HopsWorks: Multi-Tenant Hadoop-as-a-Service

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@hopshadoop

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Open, Collaborative Software Development
Enterprise-Level Hadoop: Admin-in-the-Loop

Hadoop Administrator

Please, Sir— I Want Some MORE!
>hdfs dfs -chmod -R 000 /apps/hive

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

[Mujumdar’15]
Access Control in Relational Databases

# Multi-tenancy for alice and bob on db1 and db2

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

Consistency of security and privileges guaranteed with foreign keys.

drop db2;  // deletes associated privileges
Metadata Totem Poles in Hadoop

Eventual Consistency
Why the separation of Metadata and Data?
There is another way.....
Hops: Distributed Metadata for Hadoop
HopsYARN Architecture

Up to 10K Node Clusters

YARN Client

NDB

ResourceMgrs
Scheduler
Resource Trackers

Leader Election for Failed Scheduler

NodeManagers
Challenges for Project-Level Multi-Tenancy

(How can we introduce GitHub-style projects to Hadoop?)
Problem: Sensitive Data needs its own Cluster

Alice has only one Kerberos Identity. Neither attribute-based access control nor dynamic roles supported in Hadoop.
How can we share DataSets between Projects?

Solution: Project-Specific UserIDs

- NSA_Alice
  - Member of Project NSA

- Users_Alice
  - Member of Project Users

HDFS enforces access control
Sharing Data with First-Class DataSets

NSA__Alice

Member of

Project NSA

Add members of Project NSA to the DataSet group

Users__Alice

Member of

Project Users

owns

DataSet
HopsWorks: Project-Level Multi-Tenancy
• Authentication Provider
  - JDBC Realm
  - 2-Factor Authentication
  - LDAP
HopsWorks Enforces Dynamic Roles

Authenticate

Alice@gmail.com

HopsWorks

Projects

NSA__Alice

Secure Impersonation

HopsYARN

HopsFS

X.509 Certificates

Kafka

Users__Alice
X.509 Certificate Per Project-Specific User

Authenticate

Add/Del Users

Insert/Remove Certs

Distributed Database

Cert Signing Requests

Project Mgr

Root CA

Services
Hadoop
Spark
Kafka
etc

Alice@gmail.com
A project has an owner

A project is a collection of
- Members
- HDFS DataSets
- Kafka Topics
- Notebooks and Jobs

A project has quotas
We delegate administration of privileges to users just like GitHub
YARN CPU and HDFS Storage Quotas

- Per Project GB/TB
- Per Project CPU mins

**Elastic Hadoop**
- Uber-Style Pricing for CPU
Sharing DataSets/Topics between Projects

The same as Sharing Folders in Dropbox
Delegate Access Control to HDFS

- HDFS enforces access control
  - UserID per Project
  - GroupID per Project and DataSet

- Metadata Integrity using Foreign Keys
  - Removing a project removes all users, groups, and (optionally) DataSets
Delegate Access Control to Kafka

- Kafka brokers enforce access control with certificates.
- Principle name extracted from the X.509 Certificate is: `projectName__userID`
- Hops Custom Authorizer enforces ACLs stored in the distributed database using the pair: `topic, projectName__userID`
The Distributed Database is the Single Source of Truth. Zero overhead, streaming API synchronizes Elasticsearch.
Design your own Extended Metadata

Metadata designer

- New template
- Extend template
- Upload template

Available templates

samp

Sample

Sampled time
Parent sample ID
Anatomical site
Storage temperature
Material type
Sample ID

Add table
Zeppelin (with Livy for Spark)
Automated Installation

- Vagrant/Chef to spin up on a single host
- Karamel/Chef to deploy on AWS/GCE/OpenStack or on-premises

```yaml
name: HopsWorks
dataproc:
  type: m3.medium
cookbooks:
  hadoop: github: "hopshadoop/hopsworks-chef" version: "v0.1"
groups:
  ui:
    size: 1
    recipes:
      - hopsworks

metadata:
  size: 2
  recipes:
    - hops::nn
    - hops::rm

datatransform:
  size: 50
  recipes:
    - hops::dn
    - hops::nm
```
A 2 MW datacenter research and test environment

5 lab modules, planned up to 3-4000 servers, 2-3000 square meters

[Slide by Prof. Tor Björn Minde, CEO SICS North Swedish ICT AB]
HopsWorks is providing a world’s first:

- Multi-Tenant Hadoop-as-a-Service
- Open-Source
- Self-service
- Tinker Friendly
The Team

