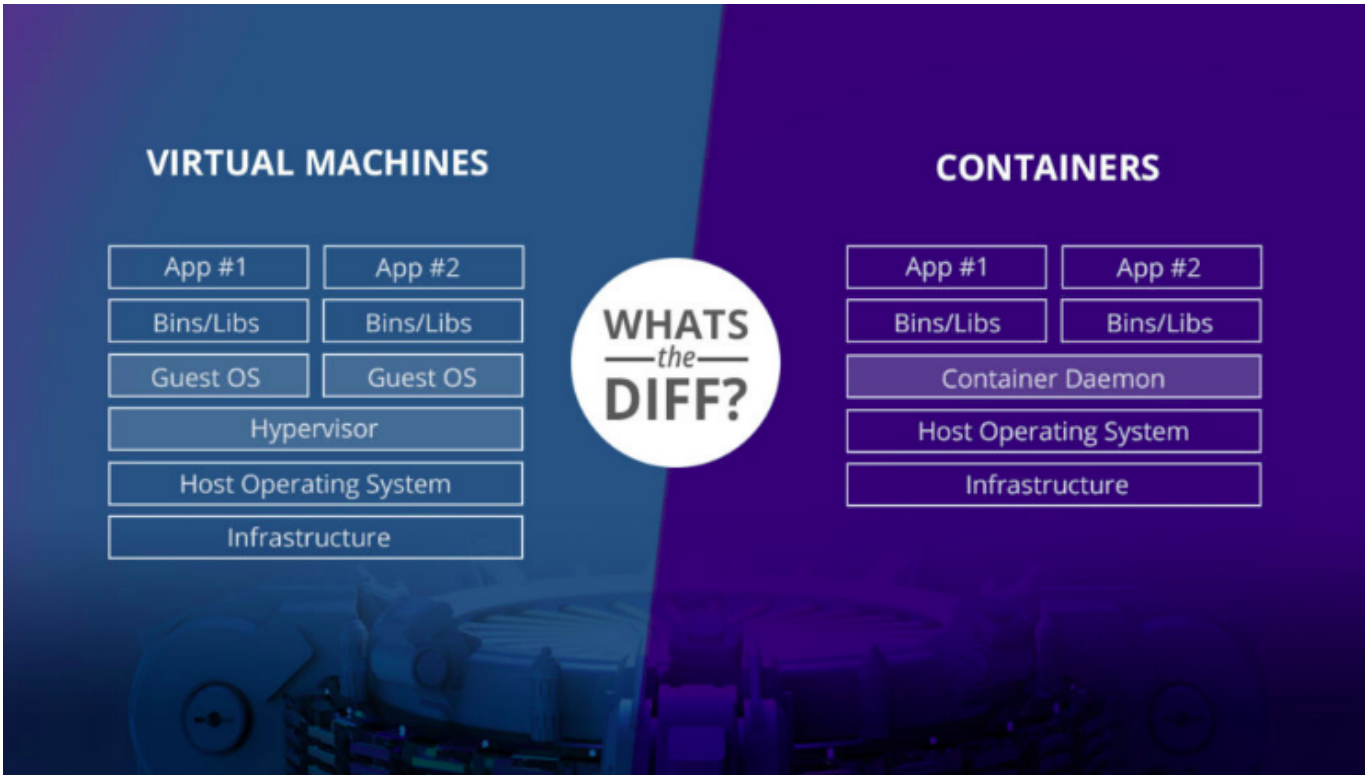
Distributed System and Big Data

Task 3

使用Docker搭建Hadoop HA集群

Docker VS VM



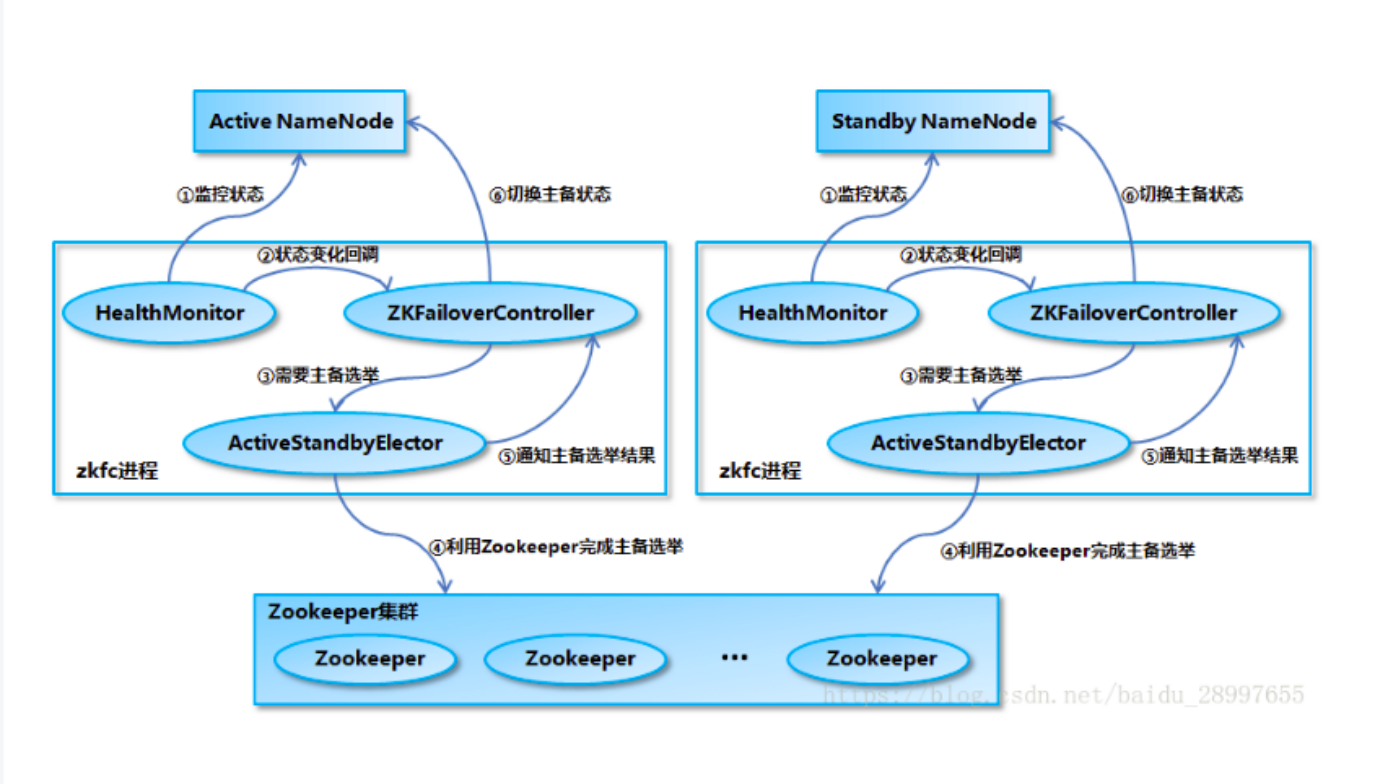
选择Docker还能方便将来将容器真正的部署到集群上。

Hadoop HA架构

ip	hostname	application	process
172.18.0.2	hadoop1	hadoop jdk	DFSZKFailoverController NameNode
172.18.0.3	hadoop2	hadoop jdk	DFSZKFailoverController NameNode
172.18.0.4	hadoop3	hadoop jdk	ResourceManager
172.18.0.5	hadoop4	hadoop jdk	ResourceManager
172.18.0.6	hadoop5	hadoop jdk	DataNode NodeManager
172.18.0.7	hadoop6	hadoop jdk	DataNode NodeManager
172.18.0.8	hadoop7	hadoop jdk	DataNode NodeManager

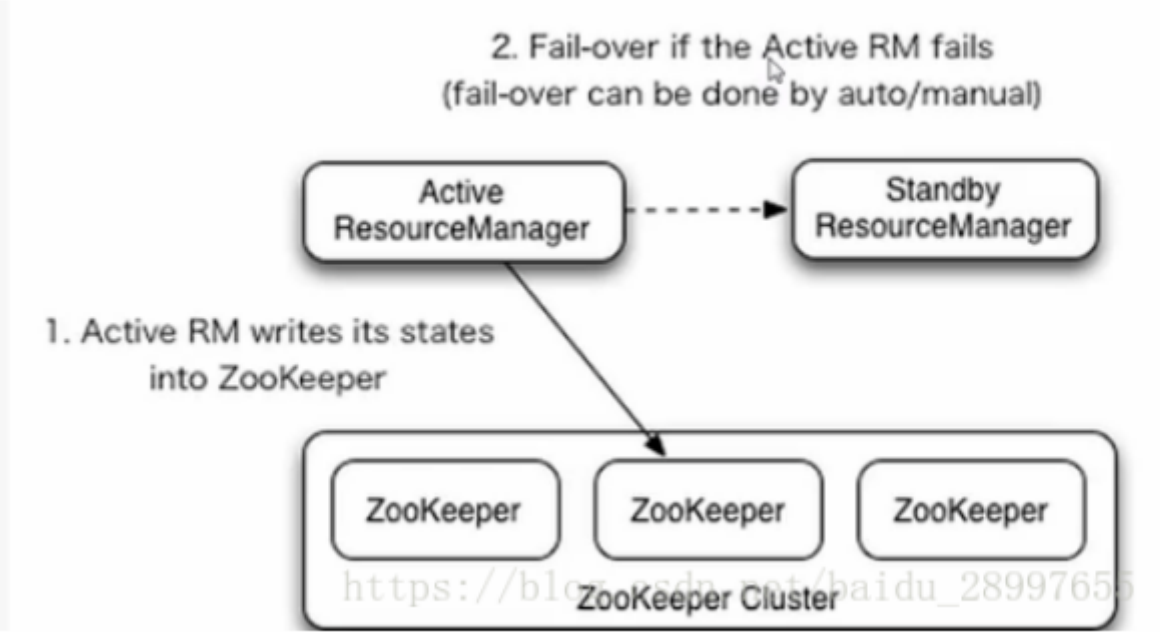
ip	hostname	application	process
172.18.0.13	hadoop8	zookeeper	zookeeper
172.18.0.12	hadoop9	zookeeper	zookeeper
172.18.0.14	hadoop10	zookeeper	zookeeper
172.18.0.11	hadoop11	hadoop jdk	JournalNode
172.18.0.10	hadoop12	hadoop jdk	JournalNode
172.18.0.11	hadoop13	hadoop jdk	JournalNode

NameNode HA



NameNode HA通过zookeeper进行状态监管，通过JournalNode（QJM原理）进行EditLog一致性管理（Paxos）

Yanr HA



Hadoop HA搭建

1. 构建镜像

```
#Dockerfile
FROM openjdk:8-jdk-buster
MAINTAINER <NIU>
WORKDIR /root
ADD hadoop-2.10.1.tar.gz .
RUN mv hadoop-2.10.1 /usr/local/hadoop

# hadoop环境变量配置
ENV HADOOP_HOME /usr/local/hadoop
ENV HADOOP_CONFIG_HOME /usr/local/hadoop/etc/hadoop
ENV HADOOP_LIBEXEC_DIR /usr/local/hadoop/libexec
ENV HADOOP_COMMON_HOME $HADOOP_HOME
ENV HADOOP_HDFS_HOME $HADOOP_HOME
ENV HADOOP_CONF_DIR  /usr/local/hadoop/etc/hadoop
ENV PATH $PATH:/usr/local/hadoop/bin:/usr/local/hadoop/sbin:

RUN apt-get update && apt-get install -y openssh-server vim && \
    ssh-keygen -t rsa -f ~/.ssh/id_rsa -P '' && \
    cat ~/.ssh/id_rsa.pub >> ~/.ssh/authorized_keys && \
    mkdir /run/sshd

RUN echo "export JAVA_HOME=\"/usr/local/openjdk-8\"" >> .bashrc && \
    echo "export JAVA_VERSION=\"8u275\"" >> .bashrc

RUN echo "root:123" | chpasswd
EXPOSE  22
```

```
ENTRYPOINT /usr/sbin/sshd -D
```

2. 配置文件

- core-site.xml

```
    <property>
            <name>fs.defaultFS</name>
            <value>hdfs://ns1</value>
        </property>
    <!-- 指定hadoop运行时产生文件的存储目录 -->
     <property>
            <name>hadoop.tmp.dir</name>
            <value>/usr/local/hadoop/tmp</value>
    </property>
        <!-- 指定zookeeper地址-->
     <property>
            <name>ha.zookeeper.quorum</name>
            <value>hadoop8:2181,hadoop9:2181,hadoop10:2181</value>
     </property>
```

- hdfs-site.xml

```
    <!--指定hdfs的nameservice为ns1，需要和core-site.xml中的保持一致 -->
    <property>
            <name>dfs.nameservices</name>
            <value>ns1</value>
    </property>
    <!-- ns1下面有两个NameNode，分别是nn1，nn2 -->
    <property>
            <name>dfs.ha.namenodes.ns1</name>
            <value>nn1,nn2</value>
    </property>
    <!-- nn1的RPC通信地址 -->
    <property>
            <name>dfs.namenode.rpc-address.ns1.nn1</name>
            <value>hadoop2:9000</value>
    </property>
    <!-- nn1的http通信地址 -->
    <property>
            <name>dfs.namenode.http-address.ns1.nn1</name>
            <value>hadoop2:50070</value>
    </property>
    <!-- nn2的RPC通信地址 -->
    <property>
            <name>dfs.namenode.rpc-address.ns1.nn2</name>
            <value>hadoop1:9000</value>
```

```
    </property>
    <!-- nn2的http通信地址 -->
    <property>
            <name>dfs.namenode.http-address.ns1.nn2</name>
            <value>hadoop1:50070</value>
    </property>
    <!-- 指定NameNode的元数据在JournalNode上的存放位置 -->
    <property>
            <name>dfs.namenode.shared.edits.dir</name>

<value>qjournal://hadoop11:8485;hadoop12:8485;hadoop13:8485/ns1</value>
    </property>
    <!-- 指定JournalNode在本地磁盘存放数据的位置 -->
    <property>
            <name>dfs.journalnode.edits.dir</name>
            <value>/usr/local/hadoop/journaldata</value>
    </property>
    <!-- 开启NameNode失败自动切换 -->
    <property>
            <name>dfs.ha.automatic-failover.enabled</name>
            <value>true</value>
    </property>
    <!-- 配置失败自动切换实现方式 -->
    <property>
            <name>dfs.client.failover.proxy.provider.ns1</name>

<value>org.apache.hadoop.hdfs.server.namenode.ha.ConfiguredFailoverProxyPro
vider</value>
    </property>
    <!-- 配置隔离机制方法，多个机制用换行分割，即每个机制暂用一行 -->
    <property>
            <name>dfs.ha.fencing.methods</name>
            <value>
                    sshfence
                    shell(/bin/true)
            </value>
    </property>
    <!-- 使用sshfence隔离机制时需要ssh免登陆 -->
    <property>
            <name>dfs.ha.fencing.ssh.private-key-files</name>
            <value>/home/root/.ssh/id_rsa</value>
    </property>
    <!-- 配置sshfence隔离机制超时时间 -->
    <property>
            <name>dfs.ha.fencing.ssh.connect-timeout</name>
            <value>30000</value>
    </property>
```

- mapred-site.xml

```
    <!-- 指定mr运行在yarn上 -->
    <property>
            <name>mapreduce.framework.name</name>
            <value>yarn</value>
    </property>
```

- yarn-site.xml

```
    <!-- reducer获取数据的方式 -->
    <property>
            <name>yarn.nodemanager.aux-services</name>
            <value>mapreduce_shuffle</value>
     </property>
   <!-- 开启RM高可用 -->
     <property>
           <name>yarn.resourcemanager.ha.enabled</name>
           <value>true</value>
     </property>
    <!-- 指定RM的cluster id -->
     <property>
           <name>yarn.resourcemanager.cluster-id</name>
           <value>yrc</value>
     </property>
    <!-- 指定RM的名字 -->
     <property>
           <name>yarn.resourcemanager.ha.rm-ids</name>
           <value>rm1,rm2</value>
     </property>
    <!-- 分别指定RM的地址 -->
     <property>
           <name>yarn.resourcemanager.hostname.rm1</name>
           <value>hadoop3</value>
     </property>
     <property>
           <name>yarn.resourcemanager.hostname.rm2</name>
           <value>hadoop4</value>
     </property>
    <!-- 指定zk集群地址 -->
     <property>
           <name>yarn.resourcemanager.zk-address</name>
          <value>hadoop8:2181,hadoop9:2181,hadoop10:2181</value>
     </property>
     <!--运行jar出现prelaunch.err新增-->
    <property>
        <name>yarn.resourcemanager.webapp.address.rm1</name>
        <value>hadoop3:8088</value>
    </property>
    <property>
        <name>yarn.resourcemanager.scheduler.address.rm2</name>
        <value>hadoop4:8030</value>
```

```
    </property>
    <property>
        <name>yarn.resourcemanager.webapp.address.rm2</name>
        <value>hadoop4:8088</value>
    </property>
```

- `slaves`

```
hadoop5
hadoop6
hadoop7
```

上述配置相关设置主要参考CSDN以及hadoop.apache.org

3. 启动容器组
    - 创建Docker本地网络

      > docker network creat

    - 拉起集群
      通过`start.sh`启动集群，使用的镜像是已经修改过配合的
4. 启动
    - 密钥分发
    - zookeeper启动
    - JournalNode启动

      > hadoop-daemon.sh start journalnode

    - namenode格式化

      > hdfs namenode -format
      > scp /tmp hadoop2:/tmp
      > hdfs namenode -bootstrapStandby
      > hadoop-daemon.sh start namenode

    - 格式化ZKFC

      > hdfs zkfc -formatZK

    - 全面启动

      > start-dfs.sh

    - 启动yarn

```
yarn-daemon.sh start resourcemanager
start-yarn.sh
```

- 全面停止

```
stop-dfs.sh
```

5. 停止容器组 使用`clean.sh`脚本

Task 1 And Task 2

具体问题

Final Project

- Which city has the highest PM25 index, and which city has the lowest PM25 index? The specific metric can be decided by yourself, and you have to detail the reason.
- Please report the air quality distribution of 北京, 上海 and 成都 throughout February in the year of 2019. To be specific, how many days were there being Good, Moderate, Unhealthy, Very Unhealthy and Hazardous?
- (Optional) Ask a non-trivial question by yourself, and then answer it.

代码详情见`code`文件夹

代码执行

1. Task1

- 运行

```
root@hadoop1:~# hadoop jar pm25-1.0-SNAPSHOT.jar PM25 /myTask /out1
21/01/12 09:19:03 WARN mapreduce.JobResourceUploader: Hadoop command-line option parsing not performed. Implement the Tool interface and execute
 your application with ToolRunner to remedy this.
21/01/12 09:19:05 INFO input.FileInputFormat: Total input files to process : 1
21/01/12 09:19:06 INFO mapreduce.JobSubmitter: number of splits:1
21/01/12 09:19:08 INFO mapreduce.JobSubmitter: Submitting tokens for job: job_1610435326809_0001
21/01/12 09:19:08 INFO conf.Configuration: resource-types.xml not found
21/01/12 09:19:08 INFO resource.ResourceUtils: Unable to find 'resource-types.xml'.
21/01/12 09:19:08 INFO resource.ResourceUtils: Adding resource type - name = memory-mb, units = Mi, type = COUNTABLE
21/01/12 09:19:08 INFO resource.ResourceUtils: Adding resource type - name = vcores, units = , type = COUNTABLE
21/01/12 09:19:09 INFO impl.YarnClientImpl: Submitted application application_1610435326809_0001
21/01/12 09:19:09 INFO mapreduce.Job: The url to track the job: http://hadoop3:8088/proxy/application_1610435326809_0001/
21/01/12 09:19:09 INFO mapreduce.Job: Running job: job_1610435326809_0001
21/01/12 09:19:28 INFO mapreduce.Job: Job job_1610435326809_0001 running in uber mode : false
21/01/12 09:19:28 INFO mapreduce.Job:  map 0% reduce 0%
21/01/12 09:19:45 INFO mapreduce.Job:  map 100% reduce 0%
21/01/12 09:19:58 INFO mapreduce.Job:  map 100% reduce 100%
21/01/12 09:20:01 INFO mapreduce.Job: Job job_1610435326809_0001 completed successfully
21/01/12 09:20:02 INFO mapreduce.Job: Counters: 49
```

- 结果

```
root@hadoop1:~# hdfs dfs -cat /out1/*
海口    16.023941
郑州    94.13384
```

2. Task2

- 运行

```
root@hadoop1:~# hadoop jar AQI-1.0-SNAPSHOT.jar AQI /myTask /out2
21/01/12 09:25:58 WARN mapreduce.JobResourceUploader: Hadoop command-line option parsing not performed. Implement the Tool interface and execute
 your application with ToolRunner to remedy this.
21/01/12 09:25:59 INFO input.FileInputFormat: Total input files to process : 1
21/01/12 09:25:59 INFO mapreduce.JobSubmitter: number of splits:1
21/01/12 09:26:00 INFO mapreduce.JobSubmitter: Submitting tokens for job: job_1610435326809_0002
21/01/12 09:26:01 INFO conf.Configuration: resource-types.xml not found
21/01/12 09:26:01 INFO resource.ResourceUtils: Unable to find 'resource-types.xml'.
21/01/12 09:26:01 INFO resource.ResourceUtils: Adding resource type - name = memory-mb, units = Mi, type = COUNTABLE
21/01/12 09:26:01 INFO resource.ResourceUtils: Adding resource type - name = vcores, units = , type = COUNTABLE
21/01/12 09:26:01 INFO impl.YarnClientImpl: Submitted application application_1610435326809_0002
21/01/12 09:26:01 INFO mapreduce.Job: The url to track the job: http://hadoop3:8088/proxy/application_1610435326809_0002/
21/01/12 09:26:01 INFO mapreduce.Job: Running job: job_1610435326809_0002
21/01/12 09:26:18 INFO mapreduce.Job: Job job_1610435326809_0002 running in uber mode : false
21/01/12 09:26:18 INFO mapreduce.Job:  map 0% reduce 0%
21/01/12 09:26:33 INFO mapreduce.Job:  map 100% reduce 0%
21/01/12 09:26:46 INFO mapreduce.Job:  map 100% reduce 100%
21/01/12 09:26:50 INFO mapreduce.Job: Job job_1610435326809_0002 completed successfully
21/01/12 09:26:50 INFO mapreduce.Job: Counters: 49
```

- 结果

```
root@hadoop1:~# hdfs dfs -cat /out2/*
成都      0 14 13 1 0 0 0
海口      0 28 0 0 0 0 0
呼和浩特          0 15 10 3 0 0 0
上海      0 16 9 3 0 0 0
昆明      0 27 1 0 0 0 0
济南      0 6 7 9 6 0 0
天津      0 12 7 8 1 0 0
厦门      0 26 2 0 0 0 0
青岛      0 10 10 6 2 0 0
郑州      0 2 8 9 8 1 0
乌鲁木齐          0 1 17 9 1 0 0
北京      0 11 9 6 2 0 0
```

发现记录

1. 在测试NameNode高可用时误将zookeeper监视进程杀死，结果同样将standby NameNode状态转换
2. yarn HA

```
21/01/12 07:07:42 INFO resource.ResourceUtils: Unable to find 'resource-types.xml'.
21/01/12 07:07:42 INFO resource.ResourceUtils: Adding resource type - name = memory-mb, units = Mi, type = COUNTABLE
21/01/12 07:07:42 INFO resource.ResourceUtils: Adding resource type - name = vcores, units = , type = COUNTABLE
21/01/12 07:07:43 INFO retry.RetryInvocationHandler: java.net.ConnectException: Call From hadoop1/172.18.0.2 to hadoop3:8032 failed on connectio
n exception: java.net.ConnectException: Connection refused; For more details see:  http://wiki.apache.org/hadoop/ConnectionRefused, while invoki
ng ApplicationClientProtocolPBClientImpl.submitApplication over rm1. Trying to failover immediately.
21/01/12 07:07:43 INFO client.ConfiguredRMFailoverProxyProvider: Failing over to rm2
21/01/12 07:07:43 INFO retry.RetryInvocationHandler: java.net.ConnectException: Call From hadoop1/172.18.0.2 to hadoop4:8032 failed on connectio
n exception: java.net.ConnectException: Connection refused; For more details see:  http://wiki.apache.org/hadoop/ConnectionRefused, while invoki
ng ApplicationClientProtocolPBClientImpl.submitApplication over rm2 after 1 failover attempts. Trying to failover after sleeping for 25050ms.
21/01/12 07:08:08 INFO client.ConfiguredRMFailoverProxyProvider: Failing over to rm1
21/01/12 07:08:08 INFO retry.RetryInvocationHandler: java.net.ConnectException: Call From hadoop1/172.18.0.2 to hadoop3:8032 failed on connectio
n exception: java.net.ConnectException: Connection refused; For more details see:  http://wiki.apache.org/hadoop/ConnectionRefused, while invoki
ng ApplicationClientProtocolPBClientImpl.submitApplication over rm1 after 2 failover attempts. Trying to failover after sleeping for 25013ms.
21/01/12 07:08:33 INFO client.ConfiguredRMFailoverProxyProvider: Failing over to rm2
21/01/12 07:09:07 INFO retry.RetryInvocationHandler: java.io.EOFException: End of File Exception between local host is: "hadoop1/172.18.0.2"; de
stination host is: "hadoop4":8032; : java.io.EOFException; For more details see:  http://wiki.apache.org/hadoop/EOFException, while invoking App
licationClientProtocolPBClientImpl.submitApplication over rm2 after 3 failover attempts. Trying to failover after sleeping for 32808ms.
21/01/12 07:09:40 INFO client.ConfiguredRMFailoverProxyProvider: Failing over to rm1
21/01/12 07:09:40 INFO impl.YarnClientImpl: Submitted application application_1610428895928_0004
21/01/12 07:09:40 INFO mapreduce.Job: The url to track the job: http://hadoop3:8088/proxy/application_1610428895928_0004/
21/01/12 07:09:40 INFO mapreduce.Job: Running job: job_1610428895928_0004
21/01/12 07:10:11 INFO mapreduce.Job: Job job_1610428895928_0004 running in uber mode : false
21/01/12 07:10:11 INFO mapreduce.Job:  map 0% reduce 0%
21/01/12 07:10:55 INFO mapreduce.Job:  map 100% reduce 0%
21/01/12 07:11:26 INFO mapreduce.Job:  map 100% reduce 100%
21/01/12 07:11:33 INFO mapreduce.Job: Job job_1610428895928_0004 completed successfully
21/01/12 07:11:33 INFO mapreduce.Job: Counters: 49
```