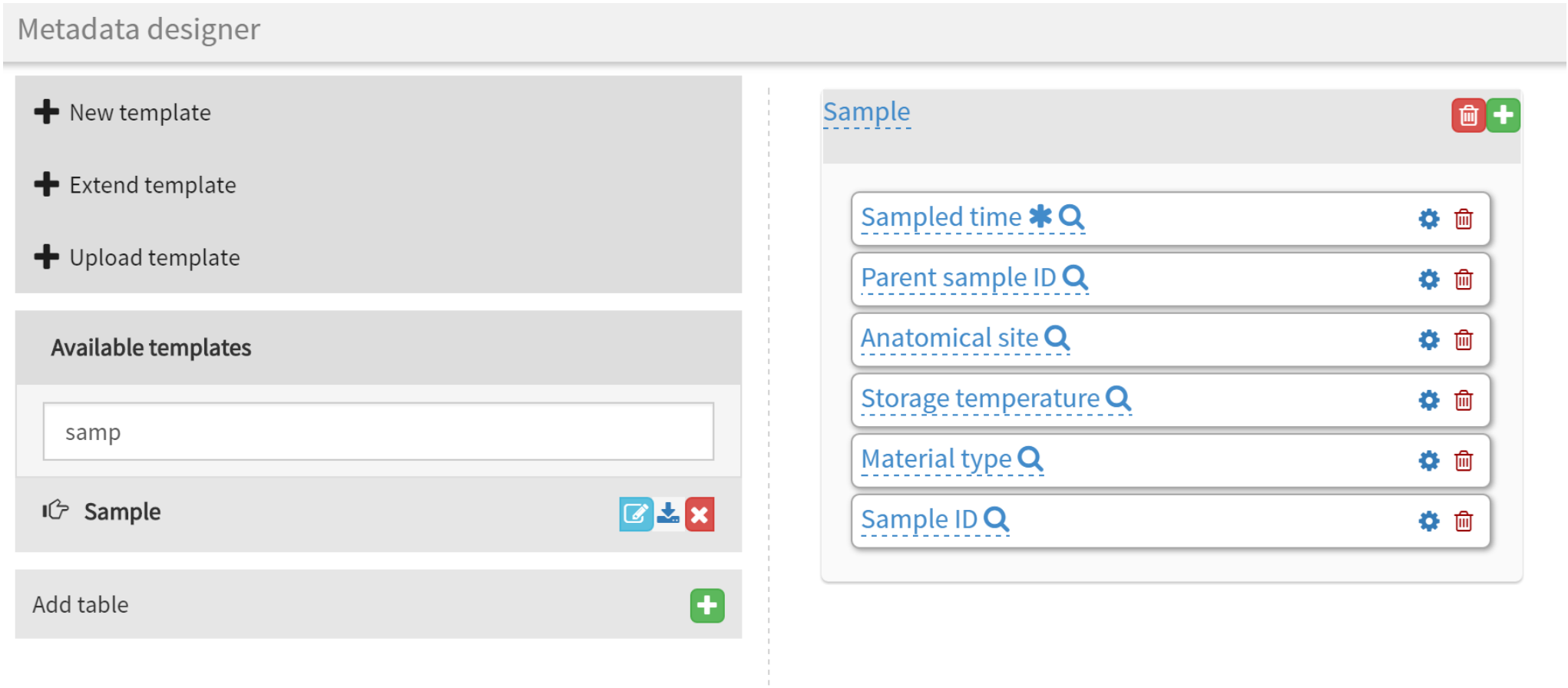
Global Search: Projects and DataSets



Project Search: Files, Directories



Design your own Extended Metadata



MetaData Entry

Sample

Sampled time

Parent sample ID

Anatomical site

Storage temperature — Select a value...

Material type — Select a value...

Sample ID

Save | Back

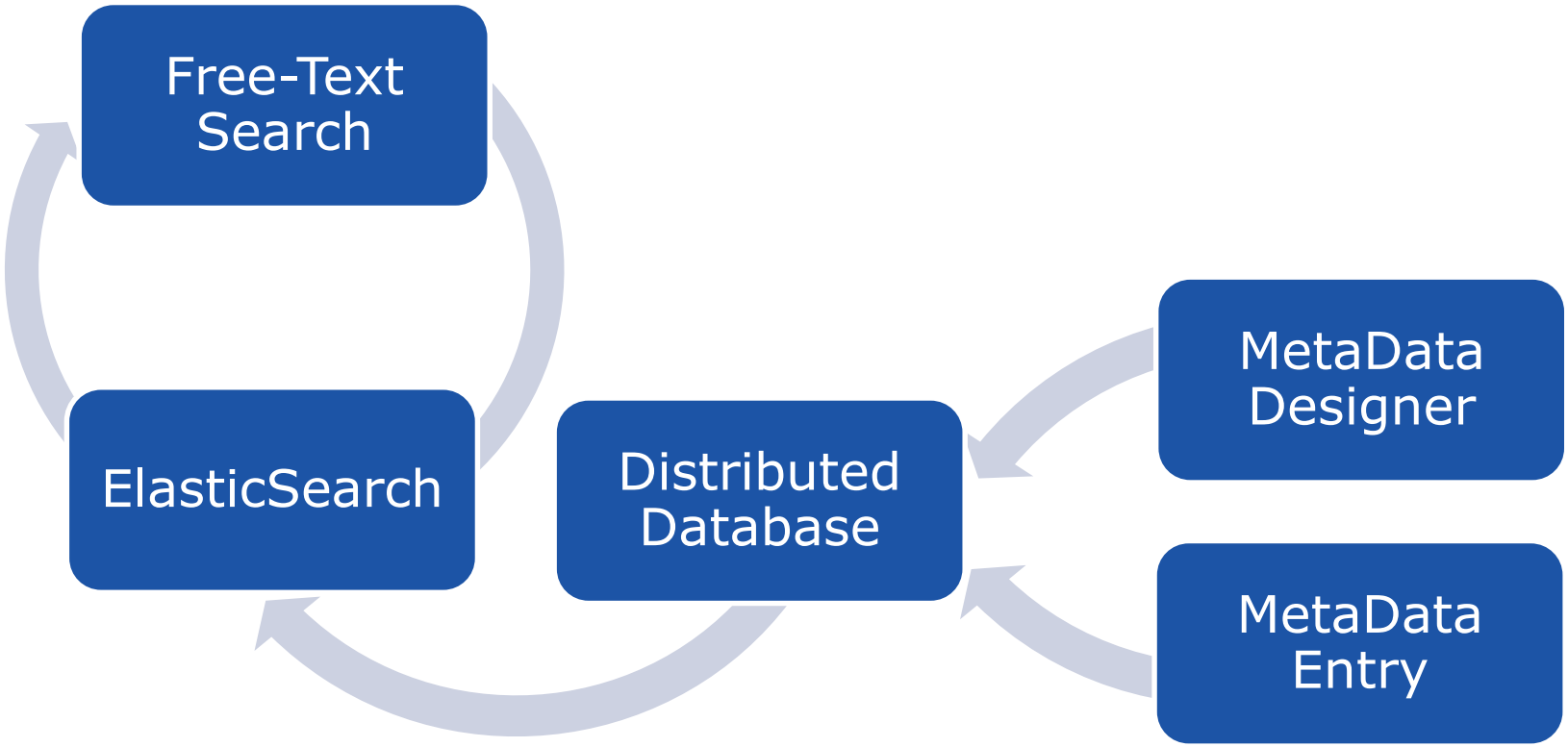
Add metadata

Metadata in file

Sample

Sampled time
19:43
Parent sample ID
1244
Anatomical site
leg
Storage temperature
-60 °C to -85 °C
Material type
Serum
Sample ID
1111

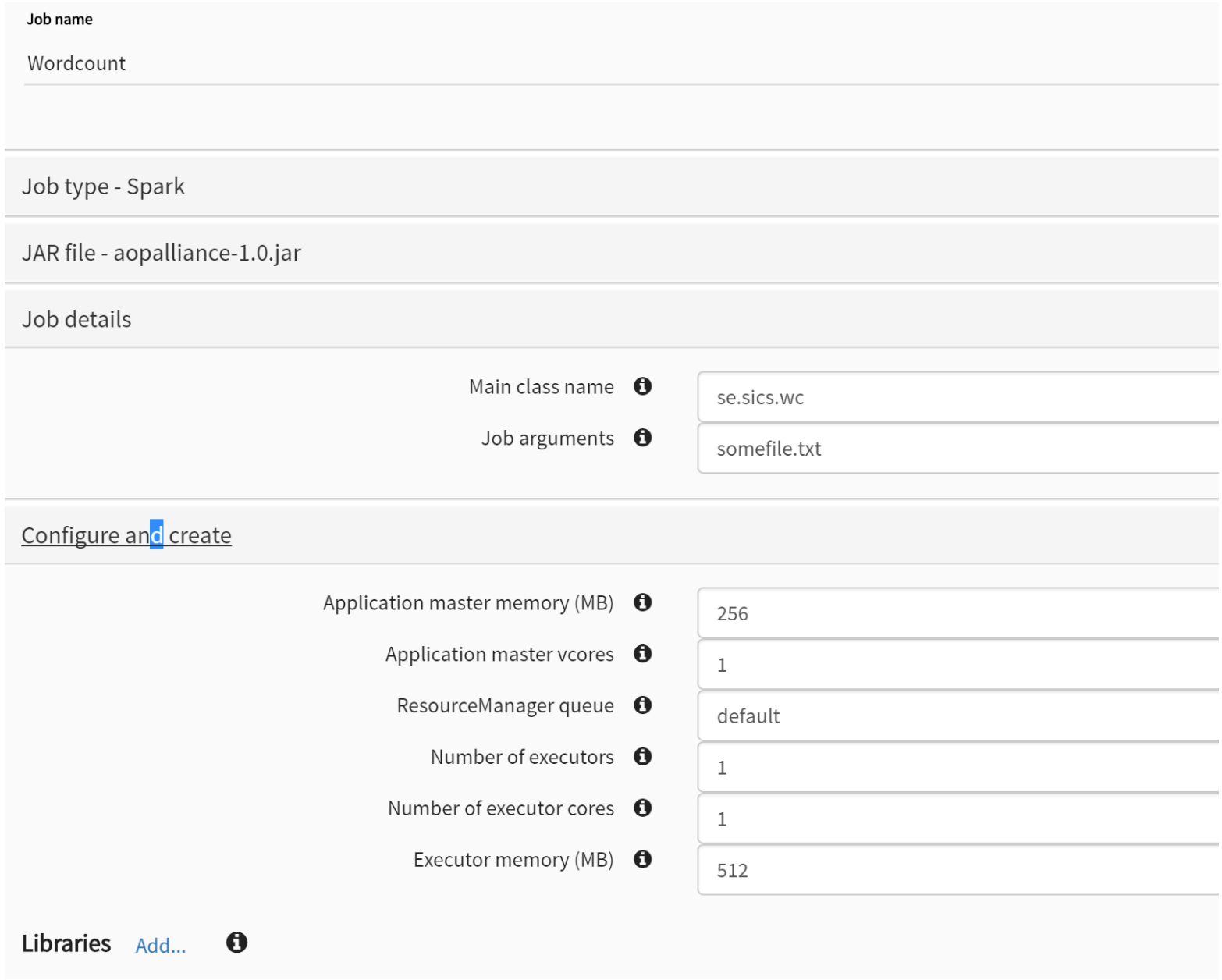
Free Text Search with Consistent Metadata



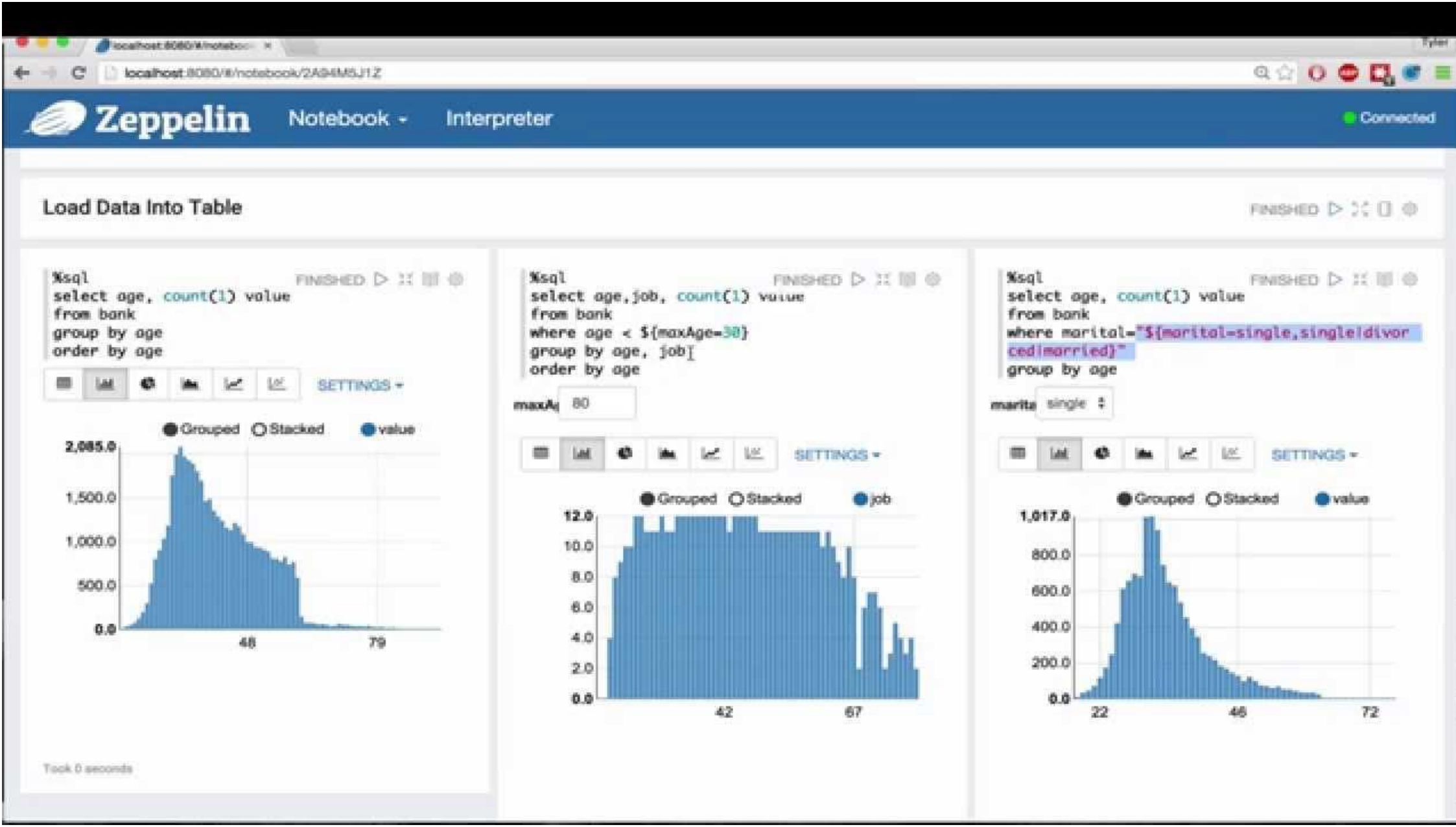
The Distributed Database is the Single Source of Truth.
Foreign keys ensure the integrity of Metadata.

Flink and Zeppelin in HopsWorks

Batch Job Analytics



Interactive Analytics: Flink on Zeppelin



Other Features

- Audit Logs
- Erasure Coding Replication
- Online upgrade of Hops (and NDB)
- Automated Installation with Karamel
- Tinker friendly – easy to extend metadata!

Conclusions

- Hops is a next-generation distribution of Hadoop.
- HopsWorks is a frontend to Hops that supports true multi-tenancy, free-text search, interactive analytics with Zeppelin/Flink/Spark, and batch jobs.
- Looking for contributors/committers
  - Pick-me-up on GitHub

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The Team

Academics:	Jim Dowling, Seif Haridi
PostDocs:	Gautier Berthou
PhDs:	Salman Niazi, Mahmoud Ismail, Kamal Hakimzadeh
MSc Students:	K.Srijeyanthan "Sri", Evangelos Savvidis, Seçkin Savaşçı, Ermias Gebremeskel
Alumini:	Steffen Grohsschmiedt , Theofilos Kakantousis, Stig Viaene, Andre Moré, Qi Qi, Alberto Lorente, Hooman Peiro, Jude D'Souza, Nikolaos Stanogias, Daniel Bali, Ioannis Kirkinos, Peter Buechler, Pushparaj Motamari, Hamid Afzali, Wasif Malik, Lalith Suresh, Mariano Valles, Ying Lieu.

Hops

[Hadoop For Humans]

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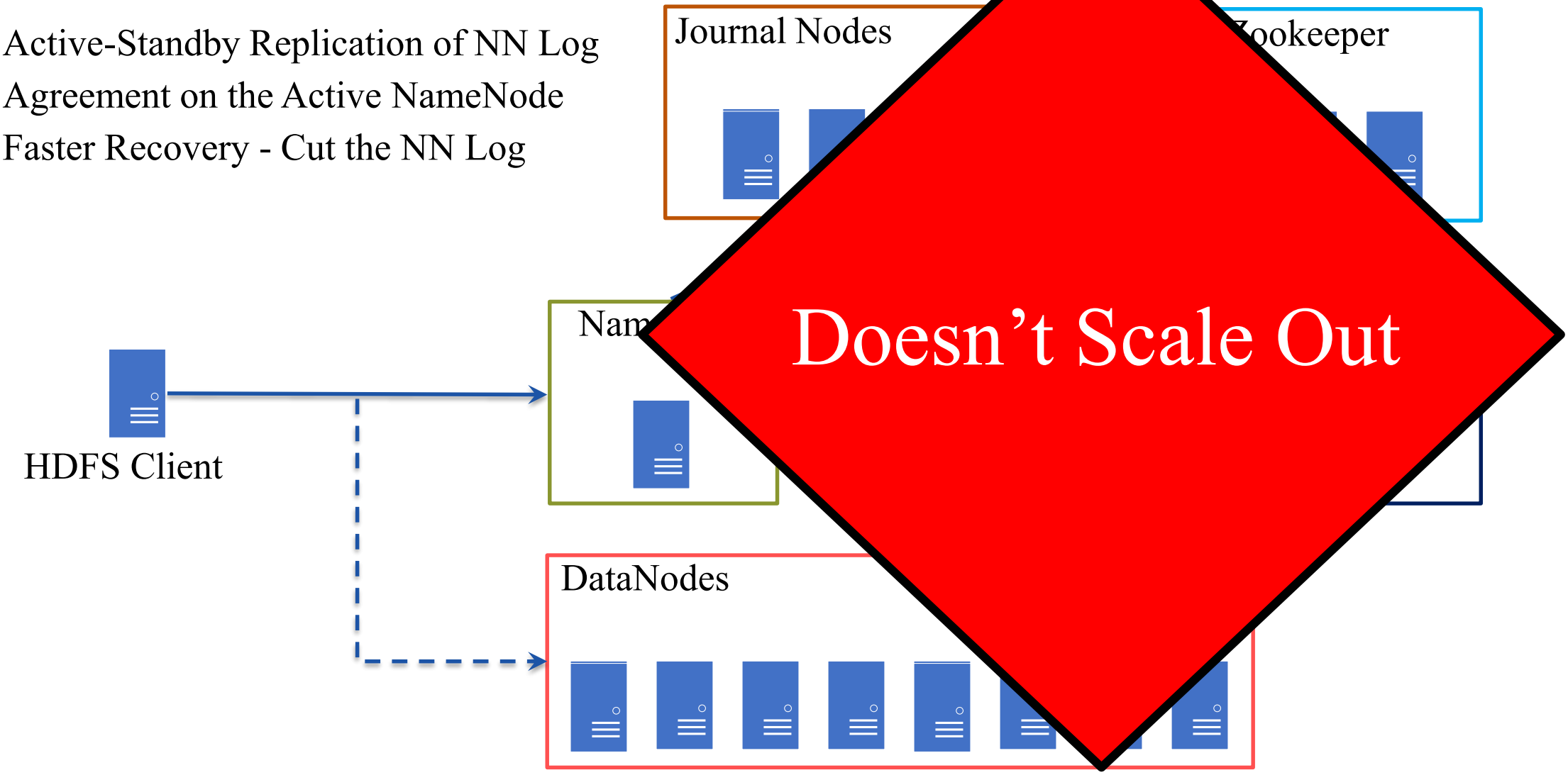
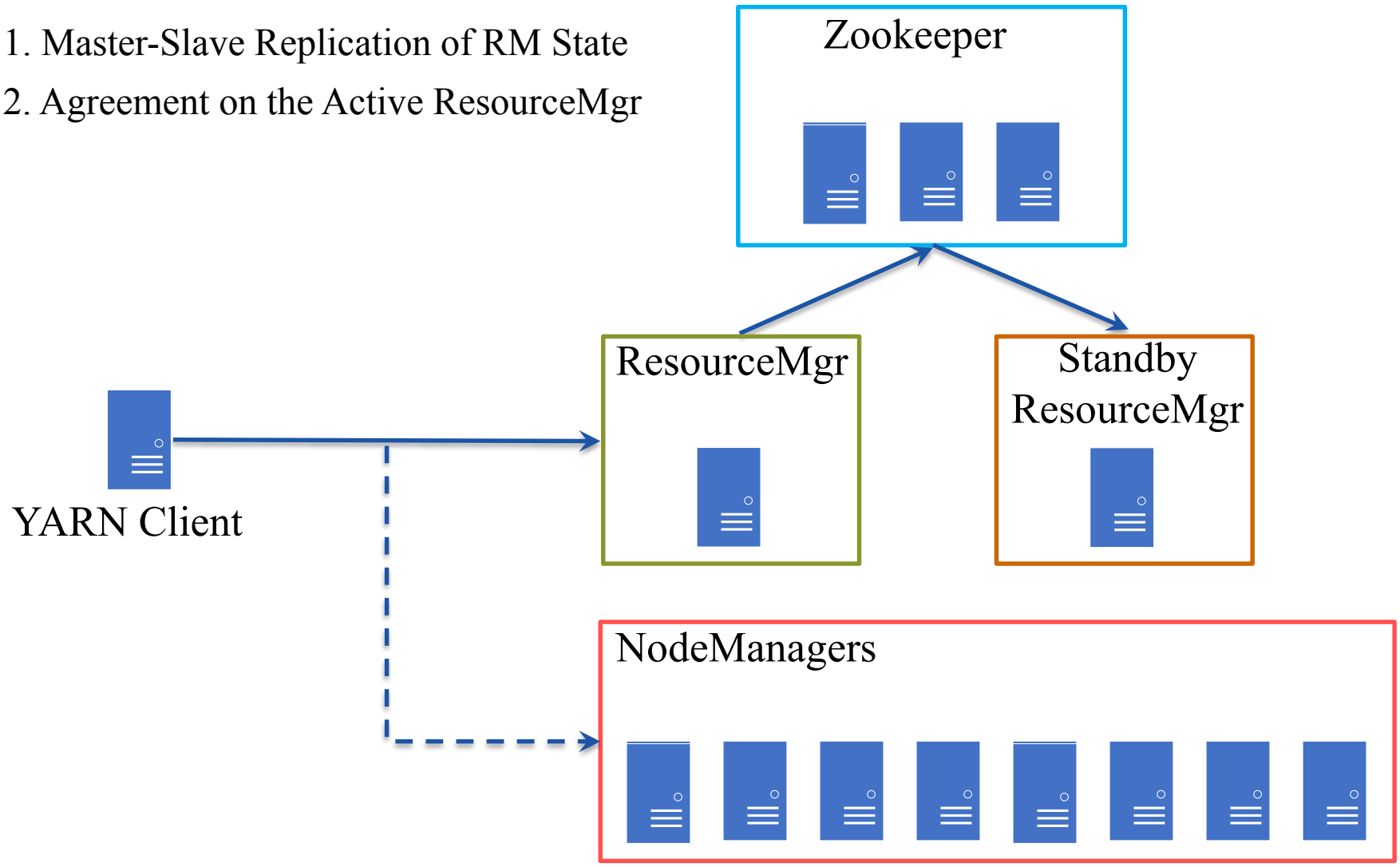
HDFS v2 Architecture

Active-Standby Replication of NN Log

Agreement on the Active NameNode

Faster Recovery - Cut the NN Log



YARN Architecture

1. Master-Slave Replication of RM State
2. Agreement on the Active ResourceMgr