HADOOP YARN在异构环境下应用与实践

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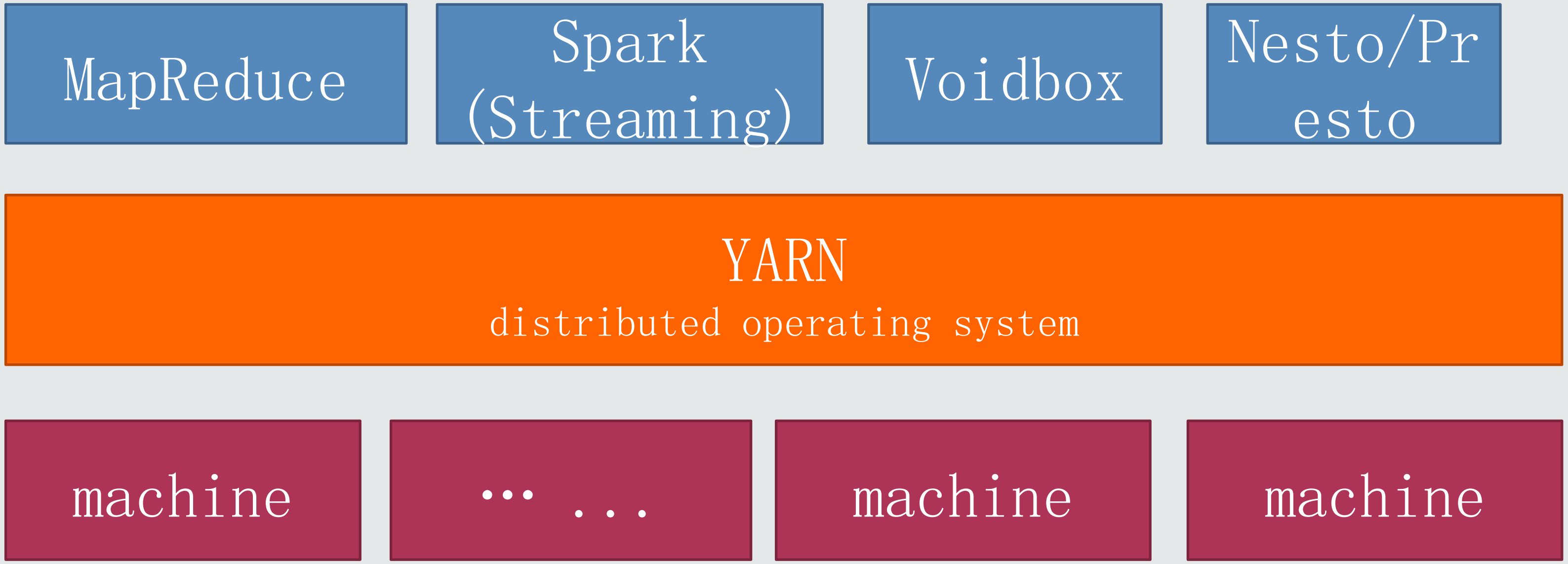
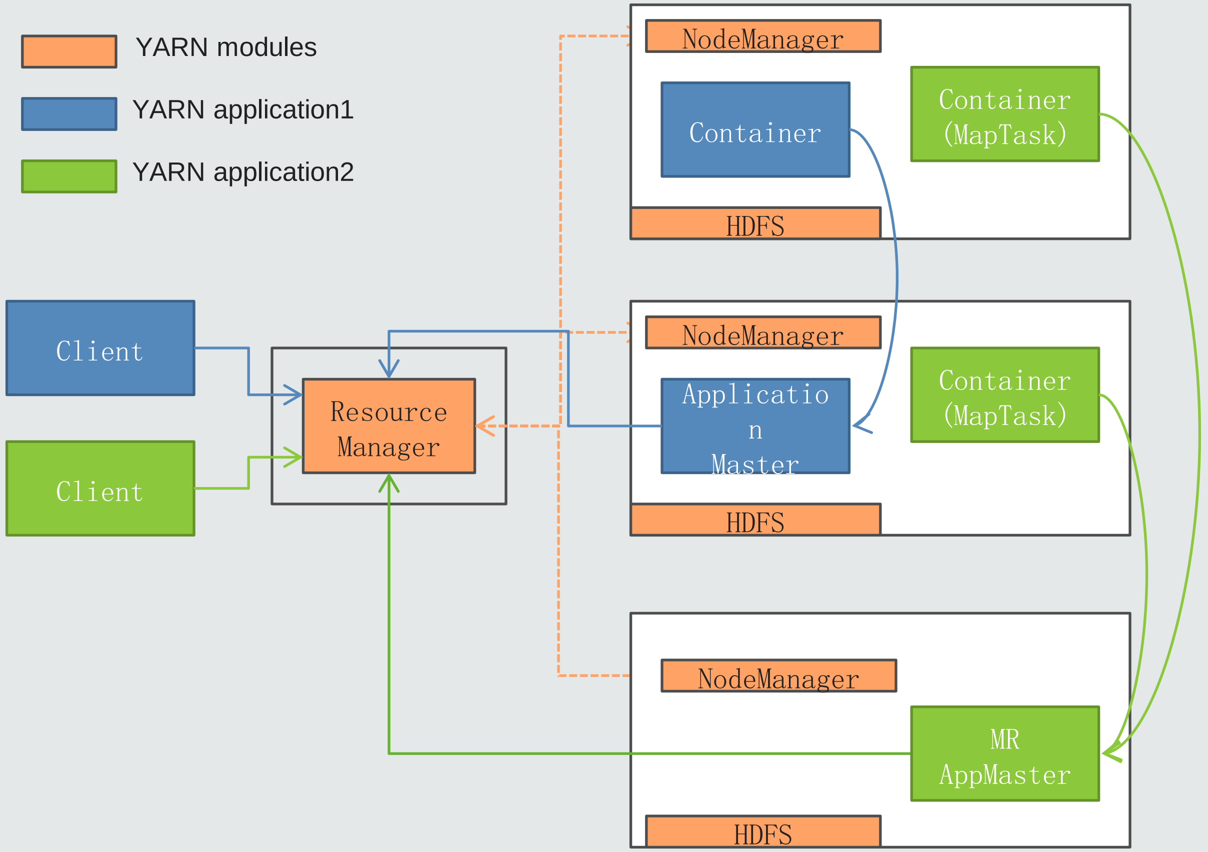
AGENDA

- Background
- Label-based scheduling
- Framework On YARN
- Experience
- Q & A

ARCHITECTURE - YARN



ARCHITECTURE – YARN



DISTRIBUTED APPLICATION TYPES

- Batch Jobs
  - Take from a few seconds to a few days to complete
  - E.g. MapReduce, Spark
- Long-running Services
  - Should “never” go down, handle short-lived latency-sensitive requests
  - E.g.Presto/Nesto, Spark Streaming, Web Services
- YARN: Data Operating System
  - ResourceManager HA & Recovery
  - NodeManager Recovery
  - Resource Scheduling(e.g. label-based scheduling)
  - Apache Slider & Apache Twill

HETEROGENEOUS ISSUES

- Heterogeneous Causes
  - Static factors: Machines(CPU, memory, network, OS, libraries)
  - Dynamic factors: Load, Network, Slow Disk …
- Solutions for static factors
  - Distinguish machines, and assign to different frameworks
  - E.g. 128GB-memory machines for spark, 10G-network machines for spark streaming/nesto/presto
- Solutions for dynamical factors
  - Solve in framework level
  - For MapReduce/Spark: speculative execution
  - For others: ?

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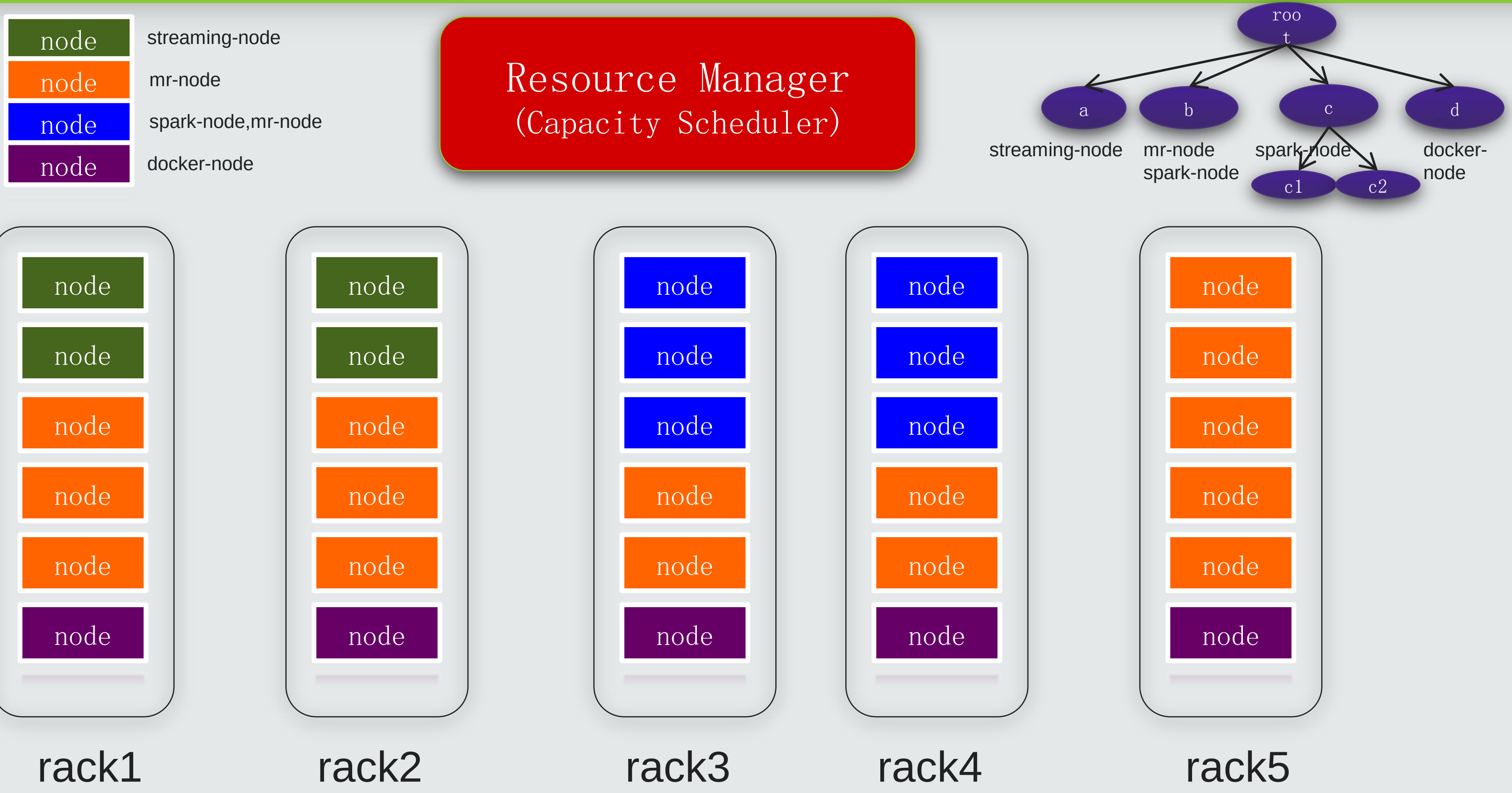
WHY LABEL-BASED SCHEDULING

- Distinguish good/bad machines for different Apps
    - E.g. Large memory machine for spark
- Apps require special libraries/services installed
    - Spark MLlib: native libraries
    - Voidbox: docker engines
- Machine-level isolation for key Apps
    - Low-latency Apps: spark streaming/presto/nesto

LABEL-BASED SCHEDULING



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LEARN FROM LABEL-BASED SCHEDULING

- Benefit
  - Static/dynamic machine-level partition
  - Elastic scalability for Apps
  - Latch to enter maintenance mode
- Issue
  - Only Capacity Scheduler is supported
  - YARN Web Portal does not support well
  - Hurt data locality

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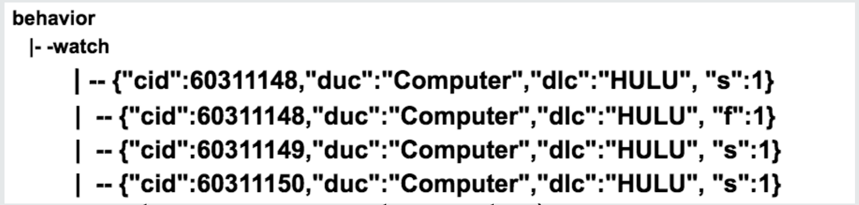
FRAMEWORKS ON YARN

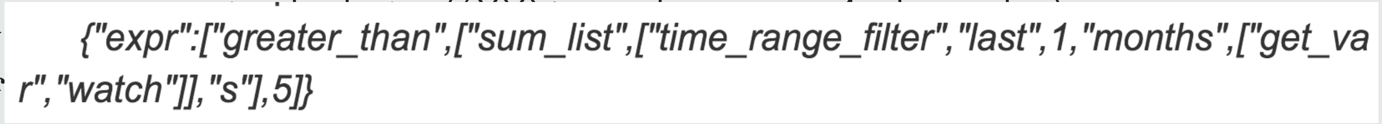
- MapReduce
- Spark
- Spark Streaming
    - Real-time processing
- Nesto/Presto
    - MPP engines
- Voidbox
    - Docker on yarn

WHAT IS NESTO

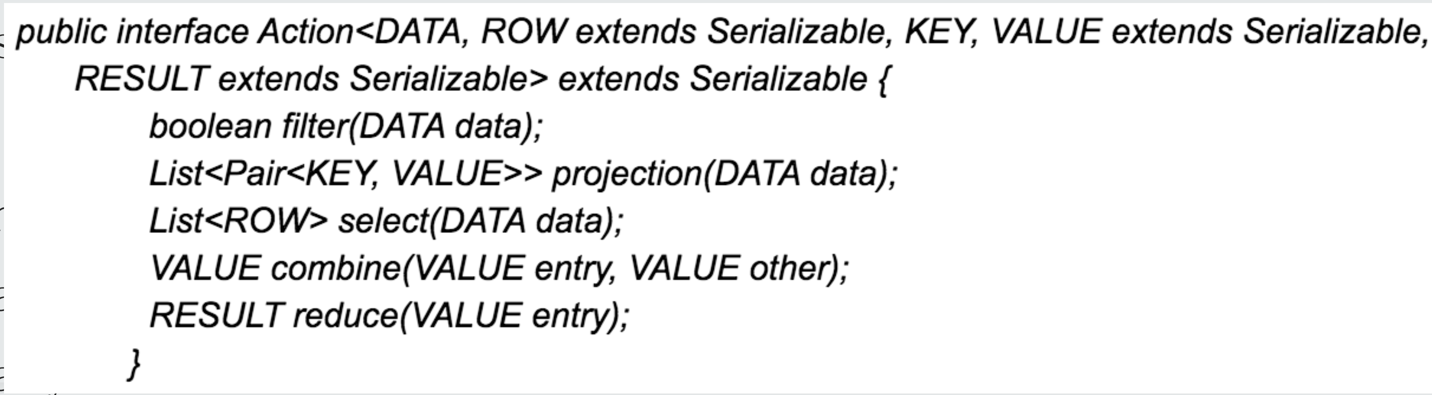
- What is Nesto
  - A distributed query engine for parquet-like nested data
  - MPP + Parquet (On HDFS)
- Nesto features
  - support l
  - support f
  - Support js
- use cases i
  - Segment ar
  - Cohort ana
  - Funnel ana



```
behavior
  |- -watch
        | -- {"cid":60311148,"duc":"Computer","dlc":"HULU", "s":1}
        |  -- {"cid":60311148,"duc":"Computer","dlc":"HULU", "f":1}
        |  -- {"cid":60311149,"duc":"Computer","dlc":"HULU", "s":1}
        |  -- {"cid":60311150,"duc":"Computer","dlc":"HULU", "s":1}
```



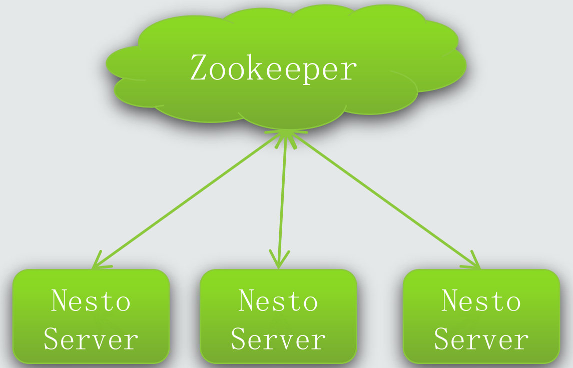
```
{"expr":["greater_than",["sum_list",["time_range_filter","last",1,"months",["get_var","watch"]],"s"],5]}
```



```
public interface Action<DATA, ROW extends Serializable, KEY, VALUE extends Serializable,
    RESULT extends Serializable> extends Serializable {
        boolean filter(DATA data);
        List<Pair<KEY, VALUE>> projection(DATA data);
        List<ROW> select(DATA data);
        VALUE combine(VALUE entry, VALUE other);
        RESULT reduce(VALUE entry);
    }
```

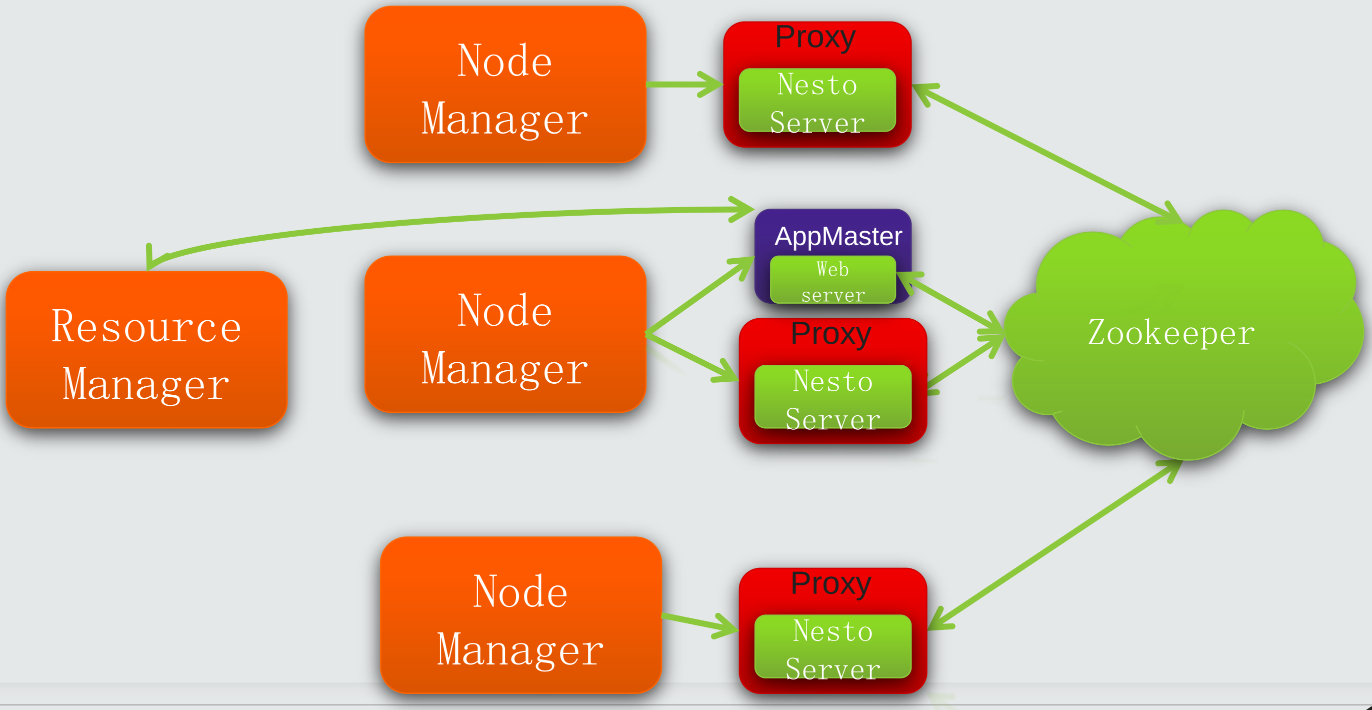
NESTO ON YARN (1)

- Requirements
  - Run Specified N containers(servers), One container on node
  - Fault tolerance
  - Tracking web UI
  - Log rotation
  - Services (Never die)
- Implementation
  - ApplicationMaster: scheduling & fault tolerance
  - Container: NestoServer (Worker)



NESTO ON YARN (2)

```
yarn jar nesto-install/nesto-0.1.0-SNAPSHOT-jar-with-dependencies.jar \
  com.hulu.nesto.yarn.NestoYarnClient \
  -conf_path /mnt/data1/home/xicheng.dong/nesto-src/yarn/nesto-install/conf/ \
  -framework_path hdfs:///tmp/xicheng/nesto/nesto-yarn.tar.gz \
  -master_memory 2048 -container_memory 2048 -container_vcores 1 -num_containers 3
```



NESTO IN HETEROGENEOUS CLUSTER

- Nesto deployment
  - Nesto is not a high-concurrency system
  - Mixed deployment with other batch/OLAP systems on YARN
- Slow task/worker
  - Slow task detection and re-dispatch
  - Worker priority scheduling based on weight

WHAT IS VOIDBOX

VOIDBOX IS A PROGRAMMING FRAMEWORK

- LIGHTWEIGHT VM
- RUNTIME ISOLATION
- UNION FILE SYSTEM

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- RESOURCE MANAGEMENT
- SCHEDULING
- FAULT TOLERANCE

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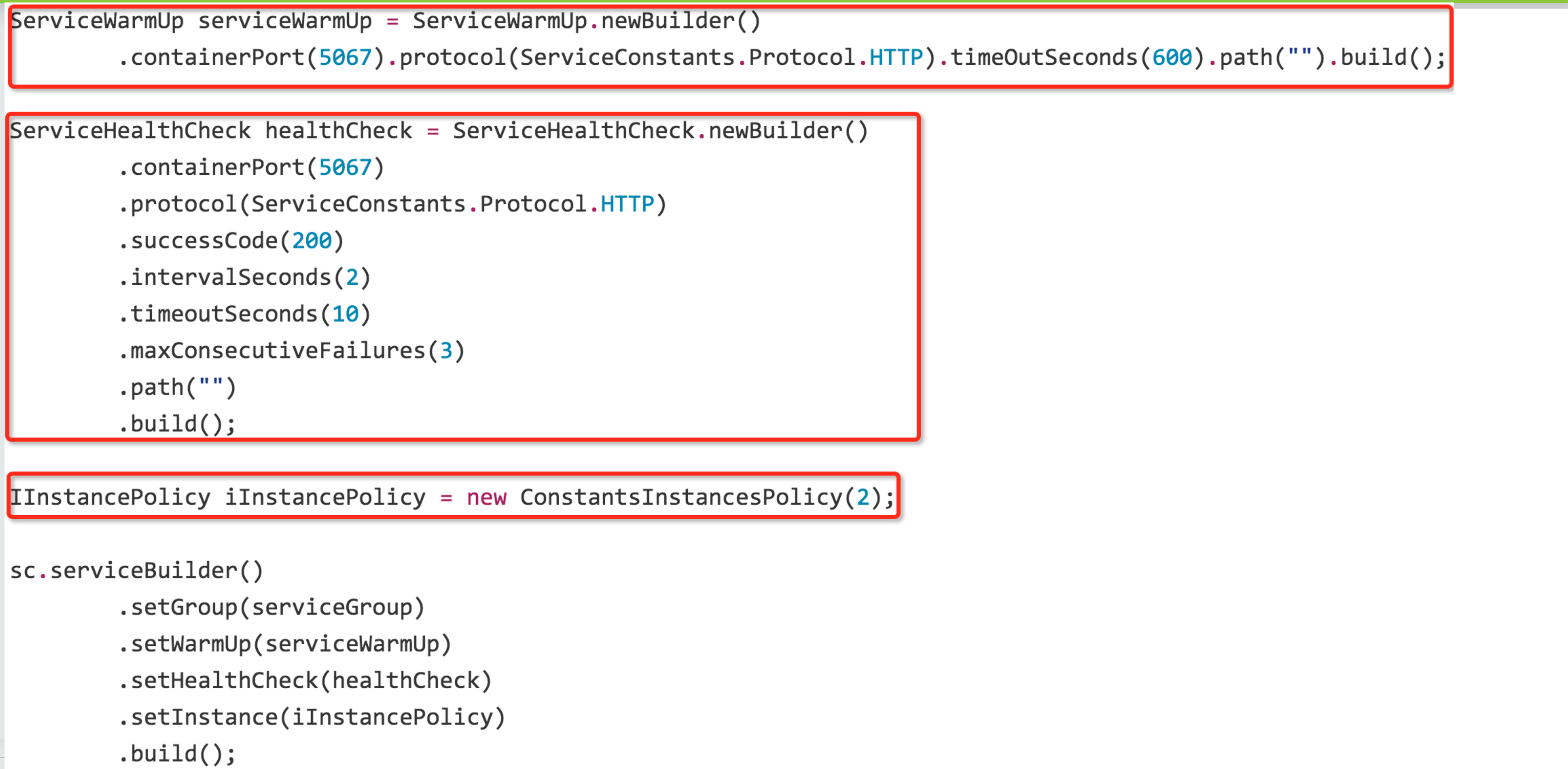
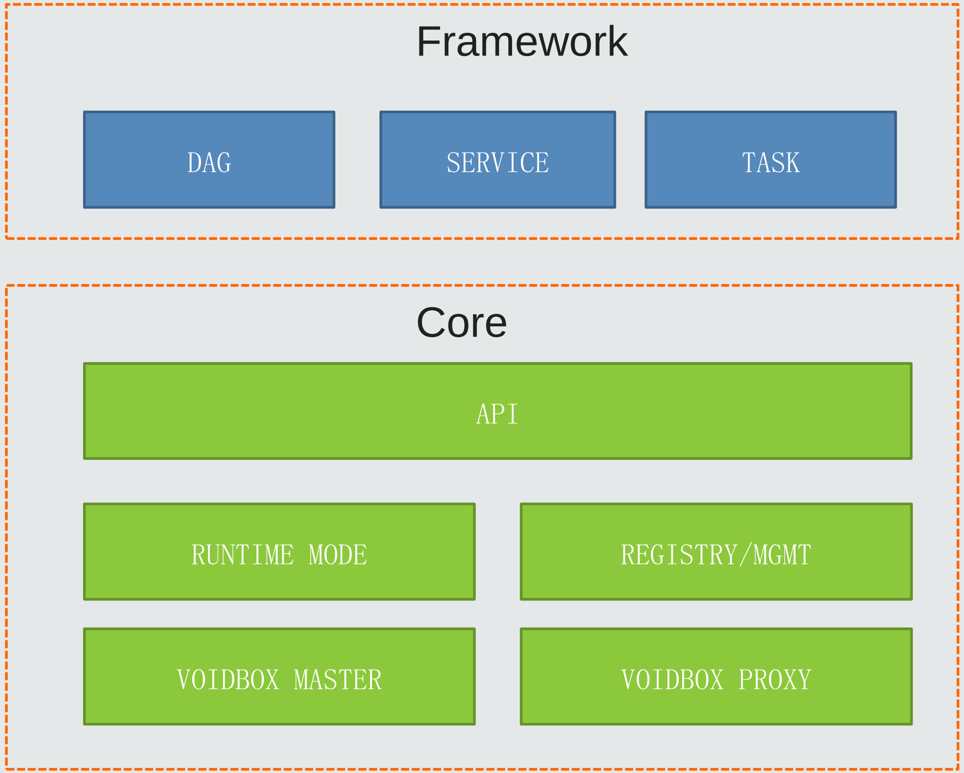
- DISTRIBUTE COMPUTATION
- ARBITRARY APPLICATION
- FAULT TOLERANCE

VOIDBOX SERVICE EXAMPLE

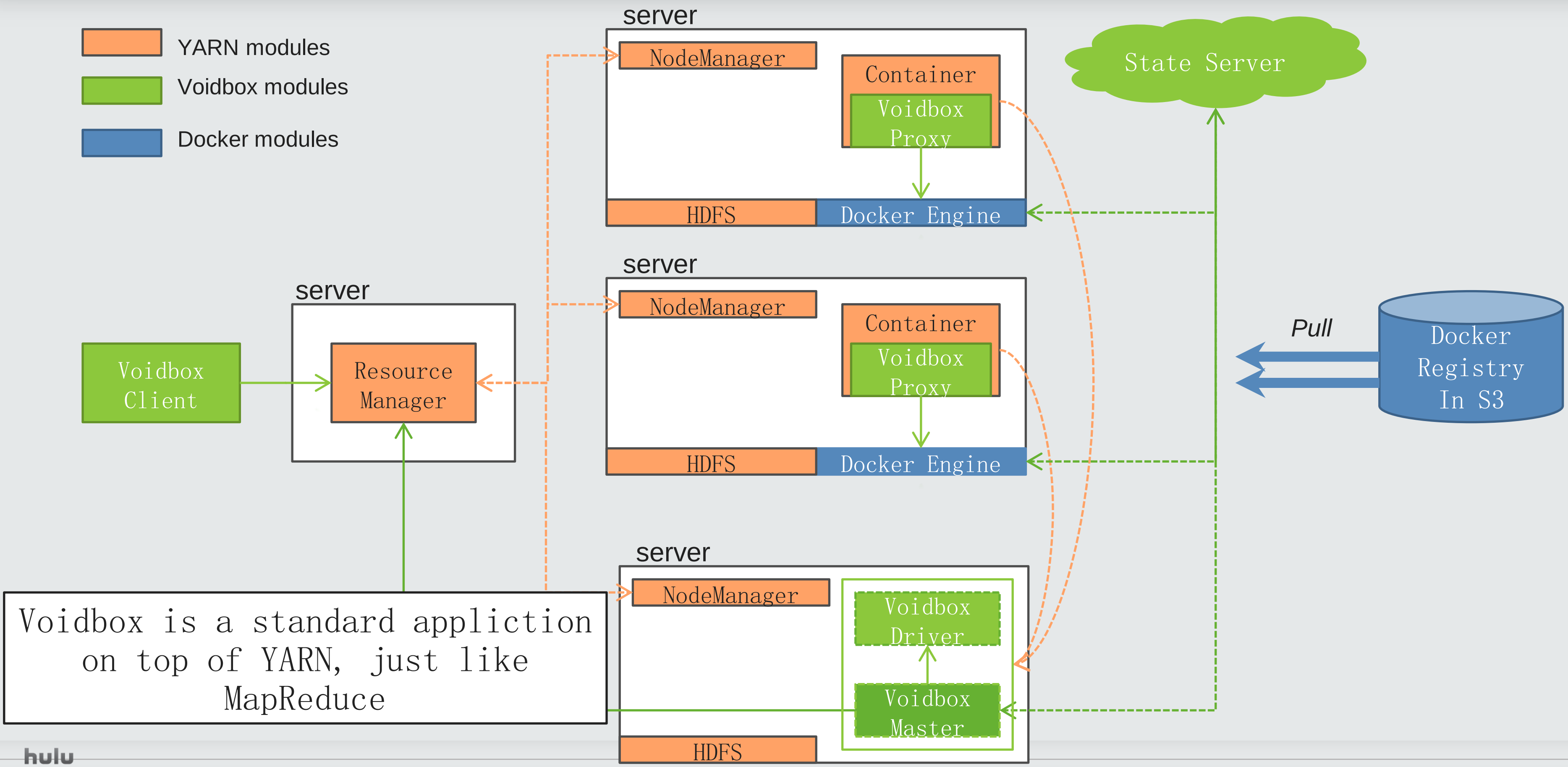


```
ServiceWarmUp serviceWarmUp = ServiceWarmUp.newBuilder()
        .containerPort(5067).protocol(ServiceConstants.Protocol.HTTP).timeOutSeconds(600).path("").build();

ServiceHealthCheck healthCheck = ServiceHealthCheck.newBuilder()
        .containerPort(5067)
        .protocol(ServiceConstants.Protocol.HTTP)
        .successCode(200)
        .intervalSeconds(2)
        .timeoutSeconds(10)
        .maxConsecutiveFailures(3)
        .path("")
        .build();

IInstancePolicy iInstancePolicy = new ConstantsInstancesPolicy(2);

sc.serviceBuilder()
        .setGroup(serviceGroup)
        .setWarmUp(serviceWarmUp)
        .setHealthCheck(healthCheck)
        .setInstance(iInstancePolicy)
        .build();
```

VOIDBOX COMPONENTS



VOIDBOX ARCHITECTURE



Voidbox is a standard appliction on top of YARN, just like MapReduce

VOIDBOX IN HULU

- Batch Jobs
  - Data Dump
  - Facematch: distributed application, face recognition in video
- Long-running Services
  - Nesto WebServer
  - Spark HistoryServer/JobServer
  - Kinko: thumbnail Generator Service

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EXPERIENCE 1: CONTAINER API

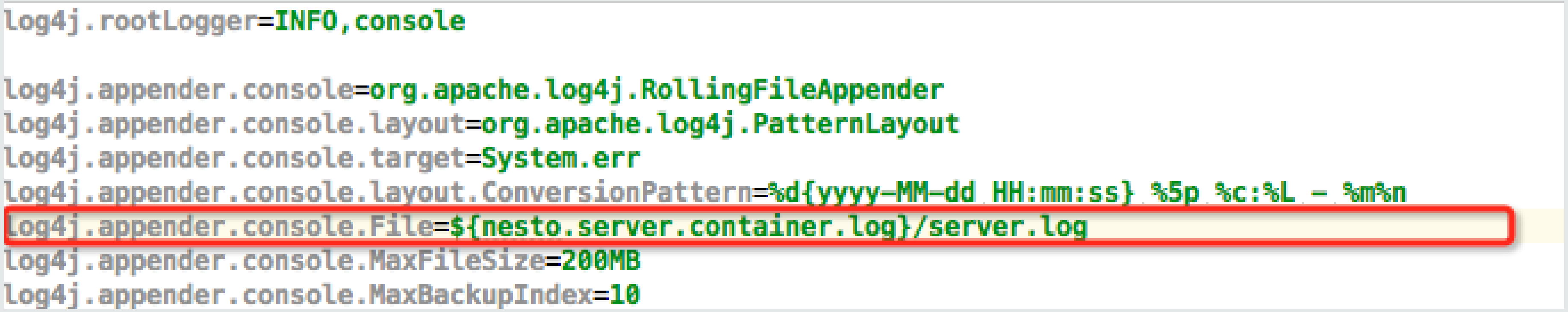
- Container Description
  - Host, rack
  - Relax locality
- Blacklisted Container
  - ApplicationMaster could put certain nodes into blacklist, then no more containers on those nodes will be received.
- Release unused containers
  - If AM allocates K containers, more containers may be received.

EXPERIENCE 2: TRACKING URL

- What’ s tracking url
  - URL of web server inside/outside AM
  - Jetty or netty
- Two tracking URL
  - Register tracking url (running)
  - Unregister tracking url (completed)
- URL Format
  - http://host:port
  - Direct URL to a. jsp, use “a. jsp” , not “/a. jsp” ; “a/b. html” not “/a/b. html”

EXPERIENCE 3: LOG ROTATION

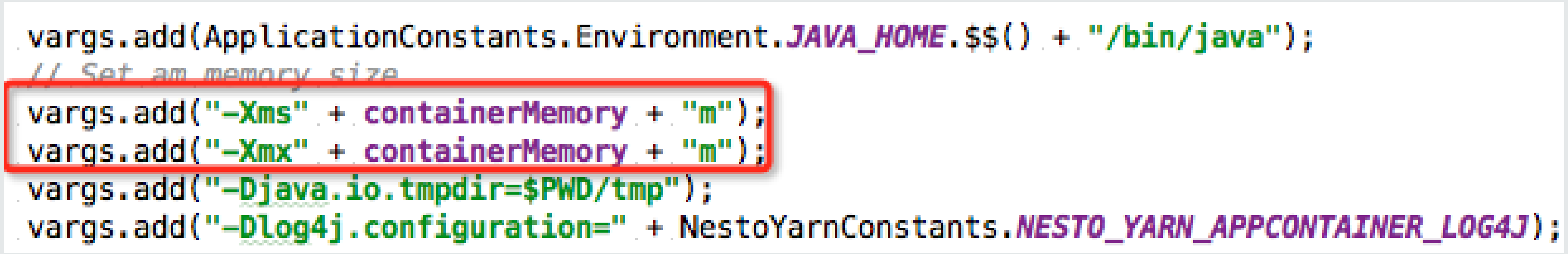
- AM or Container run command
  - $JAVA_HOME/bin/java -Dnesto.server.container.log=<LOG_DIR> -Dlog4j.configuration=**log4j.properties** … com.hulu.NestoServer 1>><LOG_DIR>/server.log 2>><LOG_DIR>/server.log
  - <LOG_DIR> will be replaced by YARN framework
- log4j.properties



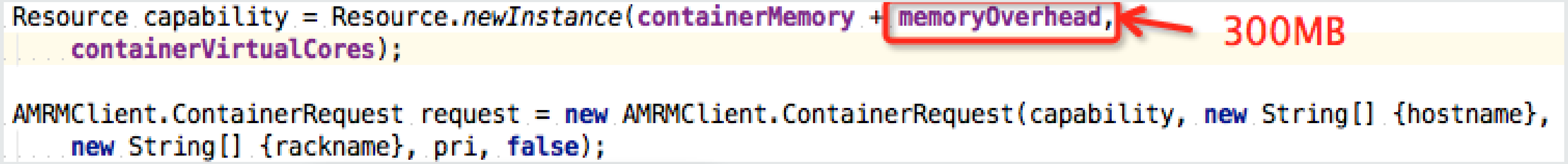
```
log4j.rootLogger=INFO,console

log4j.appender.console=org.apache.log4j.RollingFileAppender
log4j.appender.console.layout=org.apache.log4j.PatternLayout
log4j.appender.console.target=System.err
log4j.appender.console.layout.ConversionPattern=%d{yyyy-MM-dd HH:mm:ss} %5p %c:%L - %m%n
log4j.appender.console.File=${nesto.server.container.log}/server.log
log4j.appender.console.MaxFileSize=200MB
log4j.appender.console.MaxBackupIndex=10
```

EXPERIENCE 4: MEMORY OVERHEAD

- Allocate more memory than JVM heap size

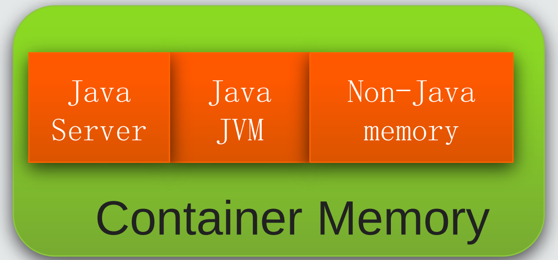


```
vargs.add(ApplicationConstants.Environment.JAVA_HOME.$$() + "/bin/java");
// Set am memory size
vargs.add("-Xms" + containerMemory + "m");
vargs.add("-Xmx" + containerMemory + "m");
vargs.add("-Djava.io.tmpdir=$PWD/tmp");
vargs.add("-Dlog4j.configuration=" + NestoYarnConstants.NESTO_YARN_APPCONTAINER_LOG4J);
```



```
Resource capability = Resource.newInstance(containerMemory + memoryOverhead,
    containerVirtualCores);

AMRMClient.ContainerRequest request = new AMRMClient.ContainerRequest(capability, new String[] {hostname},
    new String[] {rackname}, pri, false);
```

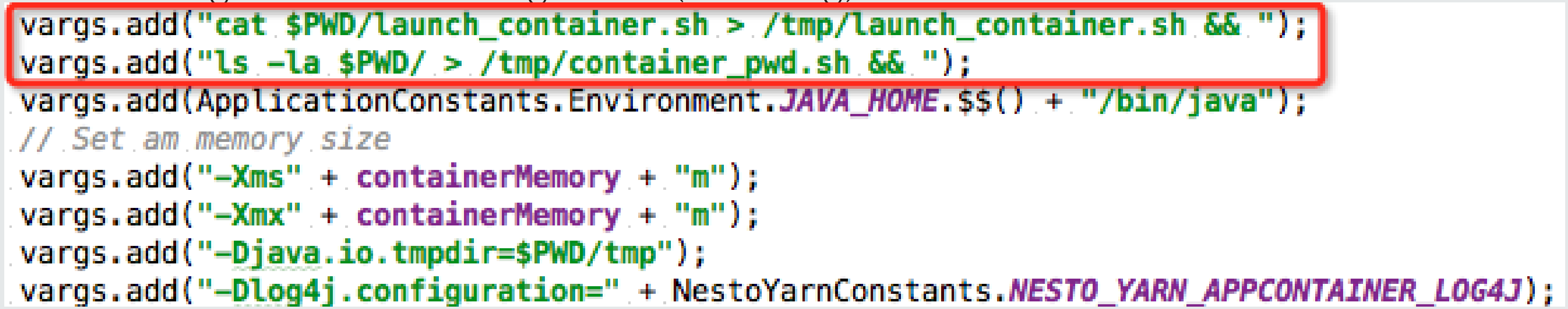
300MB



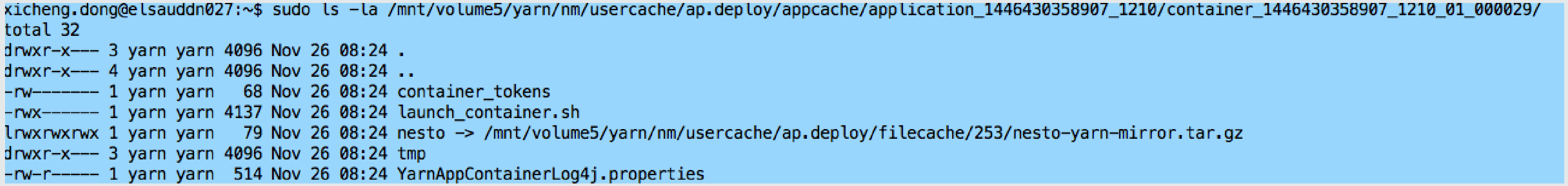
Hadoop Streaming is a good example!!!

EXPERIENCE 5: DEBUG

- Understand container environment
  - AM/container command is written to a shell script
- How to check the shell script content
  - Register tracking url (running)



```
vargs.add("cat $PWD/launch_container.sh > /tmp/launch_container.sh && ");
vargs.add("ls -la $PWD/ > /tmp/container_pwd.sh && ");
vargs.add(ApplicationConstants.Environment.JAVA_HOME.$$() + "/bin/java");
// Set am memory size
vargs.add("-Xms" + containerMemory + "m");
vargs.add("-Xmx" + containerMemory + "m");
vargs.add("-Djava.io.tmpdir=$PWD/tmp");
vargs.add("-Dlog4j.configuration=" + NestoYarnConstants.NESTO_YARN_APPCONTAINER_LOG4J);
```



```
xicheng.dong@elsauddn027:~$ sudo ls -la /mnt/volume5/yarn/nm/usercache/ap.deploy/appcache/application_1446430358907_1210/container_1446430358907_1210_01_000029/
total 32
drwxr-x--- 3 yarn yarn 4096 Nov 26 08:24 .
drwxr-x--- 4 yarn yarn 4096 Nov 26 08:24 ..
-rw------- 1 yarn yarn   68 Nov 26 08:24 container_tokens
-rwx------ 1 yarn yarn 4137 Nov 26 08:24 launch_container.sh
lrwxrwxrwx 1 yarn yarn   79 Nov 26 08:24 nesto -> /mnt/volume5/yarn/nm/usercache/ap.deploy/filecache/253/nesto-yarn-mirror.tar.gz
drwxr-x--- 3 yarn yarn 4096 Nov 26 08:24 tmp
-rw-r----- 1 yarn yarn  514 Nov 26 08:24 YarnAppContainerLog4j.properties
```

Q & A