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 @hopshadoop



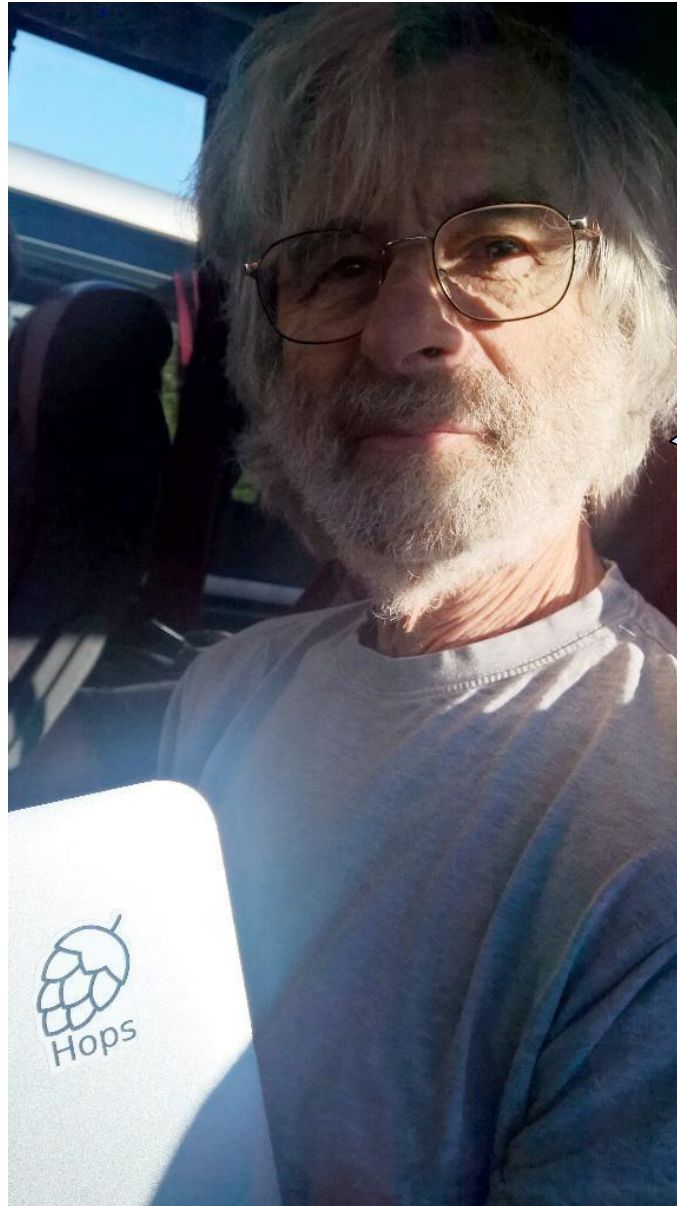
# Interactive Flink analytics with HopsWorks and Zeppelin

Jim Dowling

Ermias Gebermeskel



# Marketing 101: Celebrity Endorsements



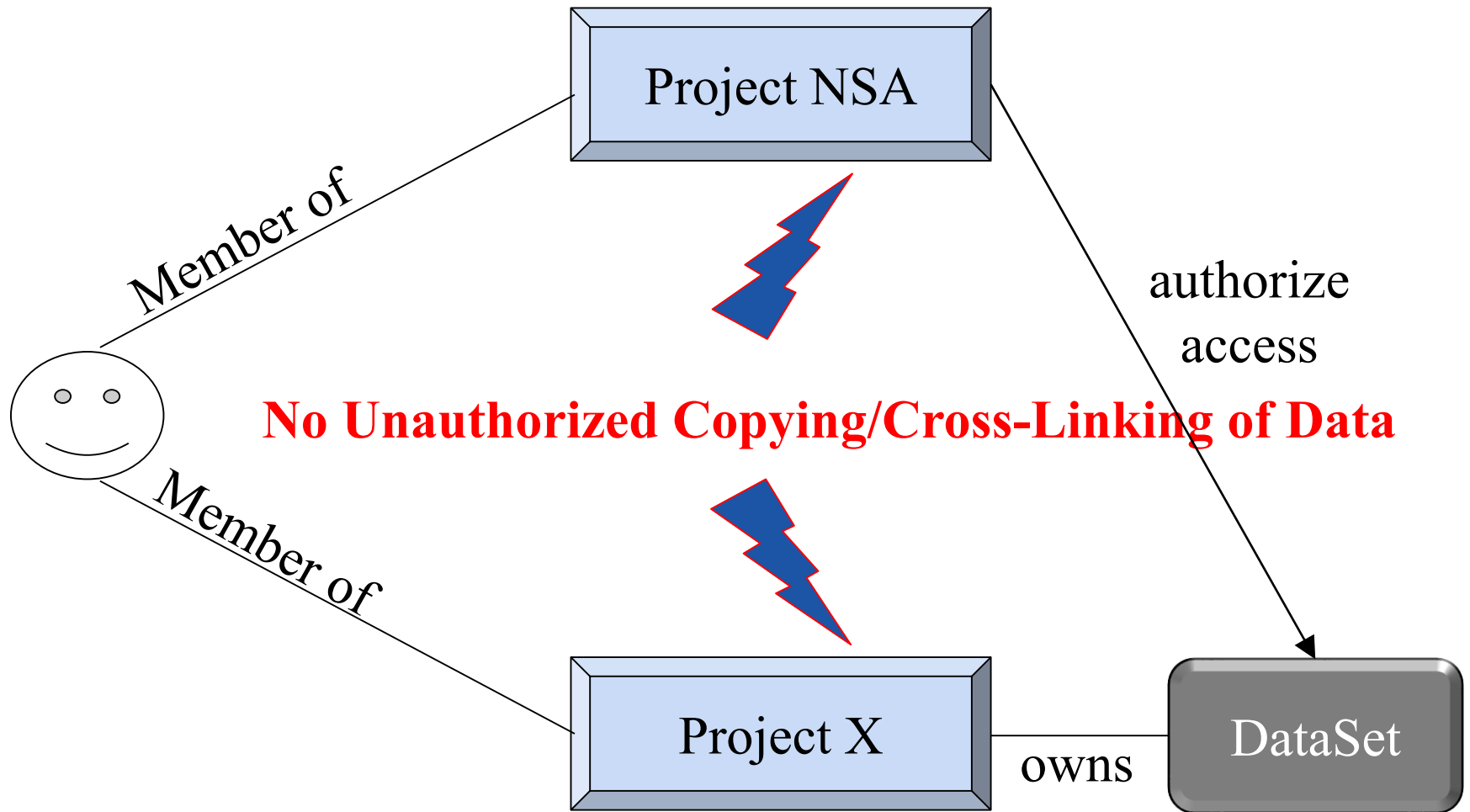
Hi!  
I'm Leslie Lamport\* and  
even though you're not  
using Paxos, I approve  
this product.

\*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**?

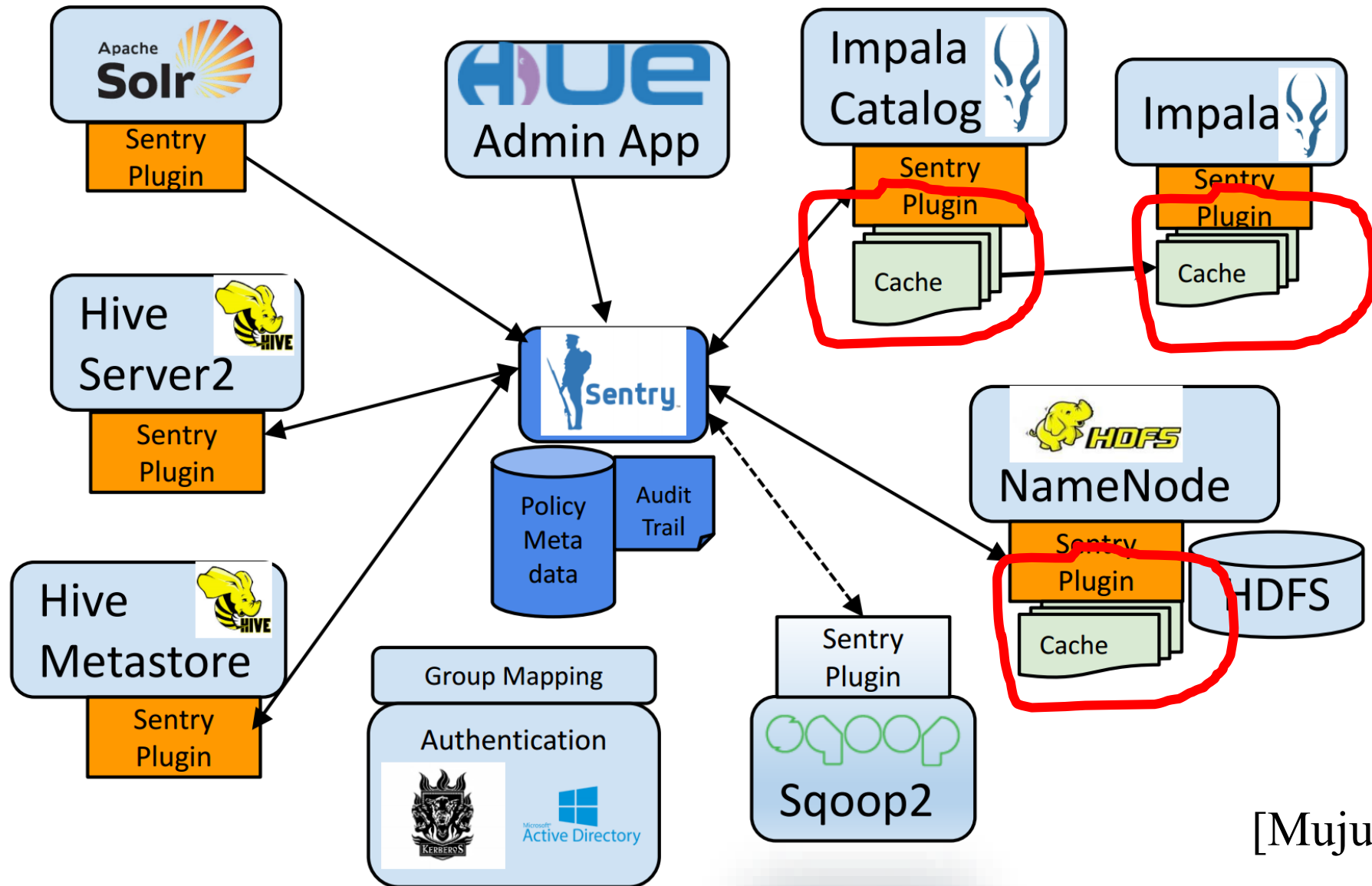
```
grant all privileges on db1.* to 'alice'@'%';  
grant all privileges on db2.* to 'bob'@'%';
```

#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

The screenshot shows the HUE web interface for managing Sentry security policies. The top navigation bar includes links for HUE, Home, Query Editors, Data Browsers, Workflows, Search, Security, File Browser, Job Browser, and Hive. The left sidebar shows the 'Hadoop Security' section with tabs for 'Sentry Tables' and 'File ACLs'. Under 'Sentry Tables', there are sections for 'PRIVILEGES' (Browse, Roles) and 'GROUPS' (ANALYST). The main content area is titled 'Roles' and contains a search bar and an 'Expand' button. Below this, there are two roles listed: 'hc\_analyst\_role' and 'retail\_analyst\_role', both assigned to the 'analyst' group. Each role has a list of privileges, each preceded by a timestamp '18 minutes ago TABLE'. The 'hc\_analyst\_role' has three privileges: a SERVER privilege on 'file://demo/data/patient\_data' with action=ALL, and two TABLE privileges on 'customer\_info' and 'patient\_data' in the 'healthcare' database with action=SELECT. The 'retail\_analyst\_role' has three privileges: a TABLE privilege on 'customer\_info' in the 'production' database with action=SELECT, a TABLE privilege on 'products' in the 'production' database with action=SELECT, and a TABLE privilege on 'products' in the 'production' database with action=INSERT.

**HUE** Home Query Editors ▾ Data Browsers ▾ Workflows ▾ Search Security ▾ File Browser Job Browser hive ▾ ?

**Hadoop Security** Sentry Tables File ACLs

**PRIVILEGES**

- Browse
- Roles**

**GROUPS**

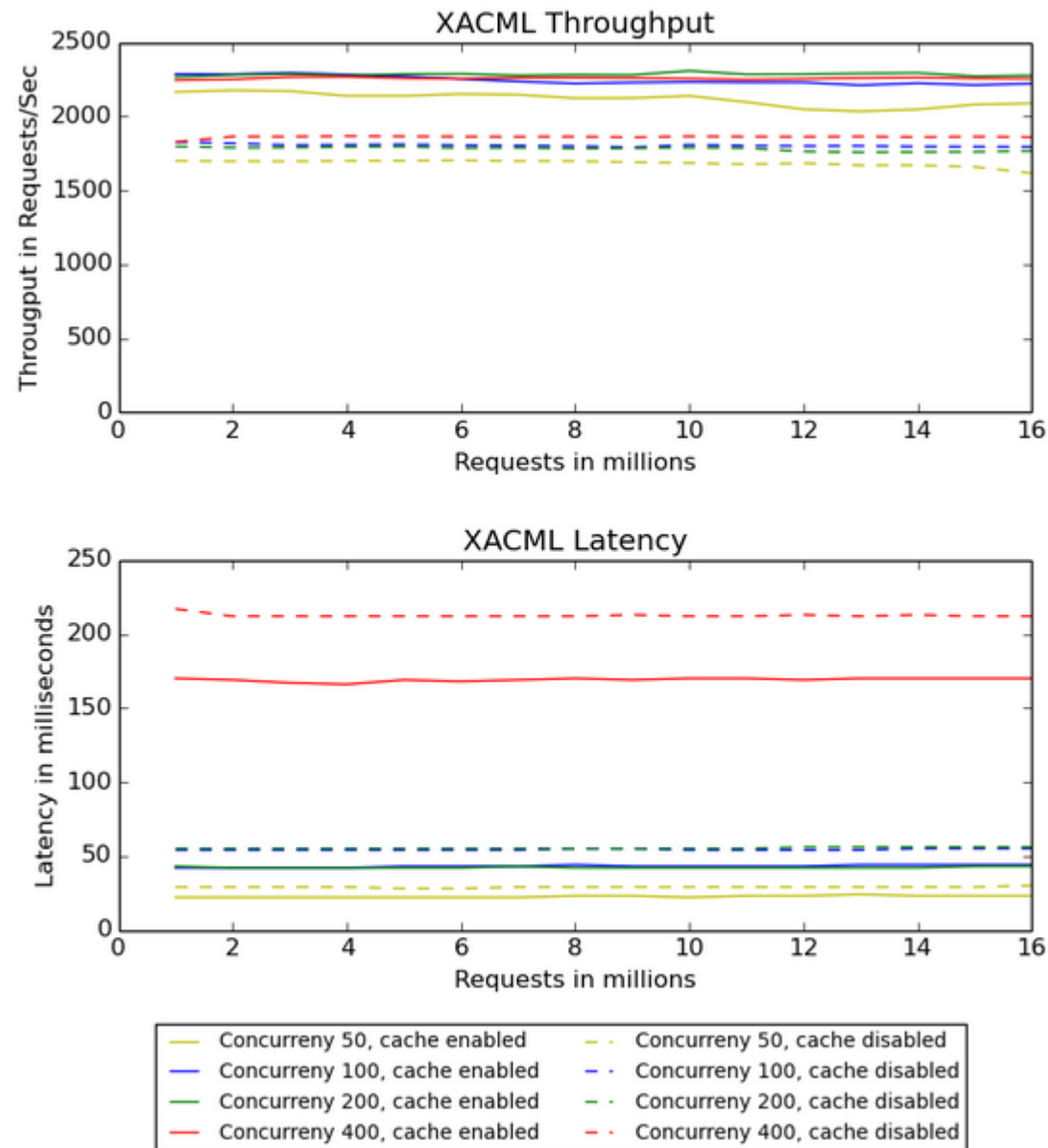
ANALYST x ▾

## Roles

Search roles by name, groups, etc... Expand

<input type="checkbox"/>	Name	Groups
<input type="checkbox"/>	hc_analyst_role	analyst
18 minutes ago SERVER server=server1 → file://demo/data/patient_data → action=ALL		
18 minutes ago TABLE server=server1 → db=healthcare → table=customer_info → action=SELECT		
18 minutes ago TABLE server=server1 → db=healthcare → table=patient_data → action=SELECT		
+		
<input type="checkbox"/>	retail_analyst_role	analyst
18 minutes ago TABLE server=server1 → db=production → table=customer_info → action=SELECT		
18 minutes ago TABLE server=server1 → db=production → table=products → action=SELECT		
18 minutes ago TABLE server=server1 → db=production → table=products → action=INSERT		
18 minutes ago TABLE		

# Performance of Policy Enforcement Points (PEP)





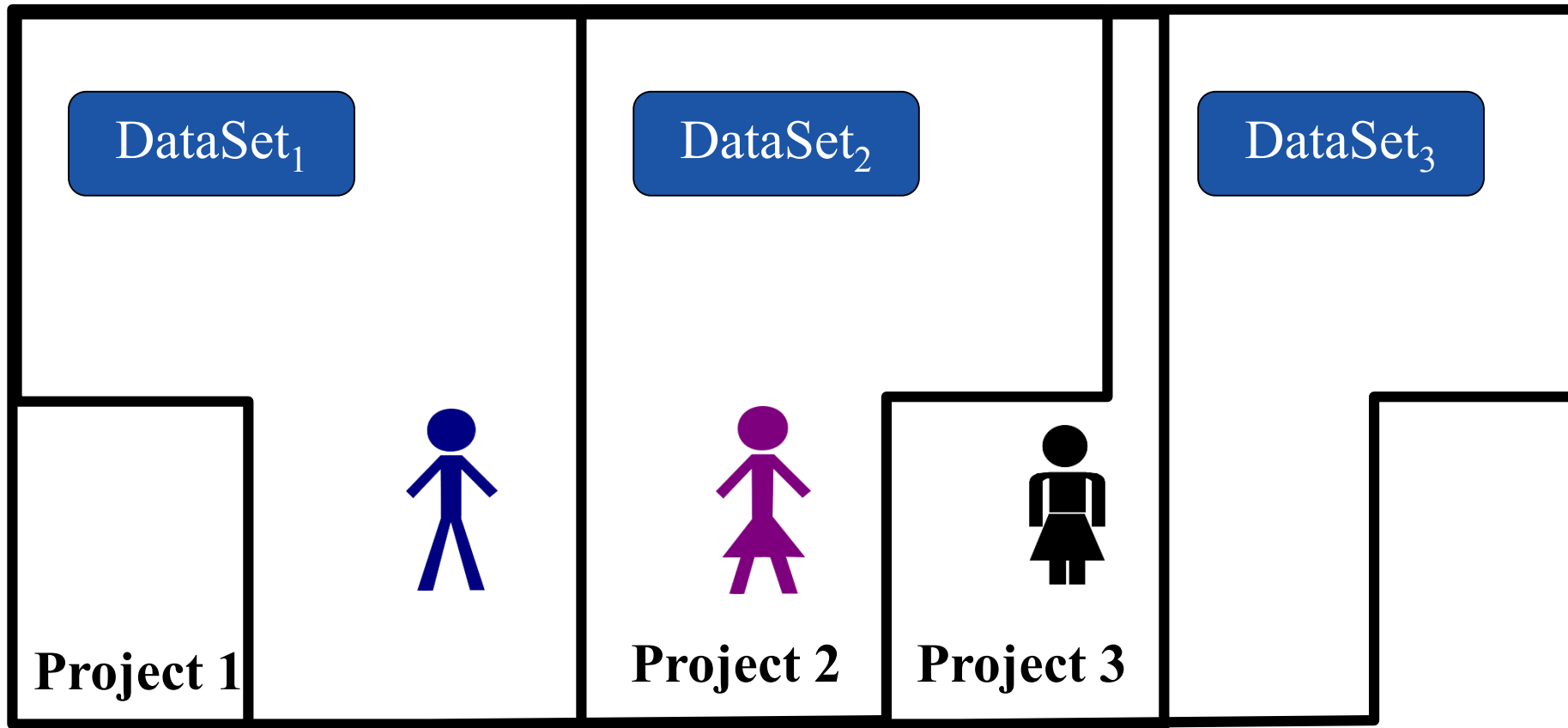
# PEPs + Hadoop = Horse-Drawn Sportscar



Policy Enforcement Engines	≈	<b>O(2,000)</b> ops/sec
HopsFS Distributed Filesystem	≈	<b>O(100,000)</b> ops/sec

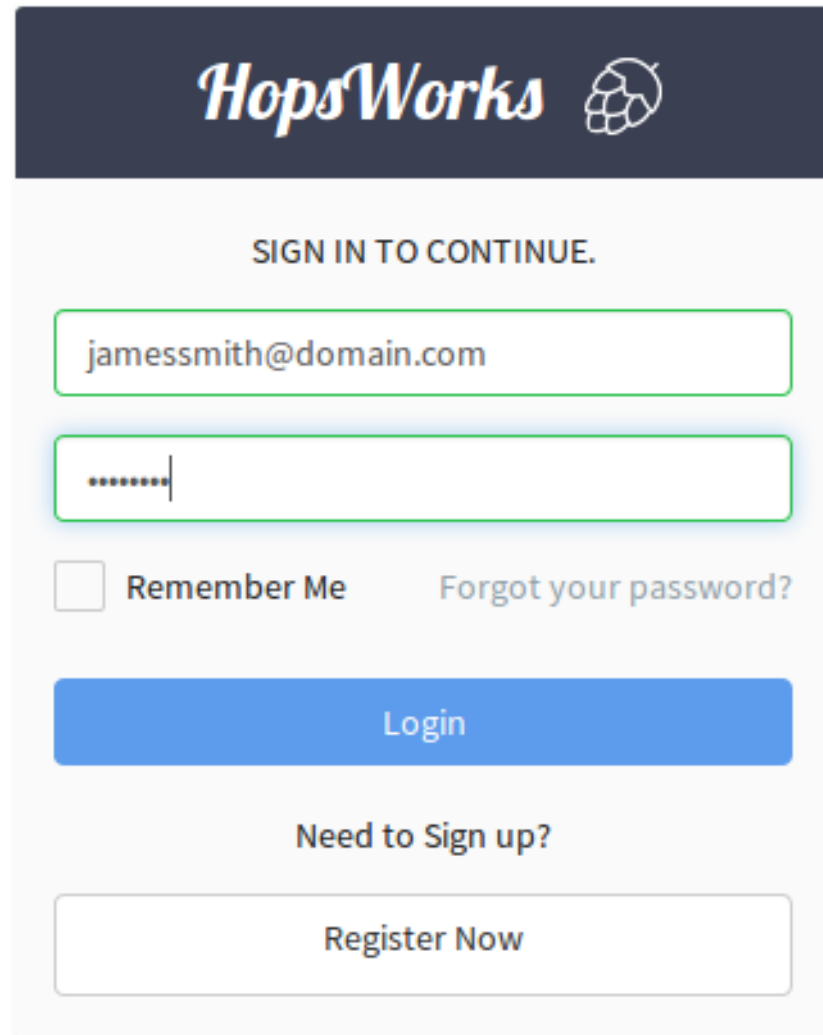
# HopsWorks

# Users, DataSets, and Projects



**In-Place Data Sharing - not Copying!**

# User

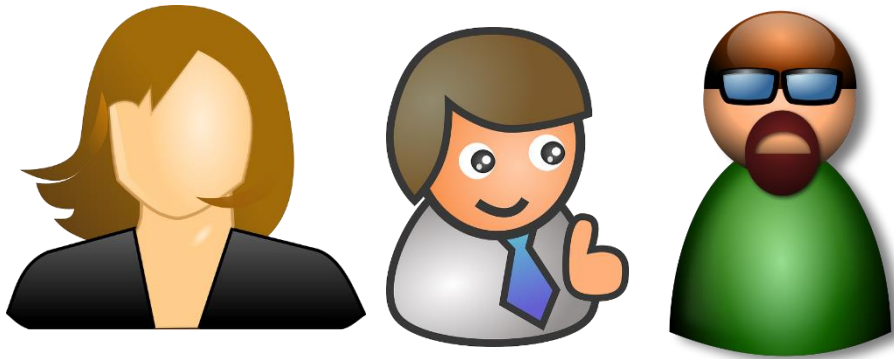


The screenshot shows the HopsWorks login interface. At the top, the HopsWorks logo is displayed on a dark blue background. Below the logo, the text "SIGN IN TO CONTINUE." is centered. There are two input fields: the first contains the email address "jamesmith@domain.com", and the second contains a masked password "\*\*\*\*\*". Below the password field, there is a checkbox labeled "Remember Me" and a link "Forgot your password?". A blue "Login" button is positioned below these options. At the bottom, there is a link "Need to Sign up?" and a white "Register Now" button.

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



# Project



- Members
  - Roles: Owner, Data Scientist



- DataSets
  - Home project
  - Can be shared

# Project Roles

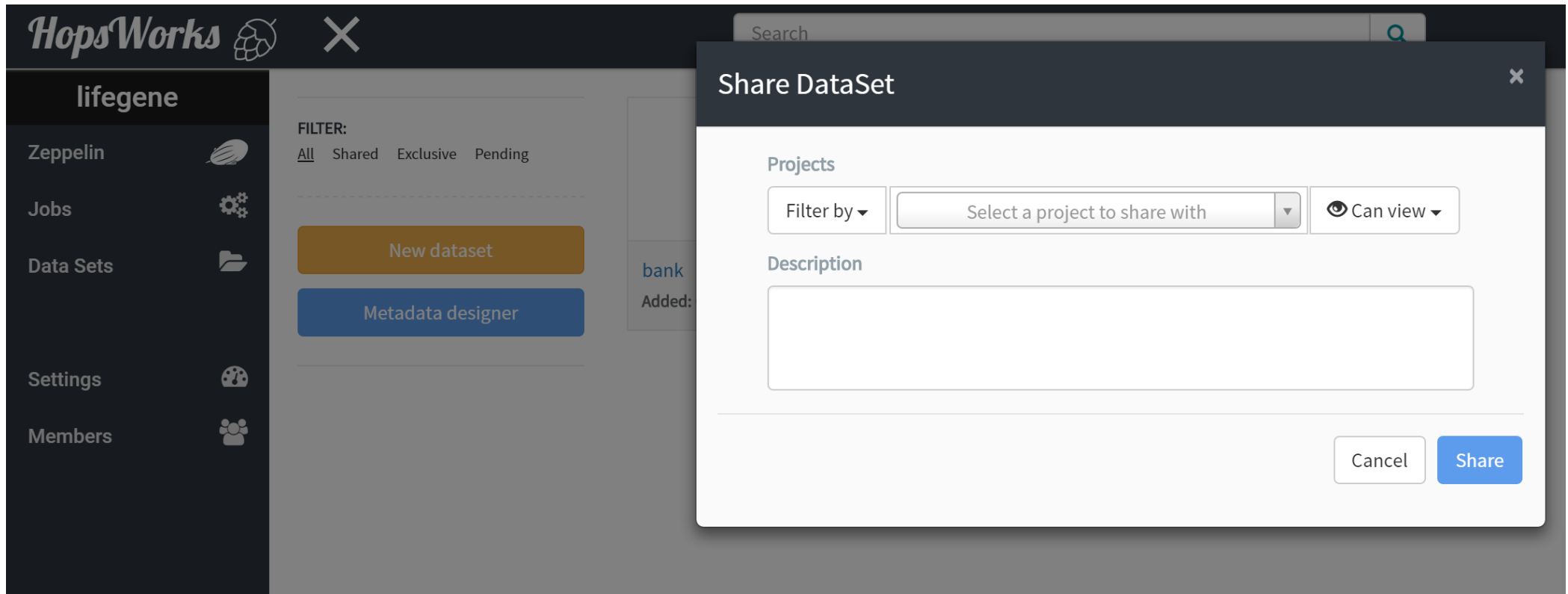
The screenshot shows a 'Members' management window. At the top, there is a search bar labeled 'Find member...' and a '+ New members' button. Below this is a section titled 'Members to be added' containing an 'Add members...' dropdown and a table for adding new members. The table has columns for 'Member' and 'Role'. One member, 'test2@kth.se', is listed with the role 'Data scientist'. A 'Save' button is at the bottom of this section. Below the 'Members to be added' section is a table of existing members with columns for 'Members', 'Role', and 'Action'. The table lists three members: 'Admin Admin (me)' with role 'Data owner', 'Test1 Test1' with role 'Data scientist', and 'Test3 Test3' with role 'Data scientist'. Each member has a red trash icon in the 'Action' column.

Members	Role	Action
Admin Admin (me) admin@kth.se	Data owner	
Test1 Test1 test1@kth.se	Data scientist	
Test3 Test3 test3@kth.se	Data scientist	

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

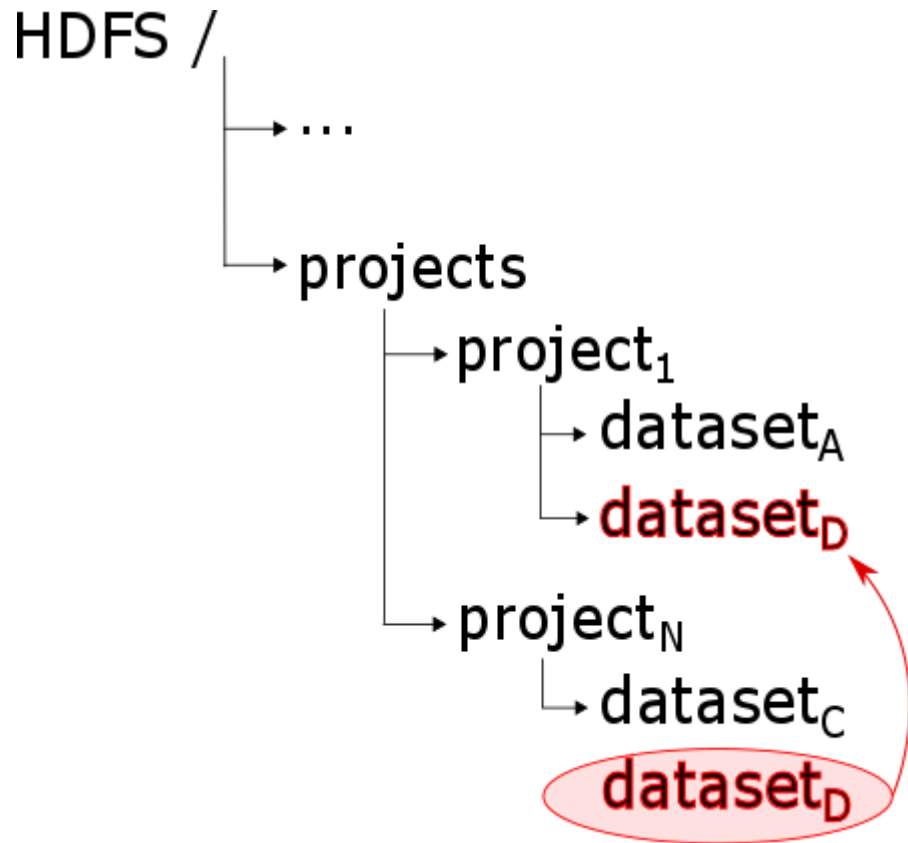
**We delegate administration of privileges to users**

# 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

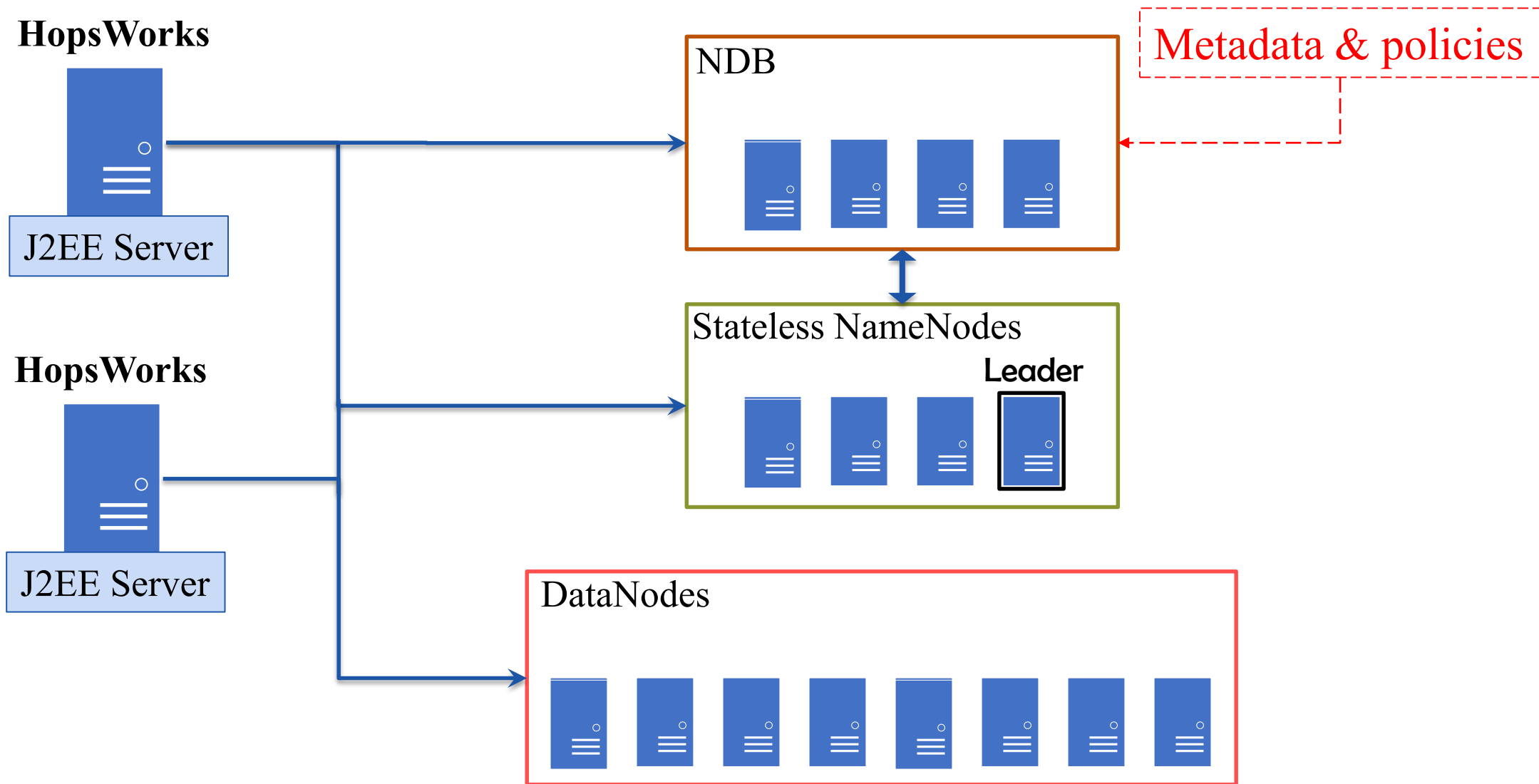
With Hadoop metadata in a DB, we guarantee policy integrity with Foreign Keys



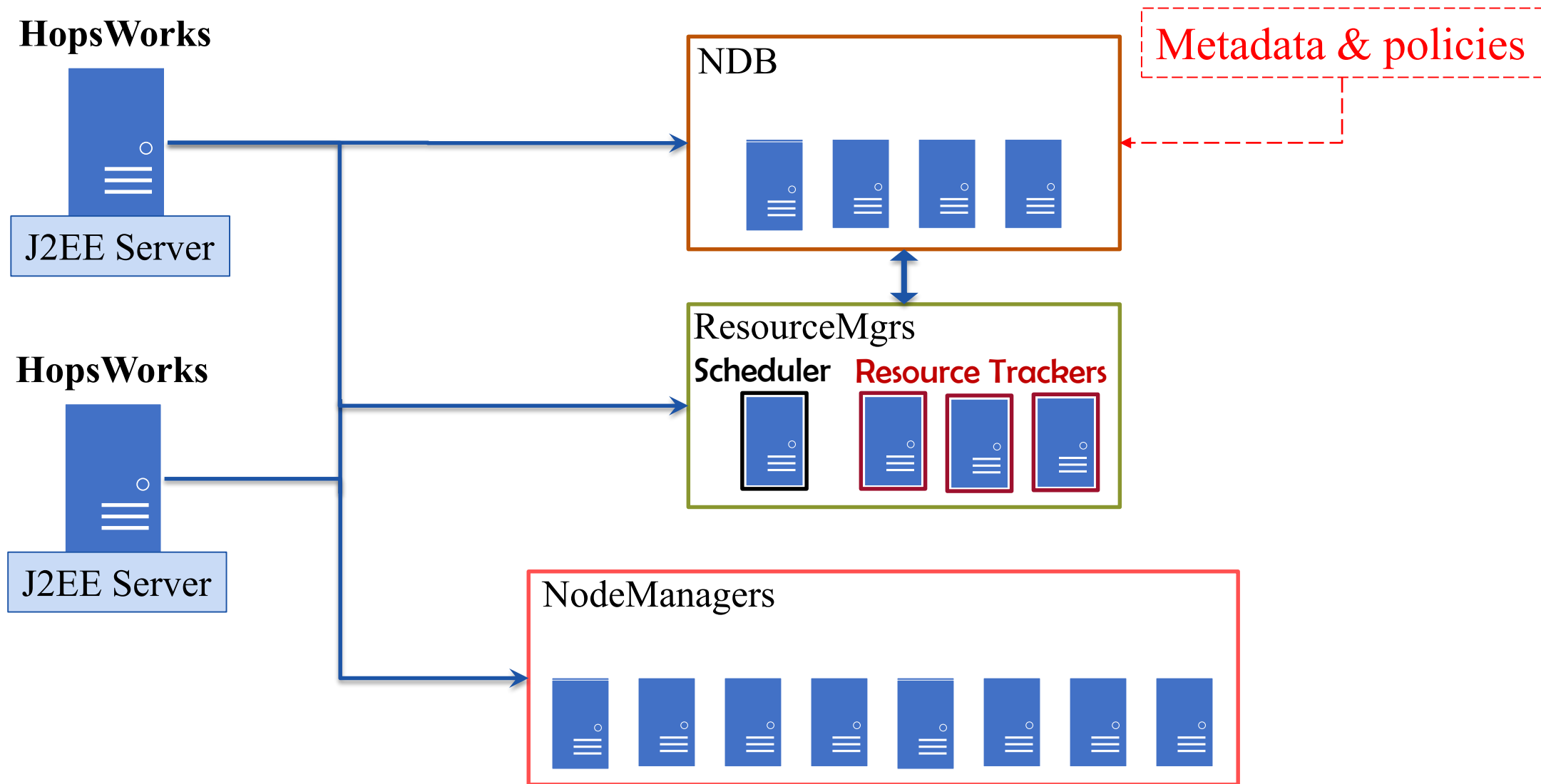
# Engine – HopsFS, HopsYARN



# HopsFS



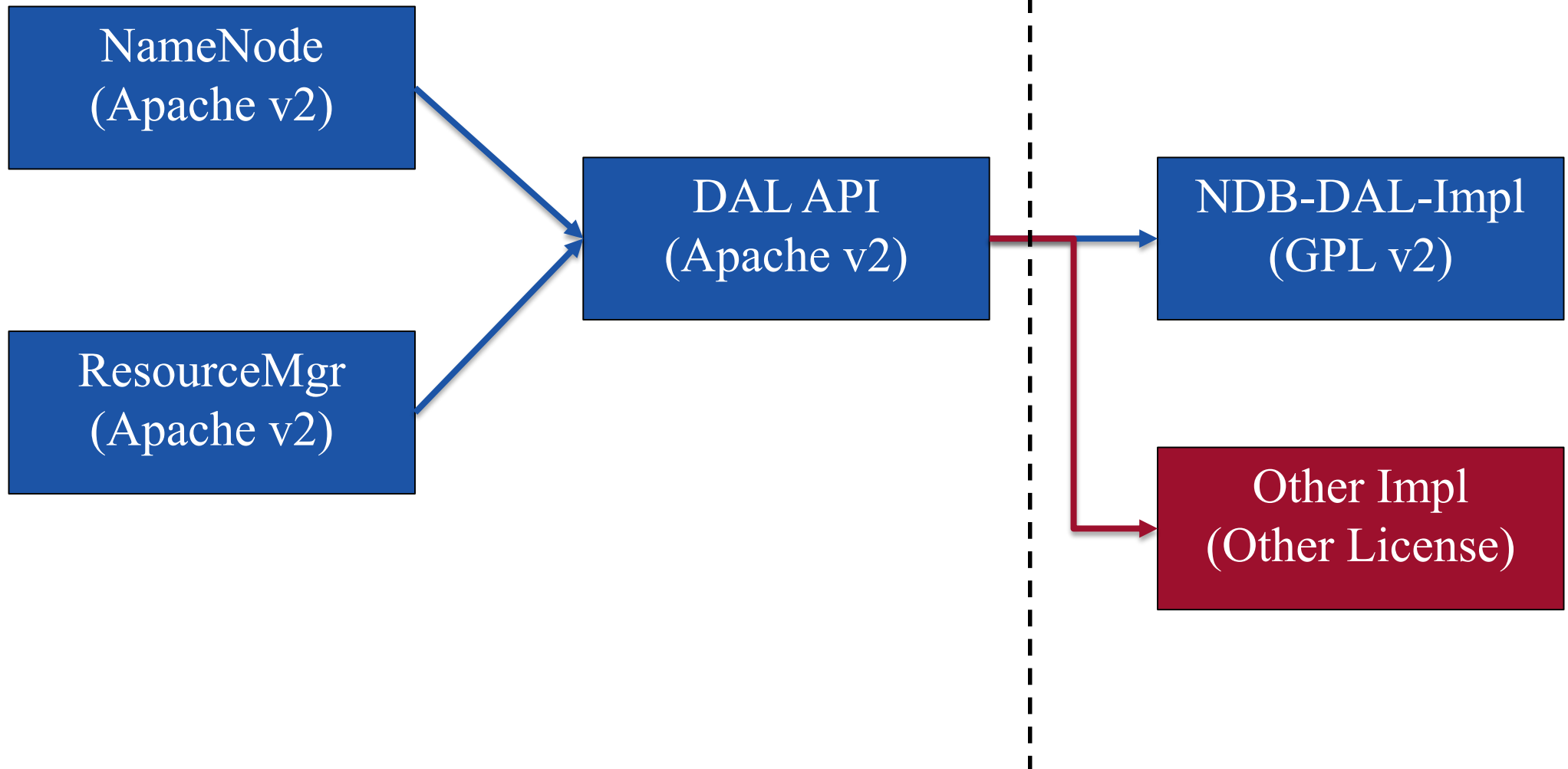
# HopsYARN



# Data Abstraction Layer (DAL)

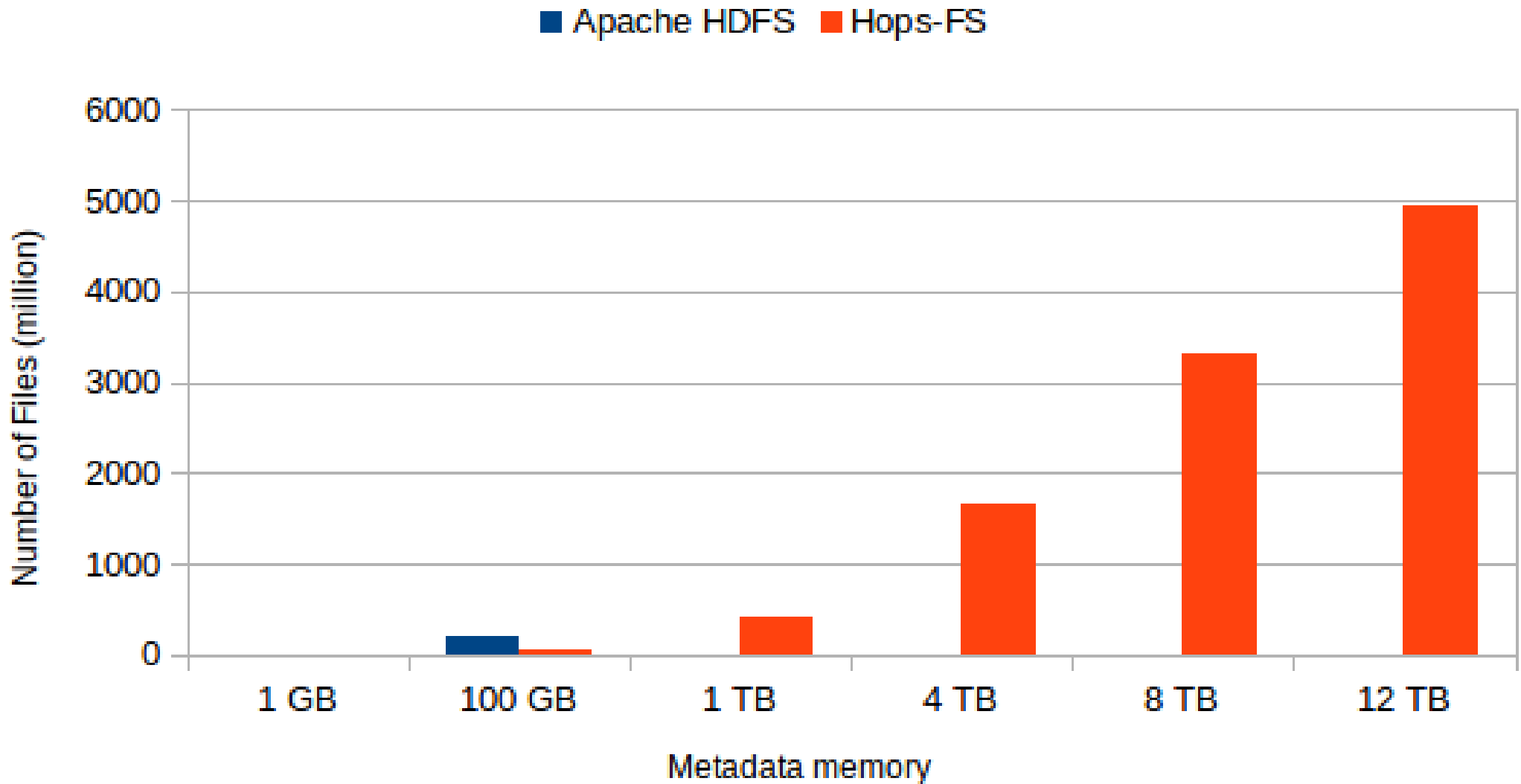
hops-2.4.0.jar

dal-ndb-2.4.0-7.4.7.jar



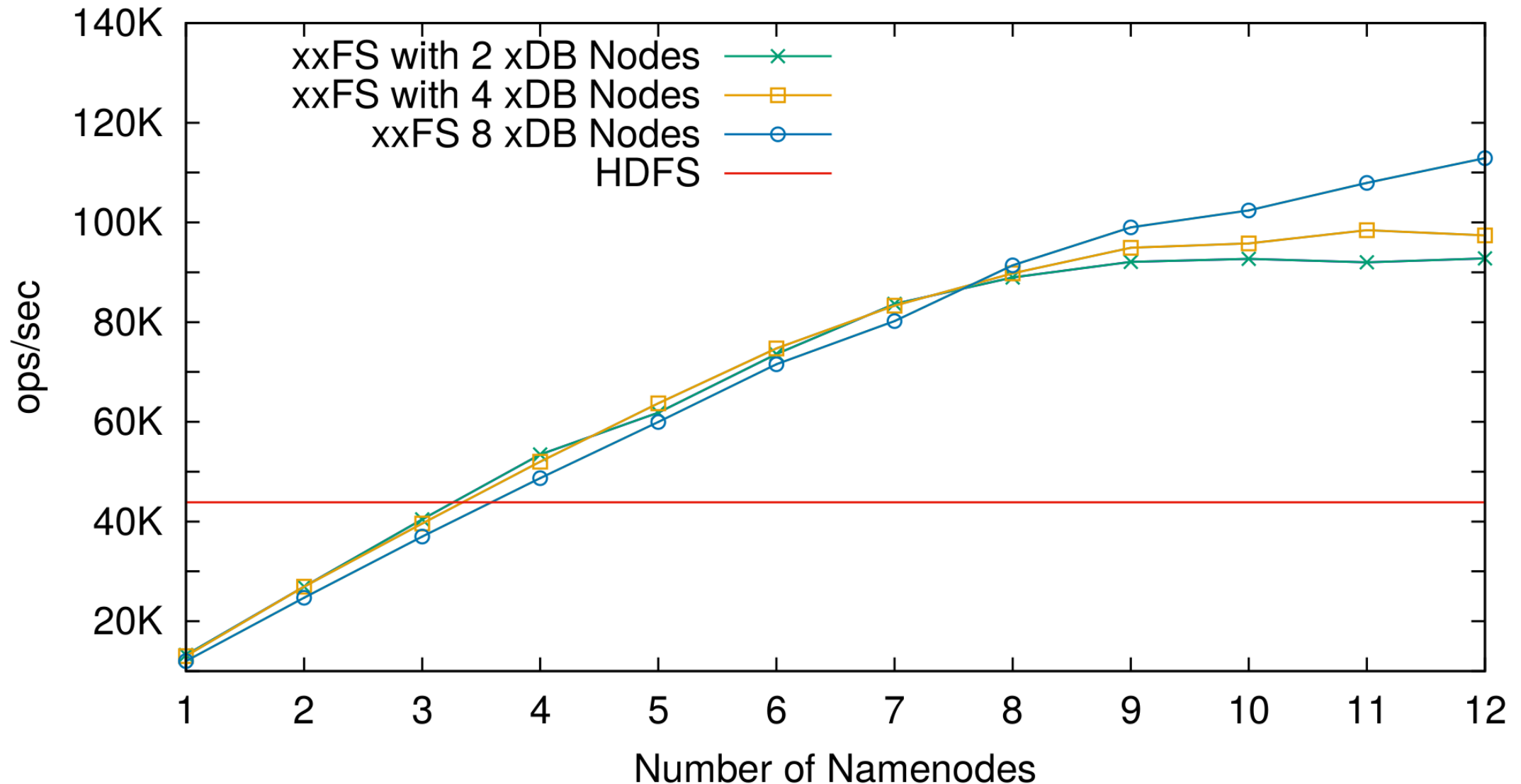
# Hops Performance

# HopsFS Metadata Scaleout



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

# HopsFS Throughput (Real Workload)

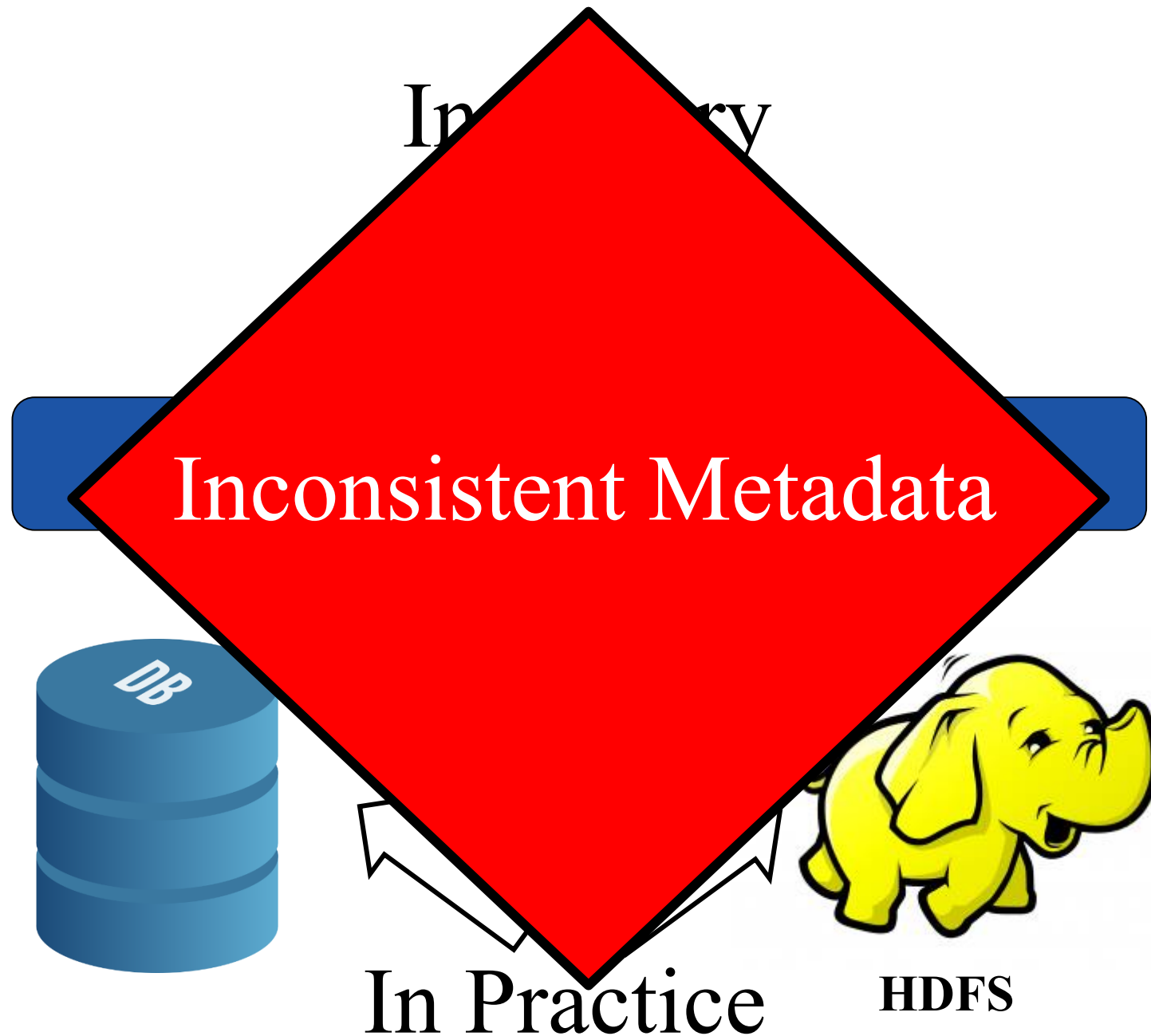


Experiments performed on AWS EC2 with enhanced networking and C3.8xLarge instances

What else can we do with metadata in a DB?



# How ACME Inc. handles Free-Text Search



# Global Search: Projects and DataSets

bank



Result for **bank**

1 result found.

bank

View

Description Dataset

Filters



By Date



By Size

from

30

# Project Search: Files, Directories



 admin@kth.se ▾

Result for **lant**  
1 result found.


lantmannen.mp3

Common folder

Filters

Apply

By Date



By Size

from

to

# Design your own Extended Metadata

## Metadata designer

New template

Extend template

Upload template

### Available templates

samp

Sample

Add table

## Sample

Sampled time \* 🔍

Parent sample ID 🔍

Anatomical site 🔍

Storage temperature 🔍

Material type 🔍

Sample ID 🔍

29

# MetaData Entry

Sample

Sampled time	!	<input type="text"/>
Parent sample ID	!	<input type="text"/>
Anatomical site	!	<input type="text"/>
Storage temperature	!	<input type="text" value="Select a value..."/>
Material type	!	<input type="text" value="Select a value..."/>
Sample ID	!	<input type="text"/>

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

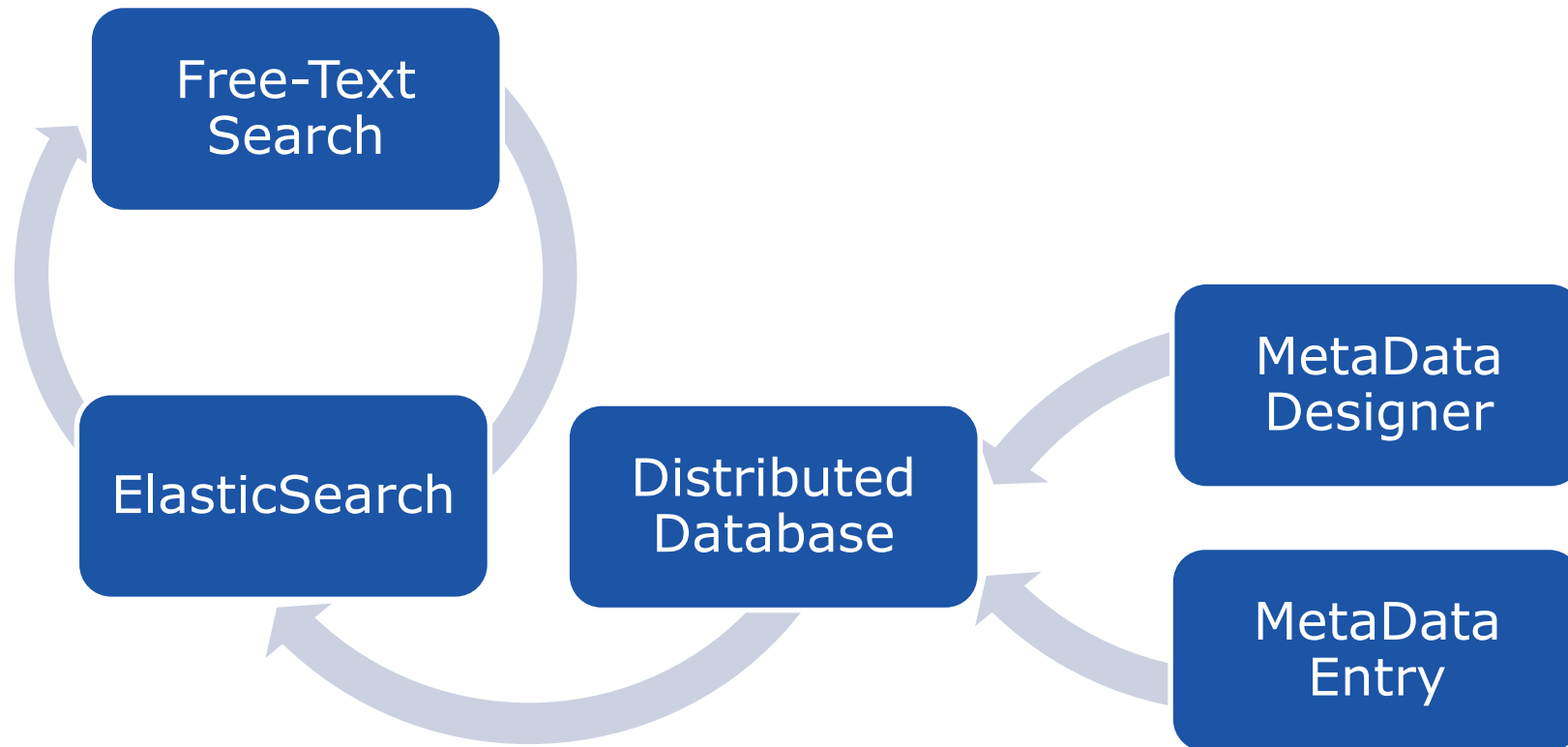
*Material type*

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.**

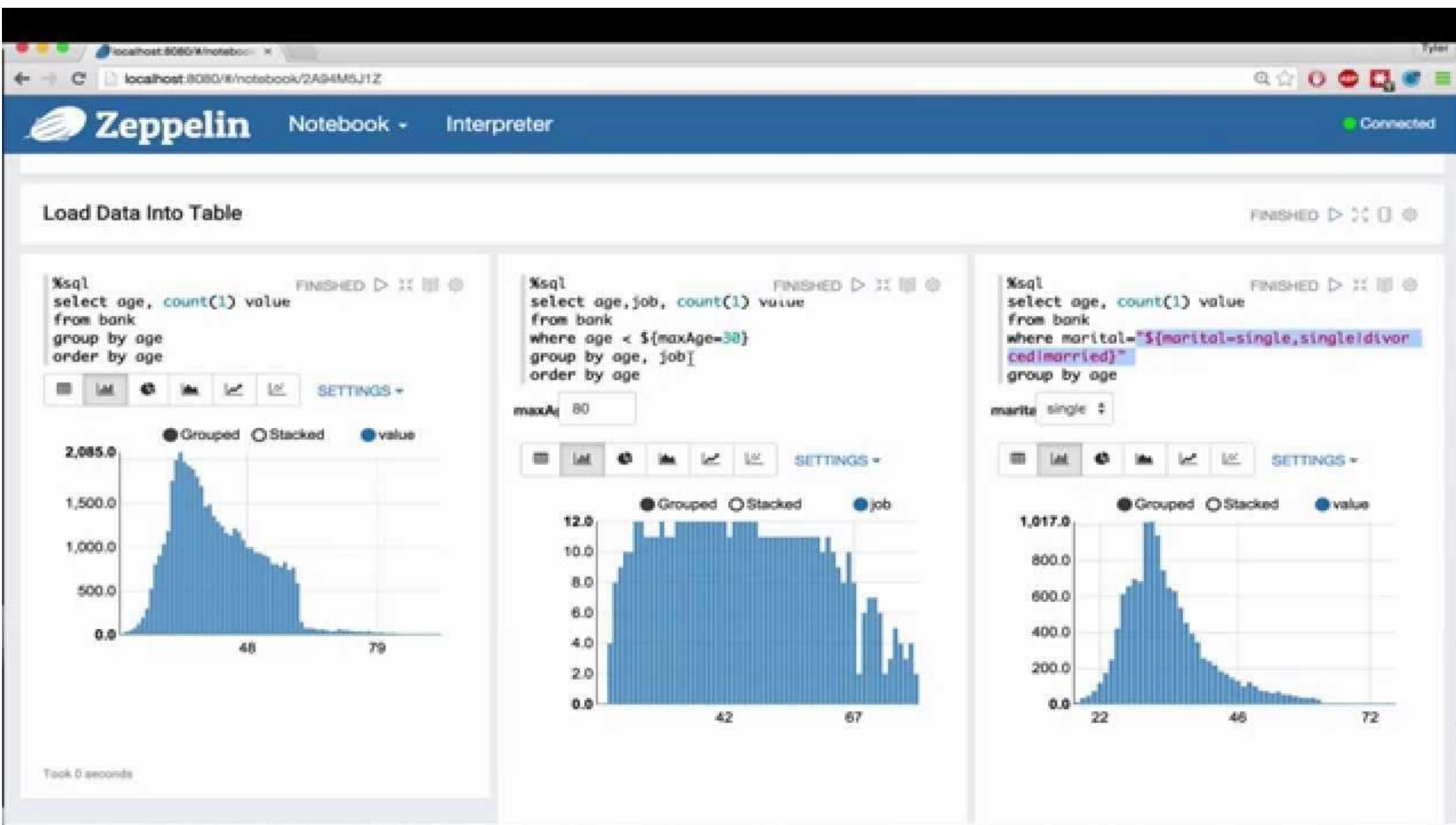
# Flink and Zeppelin in HopsWorks

# Batch Job Analytics

Job name	
Wordcount	
Job type - Spark	
JAR file - aopalliance-1.0.jar	
Job details	
Main class name ⓘ	se.sics.wc
Job arguments ⓘ	somefile.txt
<u>Configure and create</u>	
Application master memory (MB) ⓘ	256
Application master vcores ⓘ	1
ResourceManager queue ⓘ	default
Number of executors ⓘ	1
Number of executor cores ⓘ	1
Executor memory (MB) ⓘ	512
Libraries <a href="#">Add...</a> ⓘ	



# 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

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Kamal Hakimzadeh

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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

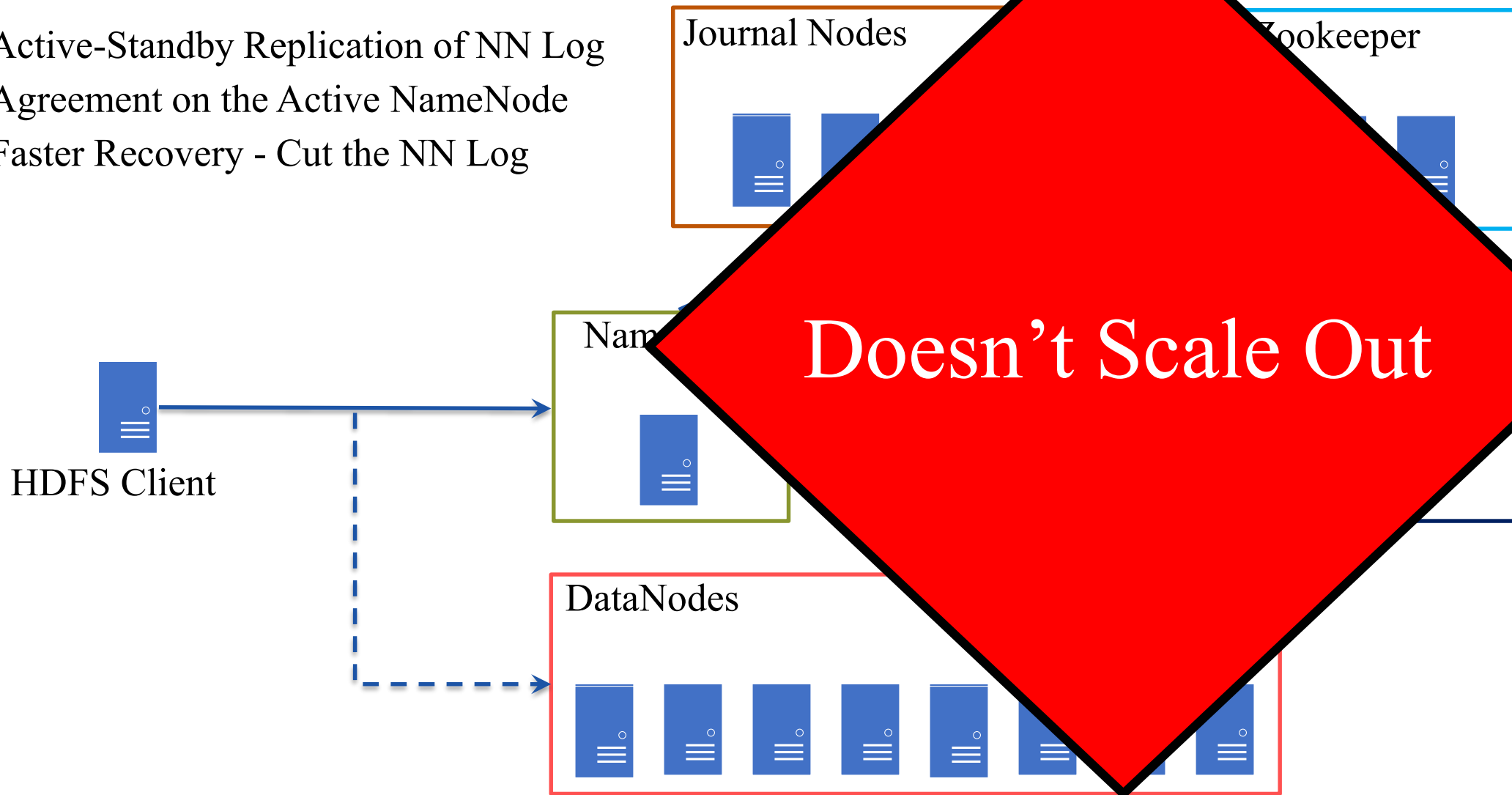
[Hadoop For Humans]

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 @hopshadoop

# 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

