Oozie

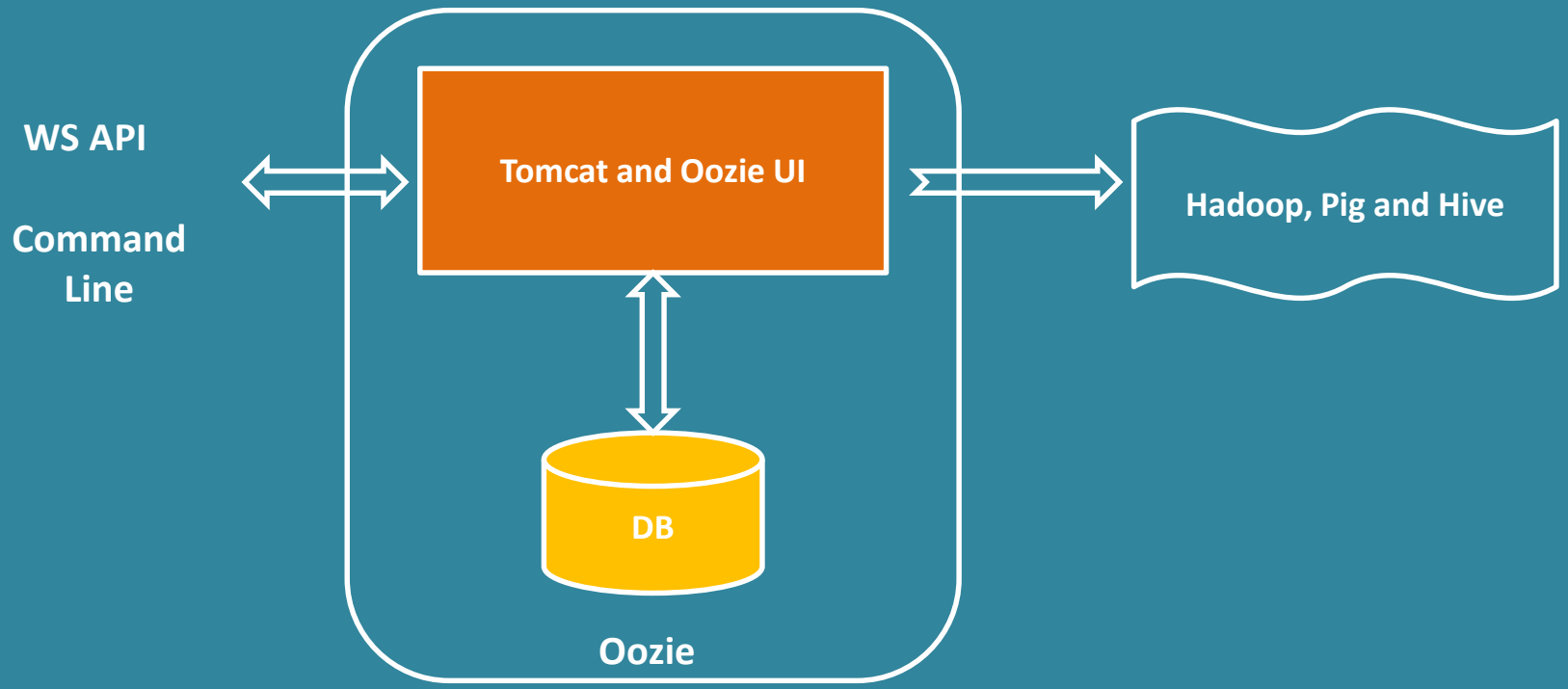
“If Opportunities don’t knock, build a door”

Presented By,
Siva Kumar Bhuchipalli

Oozie

- Workflow scheduler for Hadoop
  - ✓ Java MapReduce Jobs
  - ✓ Streaming Jobs
  - ✓ Pig
- Top level Apache project
  - ✓ – Comes packaged in major Hadoop Distributions
    - ❑ Cloudera Distribution for Hadoop (CDH)

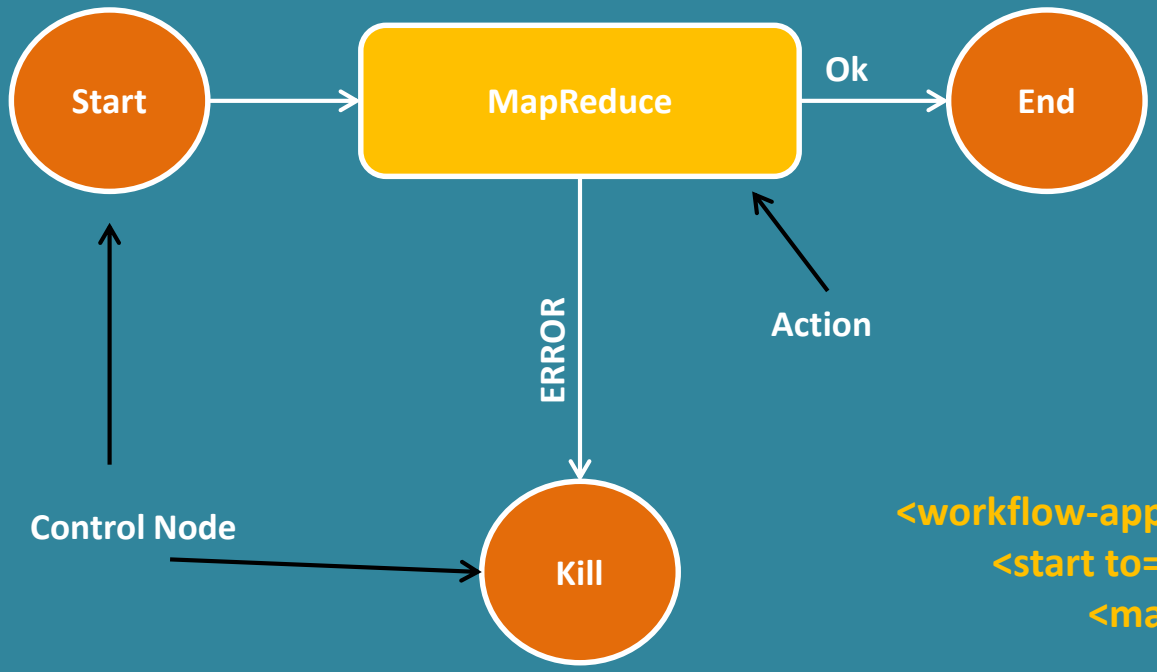
    http://incubator.apache.org/oozie
- Provides workflow management and coordination of those workflows
- Manages Directed Acyclic Graph (DAG) of actions


WS API
Command Line
Tomcat and Oozie UI
DB
Oozie
Hadoop, Pig and Hive

- Runs HTTP service
  - ✓ Clients interact with the service by submitting workflows
  - ✓ Workflows are executed immediately or later

- Workflows are defined via XML
  - ✓ Instead of writing Java code that implements Tool interface and extending Configured class

Action And Control Nodes




```
<workflow-app name="foo-wf"..
        <start to="[NODE-NAME]"/>
                <map-reduce>
                        ...
                        ...
                </map-reduce>
                <kill name="[NODE-NAME]">
                        <message>Error
                        occurred</message>
                </kill>
        <end name="[NODE-NAME]"/>
</workflow-app>
```

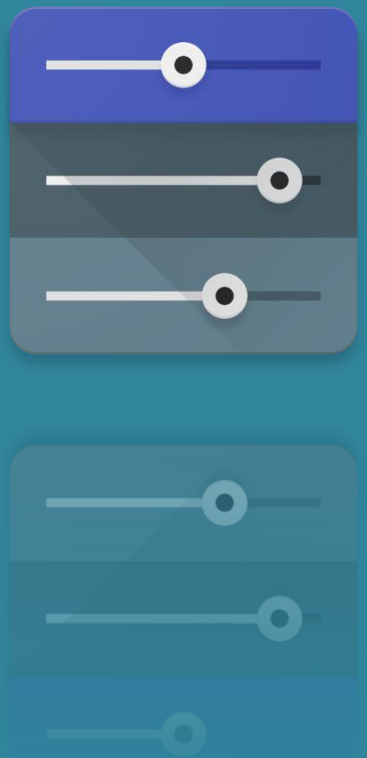
- Control Flow
  - ✓ start, end, kill
  - ✓ decision
  - ✓ fork, join

- Actions
  - ✓ map-reduce
  - ✓ java
  - ✓ pig
  - ✓ Hdfs
  - ✓ Hive
  - ✓ Shell

```
<decision name="check-output">
        <switch>
            <case to="end">
                ${wf:actionData('shell-node')['my_output'] eq
'Hello Oozie'}
            </case>
            <default to="fail-output"/>
        </switch>
    </decision>
```

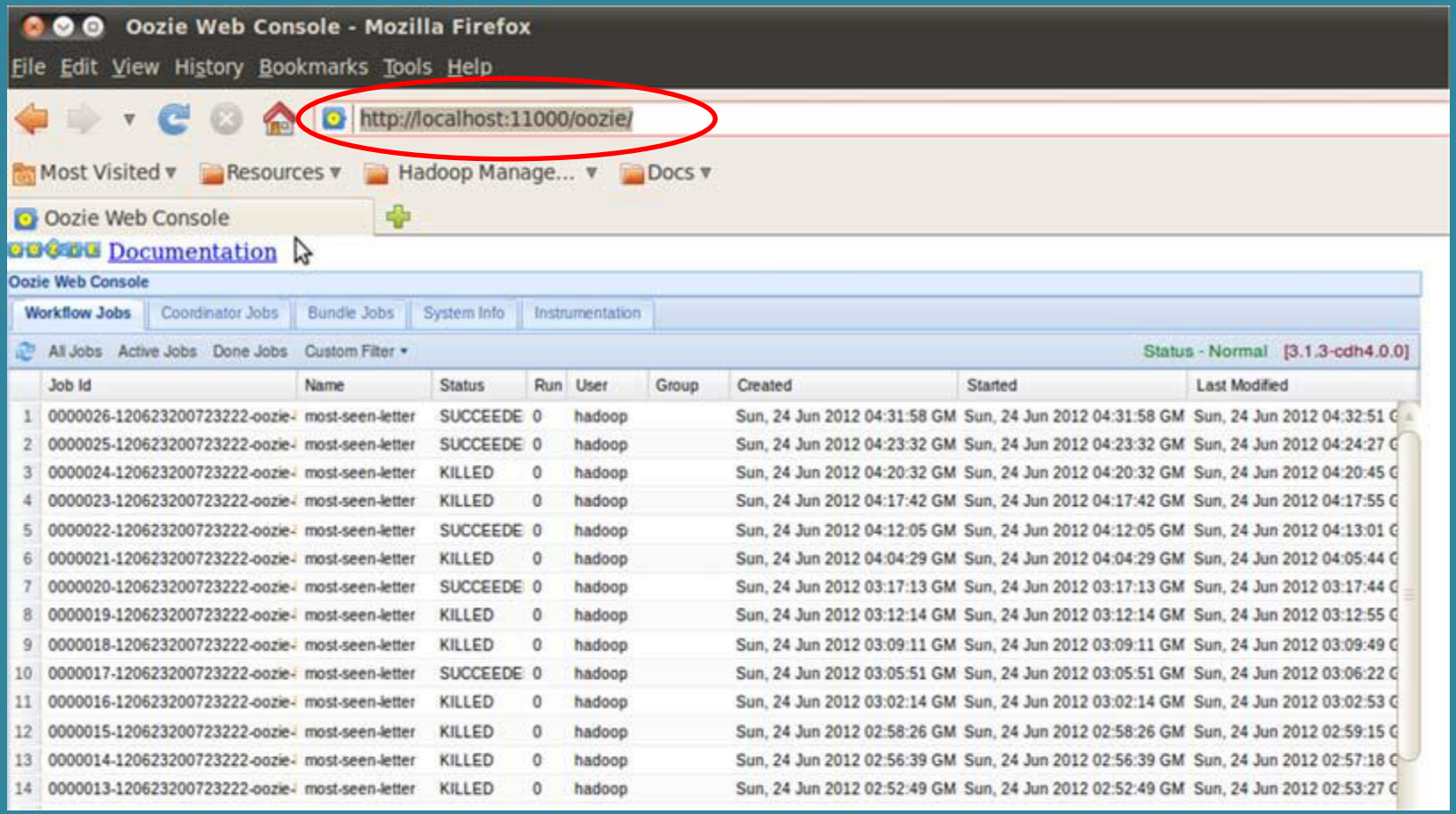
Oozie Coordination Engine

- Oozie Coordination Engine can trigger workflows by
  - ✓ Time (Periodically)
  - ✓ Data Availability (Data appears in a directory)



Test Installation

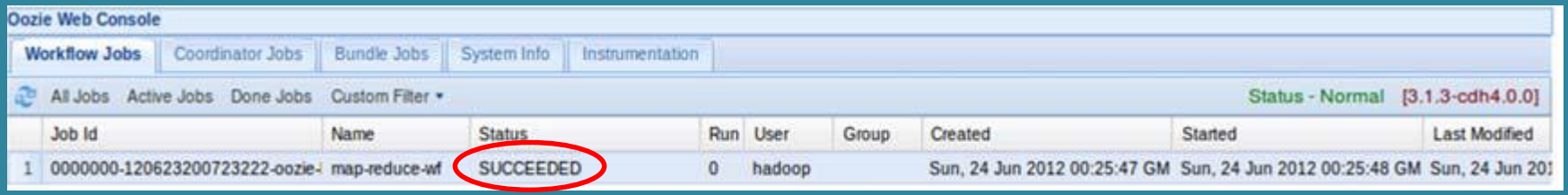
$ oozie admin -status -oozie http://localhost:11000/oozie
System mode: NORMAL



	Job Id	Name	Status	Run	User	Group	Created	Started	Last Modified
1	0000026-120623200723222-oozie-	most-seen-letter	SUCCEEDE	0	hadoop		Sun, 24 Jun 2012 04:31:58 GM	Sun, 24 Jun 2012 04:31:58 GM	Sun, 24 Jun 2012 04:32:51 G
2	0000025-120623200723222-oozie-	most-seen-letter	SUCCEEDE	0	hadoop		Sun, 24 Jun 2012 04:23:32 GM	Sun, 24 Jun 2012 04:23:32 GM	Sun, 24 Jun 2012 04:24:27 G
3	0000024-120623200723222-oozie-	most-seen-letter	KILLED	0	hadoop		Sun, 24 Jun 2012 04:20:32 GM	Sun, 24 Jun 2012 04:20:32 GM	Sun, 24 Jun 2012 04:20:45 G
4	0000023-120623200723222-oozie-	most-seen-letter	KILLED	0	hadoop		Sun, 24 Jun 2012 04:17:42 GM	Sun, 24 Jun 2012 04:17:42 GM	Sun, 24 Jun 2012 04:17:55 G
5	0000022-120623200723222-oozie-	most-seen-letter	SUCCEEDE	0	hadoop		Sun, 24 Jun 2012 04:12:05 GM	Sun, 24 Jun 2012 04:12:05 GM	Sun, 24 Jun 2012 04:13:01 G
6	0000021-120623200723222-oozie-	most-seen-letter	KILLED	0	hadoop		Sun, 24 Jun 2012 04:04:29 GM	Sun, 24 Jun 2012 04:04:29 GM	Sun, 24 Jun 2012 04:05:44 G
7	0000020-120623200723222-oozie-	most-seen-letter	SUCCEEDE	0	hadoop		Sun, 24 Jun 2012 03:17:13 GM	Sun, 24 Jun 2012 03:17:13 GM	Sun, 24 Jun 2012 03:17:44 G
8	0000019-120623200723222-oozie-	most-seen-letter	KILLED	0	hadoop		Sun, 24 Jun 2012 03:12:14 GM	Sun, 24 Jun 2012 03:12:14 GM	Sun, 24 Jun 2012 03:12:55 G
9	0000018-120623200723222-oozie-	most-seen-letter	KILLED	0	hadoop		Sun, 24 Jun 2012 03:09:11 GM	Sun, 24 Jun 2012 03:09:11 GM	Sun, 24 Jun 2012 03:09:49 G
10	0000017-120623200723222-oozie-	most-seen-letter	SUCCEEDE	0	hadoop		Sun, 24 Jun 2012 03:05:51 GM	Sun, 24 Jun 2012 03:05:51 GM	Sun, 24 Jun 2012 03:06:22 G
11	0000016-120623200723222-oozie-	most-seen-letter	KILLED	0	hadoop		Sun, 24 Jun 2012 03:02:14 GM	Sun, 24 Jun 2012 03:02:14 GM	Sun, 24 Jun 2012 03:02:53 G
12	0000015-120623200723222-oozie-	most-seen-letter	KILLED	0	hadoop		Sun, 24 Jun 2012 02:58:26 GM	Sun, 24 Jun 2012 02:58:26 GM	Sun, 24 Jun 2012 02:59:15 G
13	0000014-120623200723222-oozie-	most-seen-letter	KILLED	0	hadoop		Sun, 24 Jun 2012 02:56:39 GM	Sun, 24 Jun 2012 02:56:39 GM	Sun, 24 Jun 2012 02:57:18 G
14	0000013-120623200723222-oozie-	most-seen-letter	KILLED	0	hadoop		Sun, 24 Jun 2012 02:52:49 GM	Sun, 24 Jun 2012 02:52:49 GM	Sun, 24 Jun 2012 02:53:27 G

Running Oozie Examples

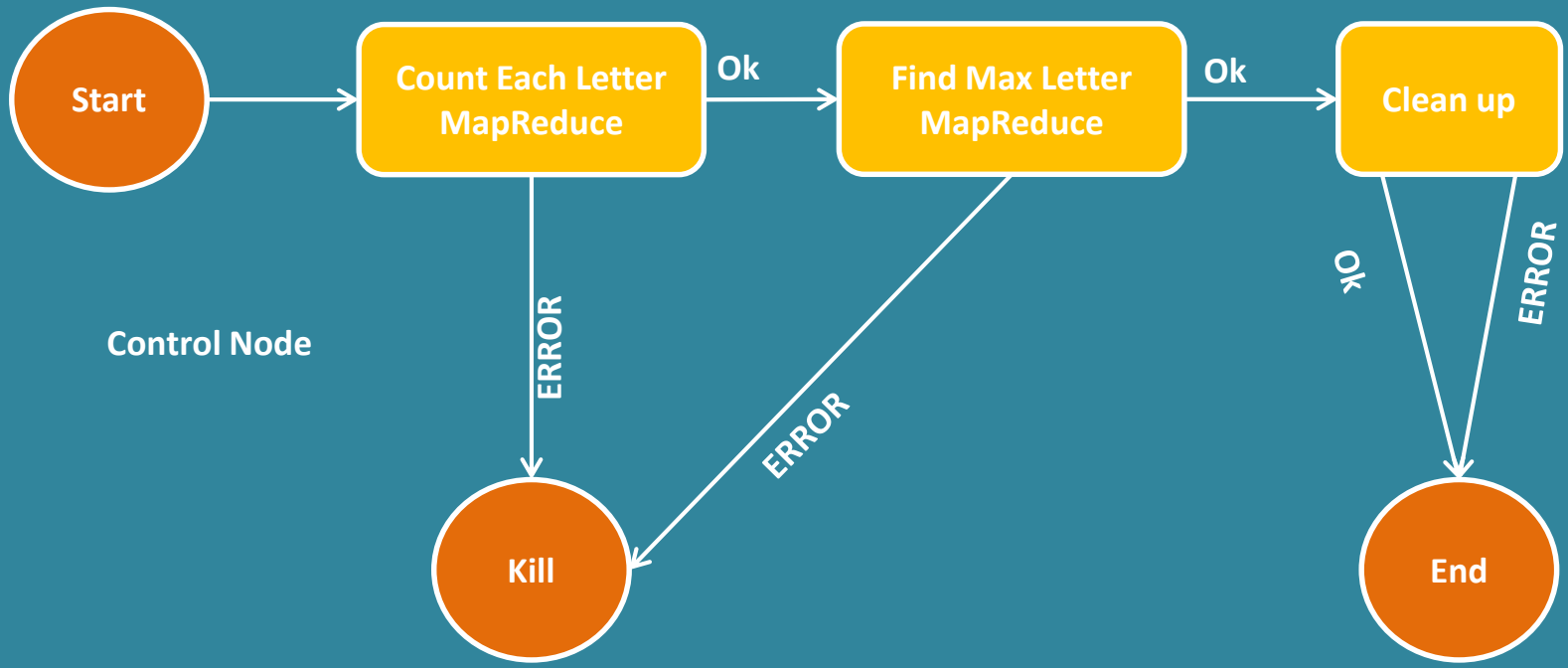
- Extract examples packaged with Oozie
  - ✓ $ cd $OOZIE_HOME
  - ✓ $ tar xvf oozie-examples.tar.gz
- Copy examples to HDFS to user's home directory
  - ✓ $ hdfs dfs -put examples examples
- Run an example
  - ✓ $ oozie job –oozie http://localhost:11000/oozie -config examples/apps/map-reduce/job.properties –run
- Check Web Console
  - ✓ http://localhost:11000/oozie/

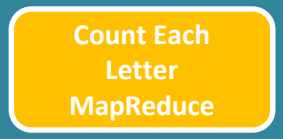


Oozie WorkFlow

- Workflows consist of
  - ✓ Action nodes
    - ❑ MapReduce, Pig, Hive
    - ❑ Streaming, Java, etc...
  - ✓ Control flow nodes
    - ❑ Logic decisions between action nodes
    - ❑ Execute actions based on conditions or in parallel
- Workflows begin with START node
- Workflows succeed with END node
- Workflows fail with KILL node
- Several actions support JSP Expression Language (EL)

Most Occurrences WorkFlows





→ Action Node

→ Control Flow Node

→ Control Node

Most Occurrences WorkFlows

```
<workflow-app xmlns="uri:oozie:workflow:0.2" name="most-seen-letter">
        <start to="count-each-letter"/>
        <action name="count-each-letter">
                <map-reduce>
                        <job-tracker>${jobTracker}</job-tracker>
                        <name-node>${nameNode}</name-node>
                        <prepare>
                                <delete path="${nameNode}${outputDir}"/>
                                <delete path="${nameNode}${intermediateDir}"/>
                        </prepare>
                        <configuration>
                                ...
                                <property>
                                        <name>mapreduce.job.map.class</name>
                                        <value>mr.wordcount.StartsWithCountMapper</value>
                                </property>
                                ...
                        </configuration>
                </map-reduce>
                <ok to="find-max-letter"/>
                <error to="fail"/>
        </action>
...
```

START Action Node to count-each-letter MapReduce action

MapReduce have optional Prepare section

Pass property that will be set on MapReduce job's Configuration object

In case of success, go to the next job; in case of failure go to fail node

First Map-Reduce Action

```
<map-reduce>
        <job-tracker>${jobTracker}</job-tracker>
        <name-node>${nameNode}</name-node>
        <prepare>
            <delete path="${nameNode}${outputDir}"/>
            <delete path="${nameNode}${intermediateDir}"/>
        </prepare>
        <configuration>
            <property>
                <name>mapred.mapper.new-api</name>
                <value>true</value>
            </property>
            <property>
                <name>mapred.reducer.new-api</name>
                <value>true</value>
            </property>
            <property>
                <name>mapred.job.queue.name</name>
                <value>${queueName}</value>
            </property>
        ...
...
```

Administrative items to indicate where namenode and resource manager is

Optional prepare section; allows to execute command prior running the job

By default “old api” is used; specify to use new api

Specify which queue to submit this job to Resource Manager

First Map-Reduce Action

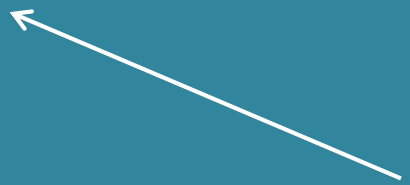
```
...
    <property>
        <name>mapreduce.job.map.class</name>
        <value>mr.wordcount.StartsWithCountMapper</value>
    </property>
    <property>
        <name>mapreduce.job.combine.class</name>
        <value>mr.wordcount.StartsWithCountReducer</value>
    </property>
    <property>
        <name>mapreduce.job.reduce.class</name>
        <value>mr.wordcount.StartsWithCountReducer</value>
    </property>
    <property>
        <name>mapreduce.job.inputformat.class</name>
        <value>org.apache.hadoop.mapreduce.lib.input.TextInputFormat</value>
    </property>
    <property>
        <name>mapreduce.job.outputformat.class</name>
        <value>org.apache.hadoop.mapreduce.lib.output.TextOutputFormat</value>
    </property>
...
```

Specify Mapper, Reducer, Input and Output formats; this is instead of Tool implementation

This action will produce a file of tab separated keyvalue pairs as specified by TextOutputFormat

First Map-Reduce Action (continued)

```
            ...
            ...
            <property>
                  <name>mapreduce.job.output.key.class</name>
                  <value>org.apache.hadoop.io.Text</value>
            </property>
            <property>
                  <name>mapreduce.job.output.value.class</name>
                  <value>org.apache.hadoop.io.IntWritable</value>
            </property>
            <property>
                  <name>mapreduce.input.fileinputformat.inputdir</name>
                  <value>${inputFile}</value>
            </property>
            <property>
                  <name>mapreduce.output.fileoutputformat.outputdir</name>
                  <value>${intermediateDir}</value>
            </property>
      </configuration>
</map-reduce>
```



These properties are substituted from job.properties file

Most Occurrences WorkFlows

```
<action name="find-max-letter">
        <map-reduce>
                <job-tracker>${jobTracker}</job-tracker>
                <name-node>${nameNode}</name-node>
                <configuration>
                ...
                ...
                <property>
                        <name>mapreduce.job.map.class</name>
                        <value>mr.workflows.MostSeenStartLetterMapper</value>
                </property>
                <property>
                        <name>mapreduce.job.combine.class</name>
                        <value>mr.workflows.MostSeendStartLetterReducer</value>
                ...
                ...
                </configuration>
                </map-reduce>
                <ok to="clean-up"/>
                <error to="fail"/>
</action>
```

Second MapReduce job

Namenode and Yarn Resource Manager Location

Token substituted from application properties file

Control Flow Node

Second Map-Reduce Action

```
...
        <property>
                <name>mapreduce.job.map.class</name>
                <value>mr.workflows.MostSeenStartLetterMapper</value>
        </property>
        <property>
                <name>mapreduce.job.combine.class</name>
                <value>mr.workflows.MostSeendStartLetterReducer</value>
        </property>
        <property>
                <name>mapreduce.job.reduce.class</name>
                <value>mr.workflows.MostSeendStartLetterReducer</value>
        </property>
...
```

Specify Mapper, Reducer and Combiner

Second Map-Reduce Action (continued)

First map-reduce action produced a file with tab separated key-value pairs; second step utilizes KeyValueTextInputFormat to read these pairs as text

```
...
    <property>
        <name>mapreduce.job.inputformat.class</name>
        <value>org.apache.hadoop.mapreduce.lib.input.KeyValueTextInputFormat</value
        >
    </property>
    <property>
        <name>mapreduce.job.outputformat.class</name>
        <value>org.apache.hadoop.mapreduce.lib.output.TextOutputFormat</value>
    </property>
    <property>
        <name>mapreduce.job.output.key.class</name>
        <value>org.apache.hadoop.io.Text</value>
    </property>
    <property>
        <name>mapreduce.job.output.value.class</name>
        <value>org.apache.hadoop.io.IntWritable</value>
    </property>
...
```

Most Occurrences WorkFlows

```
...
...
        <action name="clean-up">
                <fs>
                        <delete path='${nameNode}${intermediateDir}'/>
                </fs>
                <ok to="end"/>
                <error to="end"/>
        </action>

        <kill name="fail">
                <message>Map/Reduce failed, error
                message[${wf:errorMessage(wf:lastErrorNode())}]</message>
        </kill>
        <end name="end"/>
</workflow-app>
```

Clean node, remove temporary folder

Workflow has failed, display error message

JSP expression language

Workflow ended with success

Package And Run Your WorkFlow

1. Create application directory structure with workflow definitions and resources
   - ✓ Workflow.xml, jars, etc..

2. Copy application directory to HDFS

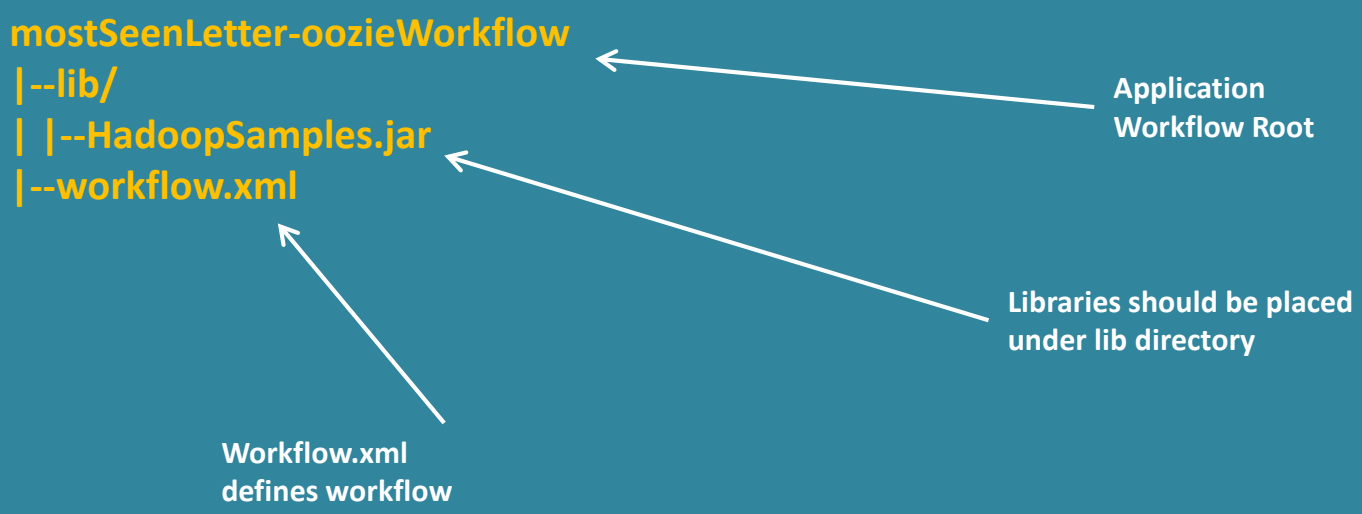
3. Create application configuration file
   - ✓ specify location of the application directory on HDFS
   - ✓ specify location of the namenode and resource manager

4. Submit workflow to Oozie
   - ✓ Utilize oozie command line

5. Monitor running workflow(s)

1.Oozie Application Directory

- Must comply to directory structure spec



1.Oozie Application Directory

- Can use a build tool to generate this structure
  - ✓ Samples use maven plugins (see pom.xml)
    - ❑ Maven-dependency-plugin
    - ❑ Maven-resources-plugin
  - ✓ Run ‘mvn clean package’
    - ❑ Will create ‘mostSeenLetter-oozieWorkflow’ directory with dependencies and workflow definitions

2.Copy Application Directories To HDFS

- Oozie utilizes HDFS to load applications

```
hdfs dfs -put mostSeenLetter-oozieWorkflow
```

Copies directory from local files system onto HDFS;
directory gets copied to user's home directory

3.Create Application Configuration File

- job.properties - Needs to exist locally, required for submission

```
nameNode=hdfs://localhost:8020
jobTracker=localhost:8032
queueName=default
```

Properties for required locations such as namenode and resource manage

```
inputFile=/training/data/hamlet.txt
intermediateDir=/training/playArea/mostSeenLetter-oozieWorkflow-tmp
outputDir=/training/playArea/oozieWorkflow
```

Properties needed for the MapReduce actions in the workflow

```
oozie.wf.application.path=${nameNode}/user/${user.name}/mostS
eenLetter-oozieWorkflow
```

Most importantly HDSF location of the application must be specified

4.Submit WorkFlow To Oozie

- Use oozie command line tool
  - ✓ For usage: $oozie help

Application configuration file

```
$ oozie job –oozie http://localhost:11000/oozie -config job.properties -run
job: 0000001-120711224224630-oozie-hado-W
```

Application ID; use this ID to get status

5. Monitor Running WorkFlow

- Two options
  - ✓ Command line ($oozie)
  - ✓ Web Interface (http://localhost:11000/oozie)

5.Monitor Running WorkFlow(s) – Command Line

```
$ oozie job -info 0000001-120711224224630-oozie-hado-W
Job ID : 0000001-120711224224630-oozie-hado-W
------------------------------------------------------------------------------------------------------------------------
Workflow Name : most-seen-letter
App Path : hdfs://localhost:8020/user/hadoop/mostSeenLetter-oozieWorkflow
Status : RUNNING
Run : 0
User : hadoop
Group : -
Created : 2012-07-13 03:08
Started : 2012-07-13 03:08
Last Modified : 2012-07-13 03:08
Ended : -
CoordAction ID: -
Actions
------------------------------------------------------------------------------------------------------------------------
ID                                                  Status    Ext ID                 Ext Status Err Code
------------------------------------------------------------------------------------------------------------------------
0000001-120711224224630-oozie-hado-W@count-each-letter OK        job_1342136595052_0006 SUCCEEDED -
------------------------------------------------------------------------------------------------------------------------
0000001-120711224224630-oozie-hado-W@find-max-letter  RUNNING   job_1342136595052_0008
```

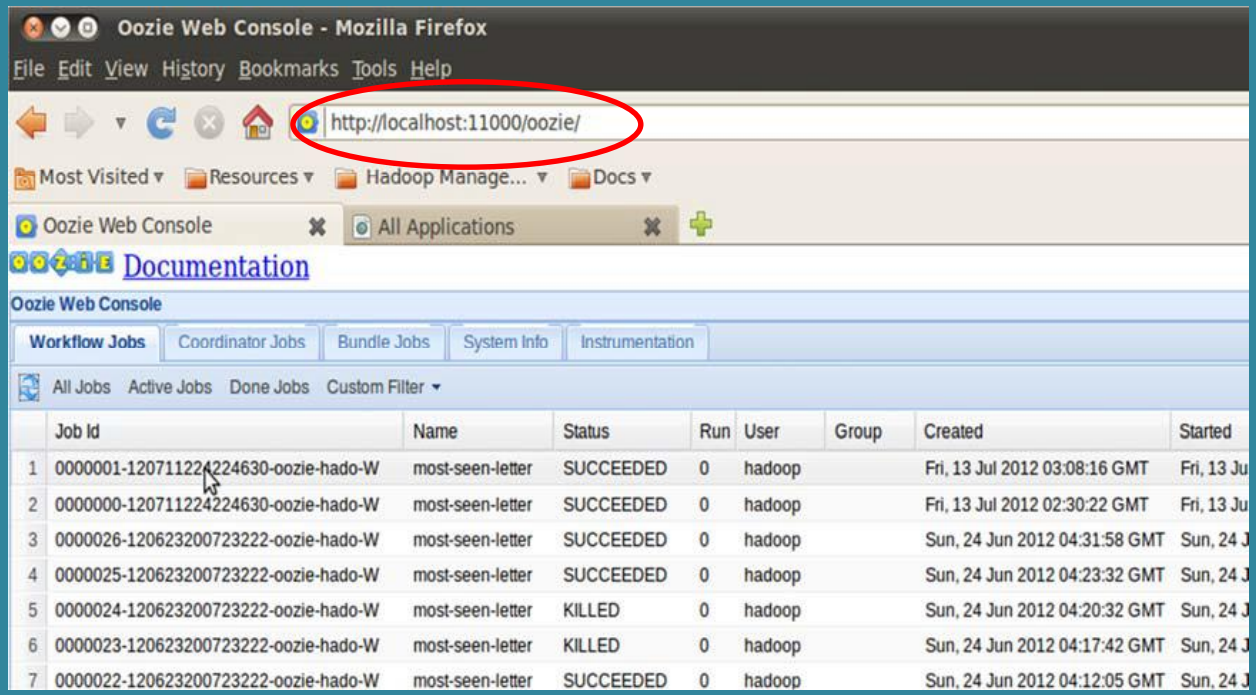
Get info by Application ID

Workflow overview

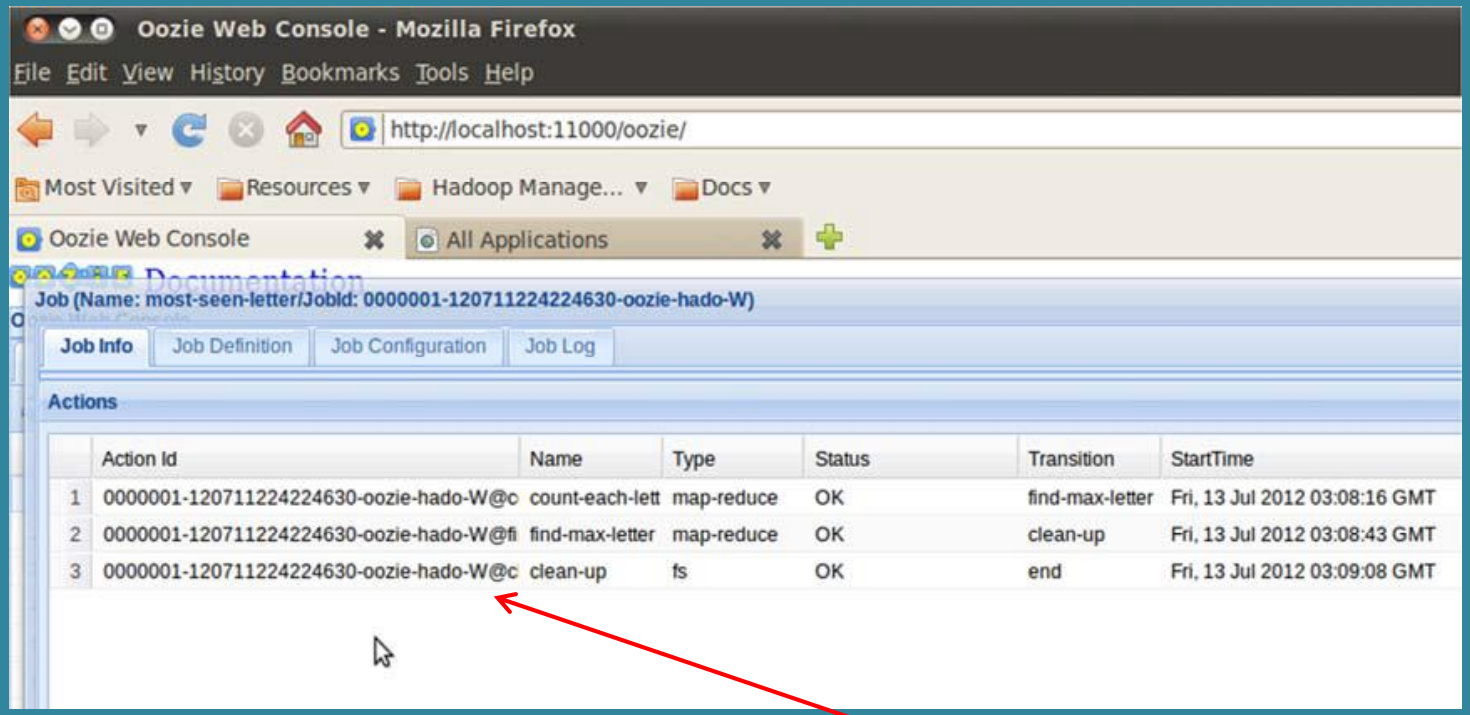
Completed and executing tasks

5.Monitor Running WorkFlow(s) – Web Interface

http://localhost:11000/oozie

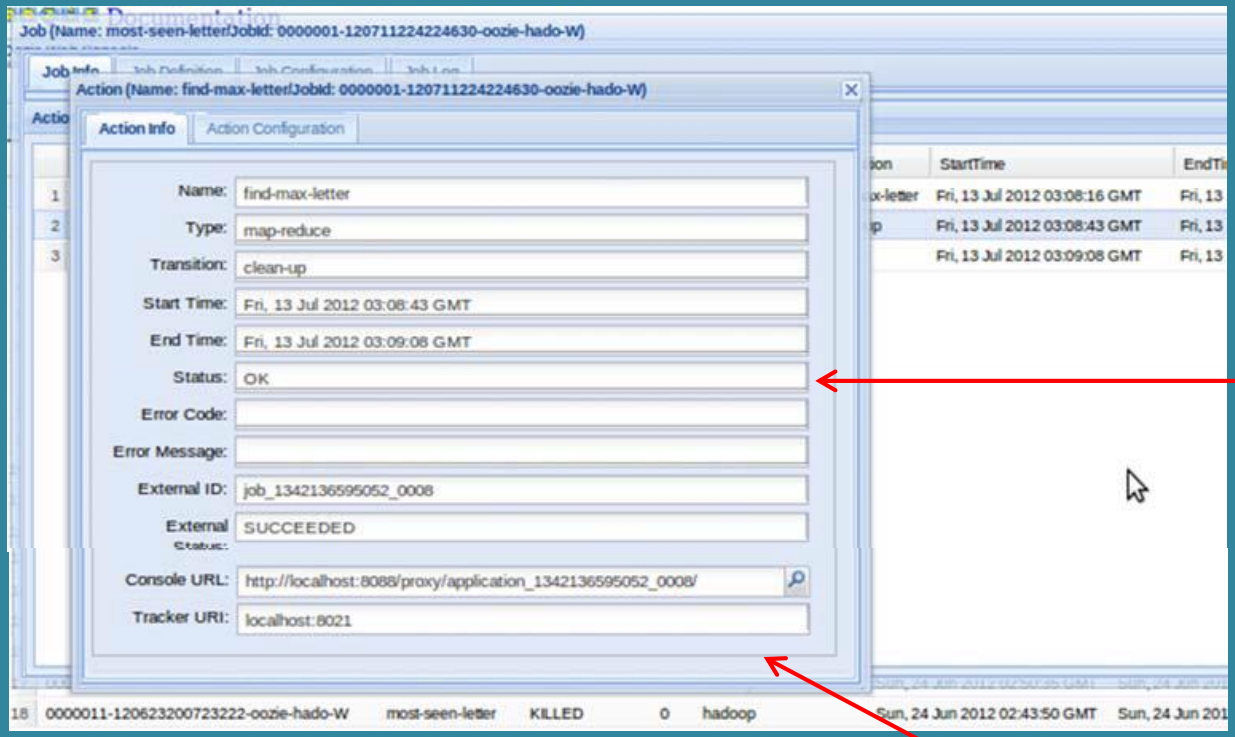


5.Monitor Running WorkFlow(s) – Web Interface



Clicking on a particular application/job will bring up list of all the actions; click on each action to get further details

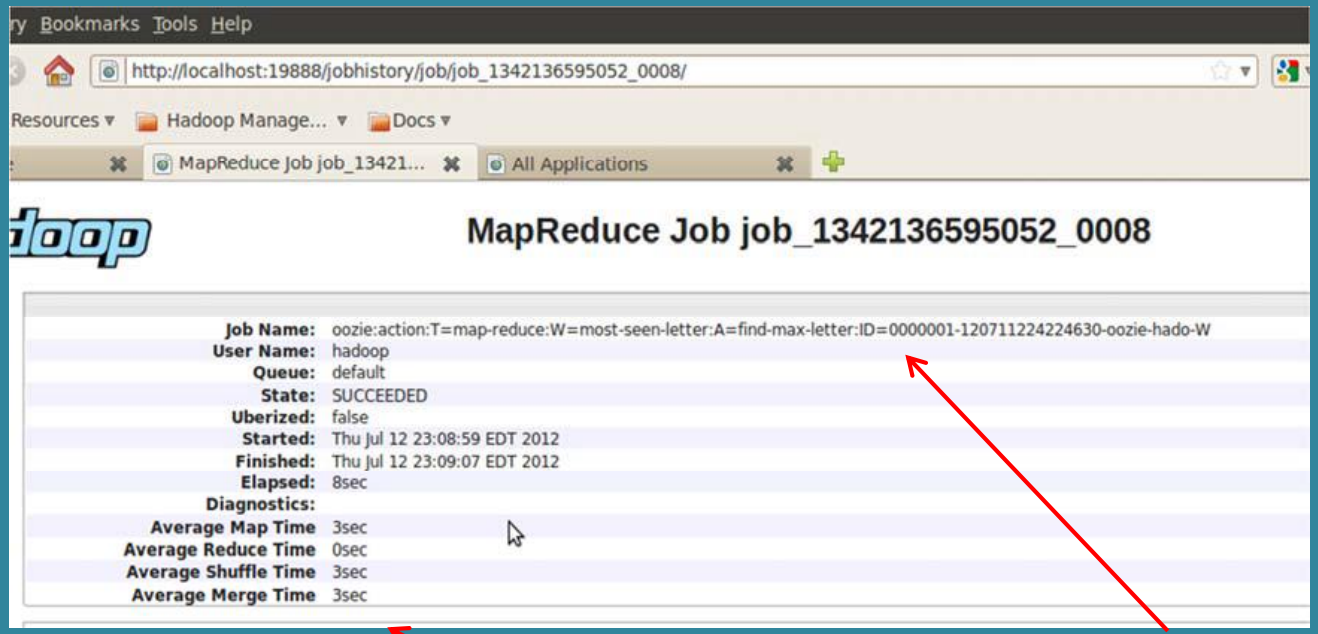
5.Monitor Running WorkFlow(s) – Web Interface



Link to Resource Manager to view details of the job for this particular Oozie Action

This view displays details for a selected action.

5.Monitor Running WorkFlow(s) – Web Interface



Oozie assigns a name to each job

Clicking on the "Console Url" from action view will take you to the details of the job for that action

Hive Action

```
<workflow-app xmlns="uri:oozie:workflow:0.2" name="hive-wf">
   <start to="hive-node"/>

   <action name="hive-node">
      <hive xmlns="uri:oozie:hive-action:0.2">
         <job-tracker>${jobTracker}</job-tracker>
         <name-node>${nameNode}</name-node>
         <prepare>
            <delete path="${nameNode}/user/${wf:user()}/${examplesRoot}/output-data/hive"/>
            <mkdir path="${nameNode}/user/${wf:user()}/${examplesRoot}/output-data"/>
         </prepare>
         <configuration>
            <property>
               <name>mapred.job.queue.name</name>
               <value>${queueName}</value>
            </property>
         </configuration>
         <script>script.q</script>
         <param>INPUT=/user/${wf:user()}/${examplesRoot}/input-data/table</param>
         <param>OUTPUT=/user/${wf:user()}/${examplesRoot}/output-data/hive</param>
      </hive>
      <ok to="end"/>
      <error to="fail"/>
   </action>

   <kill name="fail">
      <message>Hive failed, error message[${wf:errorMessage(wf:lastErrorNode())}]</message>
   </kill>
   <end name="end"/>
</workflow-app>
```

Pig Action

```
<workflow-app xmlns="uri:oozie:workflow:0.2" name="pig-wf">
   <start to="pig-node"/>
   <action name="pig-node">
      <pig>
         <job-tracker>${jobTracker}</job-tracker>
         <name-node>${nameNode}</name-node>
         <prepare>
            <delete path="${nameNode}/user/${wf:user()}/${examplesRoot}/output-data/pig"/>
         </prepare>
         <configuration>
            <property>
               <name>mapred.compress.map.output</name>
               <value>true</value>
            </property>
         </configuration>
         <script>id.pig</script>
         <param>INPUT=/user/${wf:user()}/${examplesRoot}/input-data/text</param>
         <param>OUTPUT=/user/${wf:user()}/${examplesRoot}/output-data/pig</param>
      </pig>
      <ok to="end"/>
      <error to="fail"/>
   </action>
   <kill name="fail">
      <message>Pig failed, error message[${wf:errorMessage(wf:lastErrorNode())}]</message>
   </kill>
   <end name="end"/>
</workflow-app>
```

Sqoop Action

```
<workflow-app xmlns="uri:oozie:workflow:0.2" name="sqoop-wf">
   <start to="sqoop-node"/>

   <action name="sqoop-node">
      <sqoop xmlns="uri:oozie:sqoop-action:0.2">
         <job-tracker>${jobTracker}</job-tracker>
         <name-node>${nameNode}</name-node>
         <prepare>
            <delete path="${nameNode}/user/${wf:user()}/${examplesRoot}/output-data/sqoop"/>
            <mkdir path="${nameNode}/user/${wf:user()}/${examplesRoot}/output-data"/>
         </prepare>
<command>import --connect jdbc:mysql://localhost/db --table TT --target-dir /user/${wf:user()}/${examplesRoot}/output-
data/sqoop -m 1</command>
      </sqoop>
      <ok to="end"/>
      <error to="fail"/>
   </action>

   <kill name="fail">
      <message>Sqoop failed, error message[${wf:errorMessage(wf:lastErrorNode())}]</message>
   </kill>
   <end name="end"/>
</workflow-app>
```

SSH Action

```
<workflow-app xmlns="uri:oozie:workflow:0.2" name="ssh-wf">
   <start to="ssh"/>

   <action name="ssh">
      <ssh xmlns="uri:oozie:ssh-action:0.1">
         <host>localhost</host>
         <command>echo</command>
         <args>"Hello Oozie!"</args>
      </ssh>
      <ok to="end"/>
      <error to="fail"/>
   </action>

   <kill name="fail">
      <message>SSH action failed, error message[${wf:errorMessage(wf:lastErrorNode())}]</message>
   </kill>

   <end name="end"/>
</workflow-app>
```

Coordinator XML

```
<coordinator-app name="omg_coord_app" frequency="${freq}" start="${startTime}" end="${endTime}" timezone="UTC"
xmlns="uri:oozie:coordinator:0.1">
  <controls>
    <timeout>${timeout}</timeout>
    <concurrency>${concurrency}</concurrency>
  </controls>
  <action>
    <workflow>
      <app-path>${workflowPath}</app-path>
    </workflow>
  </action>
</coordinator-app>
```

Coordinator.properties file

```
oozie.coord.application.path=hdfs://namenode:8020/user/root/omg_coordinator/
freq=30
startTime=2015-07-12T00:05Z
endTime=2015-12-09T00:04Z
timeout=30
concurrency=1
workflowPath=hdfs://namenode:8020/user/root/omg_oozie/
nameNode=hdfs://namenode:8020
jobTracker=rm:8032      //8032 in cloudera and 8050 in hortonworks
queueName=default
oozie.use.system.libpath=true
#oozie.service.WorkflowAppService.system.libpath=/user/user/share/lib/lib_20150402185013/
#oozie.wf.application.path=${nameNode}/user/${user.name}/omg_oozie
```

Any Queries?????

THANK YOU

Come Once Again