

Hadoop作业流调度引擎 Oozie与Azkaban



主要内容

1. **基本概念**
2. **Oozie基本使用方法**
3. **Azkaban基本使用方法**
4. **作业流调度系统比较**



基本概念

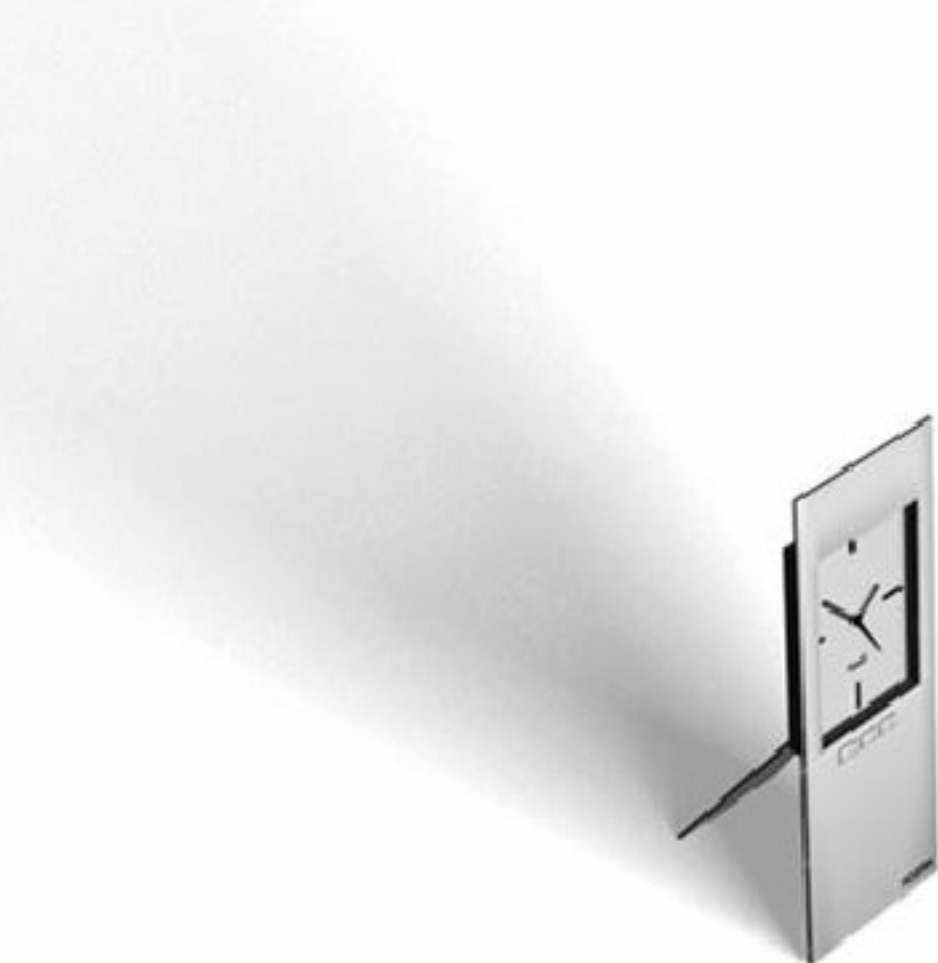
- 目前计算框架和作业类型繁多：
 - ✓ **MapReduce Java、Streaming、HQL、Pig**等
- 如何对这些框架和作业进行统一管理和调度：
 - ✓ 不同作业之间存在依赖关系（**DAG**）；
 - ✓ 周期性作业
 - ✓ 定时执行的作业
 - ✓ 作业执行状态监控与报警
- 多种解决方案：
 - ✓ **Crontab**
 - ✓ 自己设计调度系统
 - ✓ 直接使用开源系统

【作业流调度系统】



Hadoop作业流调度系统基本功能

- 对常见作业类型进行调度
 - ✓ **MapReduce (Java、Streaming等) 作业**
 - ✓ **Hive作业**
 - ✓ **Pig作业**
 - ✓ **Shell**
- 根据需要对作业进行调度
 - ✓ **按周期调度**
 - ✓ **定时调度.....**
- 支持容错与报警
- 可视化作业流运行过程



自己构建作业流： crontab+shell

```
//mapreduce_job.sh
cmd="hadoop jar example1.jar xxx -D ....."
$cmd
code=$?
while [ $code != 0 ]; do
    echo "run job failed, run submit....."
    $cmd
done
```

```
//hive_job.sh
cmd="hive -e \"use mydatabase; ALTER TABLE t_aa ADD IF NOT
EXISTS PARTITION (pt='2013052515') location '/group/data/aa/2013-
05-25-15/';SELECT COUNT(1) FROM t_aa WHERE t_aa.pt =
'2013052515'\";"
$cmd
code=$?
while [ $code != 0 ]; do
    echo "run hql failed, run submit....."
    $cmd
done
```

➤缺点：

- ✓编写复杂，不灵活
- ✓不易于管理
- ✓难以与监控、报警相结合

```
//main.sh
sh mapreduce_job.sh
sh hive_job.sh
```

```
//crontab
*/10 * * * * root /opt/bin/main.sh
```



常见的开源作业流调度系统

➤ Oozie

✓ **Yahoo!** 开源，基于xml表达作业依赖关系；

➤ Azkaban

✓ **Linkedin**开源，通过Java property配置作业依赖关系

➤ Zeus（宙斯）

✓ **阿里**开源，通过界面配置作业依赖关系

➤ 其他开源系统

✓ **Cascading**（通过Java API编程实现作业依赖关系）



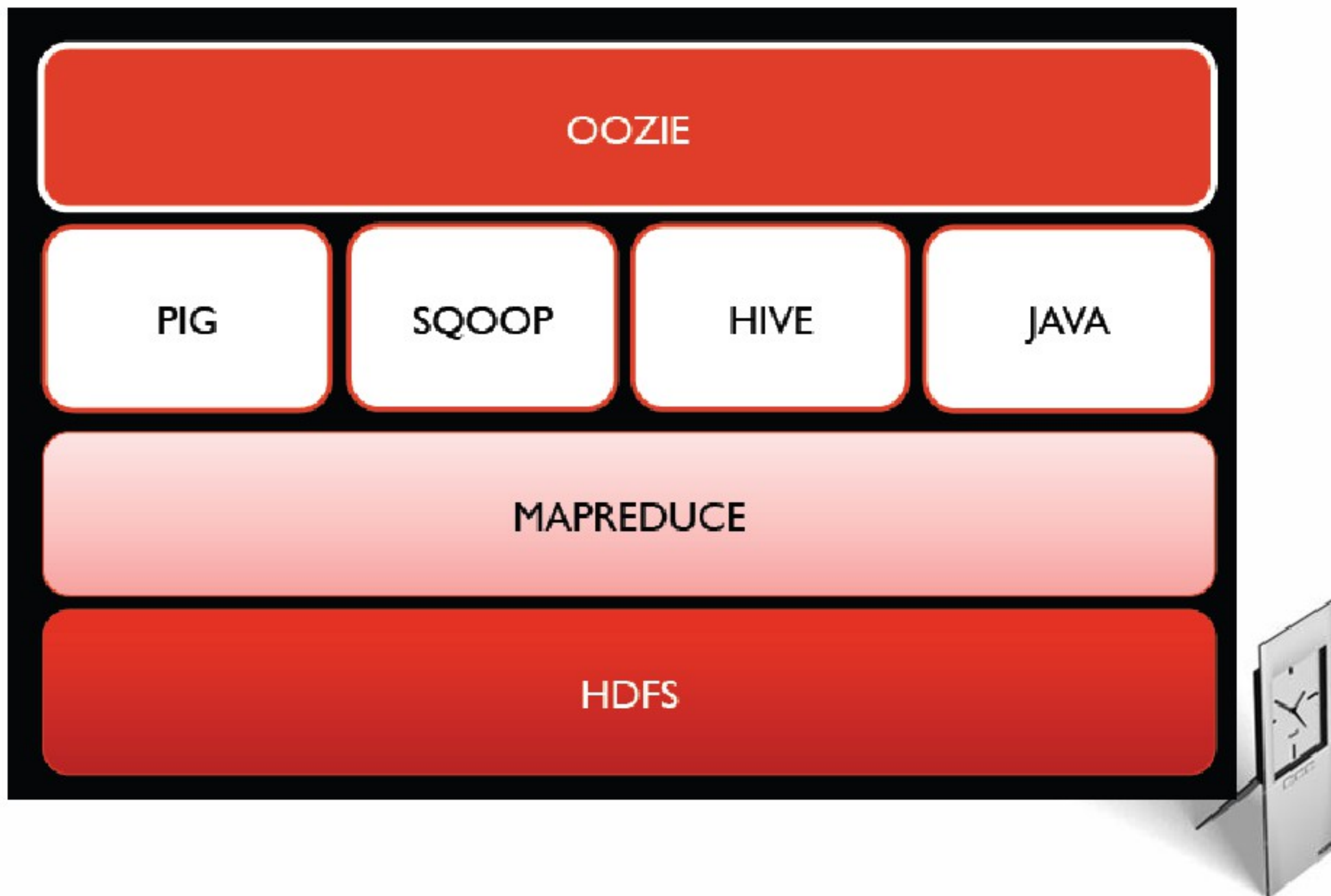
主要内容

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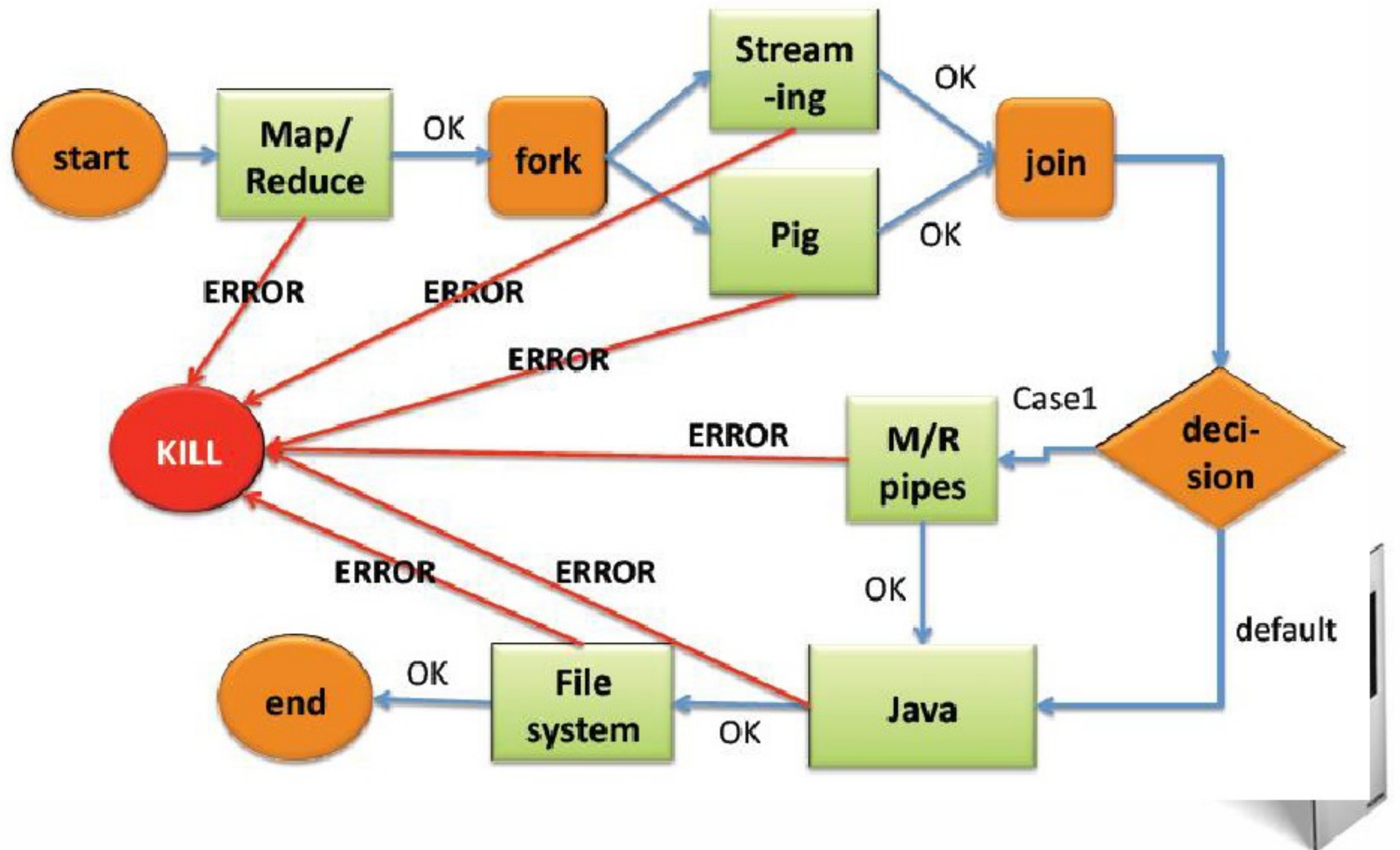
主要内容



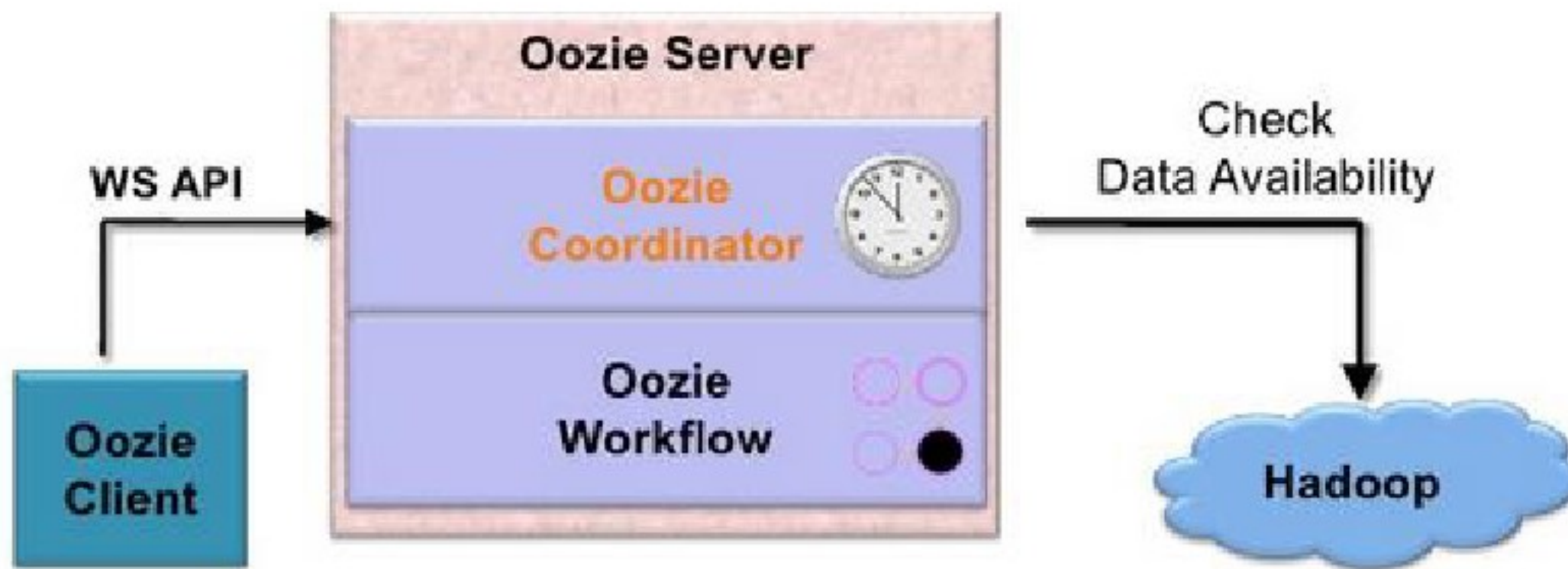
Oozie在Hadoop生态系统中的位置



认识Oozie



Oozie基本架构



Oozie 使用方式

- Oozie CLI
- JAVA API
- REST API
- WEB UI (只读)

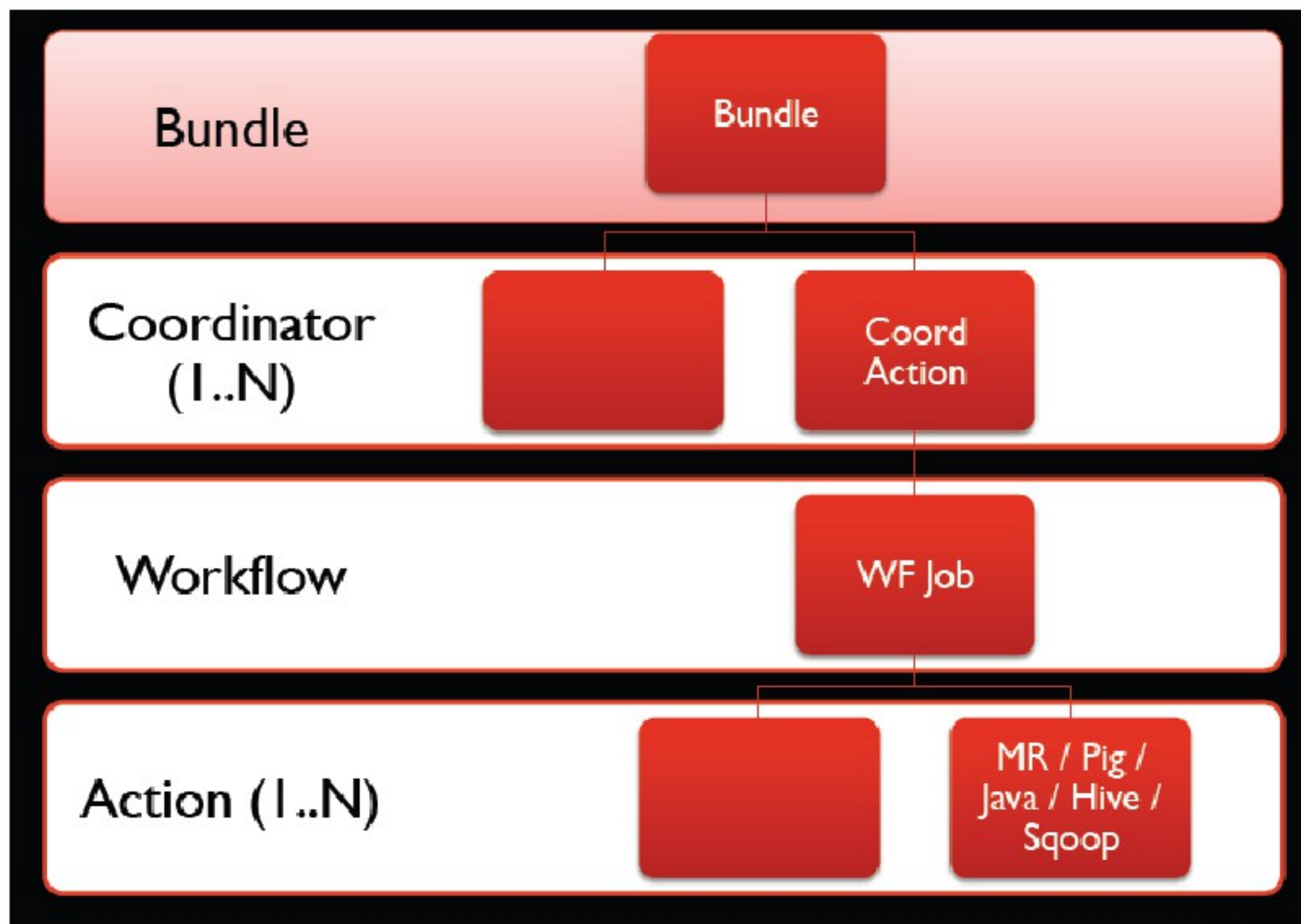


Oozie基本概念

- 作业流由一组行为节点（Hadoop MR作业、Hive作业等）构成，且这些节点通过控制流节点相连；
 - ✓ 控制流节点定义了工作流的起始与结束，并控制着工作流的执行路径；
 - ✓ 行为节点包含一个计算/处理任务，包括：**Hadoop map-reduce, HDFS, Pig, SSH, HTTP, eMail**等
- Oozie工作流是通过hPDL语言（一种XML过程定义语言）编写的。



Oozie 层次结构

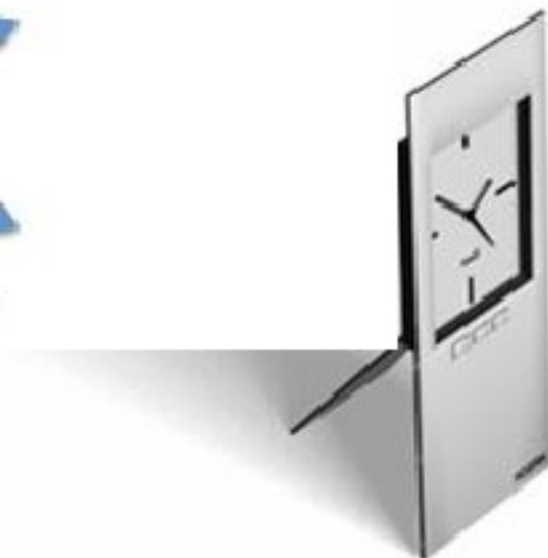
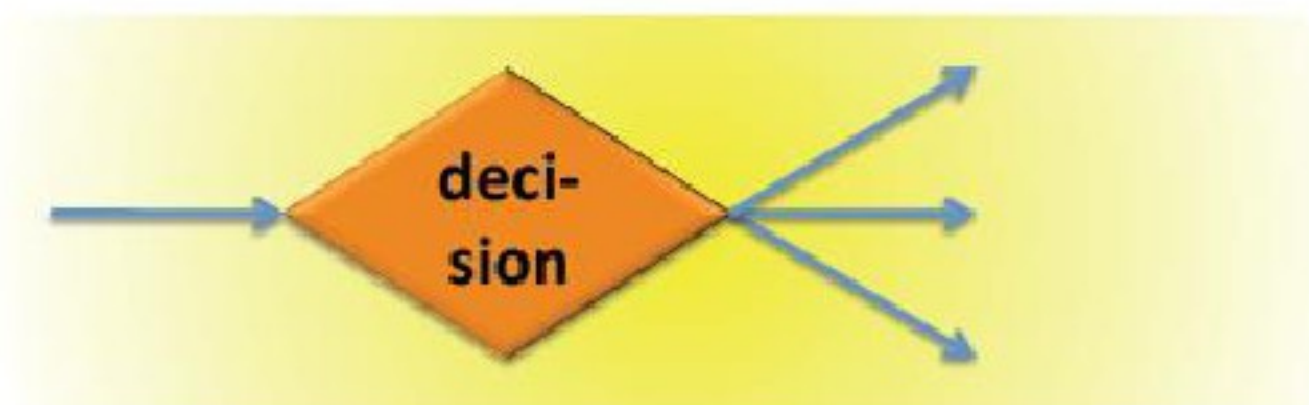
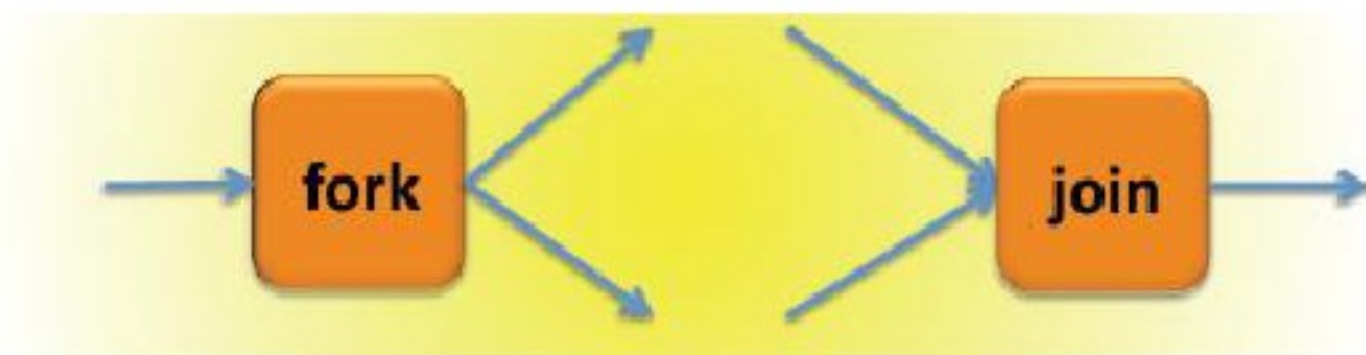
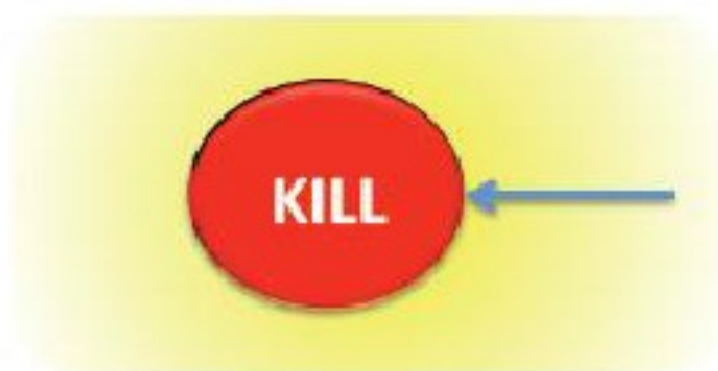
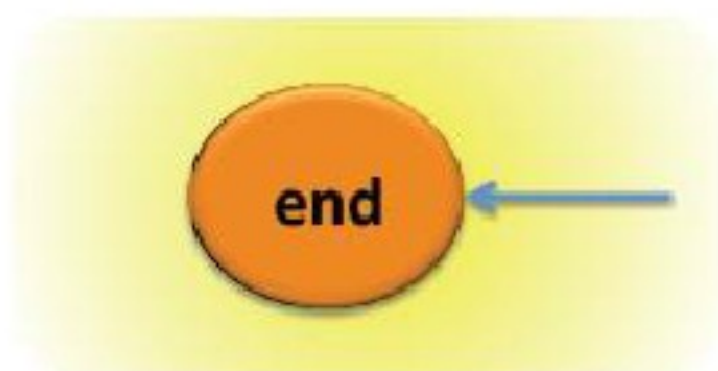


Oozie Action

- 支持Hadoop map-reduce, HDFS, Pig, SSH, HTTP, eMail等;
- 可设置重试次数。



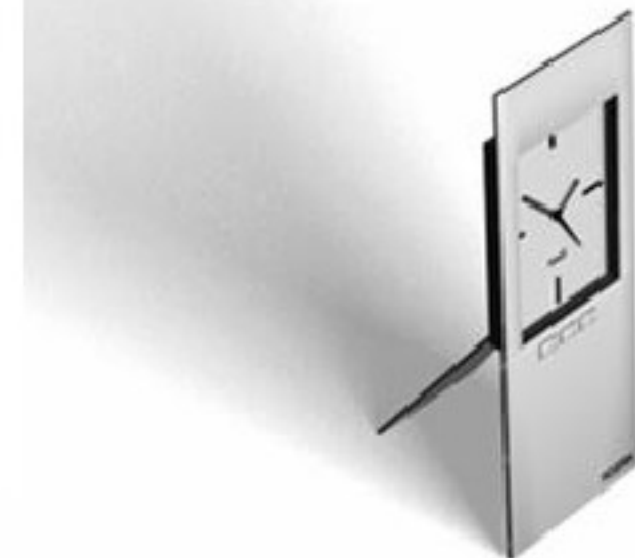
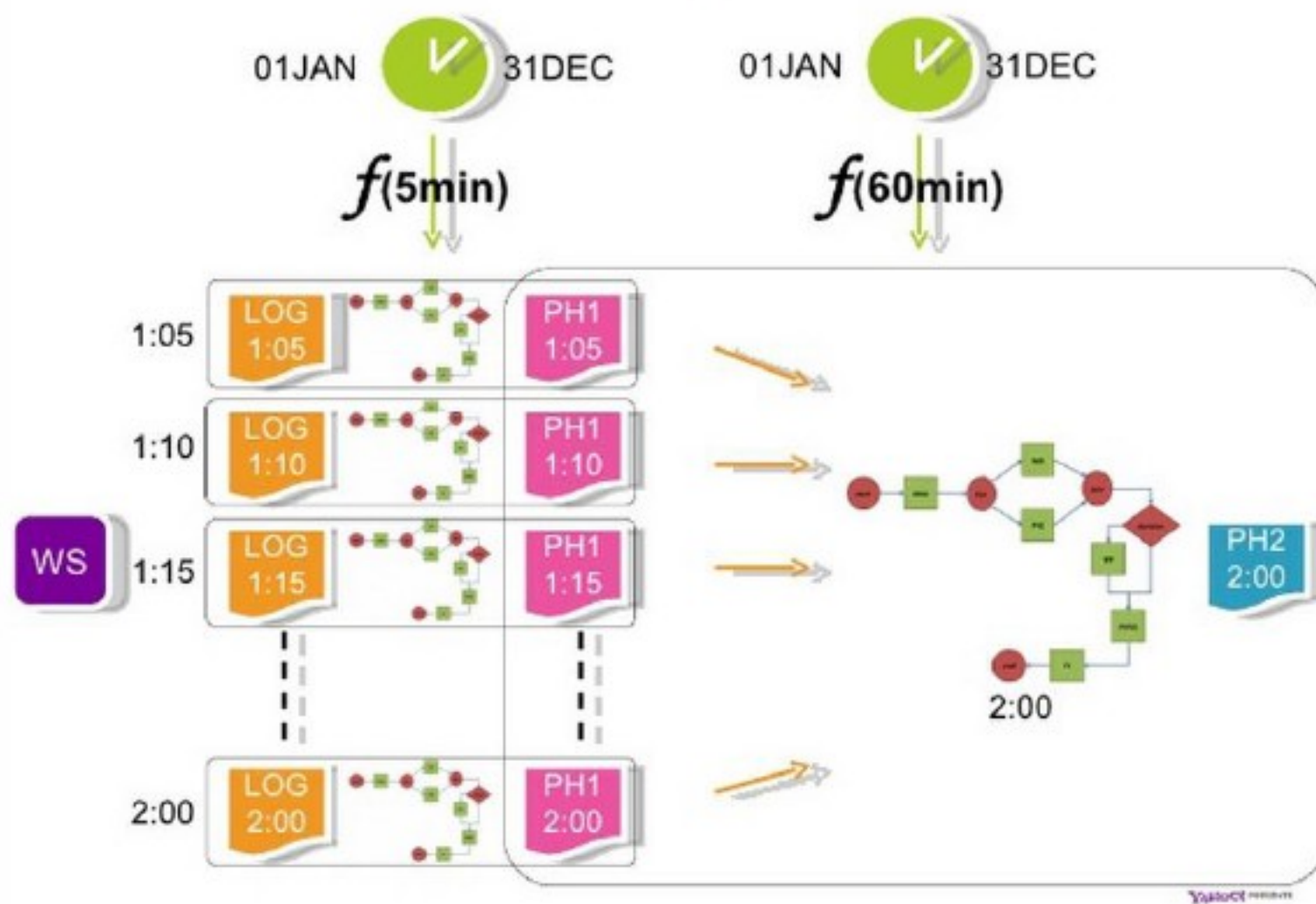
Oozie 控制流



Coordinator

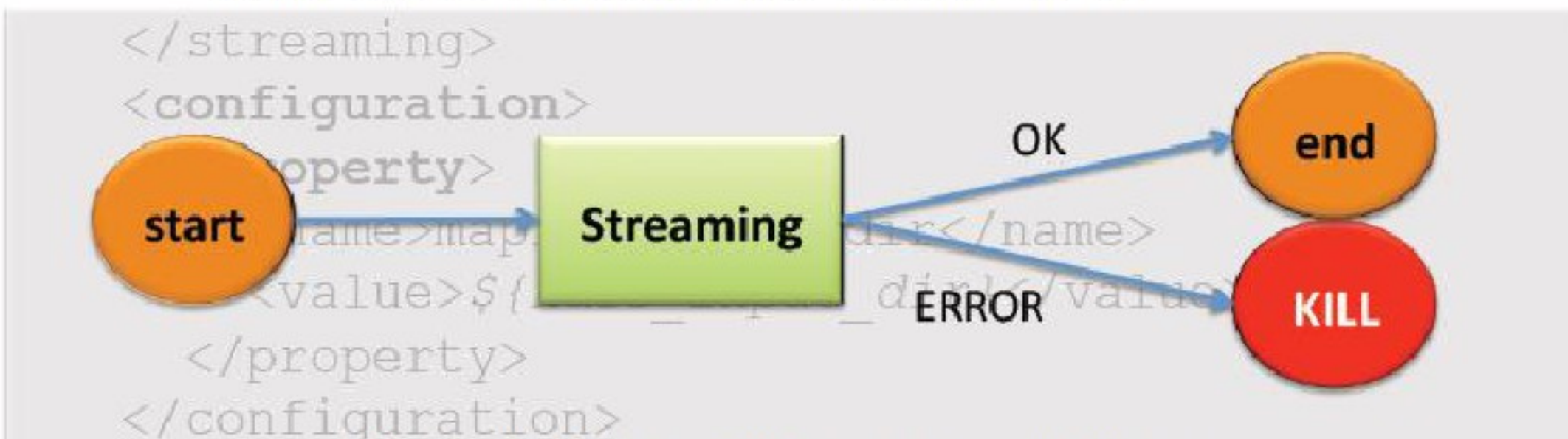
- 定期执行一个 workflow;
- 数据准备完毕后执行一个 workflow。

Use Cases: Data Pipelines



一个简单的实例

```
<workflow-app name='my_wf'>  
  <start to='myprogram' />  
  <action name='myprogram'>  
    <map-reduce>  
      <job-tracker>${jobTracker}</job-tracker>  
      <name-node>${nameNode}</name-node>
```



```
    </property>  
  </configuration>  
</map-reduce>  
  <ok to='yay' />  
  <error to='fail' />  
</action>  
  <end name='yay' />  
  <kill name='fail'><message>failed</message></kill>  
</workflow>
```

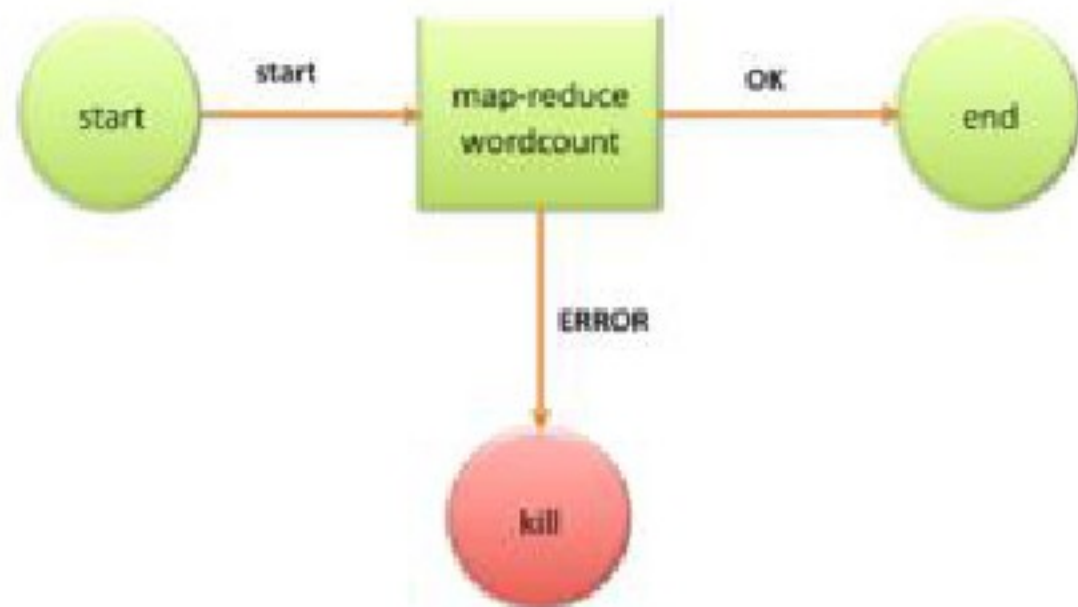


实例1：workflow作业编写流程

- Hadoop下运行Wordcount:

bin/hadoop jar hadoop-*-examples.jar wordcount /input /output

- 使用Oozie:



MapReduce Workflow DAG



Workflow.xml



workflow作业基本构成

- **workflow.xml:**
 - ✓ 作业描述信息
- **property文件:**
 - ✓ workflow.xml用到的一些参数
 - ✓ 应用程序存放路径: “oozie.wf.application.path”
- **三方库:**
 - ✓ 将依赖的.jar和.so放到lib/目录下
- **程序目录结构如下:**

```
map-reduce/  
  job.properties  
  workflow.xml  
  lib/  
    wordcount.jar
```



job.properties

```
nameNode=hdfs://localhost:9000      # or use a remote-server url. eg: hdfs://abc.xyz.yahoo.com:8020
jobTracker=localhost:9001          # or use a remote-server url. eg: abc.xyz.yahoo.com:50300
queueName=default
examplesRoot=map-reduce

oozie.wf.application.path=${nameNode}/user/${user.name}/${examplesRoot}
inputDir=input-data
outputDir=map-reduce
```



workflow.xml

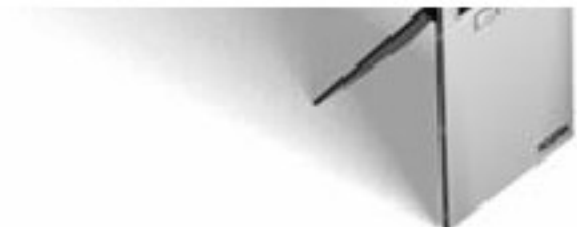
```
<action name='wordcount'>
  <map-reduce>
    <configuration>
      <property>
        <name>mapred.mapper.class</name>
        <value>org.myorg.WordCount.Map</value>
      </property>
      <property>
        <name>mapred.reducer.class</name>
        <value>org.myorg.WordCount.Reduce</value>
      </property>
      <property>
        <name>mapred.input.dir</name>
        <value>usr/joe/inputDir </value>
      </property>
      <property>
        <name>mapred.output.dir</name>
        <value>/usr/joe/outputDir</value>
      </property>
    </configuration>
  </map-reduce>
</action>
```

mapred.mapper.class =
org.myorg.WordCount.Map

mapred.reducer.class =
org.myorg.WordCount.Reduce

mapred.input.dir = inputDir

mapred.output.dir = outputDir



提交作业流

- 步骤1:将 workflow 文件上传到HDFS上
 - ✓ **hadoop fs -put ~/map-reduce map-reduce**
- 步骤2: 运行 workflow
 - ✓ **oozie job -oozie http://localhost:4080/oozie/ -config ~/map-reduce/job.properties -run**
 -
 - job: 14-20140325161321-oozie-ninj**
- 查看 workflow 运行状态:
 - ✓ **oozie job -info 14-20140325161321-oozie-ninj -oozie http://localhost:4080/oozie/**



Oozie Web

Oozie Web Console

 [Apache Documentation](#) [Yahoo Documentation](#)

Oozie Web Console (v1) [/oozie/]

[Workflow Jobs](#) [Coordinator Jobs](#) [Bundle Jobs](#) [System Info](#) [Instrumentation](#)

[All Jobs](#) [Active Jobs](#) [Done Jobs](#) [Custom Filter](#) ▼

Job Id	Name	Status	...	User	Group	Created	Started	Last Modified
0000129-120516024608778-oozie-...	map-reduce-wf	SUCCEE...	0	gmicr	users	Thu, 17 May 2012 23:24:45 GMT	Thu, 17 May 2012 23:24:45 GMT	Thu, 17 May 2012 23:25:46 GM
0000127-120516024608778-oozie-...	StartingProcessor	RUNNING	0	gmicr	users	Thu, 17 May 2012 23:24:00 GMT	Thu, 17 May 2012 23:24:01 GMT	Thu, 17 May 2012 23:30:01 GM
0000126-120516024608778-oozie-...	map-reduce-wf	SUCCEE...	0	gmicr	users	Thu, 17 May 2012 22:24:45 GMT	Thu, 17 May 2012 22:24:46 GMT	Thu, 17 May 2012 22:25:28 GM
0000124-120516024608778-oozie-...	map-reduce-wf	SUCCEE...	0	gmicr	users	Thu, 17 May 2012 21:24:44 GMT	Thu, 17 May 2012 21:24:44 GMT	Thu, 17 May 2012 21:25:38 GM
0000122-120516024608778-oozie-...	map-reduce-wf	SUCCEE...	0	gmicr	users	Thu, 17 May 2012 20:24:44 GMT	Thu, 17 May 2012 20:24:44 GMT	Thu, 17 May 2012 20:25:24 GM
0000120-120516024608778-oozie-...	map-reduce-wf	SUCCEE...	0	gmicr	users	Thu, 17 May 2012 19:24:45 GMT	Thu, 17 May 2012 19:24:45 GMT	Thu, 17 May 2012 19:25:26 GM
0000118-120516024608778-oozie-...	map-reduce-wf	SUCCEE...	0	gmicr	users	Thu, 17 May 2012 18:24:44 GMT	Thu, 17 May 2012 18:24:44 GMT	Thu, 17 May 2012 18:25:35 GM
0000116-120516024608778-oozie-...	map-reduce-wf	SUCCEE...	0	gmicr	users	Thu, 17 May 2012 17:24:44 GMT	Thu, 17 May 2012 17:24:45 GMT	Thu, 17 May 2012 17:25:31 GM
0000114-120516024608778-oozie-...	StartingProcessor	SUCCEE...	0	gmicr	users	Thu, 17 May 2012 17:24:00 GMT	Thu, 17 May 2012 17:24:00 GMT	Thu, 17 May 2012 22:39:58 GM
0000113-120516024608778-oozie-...	map-reduce-wf	SUCCEE...	0	gmicr	users	Thu, 17 May 2012 16:24:45 GMT	Thu, 17 May 2012 16:24:45 GMT	Thu, 17 May 2012 16:25:42 GM
0000111-120516024608778-oozie-...	map-reduce-wf	SUCCEE...	0	gmicr	users	Thu, 17 May 2012 15:24:44 GMT	Thu, 17 May 2012 15:24:44 GMT	Thu, 17 May 2012 15:25:38 GM
0000109-120516024608778-oozie-...	map-reduce-wf	SUCCEE...	0	gmicr	users	Thu, 17 May 2012 14:24:44 GMT	Thu, 17 May 2012 14:24:44 GMT	Thu, 17 May 2012 14:25:35 GM
0000107-120516024608778-oozie-...	map-reduce-wf	SUCCEE...	0	gmicr	users	Thu, 17 May 2012 13:24:44 GMT	Thu, 17 May 2012 13:24:44 GMT	Thu, 17 May 2012 13:25:23 GM
0000105-120516024608778-oozie-...	map-reduce-wf	SUCCEE...	0	gmicr	users	Thu, 17 May 2012 12:24:44 GMT	Thu, 17 May 2012 12:24:45 GMT	Thu, 17 May 2012 12:25:39 GM
0000103-120516024608778-oozie-...	hive-yflow-proc...	SUCCEE...	0	amidord_1	users	Thu, 17 May 2012 12:00:00 GMT	Thu, 17 May 2012 12:00:00 GMT	Thu, 17 May 2012 12:54:55 GM
0000102-120516024608778-oozie-...	rise-dri-gco4_6...	KILLED	0	hoo...	users	Thu, 17 May 2012 11:50:46 GMT	Thu, 17 May 2012 11:50:47 GMT	Thu, 17 May 2012 11:50:47 GM
0000101-120516024608778-oozie-...	map-reduce-wf	SUCCEE...	0	gmicr	users	Thu, 17 May 2012 11:24:44 GMT	Thu, 17 May 2012 11:24:45 GMT	Thu, 17 May 2012 11:25:31 GM
0000099-120516024608778-oozie-...	StartingProcessor	SUCCEE...	0	gmicr	users	Thu, 17 May 2012 11:24:00 GMT	Thu, 17 May 2012 11:24:01 GMT	Thu, 17 May 2012 14:15:34 GM
0000098-120516024608778-oozie-...	map-reduce-wf	SUCCEE...	0	gmicr	users	Thu, 17 May 2012 10:24:46 GMT	Thu, 17 May 2012 10:24:46 GMT	Thu, 17 May 2012 10:25:28 GM

实例2：编写Coordinator作业

➤ 在实例1基础上，引入一个新的问题：如何控制该workflow，让其可以每5分钟执行一次？

✓ 方法：使用**Coordinator**作业，对**workflow**进行控制

➤ 修改**job.properties**，增加以下一项：**oozie.coord.application.path**，设置为**Coordinator**作业存放目录

➤ 编写**coord.xml**如下：

```
<coordinator-app name="RunEvery15Mins frequency="15"  
                start="2014-03-02T08:00Z" end="2015-01-04T08:00Z">  
  <action>  
    <workflow>  
      <app-path>hdfs://node-master:9000/user/dongxicheng/map-reduce</app-path>  
      <configuration>  
        <property>  
          <name>key</name>  
          <value>value</value>  
        </property>  
      </configuration>  
    </workflow>  
  </action>  
</coordinator-app>
```



实例3：编写Bundle作业

➤ 在实例2基础上，引入一个新的问题：如何有多个Coordination作业，如何统一管理和调度？

✓ 方法：使用**Bundle**作业，对多个Coordination进行管理

➤ 修改job.properties

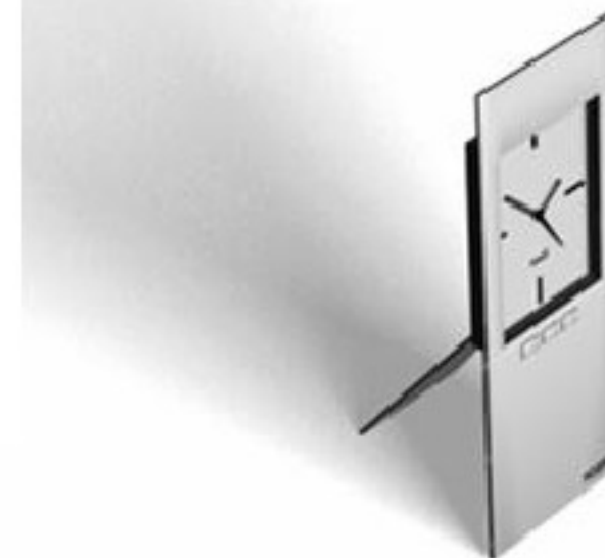
➤ Bundle作业存放目录

➤ 编写bundle.xml

```
<bundle-app name='APPNAME' xmlns:xsi='http://www.w3.org/2001/XMLSchema-instance' xmlns='uri:oozie:bundle:0.1'>
  <controls>
    <kick-off-time>${kickOffTime}</kick-off-time>
  </controls>
  <coordinator name='coordJobFromBundle1' >
    <app-path>${appPath}</app-path>
    <configuration>
      <property>
        <name>startTime1</name>
        <value>${START_TIME}</value>
      </property>
      <property>
        <name>endTime1</name>
        <value>${END_TIME}</value>
      </property>
    </configuration>
  </coordinator>
  <coordinator name='coordJobFromBundle2' >
    <app-path>${appPath2}</app-path>
    <configuration>
      <property>
        <name>startTime2</name>
        <value>${START_TIME2}</value>
      </property>
      <property>
        <name>endTime2</name>
        <value>${END_TIME2}</value>
      </property>
    </configuration>
  </coordinator>
</bundle-app>
```

Oozie调度Hive作业

```
<workflow-app name="[WF-DEF-NAME]" xmlns="uri:oozie:workflow:0.1">
  ...
  <action name="[NODE-NAME]">
    <hive xmlns="uri:oozie:hive-action:0.2">
      <job-tracker>[JOB-TRACKER]</job-tracker>
      <name-node>[NAME-NODE]</name-node>
      <prepare>
        <delete path="[PATH]" />
        ...
        <mkdir path="[PATH]" />
        ...
      </prepare>
      <job-xml>[HIVE SETTINGS FILE]</job-xml>
      <configuration>
        <property>
          <name>[PROPERTY-NAME]</name>
          <value>[PROPERTY-VALUE]</value>
        </property>
        ...
      </configuration>
      <script>[HIVE-SCRIPT]</script>
      <param>[PARAM-VALUE]</param>
      ...
      <param>[PARAM-VALUE]</param>
      <file>[FILE-PATH]</file>
      ...
      <archive>[FILE-PATH]</archive>
      ...
    </hive>
    <ok to="[NODE-NAME]" />
    <error to="[NODE-NAME]" />
  </action>
  ...
</workflow-app>
```



实例4：Oozie调度Hive作业

```
<workflow-app xmlns="uri:oozie:workflow:0.2" name="hive-wf">
  <start to="hive1"/>
  <action name="hive1">
    <hive xmlns="uri:oozie:hive-action:0.1">
      <job-tracker>${jobTracker}</job-tracker>
      <name-node>${nameNode}</name-node>
      <prepare>
        <delete path="${outputDir}"/>
      </prepare>
      <configuration>
        <property>
          <name>mapred.compress.map.output</name>
          <value>>true</value>
        </property>
        <property>
          <name>mapred.job.queue.name</name>
          <value>${queueName}</value>
        </property>
      </configuration>
      <script>org/apache/oozie/examples/hive/Employee.txt</script>
      <param>location=${concat(wf:appPath(), '../')}/data</param>
      <param>output_dir=${outputDir}</param>
      <param>min_salary=${minSalary}</param>
    </hive>
    <ok to="end"/>
    <error to="fail"/>
  </action>

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



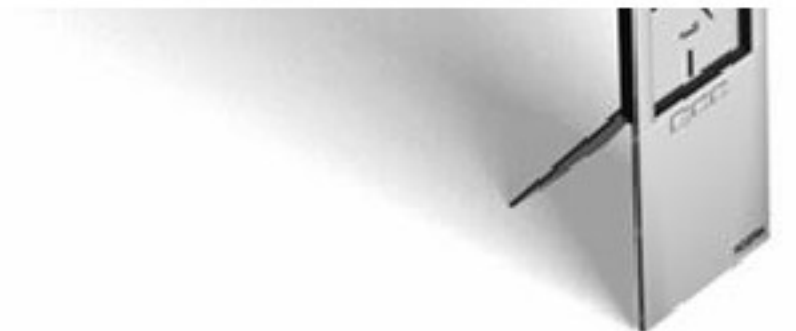
Oozie调度Sqoop作业

```
<workflow-app name="[WF-DEF-NAME]" xmlns="uri:oozie:workflow:0.1">
  ...
  <action name="[NODE-NAME]">
    <sqoop xmlns="uri:oozie:sqoop-action:0.2">
      <job-tracker>[JOB-TRACKER]</job-tracker>
      <name-node>[NAME-NODE]</name-node>
      <prepare>
        <delete path="[PATH]">
          ...
          <mkdir path="[PATH]">
            ...
          </mkdir>
        </delete>
      </prepare>
      <configuration>
        <property>
          <name>[PROPERTY-NAME]</name>
          <value>[PROPERTY-VALUE]</value>
        </property>
        ...
      </configuration>
      <command>[SQOOP-COMMAND]</command>
      <arg>[SQOOP-ARGUMENT]</arg>
      ...
      <file>[FILE-PATH]</file>
      ...
      <archive>[FILE-PATH]</archive>
      ...
    </sqoop>
    <ok to="[NODE-NAME]">
      <error to="[NODE-NAME]">
    </error>
  </action>
  ...
</workflow-app>
```



实例5: Oozie调度Sqoop作业

```
<workflow-app name="sample-wf" xmlns="uri:oozie:workflow:0.1">
  ...
  <action name="myfirsthivejob">
    <sqoop xmlns="uri:oozie:sqoop-action:0.2">
      <job-tracker>foo:9001</job-tracker>
      <name-node>bar:9000</name-node>
      <prepare>
        <delete path="${jobOutput}"/>
      </prepare>
      <configuration>
        <property>
          <name>mapred.compress.map.output</name>
          <value>>true</value>
        </property>
      </configuration>
      <arg>import</arg>
      <arg>--connect</arg>
      <arg>jdbc:mysql:file:db:mysqldb</arg>
      <arg>--table</arg>
      <arg>T1</arg>
      <arg>--target-dir</arg>
      <arg>hdfs://localhost:9000/user/tucu/foo</arg>
      <arg>-m</arg>
      <arg>1</arg>
    </sqoop>
    <ok to="myotherjob"/>
    <error to="errorcleanup"/>
  </action>
  ...
</workflow-app>
```



Oozie参考资料

➤ Oozie官网:

✓ <http://oozie.apache.org/>

➤ workflow语法:

✓ <http://oozie.apache.org/docs/4.0.1/WorkflowFunctionalSpec.html>

➤ Coordination语法:

✓ <http://oozie.apache.org/docs/4.0.1/CoordinatorFunctionalSpec.html>

➤ Bundle语法:

✓ <http://oozie.apache.org/docs/4.0.1/BundleFunctionalSpec.html>

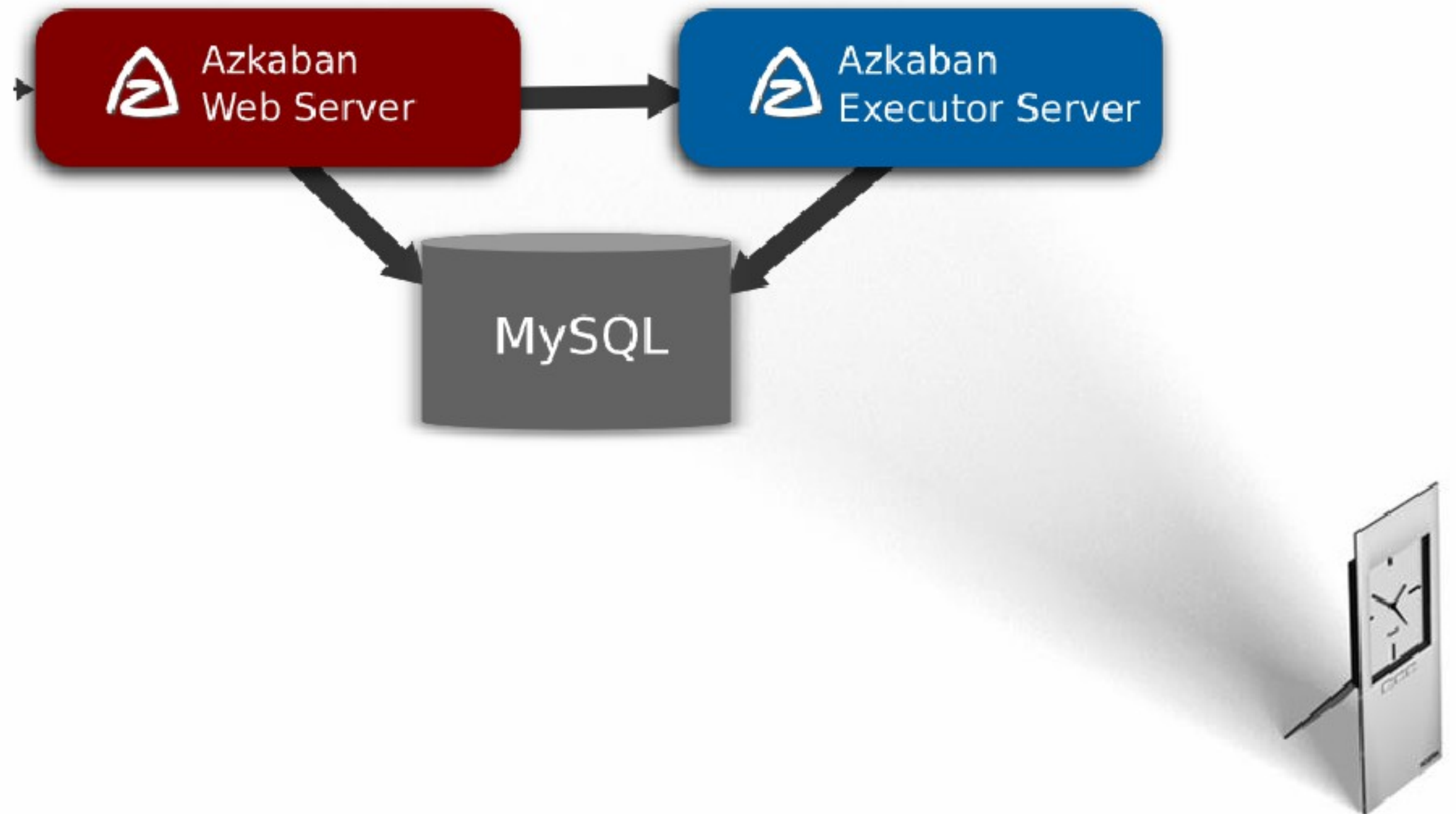


主要内容

1. 基本概念
2. Oozie基本使用方法
3. Azkaban基本使用方法
4. 作业流调度系统比较



Azkaban基本架构



Azkaban使用方式

➤ REST API

➤ WEB UI

- ✓ 用户权限管理
- ✓ 提交作业流
- ✓ 查看作业流运行进度



Azkaban作业流表达方式

- 每个作业描述对应一个“.job”文件
 - ✓ 支持Shell、Java、HadoopJava、Pig、Hive作业
 - ✓ 每种类型作业带有不同参数
- 作业依赖关系在“.job”文件设置
- 一个作业流打包成.zip，提交到Azkaban上

```
# foo.job  
type=command  
command=echo foo
```

```
# bar.job  
type=command  
dependencies=foo  
command=echo bar
```



Azkaban作业示例

```
type=hive
user.to.proxy=azkaban

hive.script=scripts/hive-wc.hql
```

```
type=hadoopJava
job.class=azkaban.jobtype.examples.java.WordCount

classpath=./lib/*,${hadoop.home}/lib/*

main.args=${param.inData} ${param.outData}

force.output.overwrite=true


input.path=${param.inData}
output.path=${param.outData}

dependencies=pig-upload
```

```
type=pig
pig.script=src/upload.pig
```



Azkaban操作界面

 **Azkaban Local**
My Local Azkaban

Projects | [Scheduling](#) | [Executing](#) | [History](#) | [HDFS](#) | azkaban -

Project embedded [Delete Project](#) [Upbad](#)

[Flows](#) | [Permissions](#) | [Project Logs](#)

User [Add](#)

User	Admin	Read	Write	Execute	Schedule	
azkaban (you)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Change

Group [Add](#)

Group	Admin	Read	Write	Execute	Schedule
No Groups Found.					

Proxy Users [Add](#)

Proxy User	
azkaban (you)	Remove

embedded
Test embedded flow

Created on 2014-02-13 06:02:22
Last modified by 2014-02-13 06:02:26
Modified by azkaban

Project admins: azkaban
Your Permissions: ADMIN



Azkaban操作界面

Execute Flow job

Flow View

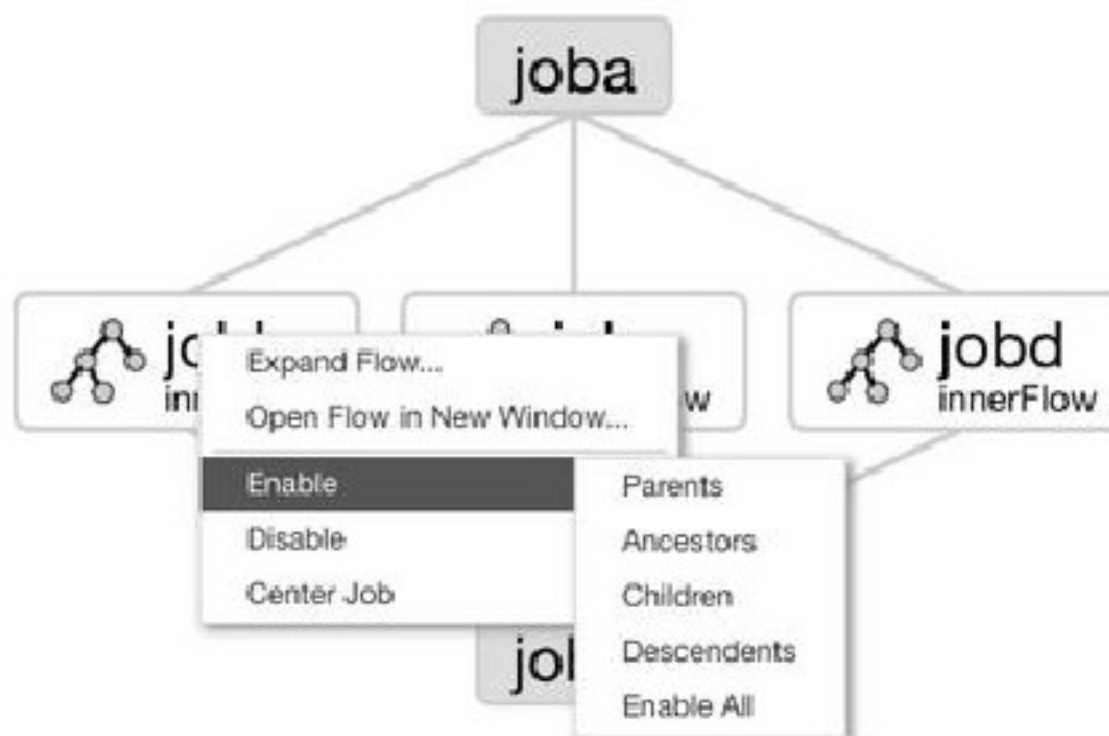
Right click on the jobs to disable and enable jobs in the flow.

Notification

Failure Options

Concurrent

Flow Parameters



Schedule

Cancel

Execute

主要内容

- 1. 基本概念**
- 2. Oozie基本使用方法**
- 3. Azkaban基本使用方法**
- 4. 作业流调度系统比较**



作业流调度系统比较

特性	Oozie	Azkaban	Cascading
workflow 描述语言	XML	文本文件 (key/value对)	Java API
是否需要安装	是	是	否
可视化展示	界面只读, 展示了必需的信息	可通过界面互动, 信息详细	-
是否支持常见的作业类型, 包括MR、Hive、Pig、Sqoop等	是	不支持Sqoop	-
是否为插件化设计 (作业类型可扩展)	是	是	-